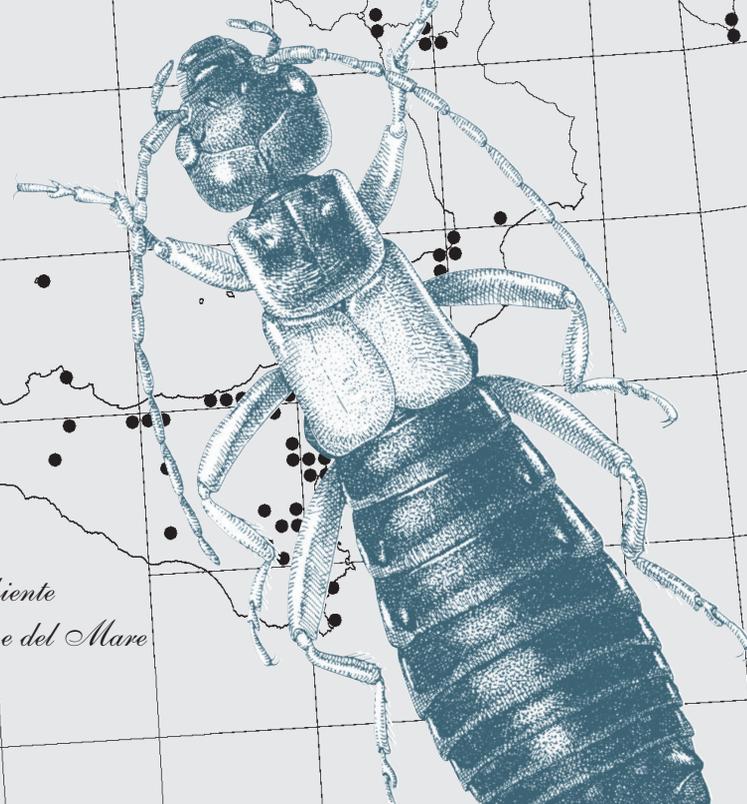
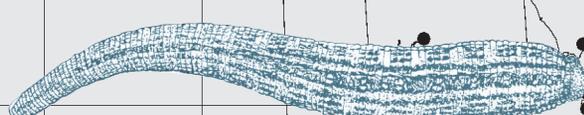
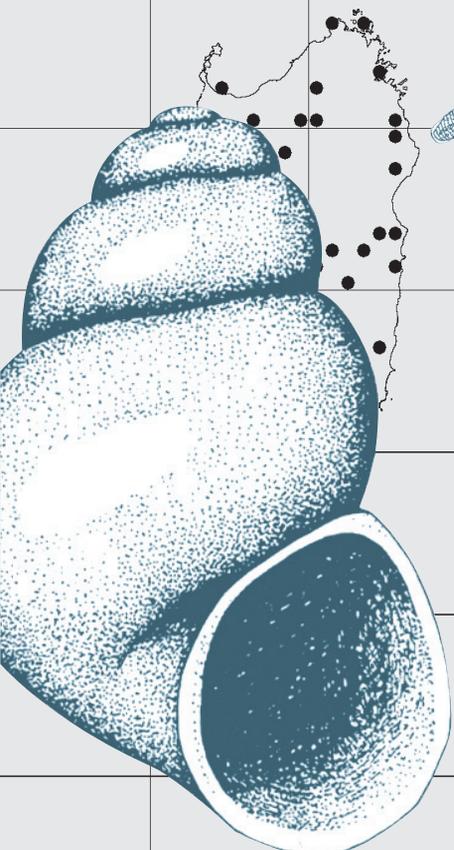


CHECKLIST AND DISTRIBUTION OF THE ITALIAN FAUNA

10,000 terrestrial and inland water species



Ministero dell' Ambiente
e della Tutela del Territorio e del Mare

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Direttore Responsabile
Alessandra Aspès

CHECKLIST AND DISTRIBUTION OF THE ITALIAN FAUNA

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Italy has a very rich fauna, with more than 57,000 species recorded so far. This high biodiversity is a privilege, but also a responsibility: its protection is one of our challenges and is a goal that everybody should take aim at. In fact, Italy together with another 180 countries ratified the Rio de Janeiro Convention on Biodiversity, which in 1992 established at worldwide level the intrinsic value of biodiversity. Ten years later, in 2002, the World Conference for Sustainable Development in Johannesburg defined a precise target: to reduce the biodiversity loss by 2010, thus the countdown has already started. Conservation of biodiversity in general, and of animal biodiversity in particular, can not be obtained without a good knowledge of what we want to protect. For this purpose the Italian Ministry for the Environment and Territory and the Nature Protection Division supported in the last years several projects aimed at the improvement of the scientific knowledge of the various components of biodiversity of Italy. Among them, the project "Checklist and distribution of the Italian fauna", the results of which are presented and discussed in this volume, represents the most complete knowledge available on the fauna of a given country. The volume and the CD report more than 500,000 distribution data of about 10,000 terrestrial and freshwater species of the Italian fauna. This huge amount of data is pride for Italy, but it is also an essential operative tool to compile Red Lists, to create environmental quality models, and to contribute to implement the Habitat Directive and thus reduce biodiversity loss in Italy by the target year 2010. The Checklist is a knowledge tool of great relevance, which places Italy in first place worldwide for biodiversity conservation.

Aldo Cosentino
General Director
Italian Ministry for the Environment and Territory and Sea
Nature Protection Directorate

It is with great pleasure that I present this volume, which represents the end point of a long and complex journey in the study of Italian fauna, to which I was fortunate to be involved at different levels and with different roles, and it is the starting point of a new phase, in which the knowledge we obtained so far will be applied to the management and protection of the fauna. This volume represents the most detailed study available on the fauna of a given country; it was the result of a long, painstaking work which involved all the zoology specialists of our country for more than 10 years. It was the result of the synergy between the Scientific Committee for Italian Fauna and the Italian Ministry for the Environment and Territory.

The origin of this project can be found in the series "Fauna d'Italia", created in 1952 under the auspices of the Italian National Academy of Entomology and the Italian Zoological Union, programmed and realised by the Scientific Committee for Italian Fauna (formally established in 1989, with the two promoting agencies represented with the same status), and published by the Calderini publishing house. The first volume was issued in 1956, the 40th is in press in this moment, and several more are in progress. This is a prestigious and long-term work, of great importance, which suffered several interruptions, and therefore it is still in progress.

The productive relationship developed during the last 15 years between the Scientific Committee for Italian Fauna and the Italian Ministry for the Environment (now Italian Ministry for the Environment and Territory) allowed to continue the publication of the monographic volumes, and to go one step ahead in the knowledge of Italian fauna. In fact, in 1989-1991 a group of Italian zoologists founded the Technical-Scientific Committee on Italian fauna of the Italian Ministry for the Environment, with Sandro Ruffo as president, and Sandro La Posta as secretary. This Committee developed the project "Checklist". This project, which we called "the three Sandro's project" from the names of the main promoters (Ruffo, La Posta and Sandro Minelli, at the time president of the Scientific Committee for Italian Fauna), realised the "Checklist of the species of the Italian fauna", published in 1993-1995 by Calderini, under the aegis of the Commission of the European Communities. The one hundred-ten chapters of the checklist include all the 57,000 species of Italian fauna. This work, which resulted from the efforts of hundreds of specialists and the cooperation of museums and scientific associations (most conspicuously the Italian Entomological Society), filled the gaps of the "Fauna d'Italia", and Italy is today the only country in the world with a complete and updated inventory of its fauna.

The next step is represented by this volume, the "Checklist and distribution of the Italian fauna", which completes the project "CKmap", developed in cooperation among the Italian Ministry for the Environment and Territory and Sea (Nature Protection Division), the Scientific Committee for Italian Fauna, the Italian Zoological Union, the Civic Museum of Natural History of Verona, and the Ecology Department of Calabria University, and was coordinated by Sandro Ruffo and Fabio Stoch. From the species checklist a good number of taxa which represented good faunistic and biogeographic indicators (more than 10,000 species) were selected to represent terrestrial and freshwater Italian fauna. Sixty-eight zoologists collected the point distribution records of these taxa in a database. Every distribution datum was georeferenced, and software which automatically analyzed the taxa distribution and produced distribution and thematic maps were developed. The result is a detailed faunistic knowledge on about one-fifth of the animal species present in Italy, which is a tool that transforms the presence-absence data of the most significant taxa into their real distribution. The point distribution so obtained is cartographable, and can be superimposed to the thematic maps, and can be used to evaluate and manage local biodiversity, and to create ecological and environmental quality models.

The project "CKmap" therefore represents the logical continuation and development of the project "Checklist": the next steps will be its extension to other species of the Italian fauna, its application to the "Natura 2000" network, and its use to check the lists of the Habitat Directive. The integration of the "Fauna d'Italia" series with the "Checklist" and with the project "CKmap" is now a reality, and our country therefore is one of the most advanced in the world in regards to the knowledge of its faunistic heritage.

Augusto Vigna Taglianti
President

Scientific Committee for the Italian Fauna

The Civic Museum of Natural History of Verona is proud to publish the “Checklist and distribution of the Italian fauna” (*CKmap*) in its Memories.

This volume completes the project of the Italian Ministry for the Environment and Territory, aimed at the informatization of the “Checklist and distribution of the Italian fauna” (1999-2002). The project was coordinated by Sandro Ruffo, Fabio Stoch and Leonardo Latella. Thanks to these efforts, the Museum became the reference point for those numerous Italian zoologists who cooperated and shared the need to continue the work developed with the 1993-1995 checklist. The result was a fundamental tool which is manageable, updatable and accessible to the public, and thus needed to be published. We thank the Scientific Committee for the Fauna of Italy, which involved us in this phase of the project, which is represented by the complete publication of the electronic checklist with its georeferenced database that included the distribution maps of more than 10,000 Italian species. This is a fundamental tool for the knowledge of Italian fauna with a potential role in biodiversity conservation, and in EU directives application. The natural history museums represent precious biodiversity archives, as shown by the large number of museums visited by the specialists involved in this project in order to complete the database.

The Civic Museum of Natural History of Verona has often promoted initiatives related to the knowledge and management of the territory. In fact, a good knowledge of the environment is the base for its management and the natural history museums, because of their multidisciplinary and their tradition of research on the territory, are probably the best place to plan and coordinate these kinds of research.

Alessandra Aspes
Director
Civic Museum of Natural History of Verona

Introduction

Sandro Ruffo, Fabio Stoch

With the publication of the Checklist of the Italian fauna (Minelli et al., 1993-95), Italy was the first country which compiled a complete list of its fauna. 55,656 species were recorded (protozoans excluded), 47,225 of which (almost 85%) are terrestrial and freshwater taxa. The animal diversity of Italy is extraordinarily rich: the number of species recorded lists Italy among the first countries in Europe, even after the completion of the checklist of the European fauna (<http://www.faunaeur.org>), which followed the same criteria of the Italian experience.

Several factors have changed from the publication of the printed version of the Checklist (110 volumes). The development of electronic databases and the resulting possibility for spreading information on the World Wide Web, made it necessary to transform the printed checklist in a searchable database (Stoch, Minelli, 2004). This database had to be updateable, publishable on the internet, and upgradeable. The creation of an electronic database represented the first part of the project described in this volume, and was developed with a cooperative agreement between the Nature Protection Directorate (formerly Nature Conservation Division) of the Italian Ministry for the Environment and Territory and Sea and the Museum of Natural History of Verona. The results was the on-line publication of the Checklist (<http://checklist.faunaitalia.it>).

Once the species list was stored into a database, the following step was the realization of the project *CKmap* (Stoch, 2004: the acronym is derived from "Checklist mapping") which lasted four years, and was carried out by the Nature Protection Directorate, the Museum of Natural History of Verona, and the Ecology Department of the University of Calabria, under the high scientific patronage of the Scientific Committee for the Fauna of Italy. More than 10,000 terrestrial and freshwater species were selected from the checklist on the basis of their greatest value as biodiversity indicators. Sixty-eight taxonomists and numerous co-workers provided data on the distribution and ecology of each of these species, which were entered in a database. The distribution data were georeferenced, and a user-friendly, interactive software for the exploration of the data set and distributional maps was developed (<http://CKmap.faunaitalia.it>).

The project *CKmap* included the following working steps:

- definition of criteria, screening of the checklist and subsequent selection of a proper number of bioindicator taxa, which would provide a representative picture of the Italian terrestrial and freshwater fauna; ten-thou-

sand taxa were thus selected among Annelids, Molluscs, Arthropods, and Vertebrates (birds excluded)

- creation of the structure of the database which would contain the information pertaining to nomenclature, ecology, biogeography of the selected species, and their georeferenced distribution data
- involvement of taxonomists who compiled the database using data from literature, from museum and private collections, and from unpublished material (in this case, if the material was provided by a third party, the taxonomists validated it); the detailed distributional records assembled by the taxonomists amount to about 548,000
- creation of georeferencing tools, the most versatile being the database of UTM coordinates (ED50 and WGS84) of the 46,961 Italian toponyms included in the Touring Club road atlases, with precision range of one meter. A more accurate and sophisticated instrument was obtained storing in a single database the toponyms of the Italian Military Geographic Institute (scale 1:25,000 maps), for a total of 728,130 toponyms (this database is not yet public, and can be used only by operators of the Italian Ministry for the Environment and Territory)
- creation of the GIS layer of the 3,556 cells of the UTM 10x10 km grid which covers the whole Italian territory (small islands included); this GIS layer was used for distribution data mapping
- accurate retrospective georeferencing of the distributional data provided by the taxonomists; doubtful or old data referred to wide areas were not georeferenced; they were not deleted from the database where they are reported as "historical" data
- creation of a software for the automatic exploration of the geographical distribution of the species; creation of distribution maps of species and subspecies of the Italian fauna for the future realization of thematic atlases, with the option of exporting data into GIS software
- production of maps of distribution over the Italian territory of species richness, rarity, and endemism, and of chorological types for the study taxa

Scope of this volume is to illustrate and make publicly available this huge amount of data. The volume is divided into two parts. The general section describes the project structure and methods, analyses the distribution patterns of species richness, rarity, endemism, and chorological categories, and provides some examples of the use of faunal data for the reconstruction of the evolution

of areals through time (also known as chronogeonomy), compilation of Red Lists, and identification of alien species. In the second section the taxonomists describe the studied taxa according to the following scheme: generalities, materials and methods, biodiversity, ecology, zoogeography, alien species, conservation. Each chapter includes a map showing the Italian territory coverage for that faunal group and the habitus of a representative species. Finally, the volume includes a CD containing the whole dataset and the software (named *CKmap*) needed to explore the interactive maps and search the database; an on-line help is provided as well.

The potential of this large data set goes beyond the production of thematic atlases; the *CKmap* database is in fact the most complete tool available in Europe to study the fauna of a nation. This operative tool allows to:

- identify the biodiversity, rarity, and endemism hotspots on the Italian territory; as a consequence, it will be possible to classify the UTM grid cells on the basis of conservation priorities
- identify vulnerable and endangered species, as well as bioindicators, in the database, in order to generate a list of species of priority interest at European, national, and regional level, and a provisional Red List of Italian fauna
- over-impose the distribution layers of the species with the Nature 2000 sites, and with the thematic maps

produced by other Agreements, with the final aim of creating ecological and management models

- identify the lesser-known areas from a faunal point of view, with the purpose of filling the gaps with field research.

The inclusion of invertebrates in this study (they represent more than 97% of the Italian fauna) will finally allow to evaluate the representativeness of the Nature 2000 network and its efficiency in protecting the species which are vulnerable, endangered or at risk of extinction, thus helping to reach the goal of biodiversity management in Italy: to halt, or at least reduce, biodiversity loss by 2010, as established in 2002 at the World Summit on Sustainable Development of Johannesburg.

But perhaps the use which the taxonomist who worked at this project will prefer is to have available “at a mouse click” all the faunal knowledge pertaining to the taxonomic group of interest, and to pass it to the students, thus creating a new generation of taxonomists which Italy needs. In fact, we know that to overcome the “taxonomic impediment” (i.e. the gaps of taxonomic knowledge) is one of the challenges of the future, as stated in the Global Taxonomy Initiative of the Rio de Janeiro Convention on Biological Diversity. The Convention was already ratified in 1994 by Italy and 180 other nations. Under its umbrella, our country, with its high species richness and its old tradition in taxonomic studies, has to use all its resources.

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The project *CKmap* (Checklist and distribution of the Italian fauna): methods and informatical techniques

Leonardo Latella, Sandro Ruffo, Fabio Stoch

The project *CKmap*

The assessment of Italian faunal resources was requested by the Italian Ministry for the Environment and Territory with the goal of identifying those areas essential for the preservation of Italian fauna. The first step of this work was the publication of the *Checklist of the species of the Italian fauna* (Minelli et al., 1993-95), followed by the project *Checklist and distribution of the Italian fauna* developed by the Civic Museum of Natural History of Verona (by Sandro Ruffo, Fabio Stoch, Leonardo Latella), which lasted three years (1999-2001) and included the convention *Completion of the knowledge (module C)* with the Italian Botanical Society, carried out by the Department of Ecology of the University of Calabria (by Pietro Brandmayr), which added the distribution of another 3,500 species of vertebrates and invertebrates.

Species selection criteria

The group of species selected was represented, at the end of the project, by more than 10,000 species of terrestrial and inland water invertebrates, which were chosen by screening the *Checklist* (Stoch, 2004). The following criteria, following Pearson (1995), were adopted when choosing the taxonomic groups:

- groups studied by professional and experienced taxonomists;
- groups which included species with well-known distribution over the entire country;
- groups which included both species with restricted habitats and small areals, and species with wide distribution;
- groups which included species with areals that do not change with time;
- groups with a well-established taxonomy, and few synonymies.

On the basis of these criteria the taxonomic groups were selected; for each of these groups a subgroup of species was then chosen. One of the requisites for the realization of the project was, when possible, the inclusion of all the species belonging to the selected groups: in this way any subjective choice which could have biased any subsequent statistical analysis was avoided.

Specialists were chosen trying to use first the authors of the *Checklist* (Minelli et al., 1993-95) and, second, using other specialists available. Each of them discussed the choice of taxa and organised the data analysis with the project coordinators.

Collection of ecological and distributional data

Data were obtained from literature, from museums and private collections, and from direct observations. Sixty-eight specialists were in charge of filling the data-files; they in turn cooperated with other specialists, both professionals and amateurs, in order to present the most updated species distribution in Italy. The specialists' data files were written in MS Access®, MS Excel®, or as ASCII, for PC or Mac. All the specialists provided three data tables: the *Species* table is a revision of the *Checklist* of each given group (Minelli et al., 1993-95), including code, scientific name, author, notes (for species new for science and for Italy); data from the checklist were completed with distributional and autoecological data such as the chorotype (according to the classification by Vigna Taglianti et al., 1995, 1999), habitat, feeding habits, conservation status according to simplified IUCN categories, and value as bioindicators. The *Stations* table included, for each species, the list of collecting sites (region, province, general and detailed location, elevation) and, for each location, the datum origin and the year of the most recent collection. The *Sources* table includes the literature that was analysed, or the collections that were examined.

Database structure

The database was entered on PC with operative system Windows 2000/XP and software MS Access® 2000. This kind of database is useful for databases not larger than 2 Gb; the capacity is large enough even for a fauna as rich as the Italian one. The database structure is very simple, so to execute research queries quickly. For this reason, the number of "key" tables is limited to the three tables provided by the specialists (*Species*, *Stations*, *Sources*), modified as necessary. The species table includes genus, species and subspecies, whereas the higher ranks (family, order, class, phylum) are included in a separate table (link based on the family code), in order to have a clearer structure. The code is hierarchical (three-digit for the phylum code, another three-digit for the class, and so on for lower ranks), allowing to easily select the species belonging to a higher taxon, and to reproduce the correct taxonomic sequence using a tree structure, which is usually available in several Windows® programming languages.

The distribution table includes, for each species, the localities given by the specialists, with coordinates,

and a field indicating the accuracy of the coordinates. The localities are presented in two fields: the first (general locality) includes the toponyms of the Road Atlas 1:200,000 of the Touring Club Italiano which are closer to the exact collecting site; the second (detailed locality) includes the exact collecting site, as reported in literature or from the collection labels (when available). The general locality is used for two main purposes: a)

easy identification of the localities in a widely-used commercial atlas; b) the possibility to attribute the coordinates on the basis of the toponym, in case more detailed information is not available.

The station table assembling the single files provided by the numerous specialists which contributed to the project includes about 548,000 records, but is continuously expanding.

Taxa	N° species	N° records
Annelida Oligochaeta	196	5644
Annelida Hirudinea	24	1076
Mollusca Gastropoda, Bivalvia	127	21310
Branchiopoda Anostraca, Notostraca, Spinicaudata	24	148
Branchiopoda Cladocera	114	5272
Maxillopoda Copepoda	312	8034
Malacostraca Bathynellacea, Thermosbaenacea	11	15
Malacostraca Isopoda (freshwater)	51	1123
Malacostraca Amphipoda	113	4119
Malacostraca Mysidacea (subterranean)	3	41
Malacostraca Decapoda	12	816
Araneae Salticidae	127	2018
Pseudoscorpionida	217	3858
Acari (freshwater)	145	1867
Chilopoda	153	13780
Ephemeroptera	105	6057
Odonata	89	14564
Dermaptera	25	3170
Orthoptera, Mantodea, Phasmodea	364	23327
Blattaria	44	1986
Plecoptera	153	4697
Neuropteroidea, Mecoptera	194	4637
Heteroptera	301	13090
Homoptera	337	5933
Coleoptera Aphodiidae, Scarabeidae	176	8205
Coleoptera Bostrichidae	2	21
Coleoptera Buprestidae	212	10181
Coleoptera Carabidae	407	16243
Coleoptera Cerambycidae	276	17475
Coleoptera Cetoniidae	3	196
Coleoptera Cholevidae, Platypsillidae	251	6275
Coleoptera Chrysomelidae	460	16135
Coleoptera Cryptophagidae	134	3790
Coleoptera Cucujidae	35	739
Coleoptera Curculionoidea	689	13004

Coleoptera Dryopoidea	74	8693
Coleoptera Georissidae	5	268
Coleoptera Elateridae	241	14283
Coleoptera Histeridae	157	12956
Coleoptera Hydraenidae	157	5781
Coleoptera Hydroadephaga, Hydrophiloidea	379	36156
Coleoptera Lucanidae	9	1191
Coleoptera Nitidulidae	178	7645
Coleoptera Staphylinidae	704	25901
Coleoptera Tenebrionidae	89	3660
Trichoptera	430	13188
Lepidoptera Hepialidae, Noctuidae, Lasiocampidae, Arctiidae, Sphingidae	176	11270
Lepidoptera Papilionoidea, Zygaenoidea	324	78615
Diptera Conopidae	63	1354
Diptera Simuliidae, Sciomyzidae	151	1836
Diptera Stratyomyidae	89	1434
Diptera Syrphidae	108	3719
Diptera Tipulidae	174	2945
Hymenoptera Apoidea	228	6623
Hymenoptera Chrysididae	231	5067
Hymenoptera Drynidae, Embolemidae, Sclerogibbidae	72	659
Hymenoptera Scolioidea	85	2546
Cyclostomata, Osteichthyes	76	16138
Amphibia, Reptilia	96	31920
Mammalia Chiroptera	34	4163
Mammalia Insectivora, Rodentia	47	12227

Data georeferencing

The Italian Touring Club (TCI) and the Military Geographic Institute (IGM) provided the toponyms database of the atlas (in .rtf format), and of the 1:25,000 scale maps (3,546 files in .dbf format), respectively. However, the structure of those data had several problems: the files of the 728,130 toponyms of the IGM maps, had coordinates erroneously converted from the Gauss-Boaga system to the UTM ED50 system, which is the one used as the base for the official map of Italy. Other files had wrong latitudes, almost all the small islands of the Tuscan Archipelago had wrong coordinates, and the toponyms of the map 323II SE bis were missing. Besides the latter one, all the remaining mistakes were corrected and all the toponyms were merged into one table, in a MS Access 2000 database. This database is protected by copyright and thus it is not accessible by the public. The file containing the 46,957 TCI toponyms had several errors: some toponyms were erroneously located, and some were missing; there were several homonyms, some due to misspellings and some due to the omission of phonetic accentuation. All

these problems were solved with a preliminary screening and with the help of the specialists who used that file. This file is available in MS Access or MS Excel format for all the specialists on the CD-ROM.

The precise georeferencing of TCI toponyms was obtained by queries and GIS techniques in Arcview®; all the questionable records were validated by manual cross-validation with the electronic IGM maps 1:100,000 and with the printed TCI atlases. The cross-checks were carried out with the aid of the Italian Toponyms file by IGM (728,130 toponyms). This check led to deletion from the TCI list of foreign toponyms and of those reported twice. The 46,957 TCI toponyms were attributed to two categories: A (correct georeferentiation) and G (georeferentiation based on the barycentre of wide toponyms, such as lakes, mountains, rivers and streams, large cities, natural reserves, exc.). In order not to lose the information regarding the corrections, the letter F was given to those toponyms within category A which did not correspond univocally to those in the Italian Toponyms file deducted from the 1:25,000 IGM maps. Moreover, the

column “notes” lists the IGM toponyms which coincided with the TCI toponyms, but had different names, and their corrected names or coordinates; most of the corrections regarded misspellings, wrong TCI coordinates in the indices, changes of l with L (L in lower case) and vice versa.

The metric coordinates (10 m precision range) were calculated for the TCI toponyms, following the system UTM ED 50, fuse 32; the toponyms were mapped on the Italian map as a layer of Arcview, to further check them by superimposing electronic maps. Finally, the toponyms were electronically assigned to their province; for those toponyms extending between more provinces (as it is the case for mountains, rivers, exc.) the province corresponding to the barycentre of the toponym (as in the IGM Italian toponyms) was used. Because this was obviously a simplification, the distribution table may show a different province, according to the mountain side or the river bank where data were collected.

The georeferencing of data provided by the specialists was a long and not error-free process, due mainly to homonyms and orthography. Data were georeferenced by query with TCI or IGM toponyms, and the coordinates provided by the specialists were manually and electronically checked (correspondence of regions, provinces, toponyms; correspondence of the cells of the UTM 10x10 Km grid with the list assembled for the entire Italian territory). Routines in Visual Basic for Applications of MS Access were run, in order to catch the georeferentiation mistakes, eliminating all those bugs that could be detected electronically. The remaining work, referring to more than 40,000 data, was done manually. The complexity of the task and the large amount of georeferenced data (more than 531,000 records) explains the possible persistence of some mistakes, which will be detected when specialists and users make use of the database, and will communicate them to the editors.

The results of this work are the georeferentiation of the sites with a degree of precision that varies according to the following parameters:

- accuracy of the data recorded by collectors, which were often transcribed from a museum collection label;
- accuracy of the data recorded in taxonomic and faunistic reports;
- density of toponyms in a given geographic region (the higher the density, the more precise the geographic localization);
- accuracy with which the specialists searched for the localities obtained by collection labels or by literature.

For those data which were univocally identifiable but did not have enough details regarding the location, the precision obtained substituting the TCI toponyms to the station name varies between 0 and 3 Km, with maximum values of 5 Km in Calabria, a function of the distribution of the

toponyms on the Italian territory. It is therefore necessary to distinguish the precision level of the georeferencing (which represents the real data display) from the accuracy of the data, which are at times so very detailed that they will be precisely cartographed in the future, if needed. The detailed position of a station, when available, is in the database, so that in the future the most accurate georeferentiation of sites of particular interest (i.e. EU interest sites, area with high endemicity or rarity, area subject to environmental impact assessment studies) will be possible.

In order to develop maps compatible with the European Invertebrate Survey and with the territory informatization systems, the TCI toponyms were georeferenced using the IGM toponyms lists and maps. The UTM international ellipsoid coordinate system (ED 50), with alphanumeric military coding (MGRS) was chosen. The barycentre of each toponym was georeferenced with a 20 m range precision and the original data were transformed and filed again according to the following coordinates systems:

- Gauss-Boaga system according to the E and W areas;
- longitude and latitude ED 50 in decimal degrees;
- UTM ED50 system according to the 32, 33 and 34 zones;
- UTM ED50 system according to only zone 32;
- WGS84 system according to the two previous modalities.

The latter value is presented to make the datum cartographable in the GIS Arcview layers available at the Nature Protection Directorate.

Data mapping

A database of all the cells of the UTM 10x10 grid included (even partially) in the Italian territory (including even the smallest islands) was created, together with an Arcview grid including all the 3,556 UTM cells. An MS Access database was created. This database contained the following information, deducted from vectorial files and from DTM of 75 m resolution, available at the Nature Protection Directorate:

- real area covered by the cell, which is less than 100 km² when: a) the cell crosses the State border; b) the cell crosses from land to sea and includes small islands; c) the cell is in the area where two UTM zones join;
- the average elevation and its standard deviation;
- minimum and maximum elevation, and elevation range;
- percentage of soil use categories (Corine Land Cover IV level);
- UTM coordinates and coordinates referred only to zone 32 of the cell barycentre.

The vectorial boundaries of Italy deducted by IGM cartography, the main hydrological network, and the UTM grid, were transferred in a base map to be used to build thematic maps for the following uses:

- data recheck and validation by specialists;

- exploration of biogeographical patterns for each species, and validation of the areals congruence;
- creation of simple high-definition vectorial maps for quick printing;
- creation of thematic atlases presenting the species distribution according to the European Invertebrate Survey standards.

The software that graphically explores the data was called *CKmap* and lately the same name was given to the entire project.

Software for automatic data exploration

The software *CKmap* (Stoch, 2004: acronym of "CheckList mapping") allows to visualise the distribution data of the Italian fauna; the software is available on line at <http://CKmap.faunaitalia.it> and the version 5.0 is in the CD included in this volume. This is a data access software that allows to correct, validate, visualise, and map the data. Even if it is a simple software using small disk memory when compared with other GIS softwares, *CKmap* is extremely versatile and powerful. It in fact allows for simple and quick mapping with statistical options which has the following distinctive features: a) a hierarchical taxonomic tree is used to visualize and explore the checklist; b) an immediate mapping of each taxon distribution on the UTM grid of the Italian territory is possible; c) maps are interactive. Data can be exported in other complex territorial analysis softwares (such as ArcView® and MapInfo®); data can thus be represented in a layer that can be superimposed over any alphanumeric or raster map.

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The software has the same base structure of the Checklist of the Italian fauna from which it stemmed, and which it perfectly interfaces. The software is a hierarchical system which represents the taxonomic information of Italian fauna; it also allows the specialists to analyse data distributions.

The software is designed for Windows 98/NT/2000/XP; the best performance is obtained with the most recent version of the operative system and a large RAM memory. The software runs without needing any other utility to visualize the data.

Distribution data will be available at the *CKmap* website in a MySQL database; in that way users will be able to access updated data in real time.

Organization of the printed volume

The CD containing the data explained above is included in this volume. We decided not to print all the distribution maps and all data contained in the various files included in the CD because of space constraints. The volume is divided into two sections. The first section includes general articles on Italian fauna, on working methodologies, and on previous projects. The second section includes the specialists' files where the authors briefly explain the general characteristic, the distribution, the data collection methodology and the conservation status of each group. All the institutions and people who cooperated with the authors to write the texts and to collect data are acknowledged at the end of the volume.

The checklist of the Italian fauna

Alessandro Minelli, Fabio Stoch

The checklist of Italian fauna (called *Checklist* in the text below) (Minelli et al., 1993-95) lists all the species of animals known at the time of its publication, and univocally identifies them with codes. With the project *Checklist*, Italy is the first European country to have a complete list of its fauna. The idea of compiling a checklist was born in an informal meeting of a group of zoologists in the Entomology laboratory of the Civic Museum of Natural History of Verona in 1991 (Minelli, 1996). A project was developed in the following months, primarily by Prof. Sandro Ruffo, at that time President of the Fauna Committee of the Ministry of the Environment, who obtained support and funding from the same Ministry. The checklist was then realized and published in the following three years (Minelli et al., 1993-95). The project was realized with an agreement between the Nature Protection Directorate and the Scientific Committee for the Italian Fauna, a committee created by the Italian Zoological Union and the National Academy of Entomology, and involved 272 specialists from 15 different countries. The publication of the *Checklist* was followed by the creation of its website in 2000 (Stoch, 2003-2004; Stoch, Minelli, 2004). Thus, the *Checklist* became an essential tool for conservation, as stated by Minelli (1995), and it allowed a simple but detailed analysis of the abundance of Italian fauna (Minelli, 1996). When the *Checklist* was transformed into a database, it was used for biogeographical and ecological studies (Stoch, 2000), particularly of the endemic species. At present the *Checklist* is available on the web (Stoch, 2003-2004) at <http://checklist.faunaitalia.it>, and it represents an operational tool for species distribution mapping (Stoch, 2000). Recently, the publication and informatization of the Checklist update began as well (Minelli et al., 1999).

Checklist structure

The printed version of the *Checklist* includes 110 chapters, where records are organized systematically at least to the genus level. Each species included in the *Checklist* is univocally identified by a numeric code of three three-digit numbers (one for the chapter, one for the genus, one for the species). The genera and species codes have an extension, which allows the insertion of new species without changing the entire *Checklist*. The *Checklist* has a simple format, and contains slim amounts of information, and therefore possible to complete (Minelli, 1996). In fact, similar checklists devel-

oped in other countries, and structured to contain more information, where never concluded.

The information included in the *Checklist* for each species are: a) distribution in 4 areas of the Italian territory (North, South, Sicily, Sardinia) for terrestrial and freshwater faunas, and in 3 areas for marine fauna (Western Basin, Northern and Central Adriatic, remaining basins); b) status as endemic or endangered species; c) synthetic indication of the hosts (for parasites) or nesting area (for birds). Notes and synonymies are reduced to the minimum necessary.

Criteria used to create the Checklist database

The Italian fauna checklist was recently transformed into a hierarchical database (Stoch, 2000); all data provided for each species were thus transformed into a user-friendly format. In this way, we obtained two results: a) data were organized in a scheme which strictly corresponds to the taxa classification used in the *Checklist*; b) the tree-structure developed is easy to use by non-experts, who can find the taxa listed in alphabetical order as well.

The creation of a hierarchical database required the use of numerical codes of three three-digit numbers, which were attributed to each taxon (phylum, class, order, family, genus, species, subspecies). The database is very simple and it includes two related tables: one with the list of groups at taxonomic levels higher than genus, and another one containing genera, species, and subspecies, and the information on their distribution. To make consultation as easy as possible, data on protozoans, invertebrates and vertebrates were listed in separate tables. The *Checklist* is available in a MS Access 2000 database, and on-line (Stoch, 2003-2004). On the web, we chose the database format MySQL, it was programmed using PHP and Javascript; these formats allow a full compatibility with any operative system. The present on-line version (3.0), available at <http://checklist.faunaitalia.it>, was completely reprogrammed as an updateable database, and it includes all detailed information regarding authors and the date of upgrading, and a versatile search function.

Notes on the Checklist updates

A database such as the *Checklist* loses most of its value if it is not updateable, and if is not available to the public in the shortest time possible. For this reason, starting in 1999, the Bulletin of the Italian Entomological Society publishes the updates for arthropods (Minelli et al.,

1999). This initiative was well-liked by the entomologists, and 18 updates have been published so far. Four years later, the structure of the *Checklist* shows limitations, due to the codes attributed to species (which are not flexible enough), and to the complexity of the rules used to update the codes.

able for Windows and for Macintosh). Those researchers who do not have computer access can still send a hard copy, but formatted as a table and not as text.

'Protozoa'	1812			Collembola	419
Dicyemida	13			Protura	31
Orthonectida	2			Microcoryphia	47
Porifera	477			Zygentoma	19
Cnidaria	461			Diplura	76
Ctenophora	32			Ephemeroptera	94
Platyhelminthes	1317			Odonata	88
Gnathostomulida	6			Blattaria	40
Nemertea	96			Mantodea	12
Gastrotricha	228			Isoptera	2
Rotifera	246			Orthoptera	333
Nematoda	1357			Phasmatodea	8
Nematomorpha	23			Dermaptera	22
Acanthocephala	27			Embioptera	5
Kinorhyncha	22			Plecoptera	144
Loricifera	4			Psocoptera	102
Priapulida	3			Mallophaga	243
Kamptozoa	16			Anoplura	24
Mollusca	2141			Thysanoptera	214
Annelida	1149			Heteroptera	1373
Pogonophora	1			Homoptera	2150
Echiura	5			Coleoptera	12005
Sipuncula	18			Megaloptera	4
Arthropoda	45888			Raphidioptera	20
Tardigrada	244			Planipennia	153
Phoronidea	3			Mecoptera	10
Bryozoa	305			Siphonaptera	81
Brachiopoda	12			Strepsiptera	21
Chaetognatha	18			Diptera	6601
Echinodermata	118			Trichoptera	367
Hemichordata	5			Lepidoptera	5086
Chordata	1419			Hymenoptera	7509
Tot.	57468			Tot.	37303

Tab. I – List of animal phyla (left) and of insect orders (right) with number of species recorded in the Checklist

The availability of the *Checklist* on-line has the greatest advantage to provide updated information in a very short time. Some drastic decision had to be made (Stoch et al., 2005): first, availability of the codes to the public was abolished. In fact, the function of the codes is not to identify univocally a species (which is identified by the Linnean binomial), but to keep the records of the *Checklist* in taxonomic order. Second, the updated format changed (Stoch et al., 2005): new records are sent to the editor (by e-mail or through the webpage) in MS Excel format (this program is widely used, and it is avail-

Future developments of the Checklist

The Italian fauna website, mastered by the Scientific Committee of the Italian Fauna and upon request of the Scientific Committee of European Fauna (<http://www.faunaeur.org>), will become the Committee focal point, representing the web portal to the information on European fauna. Therefore, the Italian *Checklist* might be modified in the future as follows:

1. Nomenclature will follow what was proposed for the European fauna: Italian specialists of the different faunal groups will be allowed to unify their nomenclature with

the proposed one and, if in disagreement, or in cases of mistakes and omissions, they will be allowed to keep the nomenclature used in the Italian *Checklist*, and the European specialists will have to conform to it, and correct the omissions.

2. Widening of the geographic distribution: in order to distinguish the Italian and European Checklists, for terrestrial and freshwater fauna authors will be allowed to detail the species distribution as to administrative Region

(instead of North, South, Sicily, Sardinia). For the 12,000 taxa included in the project *CKmap*, that information was automatically included in the website.

3. Future implementation of the *Checklist* website: each species entry will be linked to its distribution map (*CKmap*) and list of stations, if available. In a future implementation, dichotomic keys will be linked as well, integrating the information from the projects *Checklist*, *CKmap* and the contents of the monograph series "Fauna d'Italia".

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The chorotypes of the Italian fauna

Fabio Stoch, Augusto Vigna Taglianti

The geographic distribution of animals and plants can be synthetically expressed by chorotypes. These are categories derived from a classification based on distribution models, which are deduced by the compared analysis of species areas. Chorotypes have been widely used by zoologists from the beginning of 1900, but not all the authors agreed on the meaning of chorotypes and on the relative terminology. The same chorological term was used by different authors to indicate:

- (1) a recurring model of geographical distribution;
- (2) a group of species with certain ecological requirements within a selected geographical area;
- (3) a group of species which presumably have a common biogeographical history;
- (4) a group of phylogenetically closely related species with a common area of origin;
- (5) a group of species living in a certain biogeographical region, defined by climatic and phytogeographic criteria.

The scheme adopted herein corresponds to the first of the criteria listed above, as in Vigna Taglianti et al. (1993, 1999), and it is similar to the one used by La Greca (1964, 1975), who underlined the importance of defining chorotypes based on the similarity of distribution models shared by a large group of species. This approach is not meant to identify the historical factors that caused the actual distribution of the species, but to describe the distribution models. The similarity among species areas can be related to different palaeogeographic and ecological events, such as vicariance or dispersal phenomena. Because the distribution areas of the species is the base unity of biogeographical studies, a classification based on unambiguous and precise terminology is the reference point for any further comparative study. The new classification of chorotypes, as proposed by a group of specialists of terrestrial and freshwater Palaeartic fauna (Vigna Taglianti et al., 1993, 1999), is based on the following criteria:

- (1) define a reduced number of chorotypes that include all the models of area distribution for the fauna under account;
- (2) eliminate all the ambiguous terminology;
- (3) go beyond the "Eurocentric" terminology, and focus the attention on the geographic distribution of each chorotype;
- (4) attribute a numerical code and an acronym to each chorotype which can be used for databases, and to create easily understandable and comparable ranges of chorotypes.

List and description

The main chorotypes of the W-Palaeartic fauna are listed below divided in 5 groups. The Cosmopolite (0.01, COS), Sub-cosmopolite (0.02, SCO), Endemic and Sub-endemic (4-digit code) elements must be added, case by case, to the main chorotypes on the basis of phylogenetic affinities. The W-Palaeartic chorotypes absent from the Italian fauna are not included (such as the SW-Asiatic, N-European, Saharan...), but some chorotypes present only marginally are indeed included (Saharo-Sindian).

1. *Chorotypes of species widely distributed in the Holarctic region*

1.01. OLA. **Holarctic**: species distributed in both the Palearctic and Nearctic Regions.

1.02. PAL. **Palearctic**: species widely distributed in the Palearctic Region (Eurasia, extending South to the Himalayan range, North to Africa and Macaronesia).

1.03. WPA. **W-Palaeartic**: species widely distributed in Europe to the Urals, SW Asia, N Africa and Macaronesia.

1.04. ASE. **Asiatic-European**: species widely distributed in Eurasia, extending south to the Himalayan range.

1.05. SIE. **Sibero-European**: species distributed in Siberia and Europe (including the Boreoalpine disjunct distribution).

1.06. CEM. **Centralasiatic-European-Mediterranean**: species distributed from the Gobi desert to Europe and N Africa.

1.07. CAE. **Centralasiatic-European**: as CEM, N Africa excluded.

1.08. CAM. **Centralasiatic -Mediterranean**: as CEM, Central Europe excluded.

1.09. TEM. **Turano-European-Mediterranean**: species distributed in Europe (mostly Central and Southern Europe), N Africa, Middle East, Anatolia, Iran, Caucasus and Western Turkestan.

1.10. TUE. **Turano-European**: as TEM, N Africa excluded.

1.11. TUM. **Turano-Mediterranean**: as TEM, Central Europe excluded.

1.12. EUM. **Europeo-Mediterranean**: species distributed in Central and Southern Europe and in the Mediterranean basin.

2. *Chorotypes of species widely distributed in Europe*

2.01. EUR. **European**: species widely distributed in Europe, with possible extensions to Caucasus, Anatolia, Maghreb and Macaronesia.

2.03. CEU. **Centraleuropean**: species distributed south of Scandinavia to the Padana Plain, and from Rhine River

to Ukraine, at times extending to parts of Southern Europe and Great Britain.

2.04. SEU. **S-European**: species distributed in Southern Europe, extending North to Loire, Alps and Carpathians.

2.05. WEU. **W-European**: species distributed between Scandinavia and the Iberic peninsula, extending east to the Rhine and Rhône valleys, South to Tajo river.

2.06. EEU. **E-European**: species of the Sarmatic low-plain, from the Vistula river and the Carpathians to the Urals.

3. Chorotypes of species widely distributed in the Mediterranean basin

3.01. MED. **Mediterranean**: species distributed in the Mediterranean basin, sometimes extending to Macaronesia, Sahara and Iran.

3.02. WEU. **W-Mediterranean**: species distributed in the Mediterranean basin, west of the Italian peninsula, sometimes extending to the Atlantic or Saharan areas.

3.03. EEU. **E-Mediterranean**: species distributed in the Mediterranean basin, east of the Italian peninsula, sometimes extending to the Black Sea and Iran.

3.04. NAF. **N-African**: species distributed in Africa north of Sahara, with limited extensions to adjacent areas.

4. Chorotypes of Afrotropical and Eastern species present in the Mediterranean area

4.01. AIM. **Afrotropico-Indo-Mediterranean**: species distributed in the Afrotropical and Eastern regions and present in the Mediterranean area as well.

4.02. AFM. **Afrotropico-Mediterranean**: species distributed in the Afrotropical region and present in the Mediterranean area as well.

4.03. INM. **Indian-Mediterranean**: species distributed in the Eastern region and present in the Mediterranean area as well.

5. Chorotypes of widely distributed species, present only in marginal areas of the Mediterranean basin

5.04. SAS. **Saharo-Sindian**: species distributed from Mauritania to Sind, through the Saharan and Arabic deserts.

6. Distribution areas of endemic and subendemic Italian species.

In the original formulation (Vigna Taglianti et al., 1993), adopted with few modifications in the present version of *CKmap*, the distribution areas of endemic and subendemic species (category C) are the following:

1. C.01 - **Alpine**
2. C.02 - **Alpine-Apenninic**
3. C.03 - **Apenninic**
4. C.04 - **Apenninic-Dinaric**
5. C.05 - **Tyrrhenic**
6. C.06 - **Sardinian-Corsican**
7. C.07 - **Sicilian**
8. C.08 - **Dinaric**

9. C.09 - **Alpine-Dinaric**

In the following version (Vigna Taglianti et al., 1999) a more detailed scheme, listed below, was adopted:

3900.01. ITAL - Endemic to Italy

3900.02. ALPS - S-Alpine Endemic (Italian Alps)

3900.03. ALPC - Central-S-Alpine Endemic (Central Alps)

3900.04. ALPW - W-Alpine Endemic (Western Alps)

3900.05. ALSW - SW-Alpine Endemic (South-western Alps)

3900.06. ALPE - E-Alpine Endemic (Eastern Alps)

3900.07. ALPS - SE-Alpine Endemic (Southeastern Alps, Karstic-Istrian elements)

3900.08. CADI - Karstic-Istrian-Dinaric Endemic

3900.09. PADA - Padanian Endemic

3900.10. ALAP - Alpino-Apenninic Endemic

3900.11. ALWA - W-Alpino-Apenninic Endemic

3900.12. AWNA - W-Alpino-N-Apenninic Endemic

3900.13. APPE - Apenninic Endemic

3900.14. APPN - N-Apenninic Endemic

3900.15. APPC - Central-Apenninic Endemic

3900.16. APPS - S-Apenninic Endemic

3900.17. APDI - Apennino-Dinaric Endemic (Transadriatic elements)

3900.18. TYRR - Tyrrhenian Endemic

3900.19. SACO - Sarde-Corsican Endemic

3900.20. SARD - Sardinian Endemic

3900.21. SICI - Sicilian Endemic

3900.22. SISC - Sicilo-S-Calabrian Endemic

3300.01. CORS - Corsican Endemic

This scheme has not yet been used in the recent version of *CKmap*.

Chorotypes analysis

The chorotypes used here were originally defined on the basis of distribution models of some taxonomic groups such as Chilopoda, Ephemeroptera, Coleoptera (Carabidae, Hydrenidae, Phalacridae, Nitidulidae, Cateretidae, Scarabaeoidea, Meloidae, Oedemeridae, Tenebrionidae, Chrysomelidae), Amphibia, and Reptilia. The use of such a relevant number of distribution data, referring to more than 10,000 species representative of the Italian fauna, allows to analyse for the first time the distribution pattern of groups of chorotypes (expressed as percentages of the total number of species recorded in a UTM cell) in the Italian territory. The four synthetic maps presented in this chapter show the distribution in Italy of the percentages of species, respectively, widely distributed in the Holarctic Region (Fig. 1), in Europe (Fig. 2), in the Mediterranean basin (Fig. 3), and endemic *sensu lato* (Fig. 4). From the analysis of the chorological spectrum (Fig. 5) of the 10,000 species considered (which represent 25% of terrestrial and freshwater Italian fauna), it appears that the percentage of endemic or narrow-ranged species (not attributed to any reference chorotype) is the highest (35% of the total). In comparison with the data exposed in the

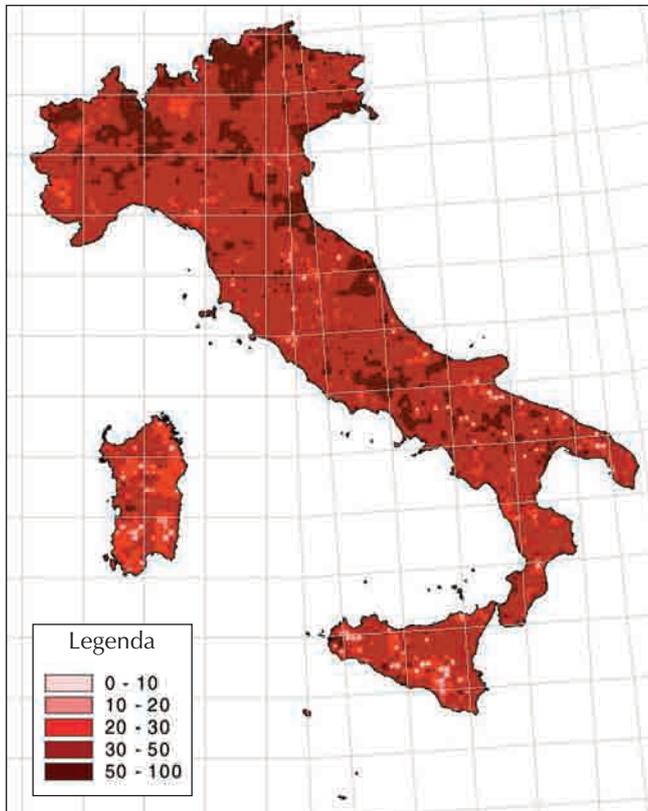


Fig. 1 - Distribution of the percentage of species widely distributed in the Holarctic area (category 1)

following chapter (Minelli, Ruffo, Stoch, 1996), this high value is due first to the groups taken into account (which are the most significant and richest of endemics), and second to the inclusion of elements not exclusively endemic to Italy (subendemic). The percentage of endemic species *sensu lato* (Fig. 4) is particularly high in the pre-Alpine area, in the western Alps and along the Apennines. The percentages progressively increases towards Calabria and the main islands, showing the importance of geographic isolation in speciation processes. The lowest percentage values of small-ranged species are those at the highest altitudes of the Alps (as a consequence of the impoverishment caused by quaternary glaciations), and in the planitial areas. However, this pattern summarizes several local cases which reveal processes typical of each species, each one with a different historical background.

In the chorological spectrum (Fig. 5), the endemic species are followed as importance by the group of species widely distributed in the Holarctic Region (27% of the total) which includes mesophile, hygrophile and stepic northern elements, that colonized Italy in the Quaternary, particularly in the postglacial. The distribution map of this group of chorotypes in Italy (Fig. 1) shows the strong presence of those elements not only in the

Padana Plain and the main alluvial plains, but also valleys, along riverbeds, and relict wetlands, even on the islands. The species widely distributed in Europe (Fig. 2, about 22%) are homogeneously distributed in continental Italy and the peninsula, but decrease in number towards the south and the islands. Their distribution, of northern and Alpine origin, is influenced by the climate and by the “peninsular effect”. The species widely distributed in the Mediterranean basin (about 13%) have an opposite trend (Fig. 3) with high number of species in the large and small islands and along the coasts, where they follow the Mediterranean bio-climatic region, but also with localized distributions in Apenninic, Alpine and pre-Alpine areas where they characterize the xerothermic communities. The Afrotropical and Eastern chorotypes (including the marginal ones) make together less than 1% of the total, whereas the cosmopolite and subcosmopolite (often of inter-tropical origin) elements represent a low percentage (about 2%) of the Italian fauna, and their dispersal is primarily due to anthropic activities.

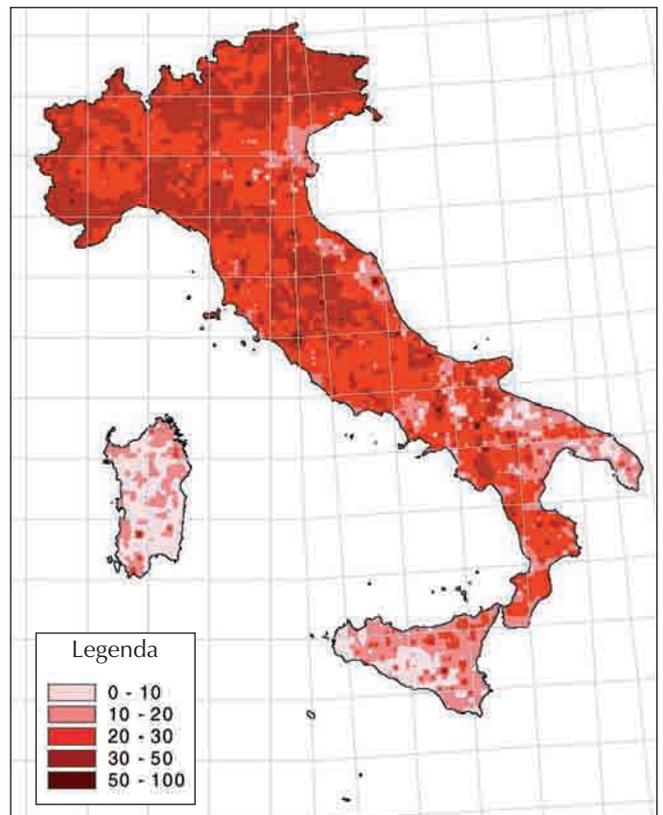


Fig. 2 - Distribution of the percentage of species widely distributed in the European area (category 2)

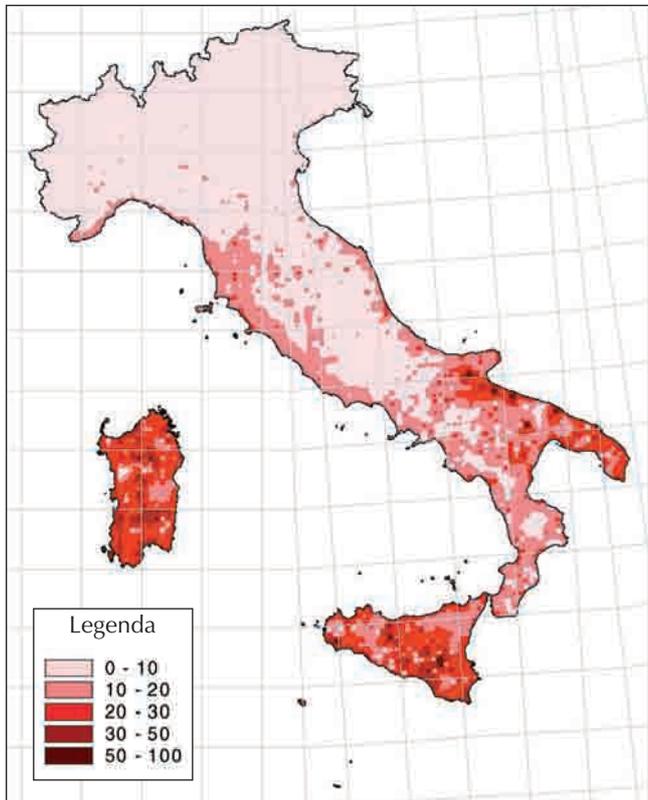


Fig. 3 - Distribution of the percentage of species widely distributed in the Mediterranean basin (category 3)

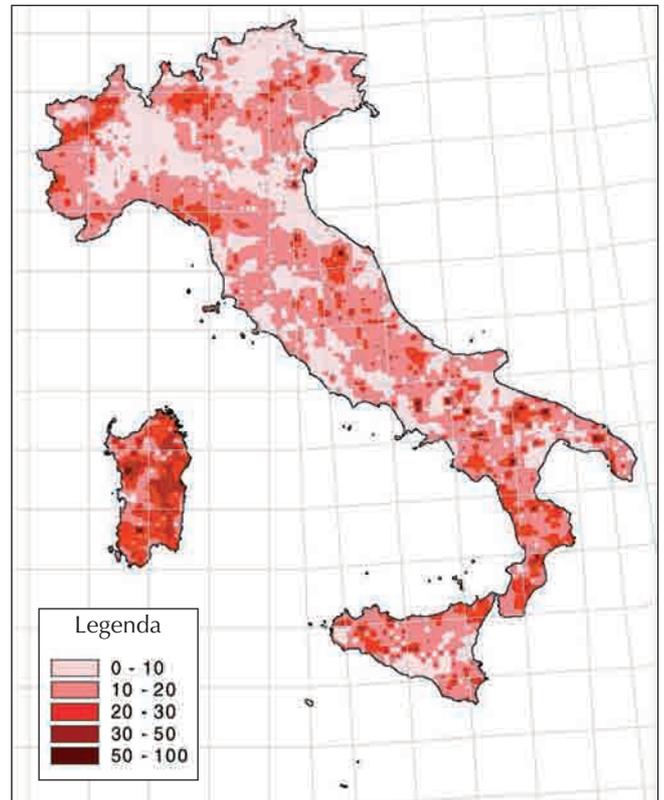


Fig. 4 - Distribution of the percentage of species with narrow distribution (category C)

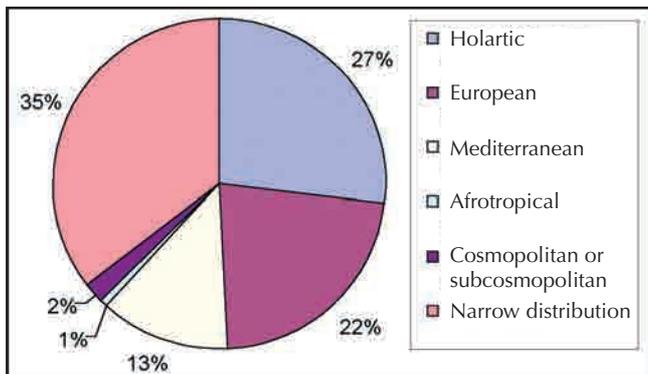


Fig. 5 - Chorological spectrum of the Italian fauna (based on taxa listed in CKmap)

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Endemism in Italy

Alessandro Minelli, Sandro Ruffo, Fabio Stoch

The endemic component of Italian fauna

A quick summary of the endemic species of Italian fauna based on the data reported in the *Checklist of the species of the Italian fauna* (Minelli et al., 1993-95) reported 4,777 Metazoan species (8.6% of the total) for the area included inside the political borders of Italy. On the basis of the cumulative curves of numbers of newly described endemic Italian species, Stoch (2000) estimated a value of 10% of the Italian fauna. This remarkable abundance is due mainly to terrestrial and freshwater invertebrates; less than 3% of the vertebrates, and 2% of the marine species, are endemic. Numerous endemics are limited to Sardinia (697, representing 6.68% of the 9,841 species recorded in the *Checklist* for this island) or Sicily (776, representing 5.83% of the 12,988 species listed). Northern Italy has particularly high biodiversity (33,414 species in the *Checklist*), and the percentage of endemic species is 5.12 of the total (1,720 species), whereas peninsular Italy has 1,825 endemic species, representing 7.60% of the 24,297 total species. Within this global picture we can now analyse the endemic component of the groups considered in this volume. In the following discussion, we will not use statistical values, because numbers (especially when they are low numbers referring to a single order or family) are often proven wrong by two causes of errors: first, faunal knowledge is still incomplete, and for some groups the classification of a species as endemic can be temporary. Second, species and subspecies ranks are often attributed subjectively to a population or to a group of populations, affecting the estimate of numbers of endemic species. Particularly significant from this point of view is the consideration of Balletto et al. (2006), who state that some of the 18 species of Rhopalocera (*Pyrgus centralitaliae*, *P. picenus*, *Lycaena italica*, *Polyommatus virgilius*, *Hipparchia neapolitana*, *H. blachieri*, *Coenonympha elbana*) considered endemic over 279 Italian species, can be subjectively considered “subspecies” of more widely distributed species, decreasing the endemism rate to 3.9%. While compiling the *Checklist*, a species was considered endemic only if its area did not trespass the Italian political borders, thus excluding from the list of endemics several taxa which were present outside Italy, only in restricted areas of Southern France, Canton of Ticino in Switzerland, Austria, and Slovenia. For situations such as this one, it should be proper to develop a less-formal analysis of endemism, referring to more “natural” geographical units. However, if it is necessary to reconsider the list of endemic species adding those species which extend their

distribution slightly beyond the Italian borders, it is also necessary to divide our country into subunits which are more natural and homogeneous than the usual “North” and “South” used in the *Checklist*. Whereas Sicily (small circum-Sicilian islands included) represents a natural unit to be used to compile lists of endemic species, Sardinia is not, because it shares several endemic species with the nearby Corsica (besides having some exclusive to Sardinia itself). On the other hand, the complex geological history of Sardinia is recognizable in the island lithology and in its fauna: it would be useful to have separate lists (of both total fauna, and mainly, endemic taxa) for each of the structural sections which compose Sardinia.

Endemism trends in different taxonomic groups

It is possible to detect trends in endemism, for the groups discussed in this volume, on the basis of the ecology of each taxon. Endemism rate is significant in soil fauna, such as earthworms, Chilopoda, Carabidae and, primarily, Pseudoscorpionida, Pselaphinae, and the genus *Lep-tusa* among Staphylinidae (which has 116 Italian species, almost all endemic in the Alps). Several endemic Chilopoda, which often belong to the genus *Lithobius*, are cavernicolous, whereas the Geophilomorpha *Acanthogeophilus dentifer* is epigeal, has a relict distribution (one locality near La Spezia, one in Gargano), and the only congeneric species is North African; this species is therefore very ancient. In Pseudoscorpionida the endemism rate is very high (more than half of the Italian species) due to their low vagility, and to their occurrence in hypogean habitats, where most of the endemic Pseudoscorpionida live, and were some ultra-specialized lineages developed (for example, two species with Dinaric affinity which are present in the Trieste karst, *Troglochthonius doratodactylus* and *Neobisium (Blothrus) spelaeum*, and the Apulian troglobitic *Hadoblothrus gigas*, with Aegean affinity). Apulia hosts two endemic epigeal Pseudoscorpionida as well. Some endemic Pseudoscorpionida (such as those belonging to the genus *Pseudoblothrus*) are probably very ancient, because our species have closest affinities with Palaeotropical ones. At the opposite, the endemic species *Roncus aetnensis* is quite young; this species lives in the recent lava caves of the Etna Volcano.

For Carabidae, Casale et al. (2006), divide the numerous endemic species into three groups. The first is represented by orophile microthermic species, derived from Euro-Siberic elements which in recent times colonized several refuges in the Alpine and pre-Alpine area, origi-

nating several endemic species (species of the genus *Carabus*, subgenera *Orinocarabus* and *Platycarabus*, and species of the genera *Trechus*, *Pterostichus* etc.). The second is an older continental element, which originated some endemic genera of Trechinae (among them, the extraordinary *Lessinodytes* and *Italaphaenops*). The third element is Mediterranean; it is rich in palaeoendemites, and includes taxa of different origin, such as the Sicilian *Carabus planatus* and the Sardinian-Corsican *C. genei*, with Maghreb affinities, the Palaeomediterranean Tyrrhenic species of the genus *Percus* and *Speomolops sardus*, with Baetic-Pyrenaic affinities, and the Aegean genera *Typhlochoromus*, *Tapinopterus* and *Speluncarius*, with Balkanic and Anatolic affinities.

The terrestrial invertebrates with wider ecological requirements and higher dispersal abilities have lower endemicity rates. For instance, groups of Diptera such as Conopidae and Syrphidae Syrphinae have no endemic species. Endemics, however, are numerous among the Coleoptera Scarabaeoidea, primarily for southern and insular species of Melolonthidae such as *Triodonta*, *Hoplia*, *Haplidia*, *Rhizotrogus*, *Amphimallon*, rather than the coprophagous species, as well as among the Elateridae (which include a monospecific endemic genus) and Buprestidae, still in Southern and insular groups. The rate of endemicity is lower in Cerambycidae, with few endemic taxa in Sicily or in the Apennines, and in Chrysomelidae Alticinae, where most of the endemic species (predominantly in the genera *Orestia* and *Psylliodes*) may have originated in the mountain forests during the Quaternary glaciations.

Springs and groundwaters are rich in endemics, with numerous and often localized species of Gastropoda Hydrobiidae, Crustacea Copepoda, Bathynellacea, Thermosbaenacea, Amphipoda and Isopoda. Numerous speciation phenomena occurred among subterranean Copepoda Harpacticoida: the genus *Parastenocaris* is present in Italy with 26 species, more than 90% of which are endemic; the genus *Nitocrella* is rich with stygobitic species, most of them endemic; the numerous endemic species of the genus *Elaphoidella*; the endemic *Lessinocamptus*, *Morariopsis* and *Paramorariopsis*, which live in the karst massifs between Slovenia and Piedmont. The pre-Quaternary origin of these taxa is indicated by their degree of differentiation to the point that some genera should be split, and mainly by their near total absence from areas that were occupied by glaciers in the Quaternary. A Tertiary Italian relict is represented by the genus *Pseudectinosoma*, which survived in surface brackish water on the two sides of the Atlantic and the Mediterranean. During the salinity crisis of the late Miocene (Messinian), it gave rise to groundwater continental species with punctual distribution in Southern France and Central and Southern Italy. The Italian stygobites originated in large part from marine ancestors, as confirmed by Isopoda such as *Microcharon*, *Microcerberus*, *Sphaeromides*, *Typhlocirolana*, *Monolista*,

Stenasellus and by significant elements of Apulian fauna such as the Decapoda *Typhlocaris salentina*, the Mysidacea *Stygiomysis hydruntina* and *Spelaeomysis bottazzii* (both with Tropical affinity, which represent two different phases of colonization of Apulian groundwater).

In surface water, endemic species concentrate in lotic habitats. This is the case of Plecoptera, with 49 endemic species (over 150 recorded as total for Italy) some of which have punctiform distribution, of the Coleoptera Hydraenidae, with 35 endemic species (over 151 total), several of which are distributed in the Sardinian-Corsican area, and Trichoptera, with 72 endemic species (over 402 total), increasing in number from North to South and particularly abundant in Sardinia, Sicily, and Elba Island. Lentic habitats are poor in endemic species, with the exception of the anostracan crustaceans of the genus *Chirocephalus*, with three endemic species (*C. marchesonii*, *C. ruffoi*, *C. sibyllae*) in small Apenninic water bodies. The endemic species of Agnatha (with the one endemic species *Lethenteron zanandreai*) and Osteichthyes concentrate in the Padano-Venetian waters, which are also rich in amphipods, hydrobiid gastropods, and other invertebrates with localized distribution. Some endemic freshwater Iso-poda are located along the pre-Alpine area, and endemic earthworms of the genera *Eophila*, *Microeophila*, and *Ocotodrilus* together with the only endemics leech of Italy (the terrestrial leech *Xerobdella praealpina*), are concentrated along the southern margin of the Alps, from Piedmont to the eastern border of Italy. All these elements usually have Dinaric or Balkanic affinities.

Several endemic freshwater species are present in Liguria and northern and central Apennines, often extremely small areas, as it is the case of the hydrobiid gastropods of the genera *Belgrandia*, *Alzoniella*, *Avenionia*, *Fissuria*, *Pauluccinella*, *Orientalina* and *Islamica*. In Sicily the endemic component, mostly terrestrial, is concentrated in the northeastern part of the island and on the Nebrodi, Peloritani, and Iblei mountains, and on the Etna volcano. Sardinia was already mentioned. It must be added that the rich Sardinian fauna of Pseudoscorpionida (78 species over 215 recorded for Italy) includes 28 endemic species, mostly cavernicolous, which demonstrate the complexity of Sardinian fauna, and the numerous temporal stratifications occurred there: there are troglobitic species with Pyrenaic and Provençal affinities (species belonging to the genera *Spelyngochthonius* and *Roncus* present in Sulcis and Iglesias), and species with Apenninic affinities - species of the subgenus *Neobisium* (*Ommatoblothrus*) - in caves of Supramonte (Oliena and Monte Albo).

Very interesting is the presence of two Sardinian-Corsican Hydracarina (*Momonides lundbladi* and *Parawandesia chappuisi*), which have closer relatives in Asia and Australia; however, the origin of these two species is difficult to interpret given the scarce knowledge of their taxonomy and chorology.

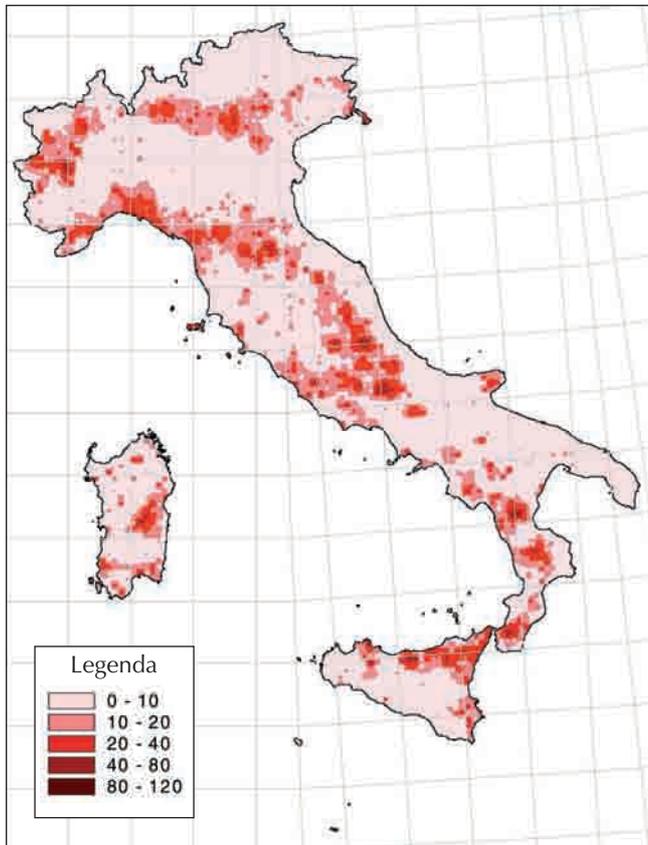


Fig. 1 - Distribution of endemic species in Italy (even if not strictly exclusive of Italian political territory) belonging to the groups discussed in this volume.

Geographic distribution of endemic species density in Italy

The geographical distribution of density of endemic species of those groups discussed in this volume (Fig. 1) is probably comparable to that of the entire terrestrial and freshwater Italian fauna. It clearly shows the concentration of endemic species on the Alps, Apennines, in the mountain ranges of the islands, highest altitude and innermost areas of the Alps excluded. The karstic areas appear to be

relevant as well, as are the islands (included Gargano, a fossil island). Endemites decrease in number in the Padanian Plain and in the marginal part of the Adriatic Region, whereas they are still abundant in the Tyrrhenic Region, probably due to the fossil islands of Latium and Tuscany. The distribution of endemites with distribution areas included inside the Italian political borders (Fig. 2) is significant: most of these endemites *sensu stricto* in Northern Italy are present along the Southern margin of the Alps which correspond to Pleistocenic refuges.

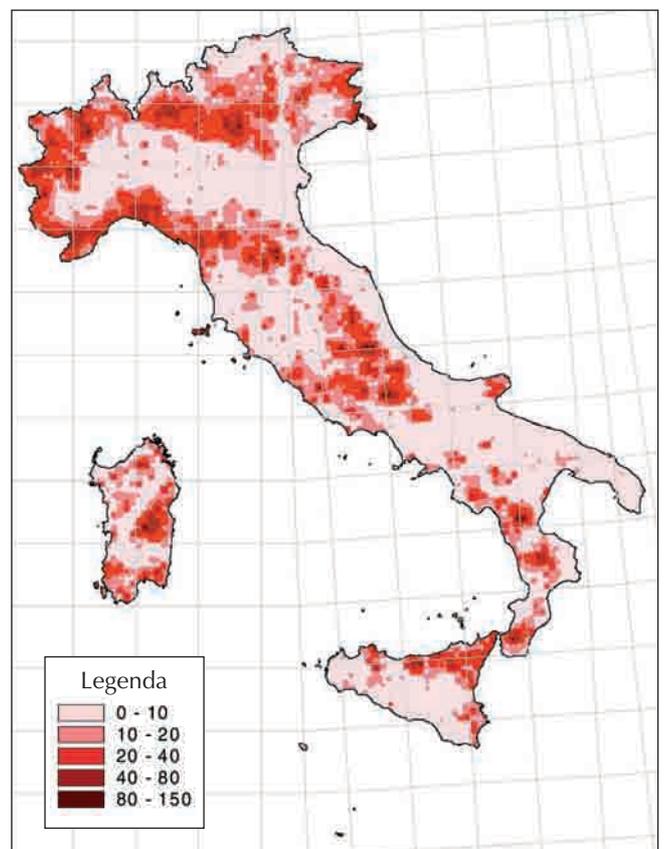


Fig. 2 - Distribution of endemic species *sensu stricto* in Italy.

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Analysys of the distribution in Italy of species richness and rarity

Fabio Stoch

Definition, quantification methods and problems

Biodiversity can be defined as the measurement of the complexity of life in a given territory; from this point of view it is difficult to give an estimate of biodiversity (Williams, 1996). Species richness is the simplest measurement of biodiversity, and it is widely used to plan environmental conservation (Araújo, 1999). In fact, an efficient faunal management requires the identification of those areas with high number of species (hotspots), which as a consequence need to be protected, and the identification of criteria necessary to preserve biodiversity at national levels.

The estimation of species richness requires inventories, based on literature and field research, which are expensive and time-consuming; for this reason it is not likely that the overall biodiversity pattern of terrestrial and freshwater fauna of Italy (which has an estimate of 47,000 species: Minelli et al., 1993-95) will ever be calculated. Therefore, while assembling the database *CKmap*, about 10,000 species were selected among taxonomic groups which, on the basis of pre-established criteria (Pearson, 1995), are considered to be biodiversity indicators. The distribution pattern of species richness in the UTM grid is presented in Fig. 1.

Species richness *per se* is not the only, nor the most important, criterion that can be used to plan conservation actions (Williams, 1996). For instance, additional criteria are rarity and endemism (Stoch, 2000), which quantify different processes. Because endemism will be discussed in another chapter (Minelli et al., 2006), we will discuss here rarity, one of the most difficult ecological parameters to define (Gaston, 1994).

Rarity is an important criterion in biodiversity management for several reasons, the most important being that it increases the number of locations or areas needed to preserve the species richness of a territory. The rarity of a species can be defined (Williams, 1996) as: 1) the condition of being present in a limited number of areas (for instance, of cells in the UTM grid), and in this case is called range-size rarity (and it expresses spatial rarity, or distribution rarity); 2) the rarity of individuals within a certain area, and it is called density rarity (and it expresses rarity at the level of densities of individuals within populations). The two definitions do not necessarily coincide: frequently, species can be present in a few areas but be locally abundant, and vice versa. For this reason, the definition of rarity used in this volume (range-size rarity) should not be confused with density

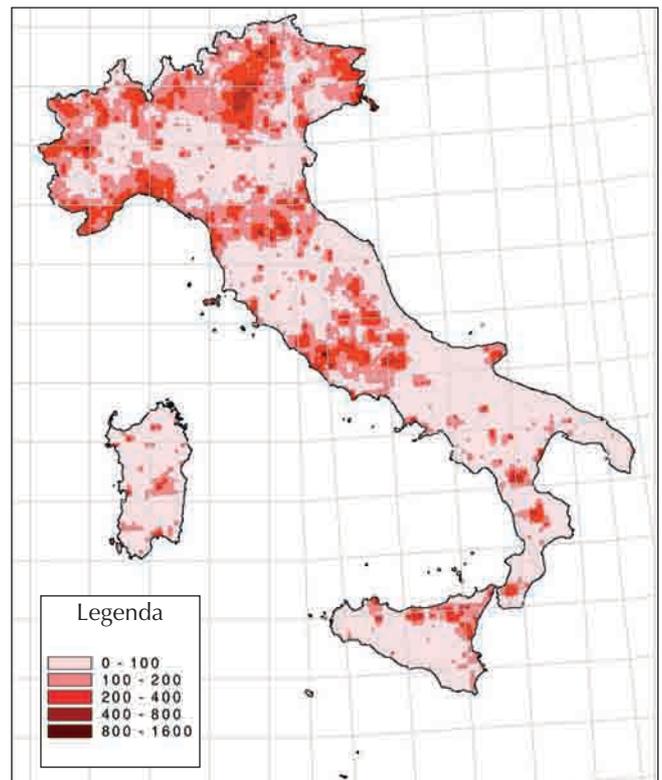


Fig. 1 - Distribution pattern of species richness (calculation based on *CKmap* database) using UTM grid cells

rarity. In fact, when species rarity is defined as its rarity in the Italian territory, there are different possible spatial patterns which, for the same number of cells occupied, range from the presence of the species in a restricted area (in this case the definition of rarity coincides with that of endemism) to the distribution of the species over the entire national territory, but with very few sites in each location.

In the distribution maps presented in this chapter, species rarity is simply quantified as numbers of cells occupied. The measurement of the so-defined rarity depends on the ecological requirements of the species and its evolutionary history, and also from the completeness of inventories, from the anthropic alteration of the environment, and from the choice of the grid-size when representing the data. As a consequence, the patterns so obtained must be interpreted with caution, because they could represent distributional models due to ecological and historical factors (natural or anthropic), or they could be false distribution, due to the scarcity of research. Fi-

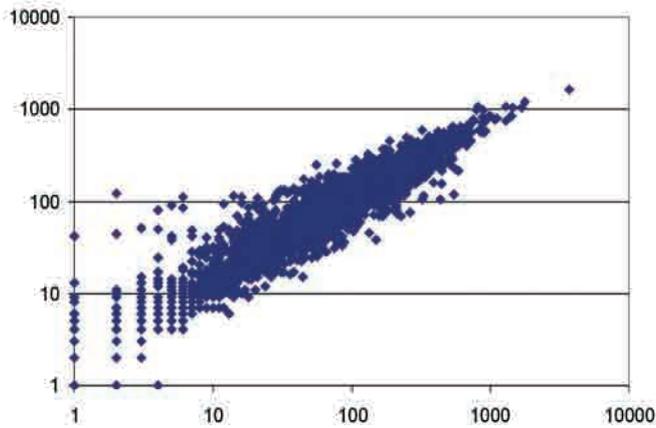


Fig. 2 - Relationship between number of records (horizontal axis) and species richness (vertical axis) for each 10x10 km UTM grid cell (logarithmic scale)

nally, rarity must be referred only to the Italian territory: a species rare in Europe could be widely distributed in Italy (for instance when it is an Italian endemic), and vice versa (for instance when the species reaches the limit of its distribution in Italy).

Measurements of distribution rarity, based on the number of cells in the grid occupied by a species, can be discontinuous or continuous (Williams, 1996). In the first case, a threshold value (i.e. the minimum number of occupied cells, below which the species is defined as rare)

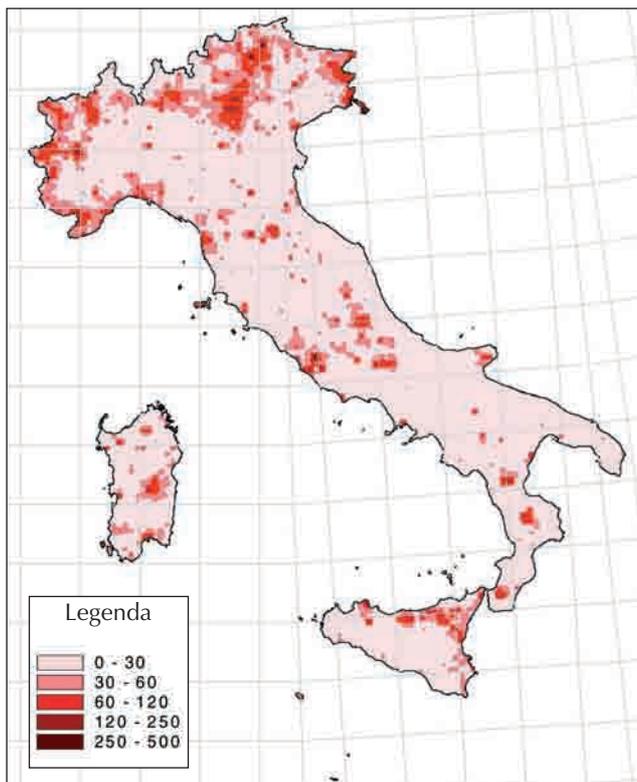


Fig. 3 - Pattern of distribution of rare species (species present in less than 10% of UTM grid cells)

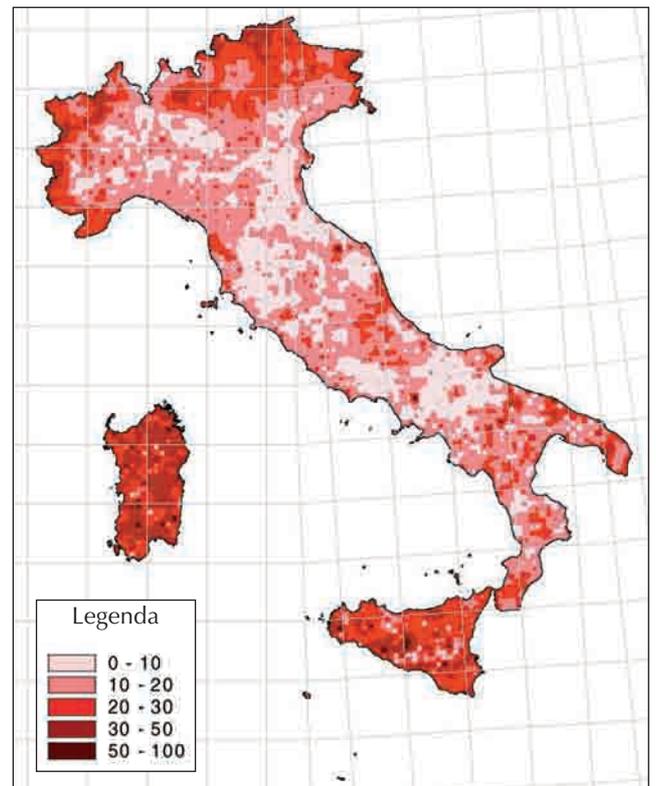


Fig. 4 - Pattern of distribution of the percentage of rare species (defined as in Fig. 3) in each grid cell

is established, in the second case a rarity value is attributed to each species. The first case is the most widely used because (as it is the case with endemism) it gives clear results, and can be immediately used for conservation; however, this criterion is not objective because the threshold value is chosen arbitrarily. The threshold value varies according to the efficiency of the maps and it is a function of the amount of rare species. In this article we chose a threshold value of 10% of the total number of cells in the Italian territory; therefore a species is rare if it is present in less than 10% of the cells. The absolute value and the percentage over the total number of species in each cell are used in the maps presented in Figs. 3 and 4.

Distribution of species richness in Italy

The distribution pattern of species richness in Italy is presented in Fig. 1. The number of species present in the cells of the UTM grid is, as foreseeable, positively correlated with the number of records (Fig. 2), and it represents the research effort and not the true biodiversity of the cells. Because the correlation is highly significant ($p < 0.001$), it is not possible to correct the data unless models are developed for each group. The development of such models is not in the scope of this work, and it is not feasible at present time, given the incompleteness of the faunal and ecological information.

Although the pattern presented herein does not represent the actual distribution of species richness on the Italian territory, it allows the identification of some biodiversity hotspots which represent the *status quo* of our knowledge. Trieste karst, the Adige valley, the Ligurian Alps and several Apenninic areas, with highest values for Pollino, are particularly well known and rich of species. These areas are extremely important for conservation because of their high biodiversity, and because one of the reasons promoting conservation actions is the scientific value of an area for faunal research. The weakness of this approach is due to the fact that some areas with high biodiversity and of great interest might not have been recorded. The general low species richness reported for the southern regions and for the islands could represent a real phenomenon, as already observed for the sole vertebrates (Massa, 1982; Contoli, Penko, 1996), and it is due to insular biogeography and to the peninsular effect.

Rarity

The distribution of rare species (i.e. those present in less than 10% of the UTM cells composing the Italian territory) is presented in Fig. 3 (total number of rare species),

and in Fig. 4 (rarity expressed as ratio between number of rare species and total number of species for each cell). The percentage value is easier to interpret than the total number of rare species, which depends on the number of records, and thus strictly influenced by the pattern of species richness (which it follows closely). The percentage value is higher in the islands, which are rich in endemics, and in the Alps and central and eastern pre-Alps. In the latter locations the high rarity percentage can be explained on the basis of historical processes (impoverishment caused by Quaternary glaciations, peripheral areas of species with Boreoalpine or Central-European chorotypes), high habitat diversity (correlated with the altitudinal gradient), and the presence of political borders (so that the lists of rare Italian fauna includes those species which are distributed in adjacent countries, with small portions of their areals included into Italian political borders). The areas listed above are rarity hotspots. There are less rare species in peninsular Italy than in continental and insular Italy; the internal, isolated areas of the Apennines, the Calabrian massifs and Salento, have the highest rarity percentage because of their isolation. In this case, the distribution of rarity could be interpreted on the basis of historical factors.

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The Italian faunal Provinces

Alessandro Minelli, Sandro Ruffo, Augusto Vigna Taglianti

The Checklist of the Italian fauna (Minelli, al., 1993-1995; Minelli, 1996) includes 57,468 species (56,213 invertebrates and 1,255 vertebrates), protozoan excluded. The project *CKmap* (which maps the distribution of Italian fauna) does not include marine species. Therefore, we will discuss here the approximately 47,000 terrestrial and freshwater species, which represent an exceptionally rich fauna, comparable to that of the other Mediterranean peninsulas and in some cases even richer. The high species diversity recorded for Italy is due to geographical, historical, and ecological factors: the latitudinal extension (about 12°, between Vetta d'Italia and Lampedusa Island); the length of the coasts (around 9,000 km); the climate varying from glacial or temperate-cold climate of the Alps, to sub-continental climate of the Padana Plain, to hot-temperate and subtropical climates of peninsular Italy, Sicily and Sardinia; the presence of two mountain ranges with different locations (East-West the Alps, and North-South the Apennines); the position of the peninsula in the Mediterranean region which allowed faunal exchanges from East and West during the Neogene. The Italian fauna Checklist takes into account four sub-areas included in the area represented by the political borders of Italy: N (Northern Italy, Emilia-Romagna included), S (Apenninic region), Si (Sicily), Sa (Sardinia). The number of species recorded for the 4 sub-areas is listed in the following table.

Subarea	Number of species	Area (km ²)
N	35,658	97,741
S	25,998	153,710
Si	14,000	25,708
Sa	10,598	24,090

Therefore, global species diversity is higher in sub-area North rather than sub-area South, as a consequence of real decrease in species numbers from North to South, and not of lack of research in the South. The groups included in *CKmap* represent a significant sample of Italian fauna. For the following groups, rich in thermophile Mediterranean or Afro-tropical elements, the gradient is opposite, and they increase southwards: Mantodea, Blattodea, Heteroptera Miridae, Coleoptera Scarabaeoidea, Buprestidae, Tenebrionidae and Histeridae, Hymenoptera Mutillidae. The overall "faunal gradient" (Massa, 1982) is due to the gradual rarefaction on a North-South direction of the Northern species; these species strongly

influenced the structure of Italian fauna after the Pleistocene. The sub-areas used in the Checklist were conveniently limited by administrative borders; they do not correspond to biogeographical regions (which are defined on the basis of the amount of species belonging to the different chorotypes: Stoch, Vigna Taglianti, 2006, of the ratio between northern and southern species, of the percentage of endemics (Stoch, 2000), with all these factors critically evaluated against an ecological and historical background. Thus we will refer to the six Provinces already proposed by Ruffo, Vigna Taglianti (2002).

Alpine Province

This province corresponds to the Alps orographic system, originated in the Oligocene-Miocene, including the older massifs originated during the Hercynic orogenesis. The descendants of the pre-Quaternary Alpine fauna are present, as relicts, primarily in caves and soil, but some are present in surface habitats as well, mostly among petrophile Arthropoda. The most diverse cava fauna, and the endemics, live in those marginal areas of the Alps that were not covered by glaciers during the Quaternary (refuge massifs). The most important characteristic of Alpine fauna is the high percentage of Northern chorotypes of Western-Palaearctic and European fauna (Vigna Taglianti et al., 1993, 1999) that colonized the Alps, as a consequence of the cold-climate phases of the Quaternary, which caused the southward expansion of the Asiatic-European species. Faunal diversity is also a consequence of the altitudinal extension of the Alps, which thus developed all the vegetation zones from lowland vegetation to the alpine tundra. Two other consequences of the Quaternary ice ages are the high number of borealpine species (more than 200), and the presence at high elevations of frigidophile species which may have originated at the limits of the Würm glaciers and followed their recession towards higher elevations. The Alpine Province has very low percentage of species with Mediterranean chorotype (2% of the total), except in the few xerothermic oases. The eastern and western parts of the Alpine Province have a very different fauna, particularly in hypogean habitats. These differences are due to different centers of origin of the most ancient fauna of the two sectors, and are further diversified by the different geological substratum (carbonatic in the Eastern Alps, and granitic or metamorphic in the Western Alps). An area of contact and partial overlap extends in the Adige and Ticino Valleys. Peculiar Dinaric-Balkan and Occitanic-

Provencal elements limit their distribution respectively in the Eastern and Western limits of the Julian Karst and the Ligurian-Maritime Alps, respectively.

Padanian Province

This Province corresponds to the Padano-Venetian Plain, which originated in the post-Pliocene, and its extension along the Adriatic side of the Apennines, from Romagna to Conero (an area where aquatic invertebrates species from the Padano-Venetian plain are present). The Padanian Province is a transition area between the Alpine and the Apenninic Provinces, and it represented a corridor between them during the Quaternary. Today, the Padanian Province is a territory which has been altered by man from centuries, with low diversity fauna. Few isolated biotopes with high biodiversity still survive, and they represent “islands” of great faunistic interest (oak and hornbeam woods, relict of once large forests, moors, riparian woods along the main rivers, resurgences, small wetlands), but are at high risk of anthropization. The surface freshwater fauna is significant, and even more so the subterranean fauna, which have Illyric and Balkanic affinities. Rare subterranean crustaceans, which are relict species, originated from marine ancestors of the Pliocene Padanian Gulf, are present along the northern borders of this Province.

Apenninic Province

This Province is represented by the peninsula, with the Apennines as its central axis; it is the consequence of the Miocene-Pliocene orogenesis, which occurred later than the Alpine one. Because of its central position in the Mediterranean, the Apenninic Province was colonized by Palaeobalkan and, primarily, by Palaeotyrrhenic elements; the descendants of these ancient fauna are now hypogean and endogean, and some of them are today represented by petrophilous and phytophagous invertebrates. During the Quaternary, fauna of northern origin (Western-Palaeartic and European) reached this region, and during the ice ages this fauna moved south, reaching Sicily. After the last Würm glaciation, this cold-climate fauna restricted its distribution to smaller areas located at progressively higher altitudes from South to North. On the other end, the Mediterranean elements increased in the opposite direction.

The Apenninic Province is divided into three faunal sectors. The northern sector extends from the hills of Langhe, Monferrato and Pavia Oltrepò to the Ombrone and Foglia valleys, and is characterized by high percentage of northern elements. The central sector extends from the Umbria-Marche Apennines to the Volturno and Fortore valleys. It includes the highest peaks of the range, and includes a eualpine habitat. In this sector, the percentage of species with northern chorotypes is still high, the few species with

boreoalpine Apenninic chorotypes are all present, and there is a rich component of Mediterranean and strictly Apenninic species, with numerous endemic species of Tyrrhenic or Balkanic origin. The Southern sector ends in Aspromonte, and includes very few peaks higher than 2,000 m. In this last sector, northern species are scarce, and concentrate in the high-humid, cool forests located between 1,400 and 1,700 m a.s.l.; the Mediterranean component is relevant, reaching high elevations with numerous xero-thermophile species, and giving this sector a Mediterranean-mountain characteristic which increases with decreasing latitude.

Apulian Province

This Province includes the territories of Gargano, Murge and Salento, which were islands until the Pleistocene, and have a geological history related to that of the Palaeo-gean area. The Apulian Province is characterized by small-elevated relief, which reach about 1,000 m only in Gargano, and are composed of karstified limestone plateaus, without surface running waters. Invertebrates represent the characteristic fauna of the Apulian province, with numerous species (more than 100 species only for Coleoptera) having transadriatic and transjonian distributions. Subterranean fauna is rich with Palaeo-mediterranean endemic crustaceans, arachnids and insects, some of which represent the most peculiar component of Apulian fauna, such as the stygobitic amphipod *Metaingolfiella mirabilis*, endemic at family level. Characteristic is the presence of endemic species of marine origin in Apulian groundwaters, which have affinities with Indopacific and/or Caribbean species, and represent Tertiary relicts of the Tethys Sea.

Sicilian Province

Sicily represents the insular extension of the Apenninic Region. In the Quaternary, during phases of connection between Sicily and the continent, northern species colonized the coastal ranges of Sicily, from the Peloritani to the Madonie mountains; those temperate-cold species are now concentrated in the oak and beech woods in the humid mountainsides facing the sea. The xerothermophile species show opposite distribution: these species are more abundant on the mountainsides opposite to the sea, and their presence stresses the arid-Mediterranean characteristic of Sicilian mountains. Sicilian fauna includes high numbers of Palaeo-mediterranean and Palaeotyrrhenic species, derived from the Tertiary Tyrrhenic fauna. Those species are part of the hypogean, endogean, and also epigeal fauna, and they represent a richer pre-Quaternary component than that of the Apenninic Province. This component includes endemic species (which represent more than 4% of the total Sicilian fauna) and Sicilo-Maghrebic, Sardo-Sicilian, West-Mediterranean species.

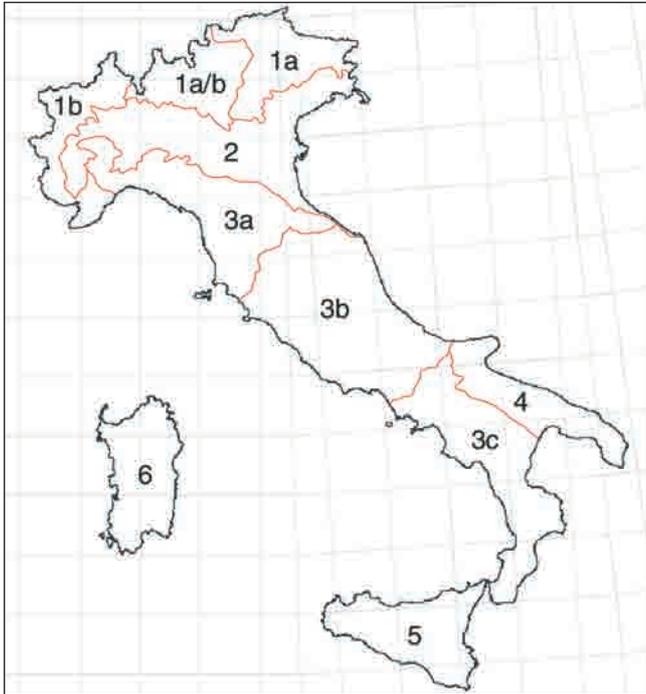


Fig. 1. The Italian faunal provinces. 1. Alpine Province (1a. Eastern-Alpine district; 1b. Western-Alpine district; 1a/b. Transitional area). 2. Padanian Province. 3. Apenninic Province (3a. Northern Apenninic district; 3b. Central Apenninic district; 3c. Southern Apenninic district). 4. Apulian Province. 5. Sicilian Province. 6. Sardinian Province.

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Sardinian Province

Sardinian fauna is characterized by some negative aspects: its biodiversity is lower than the Sicilian one even if the surface of Sardinia is only slightly smaller than Sicily; several species of invertebrates and vertebrates are lacking, even those widely diffused in Italy. At the same time, Sardinia has a remarkable number of Palaeomediterranean and Palaeotyrrhenic species, which represent the most ancient and original component of its fauna. These organisms originated from the pre-Miocene fauna of the Sardinia-Corsica microplate when it detached from the French-Iberic region. In fact, 6.5% of Sardinian species is endemic, most of the species belonging to very peculiar troglobitic and stygobitic fauna. Sardinia insularity was interrupted during the Miocene, when it was directly or indirectly connected with the Apenninic Region, Sicily and North Africa, and as a consequence its fauna includes several Sardo-Tuscan, Sardo-Sicilian, Sardo-Sicilo-Maghrebic elements. The Mediterranean component of Sardinian fauna is the highest of all the zoogeographic Italian Provinces, but species with northern chorotypes are limited, given Sardinia insularity during the Quaternary.

Chronogeonemy analysis: some examples regarding species of the Italian fauna

Pietro Brandmayr, Achille Casale, Franca Puzzo, Stefano Scalerio

The database of the geographic distribution of 10,000 vertebrate and invertebrate species is used specifically for conservation programs and, generally, for those practical uses derived from such a new and unusual pool of knowledge: the *CKmap* program shows the user the geonemy of some thousands of species that are endemic or relevant to biodiversity management in Italy. These geonemies are organized in a database where the files can be arranged to list the collection localities of each taxon in chronological order. This feature is potentially very productive: it allows to classify data as “old” or “recent”, and to distinguish between the localities with actual populations and those where the populations might be extinct. In the latter case, data represent records of the past. The transition between a datum referring to distribution to one referring to population, which is the information needed for conservation management, is very difficult, as shown by the scarce tendency of several Authors to undertake it. As an example, only the essay of Mingozzi (2003) among all those present in the recent book by Primack and Carotenuto (2003), tries to “reconstruct pre-existing areas” on the basis of the available knowledge on the Bearded Vulture *Gypaetus barbatus* in the Western Alps. Therefore, there is an apparently unfillable gap between the faunistic knowledge available for several invertebrates, and the study of their populations (or metapopulations). This is similar to the difficulties that radioastronomers have to face when they try to decipher extragalactic or at least extraterrestrial radio-frequencies. The understanding of how, for instance, a species of coleopteran is going extinct, based on few dozens of records widespread in Italian museums and private collections can be rash, but we think that a clarification of this problem will lead to a better understanding of the *CKmap* data, and the collectors will be more aware of the importance of faunistic data for the conservation of animal biodiversity.

There are several good examples of evaluation of numerical trends of insects based on museums and/or national databases in Europe (Desender et al., 1994). These authors summarized by decades, and for each UTM quadrant, the presence data of some critical species of Coleoptera Carabidae from Belgium. They detected how some taxa which are associated with open habitats such as pastures and moors (for instance *Carabus cancellatus*, *Cicindela germanica*, *Carabus nitens*) are strongly decli-

ning, whereas forest-associated taxa are increasing. The *CKmap* database, compiled on the basis of records from museums, collections, and reliable literature, is at the moment the only sure source of information that can be used to evaluate the conservation status of several species of invertebrates. In the following pages we will give examples which could be used as guidelines to expand the potential use of this tool. We focused our attention on the Cetoniidae coleopteran *Osmoderma eremita*, a priority species listed in the “Habitat Directive”. This species is an emblematic example of the conservation status of European forests and, after the Directive was published, numerous Italian (Sparacio, 2000; Audisio, pers. comm.) and European (v. Helsdingen, Villemse, 1995; Luce, 1995; Ranius, 2002) entomologists investigated findings and ecology of this species. In 1998 (Stoch, 1998) the first chronogeonemic analysis of this species in Italy was developed, on the basis of few presence

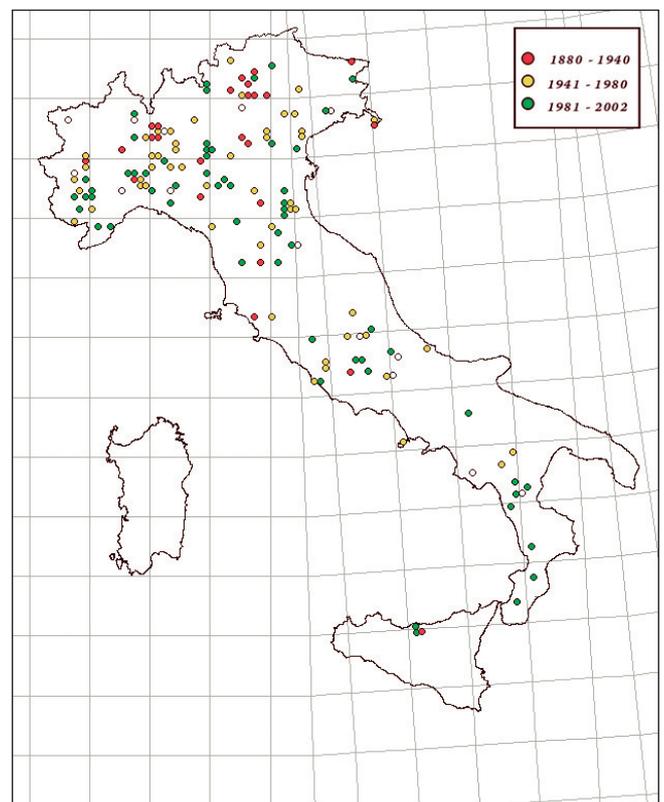


Fig. 1. Italian distribution of *Osmoderma eremita*, findings ordered into three time periods

data, and later on it was integrated with more data from Southern Italy by Brandmayr et al. (2000). We present the most extensive map in Figure 1, where the collecting stations are represented by symbols, so that they can be grouped in three time-periods: data recorded before 1900, between 1901 and 1970, and after 1970. This first analysis was incomplete, and it used records that were not aimed at species conservation; however, it shows local extinctions of *Osmoderma* in Northern and Central Italy (the most important represented by Tuscany), with some areas (for instance, Veneto) where some vital populations are still present. In conclusion, and taking into account also the small amount of data available for the South, this coleopteran associated with rotting cavities in secular broad-leaved trees was considered “endangered” in Italy, following the IUCN criteria A (the map shows a decrease in abundance for more than 50% of the populations starting from 1970). At the international level this species (which in Italy is divided into three semispecies or subspecies, see Fig. 2) is classified as “vulnerable” (VU – A1c), meaning that the surface occupied by the species is reduced. In order to explain the potential use of chronogeonemias in evaluating the viability of the invertebrate populations, we used data provided by Paolo Audisio and new data published by Sparacio (2000), to re-examine if the new records of *Osmoderma* in Italy, produced from the 1990s, confirmed the vulnerable or

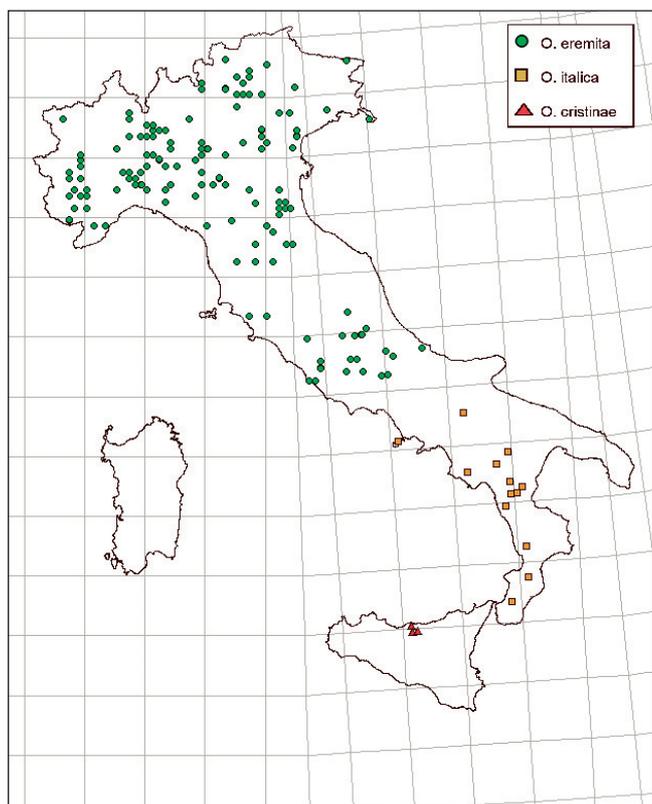


Fig. 2. Geographical distribution of the three taxa of the *Osmoderma eremita* group.

endangered status assessed in the first studies. Thus, we created a new, wider dataset, based on 205 accurately dated records distributed on the entire peninsula. The records were grouped by decades, and in Figure 3 the records are represented as geographic areas for the peninsula, and as regions for Northern Italy. Several records obviously refer to the same location but to different dates; we did not count the specimens recorded for each date, because it would not be a reliable estimate of density or size of the populations. It appears that, from the beginning of 1900, data collection strongly increased, with a peak in 1970-79, and with two wide but interpretable drops during the two World Wars 1914-18 and 1939-45. During the following decades, starting from 1960-69, the interest for entomological research in Italy greatly increased, as documented by the large number of members of the Italian Entomological Society and of similar associations. The peak recorded in 1970-79 was followed by a stable phase, which shows a decline of the species in North-Eastern Italy, relative stability in North-Western Italy, higher numbers of collections in Central and Southern Italy and the islands (*Osmoderma cristinae* was discovered in Sicily). The updating of the chronogeonemic map of this species shows how the present situation is similar to that discussed in the 1980s and 1990s, and underlines how this species is missing from some areas since 1940 (from Trieste and Verona Provinces, where deforestation was strong during WWII, see Brandmayr et al., 2004). Numerous records from Central and Southern Italy, together with the abundance in the Northwest, suggest that this species is slowly but continuously recovering, in parallel with the spontaneous recovery of the forested areas occurring in Italy from the 1960s (in spite of the human-induced damage to the centuries-old trees and older forests which slows down the process). The results of the *Osmoderma* studies suggest not taking into consideration data of the 1980s decade for a correct interpretation of the chronogeonemic analyses; it is probably safer to use the decades from 1960 or 1970, when urbanization and water and soil pollution dramatically increased in Italy.

As a further example we studied *Epomis circumscriptus*, a carabid beetle not recorded in *CKmap*, but known for its sensitivity to lotic water pollution, and associated with wetlands and estuaries in the Mediterranean region. This rare Carabidae Chlaeniinae was recently studied by Brandmayr e Algieri (2001) to validate the program “Chronogeonemie” prepared by Stoch (1998). *E. circumscriptus* is an emblematic case that shows how hygrophile and wetland species are at risk in Italy: thanks also to recent data provided by Augusto Vigna Taglianti and Achille Casale, 7 of the 48 total locations reported date before 1900, and only 8 were recorded after 1980 (fig. 4), suggesting about 40 populations might have gone extinct before. Because this is a large species, which rarely escapes

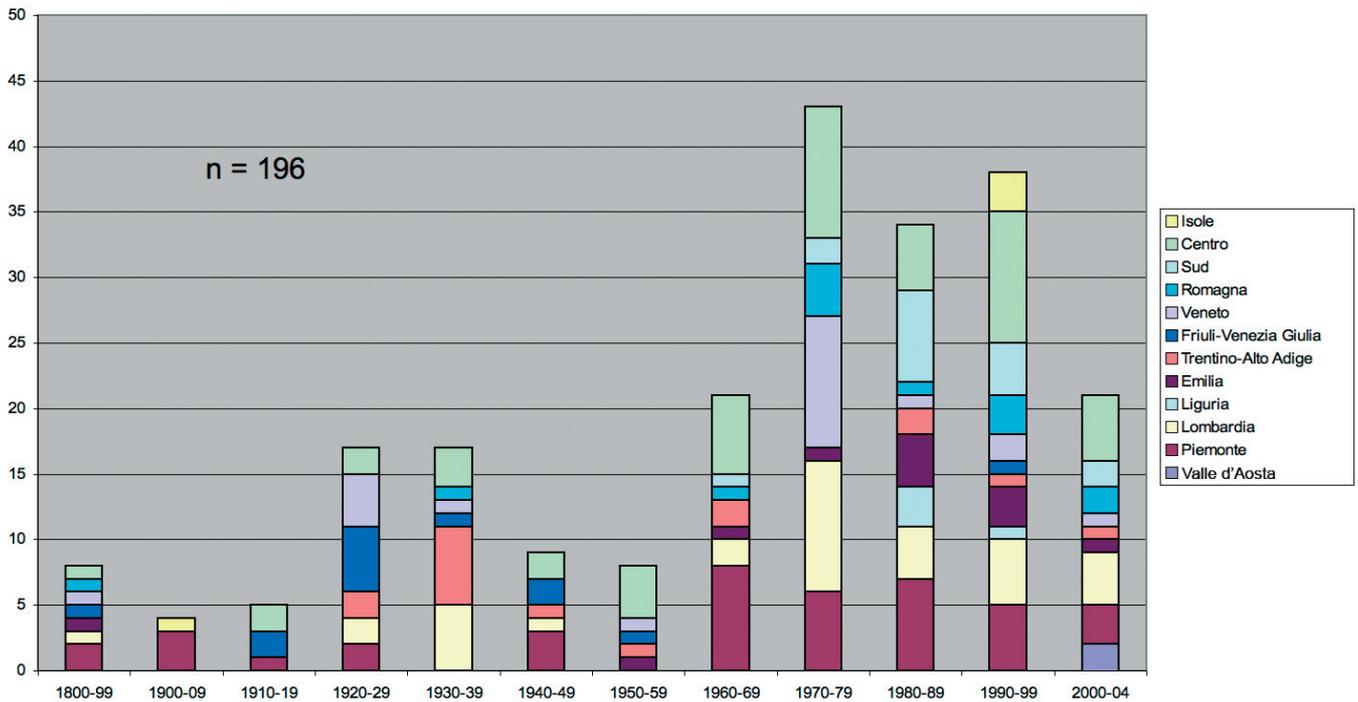


Fig. 3. Chronological and regional distribution of capture data of *Osmoderma* in Italy.

capture, we can not exclude that more than 70% of the population disappeared in the last 30 years. The IUCN criteria A defines a species as *critically endangered* when at least 80% of the previous populations went extinct in the last 10 years or within three generations (Wells et al., 1983; Samways, 1995). For *E. circumscriptus* in 1990-1999 only 5 populations are positively known: one in Castelporziano (Rome), one in Le Cesine near Lecce, one in Scarlino (Tuscany), one in Marceddì pond near Oristano and one in "Giara di Gesturi"(Cagliari province). A further population from Angitola near Vibo Valentia in Calabria (coll. Pizzolotto) has not been confirmed, even if extensively researched in the last years. The chronogeonomies study assigns *Epomis circumscriptus* to the category CR, with approximately 10% of the populations surviving until the year 2000.

Thus, *Epomis* represents a good example of the alteration of fresh and brackish water habitats. Unfortunately, there are more examples for other habitats, such as the marshy forests, for which the "umbrella species" could be another rare Carabidae: *Carabus clatratus antonellii* Luigioni. This species is known from reclaimed wetlands, and more recently from "marcite" and rice-fields in the Padana Plain (Bucciarelli, 1963; Casale et al., 1982). It was collected after 1990 only near Castiglione della Pescaia, two small lakes near Montepulciano and Padule di Fucecchio in Tuscany, although this species was documented in the marshy forests and coastal pine-woods in Ravenna province before 1980. *Carabus clatratus antonellii* is present today in 3 or 4 UTM 10x10Km

quadrants, thus less than 10% of the population known for Italy have survived, and this species should be considered as "critically endangered". The situation of this

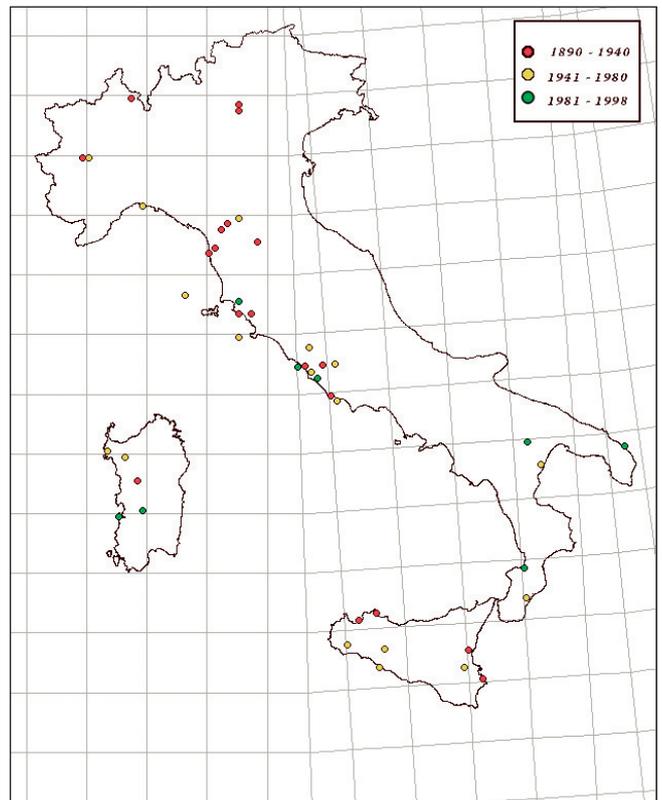


Fig. 4. Italian distribution of *Epomis circumscriptus*.

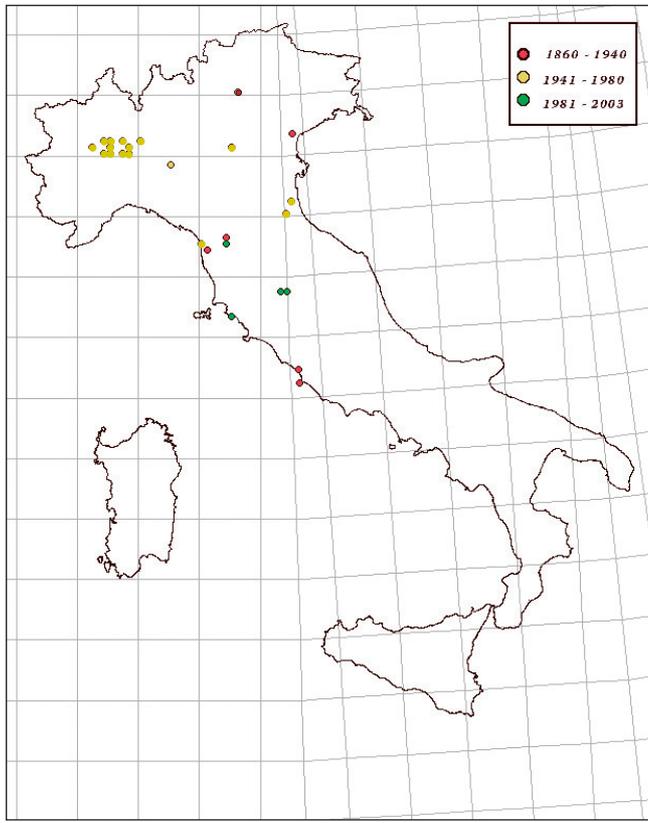


Fig. 5. Italian distribution of *Carabus clatratus antonellii*, with dating of the most recent records.

carabid species in Italy is similar to that of the rest of Europe (Turin et al., 2003), because its quick decline has been flagged for the whole continent.

The chronogeonomy analysis seems to be, overall, a good instrument to identify critical spots in a species area. A preliminary condition to make the analysis reliable is a complete database with information on the historic and present distribution of a taxon. Even if the dataset is not updated to the last decades, a “dated” chronogeonomy could nonetheless give an “alarm signal” or suggest to develop new research oriented towards population viability analysis.

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Distribution of Italian faunal species versus Eunis, Corine and Natura 2000 habitat types

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In this chapter we will discuss the potential use of the *CKmap* database to analyse the species distribution among the habitat classifications most used in Europe for ecosystem mapping (including the soil classification constructed with the remote sensing program Corine Landcover). All the vegetation types of an European territory area can be related to each other, following the directions given in the Corine Biotopes handbook, or using the Directive EU/92/43, called “Habitat”, for those habitats listed, or the Eunis manual (European Nature Information System, European Environment Agency, on the web at <http://eunis.eea.eu.int/index.js>).

The Eunis classification handbook was proposed by the European Topic Centre “Nature and Biodiversity”, and links all the typologies of habitats of the European Union in a hierarchical manner. Another tool is represented by the Corine Landcover system, which differs from the other classification methods, because it is based on multispectral analysis of satellite images. This system is based on the physiognomy of the territory, and organizes the landscape in polygons which can be easily obtained by photogrammetry. The third level of this classification

(levels 1 and 2 omitted) has the simplified contents listed in Tab. 1.

This classification can be summarized in wider habitat categories, which we represented with a colour code (pale colours or grey if the habitats have low biodiversity conservation values, gradually more vivid colours if the habitats are increasingly more relevant to conservation). The comparison of these categories with the more sophisticated classification presented in Corine Biotopes or in Eunis, shows that the Corine Landcover system is not detailed enough for description and recognition of the wide variety of natural and spontaneous habitats in Italy. As a consequence, several research groups, composed mostly by botany or forestry researchers, prefer to elaborate further levels of the Corine Landcover system, especially for forested areas and natural and seminatural grasslands, which otherwise would be under-represented (see Blasi et al., 2004a,b; Blasi, 2003a,b; Ciancio et al., 2002).

Corine Landcover remains a “key” classification, because it allows for exchanges among different disciplines (botany, zoology, ecology, forestry, agricultural study,

111 – Continuous urban fabric	243 – Land principally occupied by agriculture with significant areas of natural vegetation
112 – Discontinuous urban fabric	311 – Broad-leaved forests
121 – Industrial and commercial units	312 – Coniferous forests
122 – Road and rail networks and associated land	313 – Mixed forests
123 – Port areas	321 – Natural grasslands
124 – Airports	322 – Moors and heathlands
131 – Mineral extraction sites	323 – Sclerophyllous vegetation
132 – Dump sites	324 – Areas with developing shrub or forest vegetation
133 – Construction sites	331 – Beaches, dunes, sands
141 – Green urban areas	332 – Bare rocks
142 – Sport and leisure facilities	333 – Areas with sparse vegetation
151 – Archaeological sites	334 – Burned areas
152 – Monuments and ruins	335 – Glaciers and perpetual snow
211 – Non-irrigated arable land	411 – Inland marshes
212 – permanently irrigated land	412 – Peat bogs
213 – Rice fields	421 – Salt marshes
221 – Vineyards	422 – Salines
222 – Fruit trees and berry plantations	423 – Intertidal flats
223 – Olive groves	511 – Water courses
224 – Other permanent crops	512 – Water bodies
231 – Permanent meadows	521 – Coastal lagoons
241 – Annual crops associated with permanent crops	522 – Estuaries
242 – Complex cultivation patterns	523 – Seas

Tab. 1 - Habitats and codes in the third level of the Corine Landcover system.

etc.). This system provides an objective reference point by relating to a soil-use range that is derived from remote sensing, and that can be extended to further levels.

The results can be transformed into maps that are much more synthetic, like that of the “vegetation series” (Blasi 2003a), by adding the wide know-how provided by geobotany.

The problem increases when we try to superpose the geo-referenced polygons, which are built on the base of one of the above-mentioned classifications with the single species-presence points provided by *CKmap*. The addition of population abundance values for each species, or the superposition of entire communities would be even more complex but fascinating (Brandmayr et al., 2000). We must underline that the project is not aimed at the study of the distribution of Italian species among habitats, but represents a zoogeographical database with national relevance, which uses a homogeneous method to assess the possible presence of species at risk in Italy. In this way it is possible to understand if a taxon could be present in a landscape unit or in an area of the Italian territory. It is not possible, particularly for invertebrates, many of which are less mobile and poorly known in distribution, to use methods based on the potential presence of a species. In other words, it is impossible to define the presence of a species on the basis of the presence of the appropriate habitat within the boundaries of its distribution area.

This solution, also called “map of habitat suitability” is possible only if the distribution area is well known, if the species is the most characterizing of the ecosystems into account, and if the habitats have not been deeply altered. For invertebrates it is necessary to use the population-level approach, which can guarantee a correspondence between a point location on the map (a quadrant of 10X10 km) and a group of geo-referenced habitats. Today, the habitats occupied by several invertebrates in Italy are incompletely known, or totally unknown, to the point that the habitat classes used for the *CKmap* are simplified with respect to any classification used in Europe.

The relationship existing between the distribution areas described by points and the real complexity of the structure of a population and of the habitat of some taxa can be shown by some examples. We chose Coleoptera Carabidae as the taxon, and Calabria as one area of Italy where their ecology is well known, and we selected species which are significant as: kind of habitat occupied, conservation status, and potential vulnerability to anthropogenic disturbance. This was possible because we have data on species densities collected for the last 15 years, and in about 120 stations in Calabria; most of the stands are distributed along a transect of about 70 km length, and 2000 m altitudinal range, connecting the Tyrrhenian Sea with the Ionian Sea through the Sila high-plain. The transect covers a variety of habitats, rang-

ing from the Mediterranean sclerophylls to mountain forests, from pastures and cultivations to riparian habitats of streams. Fig. 1 groups the known distribution areas in Calabria for some species of abundant Coleoptera Carabidae: *Carabus lefebvrei*, a species tied to more or less humid forest habitats, tolerant for low calcium levels in soil; *Abax ater*, a species associated with a wide variety of forest types and widely diffused in Italy and Europe, and *Steropus melas*, an euryoecious species abundant in cultivated areas. In the low right quadrant the Calabrian distribution of an Italian endemic species is represented, *Poecilus (Metapedius) pantanellii*. This ground beetle is stenotopic and lives on bare clay soils in the so-called “calanchi” badlands, that are very common on the Ionian side, therefore this species has a peculiar ecology, due to its strict pedological preferences. Fig. 2 represents the findings in Calabria of *Sorex minutus* and *Suncus etruscus*, two insectivore small mammals typical, respectively, of mesophilous forested areas, and of termoxerophilic open lands.

The remaining figures show the population density of the four selected beetle taxa along the Tyrrhenian-Ionian transect. The transect is represented as a sequence of habitats and elevations, characteristic of each station, together with the “Corine Biotopes” habitat classification reported on the X axis. In order to make the interpretation of the figures easier, we gave a different colour to each type of habitat, strongly simplifying the forested woods variants, which have in reality more complicated phytosociological branches.

Fig. 3 and the following ones represent the activity-density of the four ground beetle species along the Tyrrhenian-Ionian transect, and the habitat and elevation of each collecting station. It appears that:

Carabus (Chaetocarabus) lefebvrei: populations are more concentrated on the western side of Calabria, in beech, oak, and chestnut forests, they decrease in density towards the Ionian Sea. The highest abundances are clearly found in the Western section, as shown by the associated polynomial curve (Fig. 3), on this side the beetle is missing only in the calcareous pastures of the Cocuzzo Mt. (green columns). Also in Fig. 1, it appears that all the stations of *Carabus lefebvrei* are concentrated towards the Tyrrhenic coasts.

Abax parallelepipedus curtulus (syn: *Abax ater curtulus*): populations are particularly abundant in the beech, oak, and chestnut forested woods west of the Crati valley, with a strong reduction eastward, as it was expected given that this species is one of the most common and abundant Carabidae in the forests of central and western Europe. The geonemy in Fig. 1 does not perfectly correspond to a western centroid, and indicates lack of records along the Calabrian coastal range (data presented here are not totally exempt from possible corrections and additions by the authors).

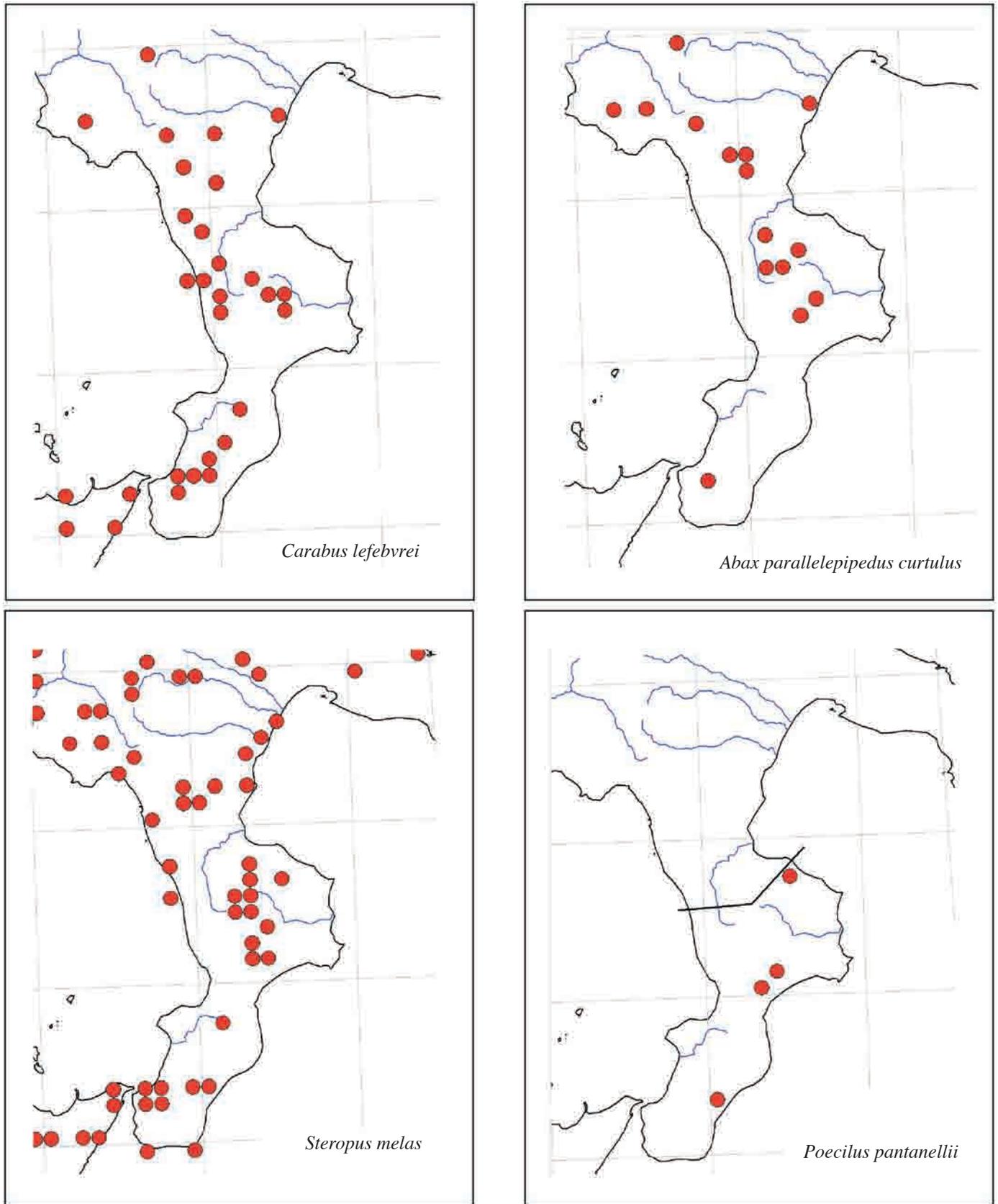


Fig.1 - Distribution in Calabria of four species of Coleoptera Carabidae used for CKmap. The bottom left quadrant underlines the Tyrrhenian-Ionian transect, which connects to city of Paola, on the Tyrrhenian coast, to the city of Calopezzati on the eastern side of Calabria, passing through the Crati valley and the Sila high-plain.

Steropus (Feronidius) melas: widely distributed in all Calabrian habitats, but with an abundance peak in the *Pinus laricio* woods of the Sila high-plain, it reaches the beech woods only on warm and dry soils. Collecting stations concentrate on the Sila upland. This specie tolerates anthropic pressure, it is abundant in cropland areas, in tree cultivations as well as in arable land.

Poecilus (Metapedius) pantanellii: it has been found only in four stations of the transect, strictly associated with yellow or bluish-grey clay soils of the “calanchi badlands”, even if regularly cultivated and ploughed (such as durum wheat fields). For this endemic taxon, ecological mapping is the best method for entering this species in a database, even if *CKmap* shows an Eastern gravi-

a centuries-old chestnut wood on the coastal range. It is known that several *Leistus* behave as dendrophilous at low altitude, their presence seems linked to that of ancient trees, thus depending on the application of the peculiar habitat-protection policies to the area that is represented by the forest or by the reference polygon. This case shows how the “automatic” transfer of a species presence may be misleading, because a species with such habitat requirements will search among all the potential suitable sites of an area only the forest stand conditions that fit perfectly the above constraints.

Figure 6 illustrates, in our opinion, an outstanding case of stenotopy, very difficult to solve also by modern automatic mapping methods, at least as far as future mapping

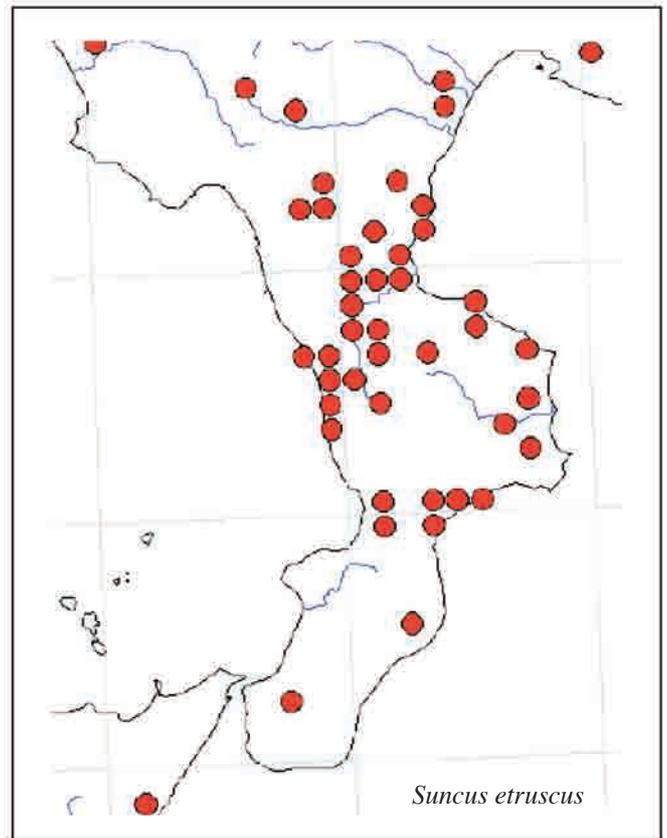
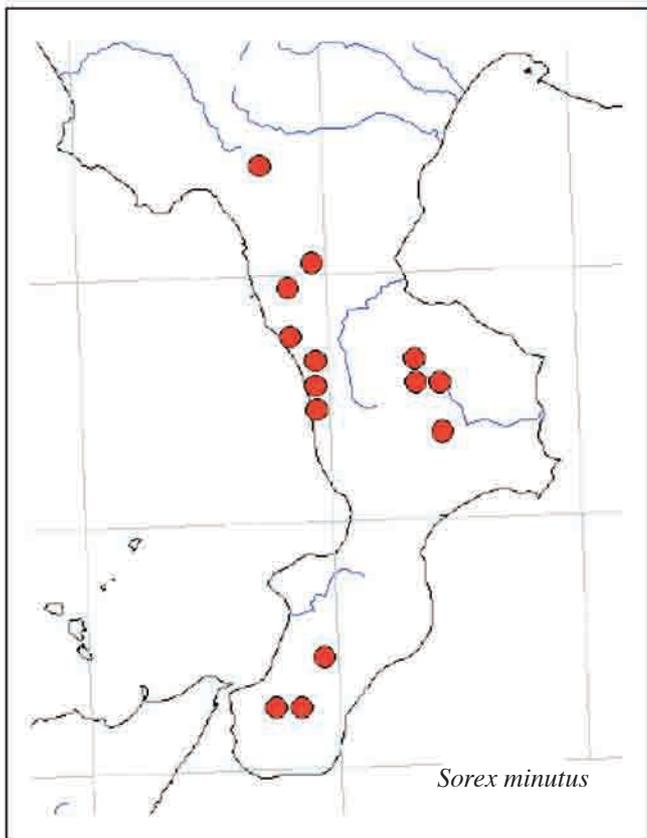


Fig. 2 – Distribution in Calabria of two species of Mammalia Insectivora used for *CKmap*.

tation, which corresponds to the distribution of many moderately salted clay vertisol areas of Pliocenic origin in Calabria (AA. VV., 2003).

We also chose to present the population density of *Leistus sardous*, a species not yet included in *CKmap*, but of great interest for conservation. This species is a W-Mediterranean (Tyrrhenic) endemic species, widely present in Sardinia, Sicily, and in the western section of peninsular Italy. The presence of this species in the transect is probably reduced by anthropogenic pressure, one single individual has been found in an ancient beech wood on limestone soil, located on Mount Cucuzzo, and in

methods will discriminate between forest stands of different age and structure.

A last example was chosen among vertebrates, because soil small mammals (Rodentia and Insectivora) were included among the taxa studied in the transect. The activity-density distribution of two insectivores of different ecological valence (*Sorex minutus*, mesophilic species tied to forested areas, and *Suncus etruscus*, a thermoxerophilous open habitat dweller) shows the ecological preference of these two small vertebrates along the transect (Figs. 8 and 9).

In conclusion, we can state that:

- 1) there is a quite good correspondence between the geonomy data entered in the *CKmap* database and the habitats map, independently from the type of classification (i.e. in the case of abundant and well-documented species, the quadrants occupied by records represent a gravitation that reflects the habitat types);
- 2) this correspondence is not always immediate: the transfer of geonomic data into habitat maps must be verified on the basis of the real population distribution, because the zoogeographic datum could be incomplete or outdated;
- 3) the geonomies of rare, endemic, or stenotopic species can not be translated automatically into habitats; only

a previous quantitative ecological study can provide data necessary for the reconstruction of an ecoarea, because there are too many limiting factors that are not detected in standard mapping (which follows the Corine or other codes).

Corine, Eunis and "Habitat" maps are not detailed enough to mirror the ecological factors involved, especially soil characteristics, which are vital to many animals. The future ecological mapping systems should be based on multi-layer GIS software, which take into account a wider range of ecological features, and thus allow to obtain more precise "suitability maps", or maps of potential presence of the species.

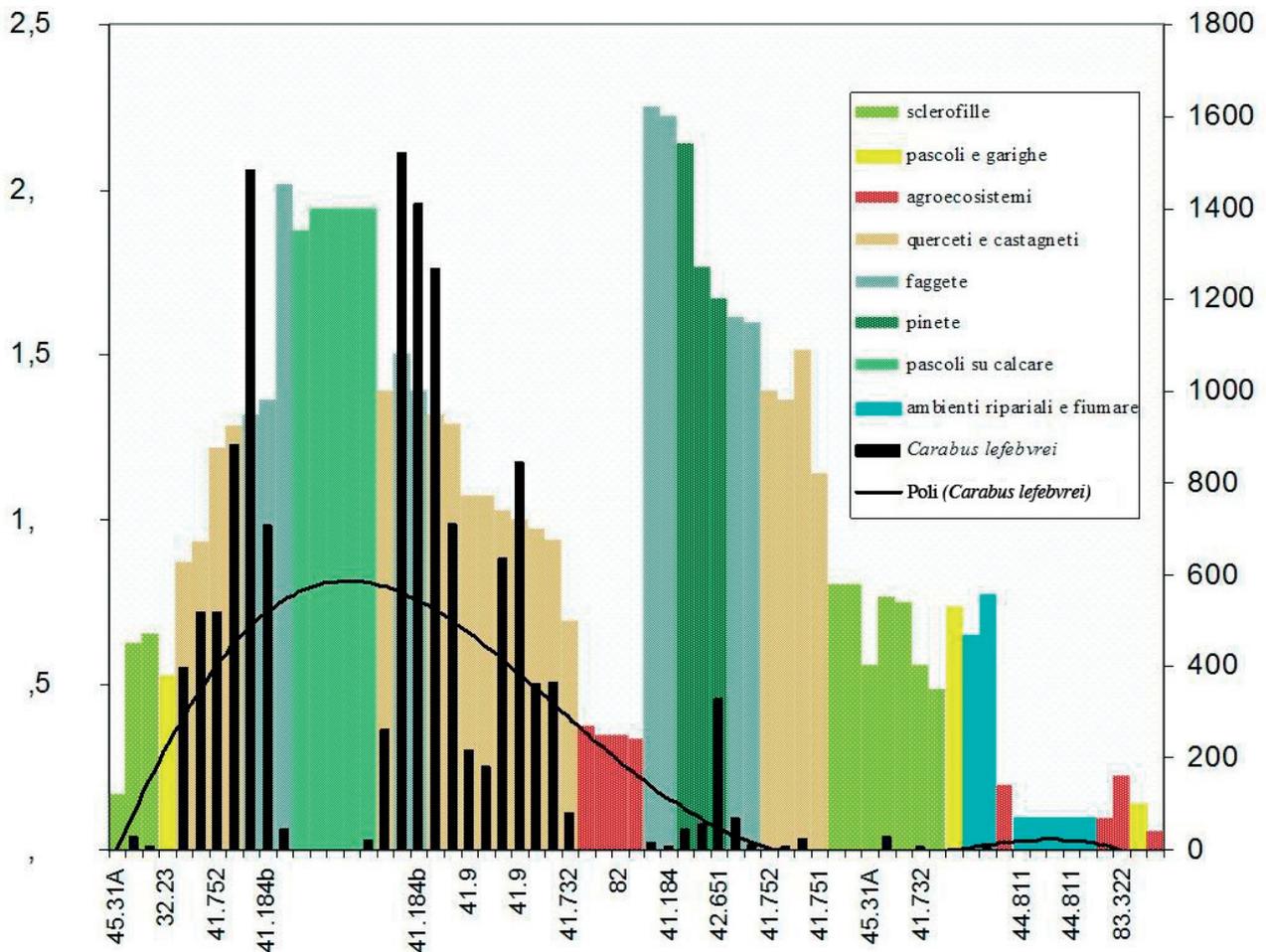


Fig. 3 - Ecological distribution of *Carabus (Chaetocarabus) lefebvrei* along the main habitats ("Corine Biotopes") of the Tyrrhenian-Ionian transect. The strong western gravitation of the population is stressed by a sixth order polynomial. Stations are ordered from West to East, and the length of the column corresponds to altitude. The colour of each habitat column reflects the zonal/azonal vegetation belt or type. Legend: sclerofille - mediterranean evergreen sclerophyll forest or "macchia", including cork-oak woods and shrubs; pascoli e garighe - pastures and garrigues at lower height; agroecosistemi - croplands; querceti e castagneti - deciduous oak and chestnut forests, inclusive of all endemic semi-evergreen oak species; faggete - beech forests at any height and conservation status; pinete - *Pinus laricio* forests of the Sila upland; pascoli su calcare - calcareous pastures of the Mount Cocuzzo; ambienti ripariali e fiumare - river beds of mediterranean summer dry and gravel rich "fiumare". The same habitat types are reported on the following graphs.

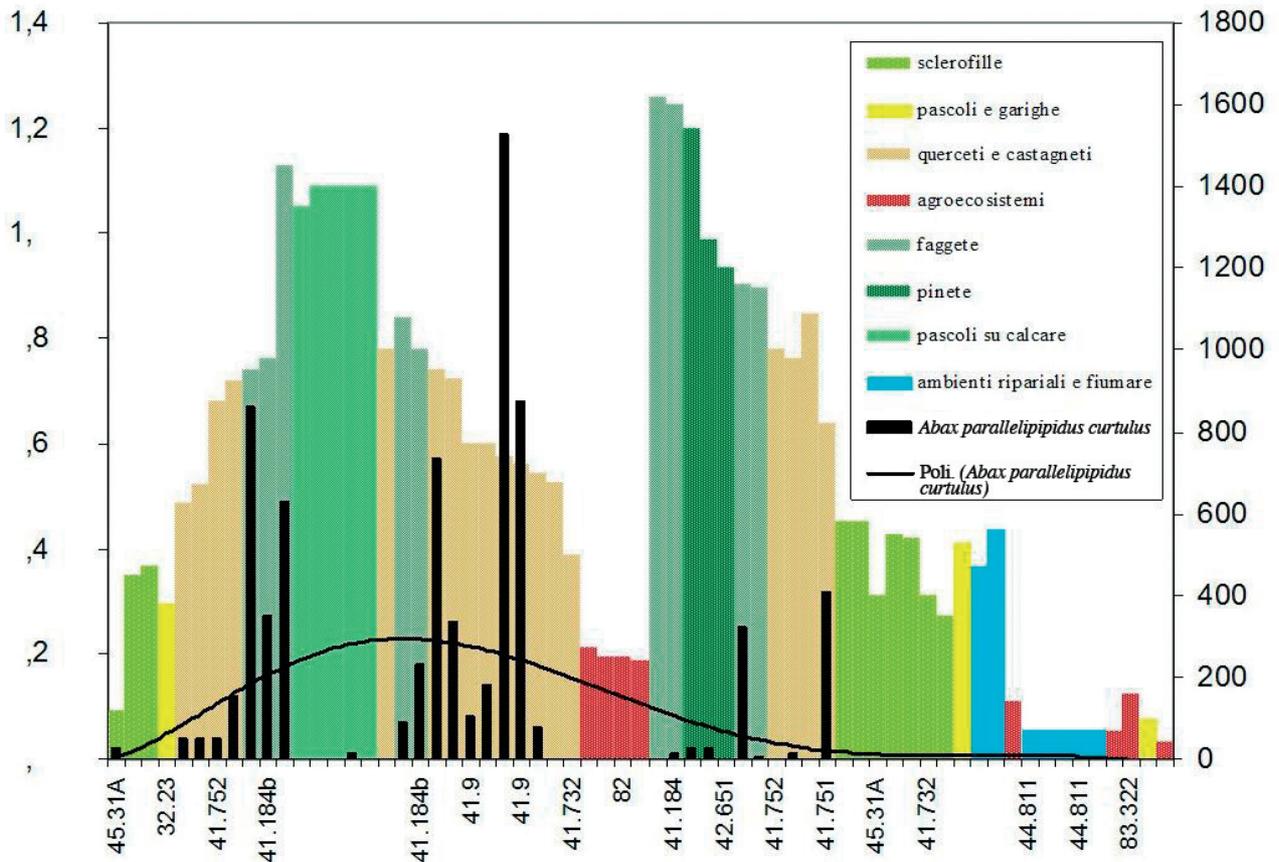


Fig. 4 - Ecological distribution of *Abax parallelepipedus curtulus* along the main Habitats "Corine Biotopes" of the Tyrrhenian-Ionian transect.

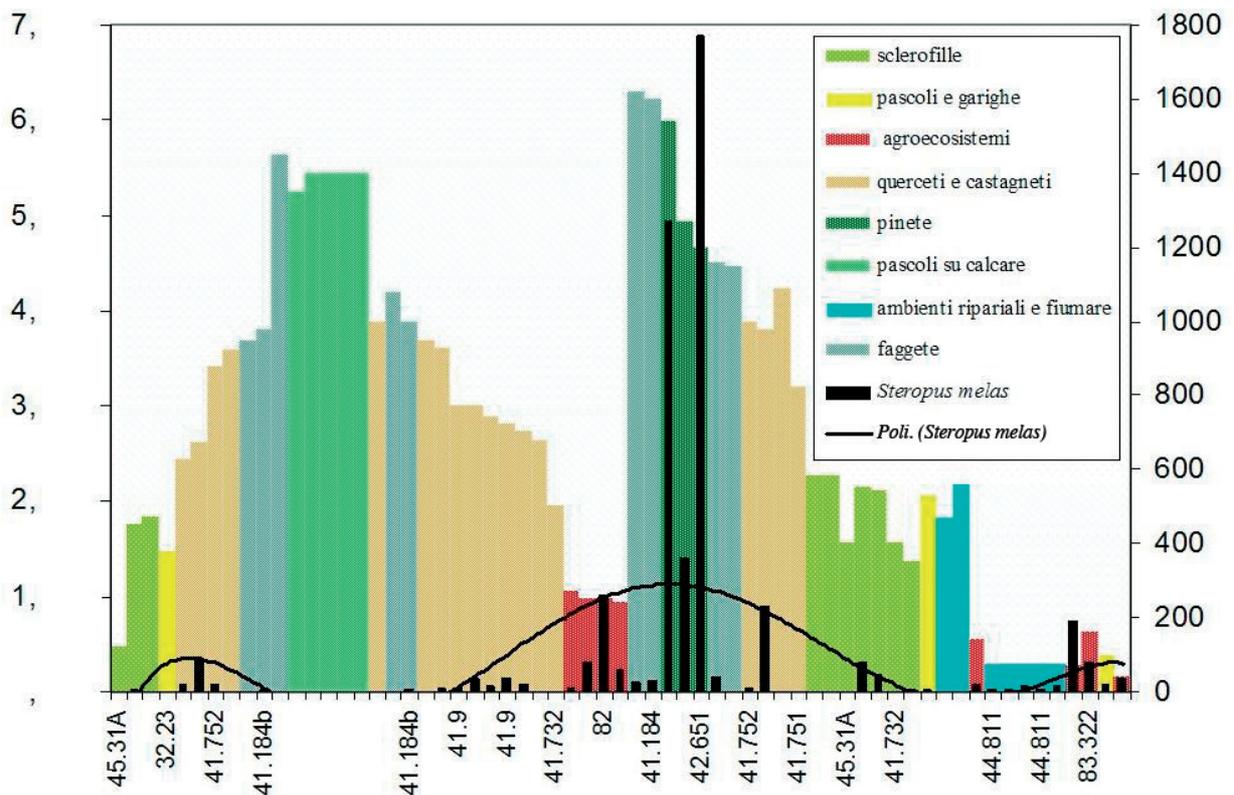


Fig. 5 - Ecological distribution of *Steropus melas italicus* in the main Habitats "Corine Biotopes" of the Tyrrhenian-Ionian transect.

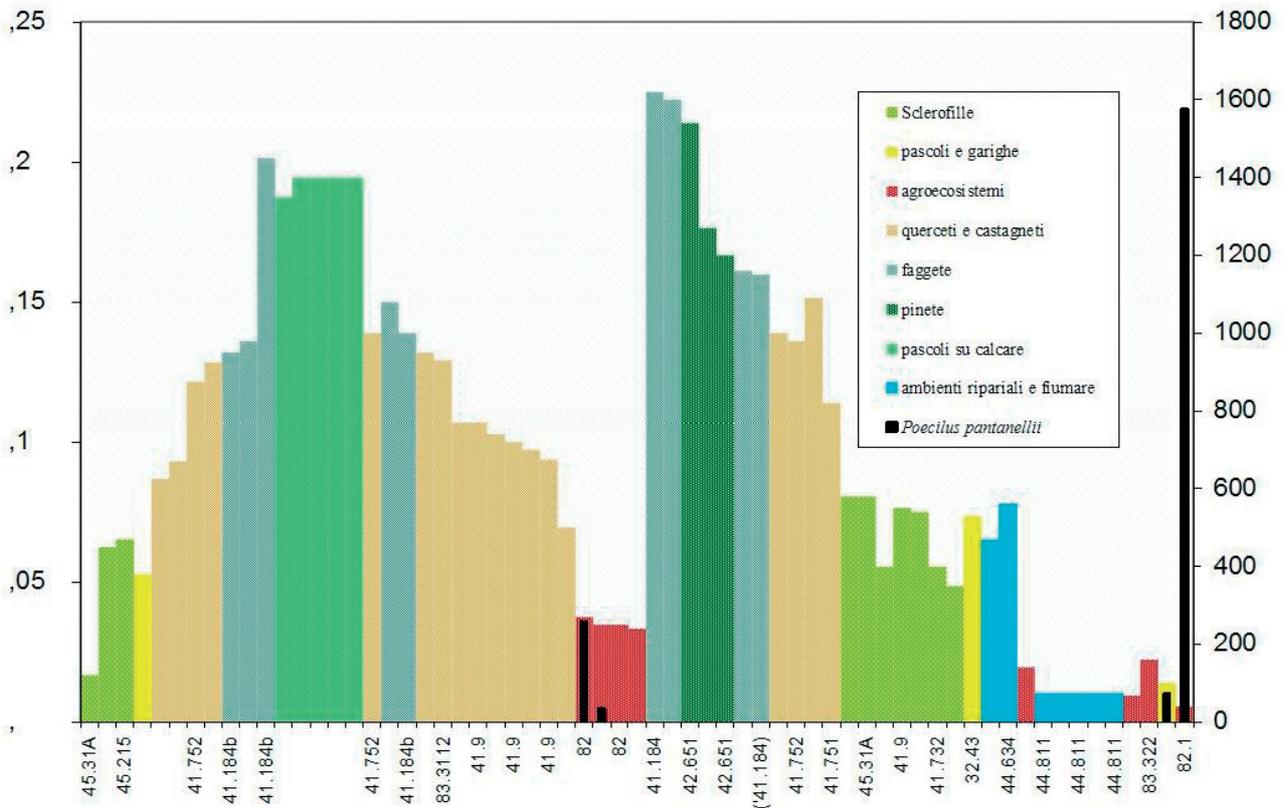


Fig. 6 - Ecological distribution of *Poecilus (Metapedius) pantanellii* along the Tyrrhenian-Ionian transect. Most of the clay soil in erosion furrows are present in the Crati valley sand on the western coastal hills of Calabria.

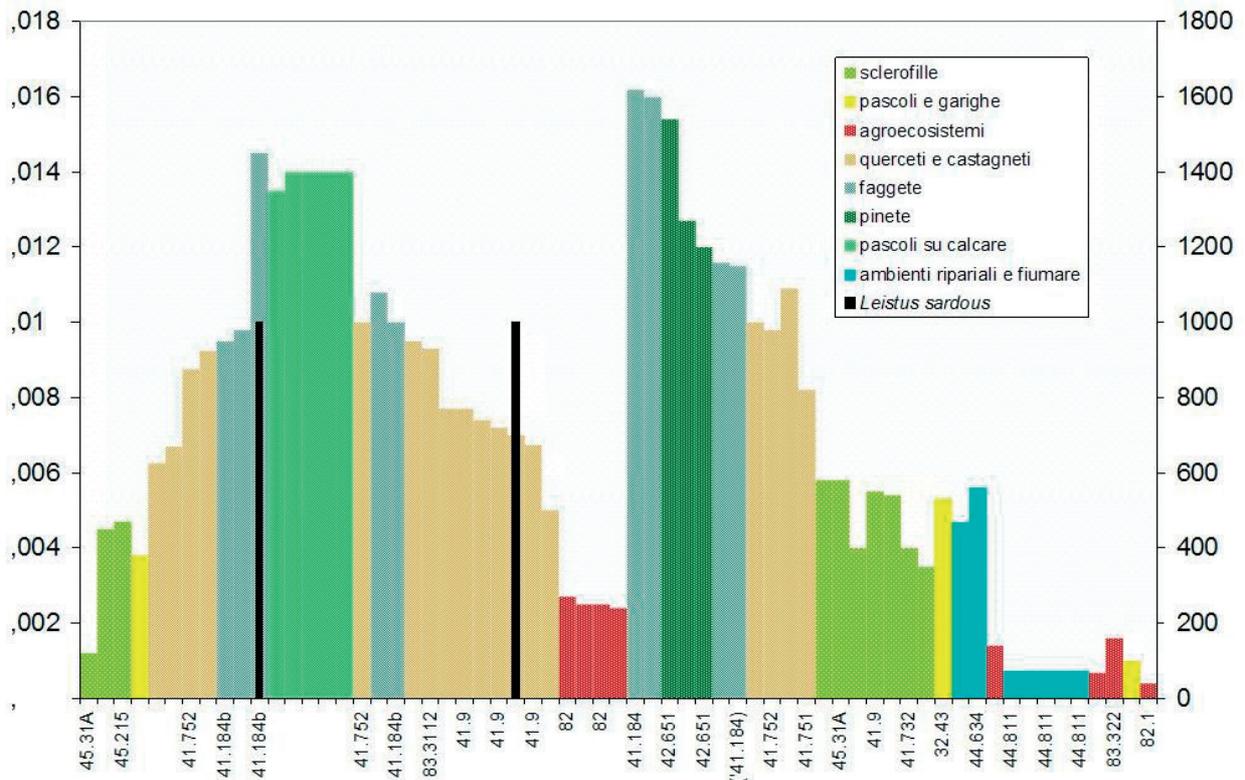


Fig. 7 - Ecological distribution of *Leistus sardous*, W-Mediterranean endemism, along the Tyrrhenian-Ionian transect.

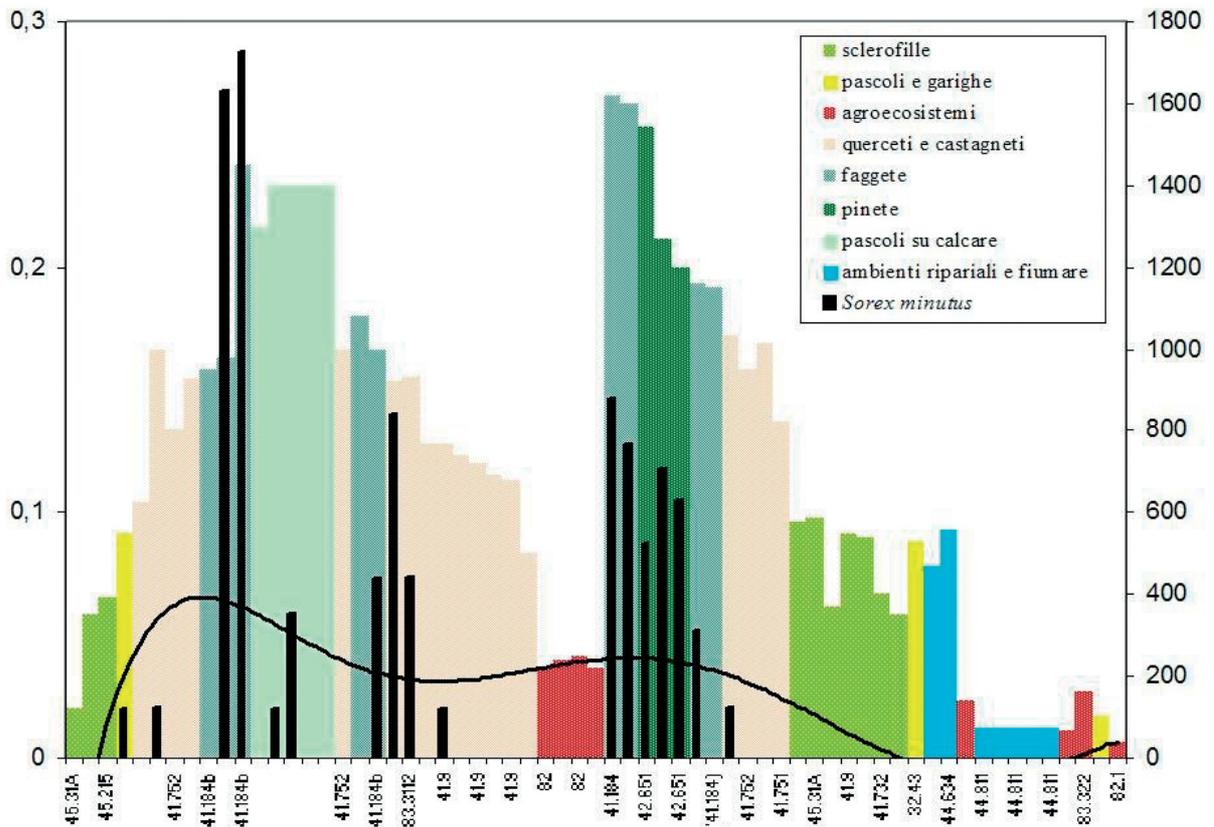


Fig. 8 - Ecological distribution of *Sorex minutus* along the Tyrrhenian-Ionian transect.

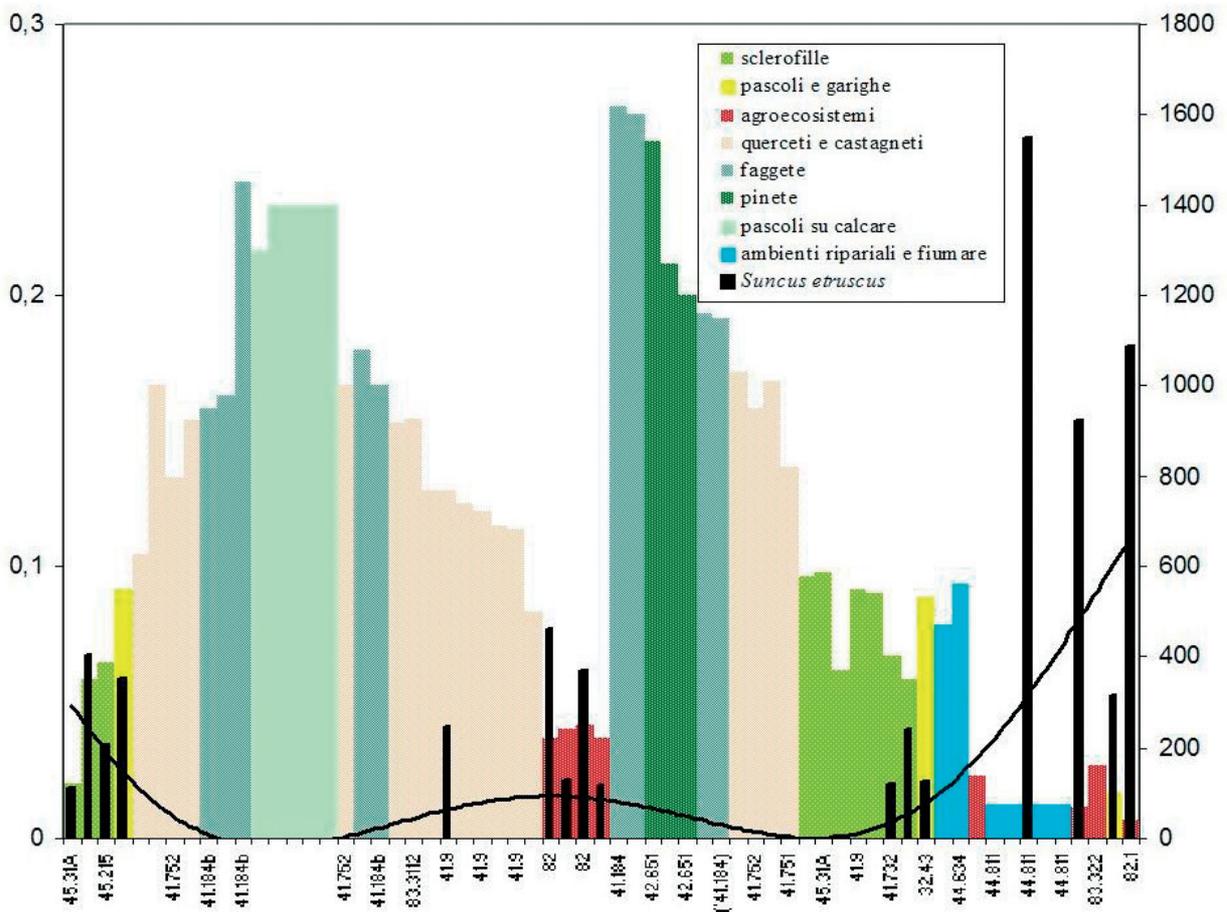


Fig. 9 - Ecological distribution of *Suncus etruscus* along the Tyrrhenian-Ionian transect.

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The exotic species of the Italian fauna

Marzio Zapparoli

We will indicate here as “exotic species” those animal species which were originally not part of the fauna of a given area, and were subsequently introduced by man, either voluntarily or involuntarily (possible synonyms: allochthonous species, non-indigenous species, non-native species, alien species). Sometimes the term “biological invasions” is used, to underline the quick expansion of some of these species after introduction (invasive species), and to stress the negative effects that follow these introductions. The introduction of exotic species, and particularly of invasive ones, is today considered one of the worst dangers to biodiversity conservation, together with habitat fragmentation and destruction. It has been confirmed that the presence of such organisms has negative effects on several other aspects of the life of man: economic, social, sanitary, educational both at local, national and international levels (Andreotti et al., 2001; Scalera, 2001). Lately, the awareness of this problem has greatly increased, and several countries have adopted regulations and technical tools to limit, at least potentially, the effects of allochthonous invasive species. In Italy the first signs of awareness are represented by the compilation of the “*Checklist of the Italian fauna*”, promoted by the Ministry for the Environment and Territory and Sea and by the Scientific Committee for the Italian Fauna (Minelli et al., 1993-1995), the development of several research projects, the acceptance of international conventions and protocols (Rio de Janeiro, Ramsar, Bonn, Bern, Washington, Barcelona) and of European Union directives (“Birds”, “Habitat”), the issuing of a national law (L. 157/92), and of several regional laws. Lately, the Permanent Committee for the Bern Convention approved (December 2003) the “European strategy for invasive alien species”. This document underlines the need to address the danger of transnational diffusion of allochthonous species, and promotes cooperation among European countries, with the purpose of developing coordinated actions that could prevent or minimize the negative impacts of invasive species on biodiversity. This document applies to: exotic species of animal, plants, fungi, bacteria, virus, prions, and stray animals living in marine, freshwater and terrestrial habitats which are under the jurisdiction of the countries part of the Convention, and excludes GMOs. The scope of this document is to increase understanding of the risk associated with the diffusion of these species, to prevent their introduction, to reduce the impacts of those already present, to identify priorities for intervention, to preserve and restore autochthonous species, habitats, and ecosystems.

The specialized literature on animal introduction is abundant but, despite the need of a strong awareness in the public, the diffusion of this subject in Italy is still scarce. From calculations by the writer, based on literature data, 970 cases of introduced animals, protozoans excluded, are signalled for Italy (150 of which are discussed in this volume): this datum suggests the magnitude of the problem for our country. This estimate is approximate because more species are introduced every year, and because several groups of invertebrates are insufficiently known. Moreover, in several cases it is insufficiently known if the introduced species is acclimated, and it is difficult to evaluate the status of several synanthropic species, which could have been accidentally introduced in proto-historic times, or even before. As a comparison, at the end of the 1990s, 741 cases of modern introductions (occurred after 1492) were signalled for Germany, representing 1.6% of the national fauna, with only 190 acclimated species (Doyle, 1999).

In the paragraphs below I will give a synthetic description for the most significant cases and ways of introduction and related problems, in terrestrial and freshwater habitats of Italy. Data were obtained from the *Checklist*, from pertaining literature (primarily the papers listed in the essential literature at the end of this chapter), and by information provided by numerous researchers working on this issue, which I gratefully acknowledge.

About 450 cases of introduced species are known for terrestrial habitats. This number includes mainly nematodes, gastropods, arthropods and vertebrates, but the most part (80-90%) is represented by insects. Among them, most of the species were introduced in recent times: 115 species of phytophagous insects impacting agriculture and forestry (75% of which are represented by Homoptera Sternorrhyncha: Psyllidae, Aleyrodidae, Aphidoidea and Coccoidea, mainly Diaspididae) were introduced in 1945-1995, the introduction occurred through commercial trades (of plants, seeds, etc.). About 80% of these species is acclimated and numerous species are associated with ornamental plants. These acclimated species do not seem to interfere negatively with the autochthonous fauna of natural habitats, and their damage is limited to cultivation. Numerous cases of acclimation are known for those arthropods used in integrated pest control (e.g. the Australian Coccinellidae *Rodolia cardinalis*), even if sometimes those introductions were not successful (some Coccinellidae introduced to control Coccidae). Some insects were reared and released for

pest control (Neuroptera Chrysopidae, Coleoptera Coccinellidae, Hymenoptera Aphelinidae).

Most of the introductions of phytophagous insects occurred in urban ecosystems (for instance, the Homoptera Flatidae *Metcalfa pruinosa*, the Heteroptera Coreidae *Leptoglossus occidentalis*, both Nearctic, the Lepidoptera *Parectopa robiniella* and *Cacyraeus marshalli*, respectively Nearctic and South-African) and in agroecosystems (Thysanoptera Thripidae, Homoptera Aphidae, Psyllidae, Coccidae, Diptera Agromyzidae). One terrestrial Platyelmintha of the New World, today cosmopolitan, *Bipalium kewense*, was introduced with the soil of tropical plants, and now lives in numerous greenhouses and gardens all over Italy. Several species of ancient or recent introduction are present in urban ecosystems: this species are associated with foodstuffs (for instance, Blattaria, Coleoptera Dermestidae, Anobiidae and Curculionidae, Lepidoptera Pyralidae) or they affect human health (for instance, the eastern Culicidae *Aedes albopictus*, several Formicidae such as *Monomorium pharaonis* and *Linepithema humile*, today cosmopolite).

Several taxa were introduced in natural habitats (the West European Gastropoda Pulmonata *Arion lusitanicus*, the South European Coleoptera Carabidae *Carabus montivagus*, the Indian Hymenoptera Sphaecidae *Sceliphron curvatum*).

Faunal transfers (introduction of an autochthonous species outside its primary area) occurred with some insects, in most cases from the continent to Sardinia (e.g. the Coleoptera Meloidae *Mylabris variabilis*, intentionally introduced to control grasshoppers). Deliberate introductions and faunal transfers even occurred for hypogean fauna (Coleoptera Bathyscinae *Bathysciola derosasi* and *Parabathyscia dematteisi casalei*, the Orthoptera Rhaphidophoridae *Dolichopoda laetitiae*).

Records of allochthonous Diptera are scarce, although several anthropophilous species (such as those affecting man and livestock) with wide geographical distribution or cosmopolitan (some Drosophilidae, Muscidae, Sarcophagidae, Fannidae, Scatophagidae, Oestridae, etc.), were introduced in ancient times; the same process applies to some Chloropidae associated with cereals.

Very few Arachnida were introduced, one of them being the epigeal, Nearctic Araneidae *Eperigone trilobata*. For these organisms, it is likely that several synanthropic species (spiders, mites) were passively introduced by man in ancient times.

Regarding vertebrates (Scalera, 2001), two cases of introduction are known among amphibians: the Nearctic *Rana catesbeiana*, and the Balkanic *R. kurtmulleri*.

There are at least 6 non-indigenous reptiles in Italy, the most worrisome case being the Nearctic aquatic turtle *Trachemys scripta*, which competes with the indigenous *Emys orbicularis*. The number of exotic birds is very high, 110, but only one dozen are acclimated or naturalized, about half of them are Phasianidae, introduced for hunting. Non-indigenous mammals are 16, mostly rodents. Particularly worrisome is the case of the Nearctic *Sciurus carolinensis*, now present in Turin and Cuneo Provinces, which might quickly expand its distribution to the Alps, greatly endangering the survival of the indigenous *S. vulgaris*. Another invasive species is the Neotropical *Myocastor coypus*, introduced for fur industries in the 1920s, and today responsible for large damage to riparian habitats.

The number of species introduced in freshwater habitats is much lower (Occhipinti Ambrogi, 2002). About 50 cases are known for invertebrates, more than 2/3 being crustaceans, primarily Cladocera (9 species), Ostracoda (20 species, many of which inhabit ricefields), Copepoda Calanoida (1), Amphipoda (2) and Decapoda (4). Among Decapoda, crayfish *Procambarus clarkii*, from the southeastern United States, imported to Italy for aquaculture, is dangerous because it is invasive (Petrini & Venturato, 2002). There are less than 10 species of introduced molluscs, mostly Gastropoda Pulmonata (5), but also some Bivalvia such as the East-European *Dreissena polymorpha*. Other introduced invertebrates are represented by some Annelida Oligochaeta, Hirudinea (*Eukerria saltensis*, *Piscicola geometra*, *Cambarincola mesochoreus*), a couple of Nematoda parasite on fish (*Anguillicola*), one North American Platyhelmintha (*Dugesia tigrina*). The only introduced species known for insects is the East European Ephemeroptera *Ametropus fragilis*. With the exception of some intentional introductions of species reared for commercial purposes (decapods), and excluded the species associated with ricefields, most of the introductions discussed above occurred in recent times, were accidental, and were often related to uncontrolled introduction of non-indigenous fishes and fry release.

The situation is critical for Osteichthyes (Zerunian, 2002): 60% of the 67 Italian freshwater fishes are allochthonous species, which were introduced in recent times and which subsequently acclimate, or by indigenous species which were moved from their original area to a different one. These introductions and faunal transfers were developed for commercial or recreational purposes, and are now troublesome because these species are disrupting the distribution pattern of Italian species, strongly affecting the conservation of endemic fishes.

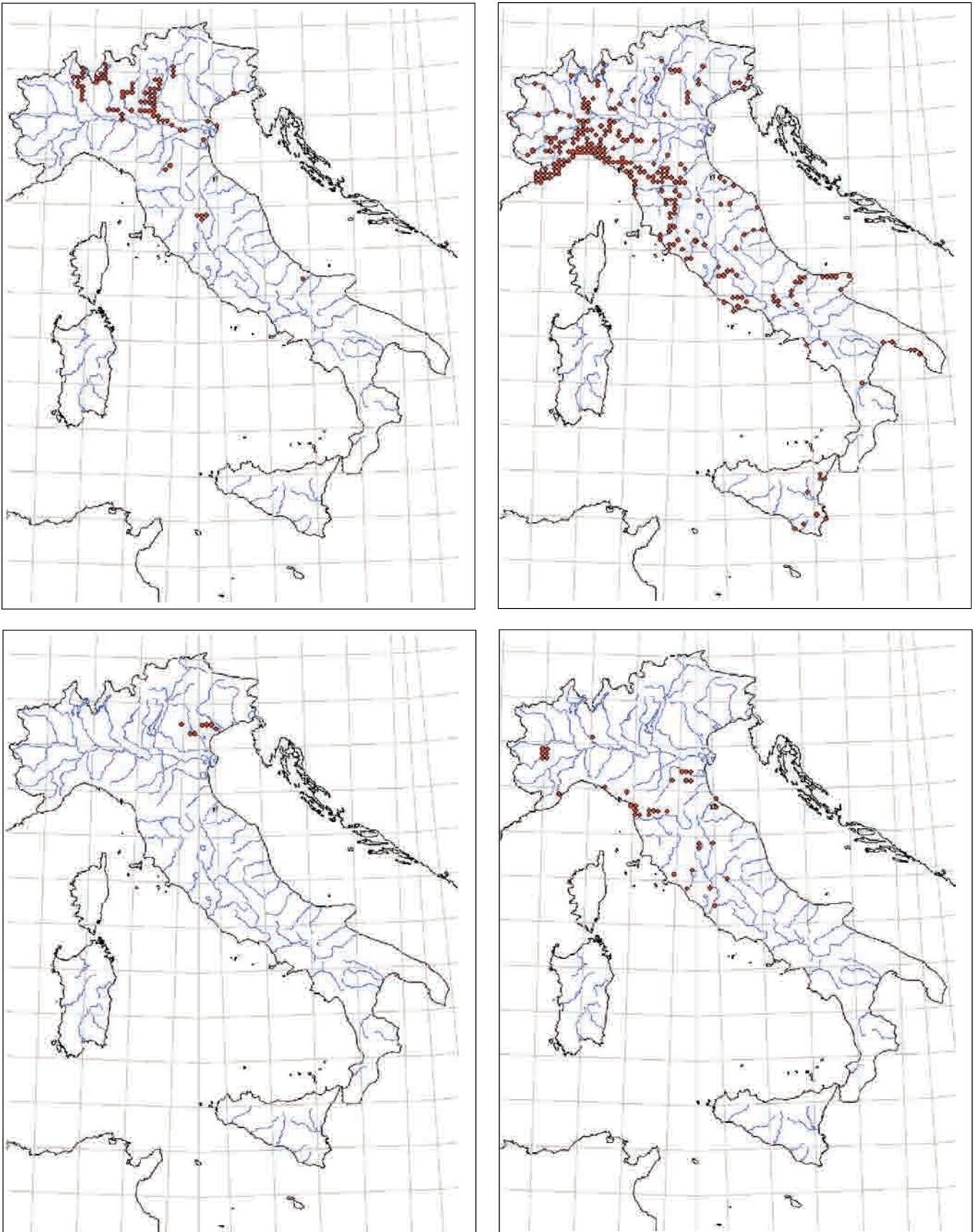


Fig. 1 - Distribution in Italy of the bivalve *Dreissena polymorpha* (left high: data from Bodon et al.), of the gastropod *Potamopyrgus antipodarum* (right high: data from Bodon et al.), of the amphipod *Gammarus roeselii* (left low: data from Ruffo and Stoch) and of the american shrimp *Procambarus clarkii* (right low: data from Froglià).

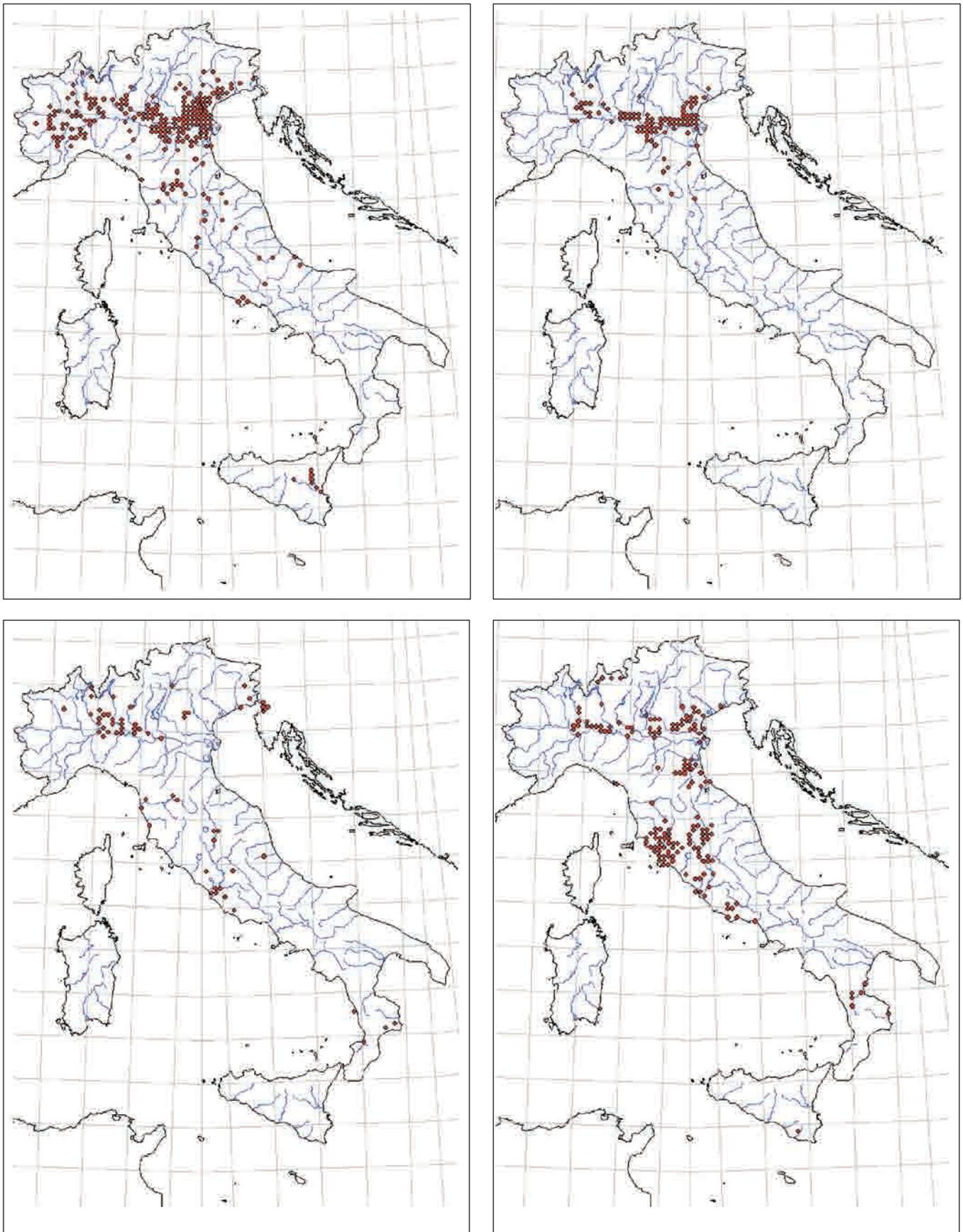


Fig. 2 - Distribution in Italy of the cyprinid of the genus *Carassius* (high left: data from Bobbio and Sala) and *Pseudorasbora* (high right: data from Bobbio and Sala), of the bullfrog, *Rana catesbeiana* (low left: data from SHI) and of the coypu, *Myocastor coypus* (low right: data from Amori)

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Criteria for the compilation of the first Red List of species of national and regional interest

Marco A. Bologna

In recent years, Italian zoologists had to face a new approach to faunistics, aimed not only at basic knowledge, but also at the conservation of animal diversity of Italy. The European Union requested to build a network of areas in Europe devoted to the conservation of threatened habitats and species. As a consequence, several projects were developed: 1) the production of a *Checklist delle specie della fauna italiana* (see Minelli et al., 1995), which includes a collection of synthetic information which are essential to estimate the animal diversity of Italy; 2) the project *Natura 2000*, together with its extension at national level, the project *Bioitaly* (La Posta, 1999; D'Antoni et al., 2003); 3) the project *CK-map* which, when completed, will produce a very large and updateable database of Italian fauna; this database already includes more than 548,000 records referring to several of the species listed in the *Checklist of the Italian fauna* (discussed in this volume). Even if the scope of these projects differ, they are linked and aimed at the production of new and more objective tools for management of the Italian natural resources and biodiversity. The SIC (with the addition of SIN and SIR) and the network of protected areas, together with a good knowledge of faunal diversity and its distribution (managed with modern GIS systems), promote and sustain protection and management plans. These plans would then be based on precise and detailed knowledge not only on some target species, as it was the case in the past, but also the faunistic and zoocenotic complex of each area of Italy. Specific initiatives of the Italian Ministry for the Environment and Territory promoted studies going beyond faunistics: these studies provided information on conservation and preservation of populations of some groups of Italian fauna (mostly vertebrates), and defined the genetic diversity for some taxa (see Bologna, La Posta, 2004). As a result of all these studies, it emerged that the priorities in conservation plans for Italian fauna at local and national scale, had to be defined. Some of these initiatives need to be briefly discussed.

First, the species listed in the European directives, such as the Habitat and the Bern Directives, were chosen following the criteria of conservation at continental level, which does not always correspond to the Italian needs: the number of threatened species in Italy is higher than the ones listed, and while some of the species listed in the appendices are not at risk and are well-distributed

in Italy (for instance, the two moths *Callimorpha quadripunctaria* and *Eriogaster catax*), other species which are highly endangered in Italy (for vertebrates, the Parsley frog, *Pelodytes punctatus* and the Ocellated lizard *Timon lepidus*) are not listed because they are common in the Iberic Peninsula and in France. Several researchers realized that the need for conservation must be evaluated not only on the basis of the global distribution of a species, but often at population levels, or at the national scale. This problem was only marginally mentioned in the Habitat Directive, when describing the different risk level for the European populations of *Canis lupus*.

The program *Bioitaly* collected information among Italian specialists on the species in need of conservation, and a temporary list of species which was supposed to be submitted to the European Union for inclusion in the Appendices of the Habitat Directive, was prepared. The heterogeneity of the criteria used to include the species in the list was a limit, and the lack of precise and objective knowledge and universal criteria was recognized. Even the recently published Red Book of Italian vertebrates (Bulgarini et al., 1998), is based primarily on personal experiences and considerations of some specialists. Some regions or autonomous provinces published partial lists of species which are endangered at a local scale (for instance: AA.VV., 1994; Sforza, Bartolozzi, 2001), but those reports were not always accepted by the taxonomic specialists, or they were biased by subjective evaluations.

All these considerations suggested that a fundamental objective is the compilation of a national Red List and local lists, based on two criteria: (a) presence of detailed faunal information, provided by taxonomists specialized in each group, who have updated information at the local and national level; (b) use of valid, shareable and explicit criteria to choose the species and categorize their risk level. The Italian Ministry for the Environment and Territory formed a Scientific Committee to address this objective. Regarding point (a), the general knowledge of the Italian fauna was presented in the *Checklist delle specie della fauna italiana* (Minelli et al., 1995), and its upgrade now in progress, where the total species of Italian fauna are estimated to be more than 58,000. This high diversity is due to the location of Italy in the Mediterranean basin, its biogeographic history, and its habitat heterogeneity (due to the orography and geography of Italy). Faunistic and

taxonomic studies are continuously in progress, monographic works on single groups are regularly published in the series *Fauna d'Italia*, and research papers are published on national and international journals. Thus, the ecology and zoogeography of Italian fauna are at present well outlined (Minelli et al., 2002). In recent years, the database *CKmap* and its GIS maps collected tens of thousands of faunal and ecological data, pertaining to the past and present distribution of most of Italian taxa. The future completion of the database with data for all Italian species will provide an interpretative and applicative tool, which will be used for numerous purposes, and will improve the above-mentioned need to know the actual distribution of animal taxa in our country. In this way, it will be possible to evaluate the size of entire ranges (for endemics) or Italian sub-ranges, the number of stations known for each species, and their ecological distribution in Italy. Studies on the chronogeonomy, (i.e. recent changes in distribution, which can be conducted because museums possess data from the last 100-120 years) and populations microdistribution will allow the evaluation of rarefactions, or range contractions or expansions. Regarding point (b), problems related to rarefaction and extinction of Italian fauna, and the need for its conservation were discussed in recent essays (Bologna, 2002; La Posta et al., 2002) where the necessity of continuous populations monitoring was highlighted as well. In fact, species which appear to have a good conservation status can suddenly and dramatically decline at local or general levels, one reason being the introduction of competing exotic species, in synergy with the reduction of suitable habitats (this is the case, for instance, of the European Terrapin, *Emys orbicularis*). In some cases populations which seemed to be declining or risking extinction, were in fact undergoing irregular density fluctuations (for instance, among beetles, *Carabus olympiae* and *C. cavernosus*). Other taxa can be quickly expanding, for unknown reasons, such as the Jackal, *Canis aureus* and the Collared Dove *Streptopelia decaocto*, or they can be dispersing only occasionally (the Common Genet *Genetta genetta*). On the opposite, evident factors such as climatic changes (global warming) can cause a quick dispersion of some species, as has happened for thermophile species of different groups (i.e., the butterfly *Danaus chrysippus*). Because of these reasons, objective criteria to categorize the level of risk have not yet been defined. It is still not clear at which level (national or local) risk assessment should be generated, because the results could be very different (see above). In the following paragraph, we propose and discuss some criteria aimed to render the risk assessment of Italian fauna as objective as possible. Obviously, the classification of risk levels obtained in this way must correspond to the IUCN international classification, which was already produced for several Italian species, primarily of vertebrates.

Risk assessment at national levels requires the creation of a scale of risk levels, based on the sum of scores of the following population features (listed as decreasing values) which are based on their zoogeography and ecology: 1) endemic species, with puntiform or very restricted distribution, often K-selected, stenoecious and with numerically reduced populations, endangered by human activities in their ranges; 2) endemic species, with restricted distribution, stenoecious and with numerically reduced populations, potentially endangered by potential or nearby human activities; 3) endemic species or subendemic, with very restricted distribution in Italy, with numerically reduced populations, stenoecious or at least specialized for relict habitats, or for habitats subjected to anthropic pressure; 4) species with distribution in contraction, represented in Italy by few individuals or few populations particularly if fragmented, and which are potentially or actually in rarefaction (even if this last characteristic is not experimentally tested); 5) species not in contraction over the general area, but present in Italy with few populations which could be in rarefaction (even if this last characteristic is not experimentally tested); 6) species endemic to Italy with no apparent reduction of populations; 7) species with wide or narrow distributions, with abundant populations, but with some specialization of its ecological niche, particularly if associated with habitats in contraction in Italy.

We gave more importance to some features (such as endemism), which can be important discriminant factors if evaluated together with ecological and population features. The degree of ecological specialization is important as well, in fact some habitats such as wetlands and littoral dunes (and the zoocenoses living there) are at high risk in Italy (Bologna, 2002), a problem already stated in the Habitat Directive.

La Posta et al. (2002) already reported that 292 species of invertebrates are listed as endangered in the *Checklist* (Minelli et al., 1995): 18 Nematoda, 31 Mollusca, 34 Crustacea, 9 Blattaria, 91 Orthoptera, 19 Plecoptera, 18 Odonata, 11 Coleoptera, 23 Diptera, 26 Lepidoptera, 8 Tardigrada, 1 Phasmida, 1 Heteroptera, 1 Ephemeroptera, and 1 Homoptera. Only a few of these species were already included in the Habitat Directive, and they actually represented a small number when compared to the list proposed by Italian specialists in the project *Bio-italy*. Three hundred sixty-one species and subspecies on the 450 Italian ones are listed in the Italian WWF Red Book (Bulgarini et al., 1998), indicating a deeper level of knowledge; some of these species were already listed in the Appendices of the Habitat Directive. Thus, data provided by the database produced in the project *CKmap* allow for a more precise and detailed evaluation, which takes into account invertebrates, a group often neglected. When the database will be completed, it will be used for management, and for the compilation of a *National*

Red List. The brief examination of the invertebrates that have been classified as endangered or vulnerable in the *CKmap* project, presented below, shows the importance of this database:

Gasteropoda	7
Bivalvia	2
Hirudinea	3
Arachnida	30
Crustacea	75
Ephemeroptera	40
Odonata	16
Orthopteroidea	188
Plecoptera	79
Heteroptera, Homoptera	27
Coleoptera	684
Neuropteroidea	10
Diptera	95

Trichoptera	2
Lepidoptera	32
Hymenoptera	8
Vertebrata	63

It is evident how this list, however limited to some groups, underlines previously undetected needs of conservation particularly for several invertebrates. The conservation of invertebrates primarily implies the protection of habitats to which the species are associated, more than a direct action on the species (which is a more effective approach for vertebrates). In conclusion, the key to compile a *National Red List* and local lists as well, is to associate the risk criteria at different geographical levels to the evaluation of the faunistic knowledge obtained from the *CKmap* project. These so-compiled lists should be used to provide recommendations for conservation actions at the local and national level.

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Strategies for the conservation of the Italian fauna

Eugenio Dupré, Fabio Stoch

Premise

One of the most crucial problems facing mankind is the human-induced extinction of species (UNEP, 1992). The conservation of biodiversity in general, and of animal diversity in particular, cannot be achieved without a good base-knowledge of what we need to protect. For instance, at present we do not know how many species live on our planet, not even approximately (May, 1990), nor do we know the patterns of biodiversity and endemism (Minelli et al., 2005; Stoch, 2005), the historical factors which produced those patterns (Minelli et al., 2005; Stoch and Vigna, 2005), and the ecological factors which maintain and modify them (Brandmayr et al., 2005a). The projects “*Checklist of the species of the Italian fauna*” (Stoch and Minelli, 2004) and “*CKmap*” (Stoch, 2004a), described in this volume, represent an important base of knowledge needed for the conservation of biodiversity in Italy. These projects provide a detailed analysis of the fauna of our country, and of the distribution patterns of more than 10,000 species; the projects represent the first steps to prepare an appropriate strategy of biodiversity conservation. The scope of this contribution is to analyse in detail the knowledge which these projects provide for conservation, how this knowledge can be integrated into legislation, and finally how it can be used to identify conservation strategies for the Italian fauna.

Legislative tools

So far, legislation has dealt with the conservation of Italian fauna from two complementary aspects: the species protection, and the protection of the territory or the habitats where those species live. The reference framework is represented by international conventions, such as Rio Convention on Biodiversity, Bonn Convention, Bern Convention, and Barcelona Convention. The first represents the framework for all aspects of biodiversity conservation; Bonn Convention refers to the conservation of all migratory species, because their conservation is strongly related to transnational conservation measures; Bern Convention applies to European countries and protects a specific list of animals and plants. Finally, the Barcelona Convention gives an integrated approach to the conservation of species and habitats of the Mediterranean basin, with particular emphasis on marine habitats. The Directives “Birds” (79/409/CEE) and “Habitat” (92/43/CEE) give the protection regulations for the European Union as derived from the above-mentioned conventions. The two directives complement each other, and

have the objective of preserving a long list of habitats and of animal and plants, chosen among the most relevant for the conservation of biodiversity in Europe. Following what was stated in the international conventions and the recent methodological approach to conservation, the protection of species is obtained by direct and indirect actions; the latter guaranteeing the conservation of the species’ habitats. Several conservation actions have been identified, such as the limitations and ban on specimens uptake, and the identification of areas which need to be protected in order to preserve or restore those habitats available for the target species.

The Bird Directive (79/409/ CEE) was applied in Italy with law no. 157 11 February 1992, named “ “Norme per la protezione della fauna selvatica omeoterma e per il prelievo venatorio”. The Habitat Directive (92/43/CEE) was applied with the Presidential Decree no. 357, 8 September 1997, named “Regolamento recante attuazione della direttiva 92/43/CEE relativa alla conservazione degli habitat naturali e seminaturali, nonché della flora e della fauna selvatiche”; modified and completed by the Presidential Decree no. 120, 12 March 2003.

Law no. 157 and Presidential Decrees n. 357 and 120 represent the main national laws for the conservation of Italian fauna. The legislation gives more relevance to mammals and birds: in fact the interest toward homeothermic fauna derives from their importance for sport hunting, and from a larger interest to the “higher-ranked” fauna. In contrast, it must be noted that only a very small amount of the remaining animal species is protected, even if fishes, amphibians, reptiles, and invertebrates represent the great majority of Italian fauna: if we exclude mammals and birds, only those species listed in the appendices 2, 4, and 5 of the Habitat Directive are protected in Italy (D’Antoni et al., 2003).

A law which includes all the aspects linked to the protection of fauna, and not only to its exploitation by hunting and fishing, has been in progress for several years. The scarcity of national laws is balanced by regional and provincial conservation laws for fishes and “low-ranked” fauna. Those laws are not equally distributed in the legislation of all regions, but they are well present. The regions establish laws to rule fishing and, as a consequence, they provide legislation for the protection of inland-water fishes. Finally, there are a number of regional laws which define conservation tools for species which otherwise would not be protected.

As a consequence, with the exclusion of the laws on fish-

ing and hunting, the protection of fauna depends on the establishment of protected areas. The law on protected areas no. 394, 6 December 1991, defines a system of protected areas which are established with various scopes, included the conservation of fauna. Those areas, identified within the Bird and Habitat Directives framework, are tools for conservation of fauna on a large scale of Italian territory. For each project which might negatively affect the habitats or those species for whose protection the habitat was selected, an impact assessment is required, as it is required to operate all the measures which guarantee a satisfactory preservation of the same habitats and species.

The SPA (Special Protection Areas) established according to the Bird Directive and the SCA (Special Conservation Areas), which are established starting from the SCI (Areas of Interest for the EU) according to the Habitat Directive, represent the Nature 2000 Network. In Italy this network is composed by at least 503 ASP which cover about 2,500,00 hectares (8% of the national territory) and by 2,256 SCI which cover about 4,400,000 hectares (14% of the national territory). Over all, the Nature 2000 Network covers about 5 millions hectares, representing almost 17% of the national territory, because several ASP coincide or overlap with the SCI. The Nature 2000 areas widely overlap with the protected areas established by Law 394/91 and together represent a very efficient tool for the conservation of Italian fauna.

Knowledge and conservation priorities

The knowledge needed for the protection of fauna are numerous, and can be grouped into two main categories:

1) Knowledge of the intrinsic value of fauna. This category includes: national fauna databases such as the “*Checklist of the Italian fauna*” (Minelli et al., 1993-95; Stoch, Minelli, 2004) and the database “*CKmap*” (Stoch, 2004a); local databases of various institutions such as regions, provinces, museums, and research organizations; results of monitoring plans developed by Autonomous Regions and Provinces, and monitoring plans still in progress (such as those proposed in section 17 of the Habitat Directive, and the indicator monitoring plan which will be proposed by the EEA by the 2010 target date of the Biodiversity Conservation (UNEP, 1992)).

2) Knowledge of the faunal risk index. This category includes the Red Lists, the environmental data resulting from air, water, and soil quality monitoring (under the jurisdiction of the Regional Agencies for Environmental Protection), and the results of the preliminary research carried out by the APAT (Agency for Environmental Protection and Technical Services) for the redaction of the Nature Maps (law 394/1991).

This knowledge is used to define priorities for faunal conservation, which is one of the objectives stated by the Convention on Biodiversity (UNEP, 1992). This con-

vention was signed by most of the world nations, and defines as its objectives: “to conserve the sustainable use of biological diversity for the benefit of present and future generations”. So far only limited objectives have been reached, such as the actual protection of part of the biodiversity of a nation by using protected areas (in Italy this occurred with the application of Law 394/1991 and the implementation of the Nature 2000 Network). However, according to the Convention on Biodiversity, a multiple approach should be preferred, including (UNEP, 1992): 1) the gene level; 2) the species level, including the use of taxonomy (the Global Taxonomy Initiative within the Convention); 3) the ecosystem level; 4) the integrated approach, i.e. including significant economic, social and cultural information besides the biological criteria.

The Habitat Directive strongly modified the meaning of conservation in Italy (Balletto, 2002): beforehand, every conservation action was based on the ecosystem approach, whereas now it is based mainly on the habitat and species approach.

Criteria used to attribute a conservation value to fauna

The *CKmap* project is a tool for a species-level approach to the definition of the priorities for the conservation of fauna. In fact, the definition of priorities requires the use of standard criteria to attribute its conservation value to a species or to a group of species. Given the complexity of biodiversity, the number of possible criteria is very high, but only a small subset is commonly used. These criteria can be grouped into two categories: biological and anthropic (social, economic, normative). In this volume we dealt with criteria of the first kind: species richness (Stoch, 2005), endemism (Minelli et al., 2005), rarity (Stoch, 2005), chronogeonomic evolutionary trends (Brandmayr et al., 2005b) and species risk (Bologna, 2005). Other criteria could be added: taxonomic distinctness (how much a species is distinct from the rest of the community on the basis of its systematic position), the representativeness (related to the concept of “umbrella species”), and the ecological function (related to the concept of “keystone species”). The records of the *CKmap* database allow to obtain updated information, although still incomplete, to apply all these criteria.

From the above-mentioned works, the criticism to the biodiversity concept as an operative tool emerges. It is well-known that the biodiversity of a given territory and of its hotspots (Myers, 1988), which are usually estimated mainly on the basis of species richness of some of the taxa living in the area, is an appropriate tool to establish conservation priorities. Unfortunately high biodiversity values (i.e. high species richness hotspots) are often derived from the presence of numerous common species; moreover, the hotspots of different taxa sometimes do not correspond, precluding the identification of indicator species and um-

brella species. Finally, several endemic and rare species are not present within the biodiversity hotspots (Prendergast et al., 1993). As a consequence, the rarity and endemism criteria should be used and complement each other (Minelli et al., 2005; Stoch, 2005), especially when the biogeographical relevance of a species or a group of species is added (Stoch and Vigna, (2005).

The need to use species with the same taxonomic value when using species richness for conservation represents a further problem. In other words, using of only the concept of biodiversity requires all the species having the same value for conservation, and all having the same weight when selecting priority areas. This paradox can be solved by giving to some species a different value which should be defined on the basis of the rarity and endemism of the species, and also its taxonomic distinctness and ecological function. In particular, taxonomic distinctness is often neglected by conservationists: the protection of a species which is the sole living representative of a genus, a family, or a higher taxon, contributes more to faunal conservation than the protection of a species with numerous related species, for instance of the same genus (Williams et al., 1991).

The concept of ecological function is commonly used and it is based predominantly on the trophic role of a species. The *Checklist* is the tool to quantify the taxonomic distinctness of a species, the database *CKmap* provides the necessary information regarding the trophic role and habitat preference of the species.

Finally, a criterion widely used in the recent years by conservationists to define priorities and optimal strategies of conservation, and so far rarely applied in Italy, is the "complementarity" criterion. This criterion is used to select those areas (and therefore the group of species living there) that, combined together, better represent and allow to preserve the biodiversity of a nation. To explain this concept, consider an area (for instance a cell of the UTM grid 10x10 Km) which includes species A, B, and C, and another area which includes species C, D, E: the second area "complements" the first one with the species D and E. In this way, it is possible to identify a minimum set of areas that include the highest possible number of species, reducing the duplications to a minimum. This approach is today widely used (Williams, 2001) and can be based on the distribution data presented in the *CKmap* database. Unfortunately this method, however correct from a mathematical point of view, does not consider the intrinsic value of the species in the selected area.

Future developments: towards an integrated conservation strategy

The knowledge needed for faunal management, with the first step represented by the *Checklist* and the database *CKmap*, will have to be completed in the future to make it effective and for its uses. In particular, besides the completion of the base of knowledge, obtained by adding the distribution data of as many species as possible, it will be necessary to develop the following points:

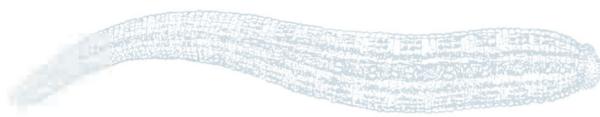
1. Use appropriate models and select a set of taxa which would represent "surrogates" for the protection of biodiversity in the widest sense possible, including rare and endemic species ("biodiversity indicators": Stoch, 2004b).
2. Fill the gaps in the knowledge of the distribution of the indicator species using stratified sampling by habitat. This kind of data is essential to obtain updated and correct distributions: they cannot be extrapolated using models based on areals and habitats of the species most valuable for conservation (Brandmayr et al., 2005a). The development of gap analysis is necessary for the most widespread taxa and for those with wide ecological preferences.
3. Identify the most representative areas (complementarity, hotspots) of the Italian territory that can optimise the conservation of biodiversity. The definition of a hotspot (based on species richness, or for endemism, species rarity, or high conservation value) does not necessarily require the institution of a protected area, but of a territorial asset plan, with the ultimate realization of the National Ecological Network (whose phytoclimatic and vegetational background are already completed: Blasi et al., 2004).
4. Realize a national Red List of the Italian fauna (Bologna, 2005) which would complement the "status" criteria with "risk" criteria, and would allow a selection of priority species for conservation plans (IUCN, 1984).
5. Finally, to combine faunal data with vegetational, ecosystemic, socio-economic and cultural data, and thus provide an integrated approach which would overcome the limitations of the actual models, and would allow to develop the National Biodiversity Plan. With this plan, Italy would follow the other nations which signed the Convention on Biodiversity (UNEP, 1992); to be effective, the plan would have to be transformed into legislation and integrated with existing laws.

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Taxonomic section

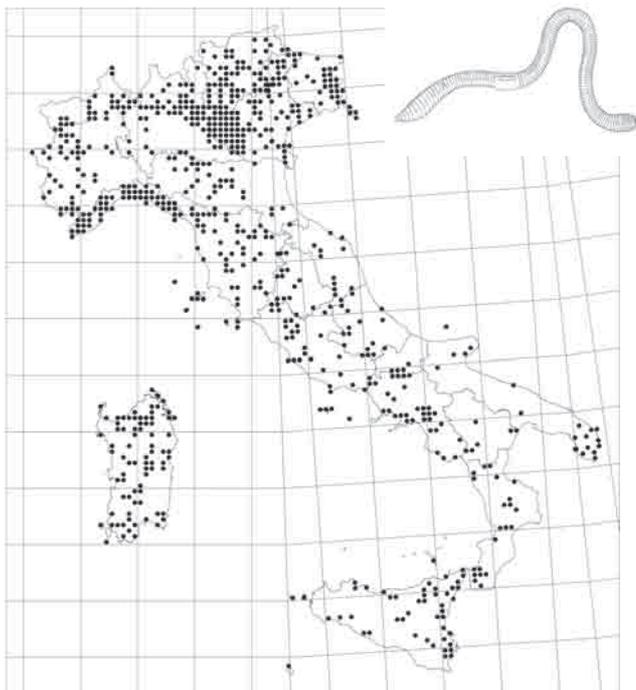
Annelida
Mollusca
Arthropoda
Chordata





Annelida Oligochaeta

Pietro Omodeo, Emilia Rota, Beatrice Sambugar



Oligochaeta form a class of the phylum Annelida, of which they share the basic characteristics although they possess the following peculiarities: 1) a clitellum, i.e. a sleeve of glandular epithelium that secretes a cylindrical cocoon which is then modelled into a globular, fusiform or flattened structure; eggs and sperm are discharged separately into this structure and produce embryos which develop directly into juvenile worms, given the lack of a trochophore larva; 2) hermaphroditism is the rule; 3) the gonads are restricted to 2-4 segments, between the 5th and the 13th. A traditional, convenient classification distinguishes “limicolous” from “terricolous” or “microdrile” from “megadrile” Oligochaeta. These divisions nearly coincide, but the group-names are unsatisfactory due to too many exceptions. Another classification, more recent and less used but closer to reality, is the one that divides the class into “tenuiclitellata” and “crassiclitellata”: the former produce thin-walled cocoons in which mesolecithal eggs develop via epibolic gastrulation, whereas the latter produce thick-walled cocoons in which minute eggs gastrulate by emboly. This division, which coincides with the previous ones, does not reflect phylogeny, since it is believed that the megadriles or crassiclitellata have descended from the Haplotaxidae, a family of primitive microdriles which is also the ancestor of other microdrile families.

Regarding the latter, all families occurring in Italy are treated here except for the Enchytraeidae.

Material and methods

Data on the distribution of megadriles are based on 71 sources from the literature (from Rosa’s monograph on the earthworms of Piedmont (1884) to Rota’s note on the annelids of the La Verna (1997)) and on unpublished material from collections (P. Omodeo collection; collection of the Natural History Museum of Genoa), which account for 12% of records. The collection used by Paola Barenghi for her graduation thesis (1982) has since been revised (Omodeo & Rota, 2004).

As far as the microdriles are concerned, the basis of all data were the works on the Italian freshwater Oligochaeta, starting from those by Garbini of the end of the XIX century, and many unpublished data from studies carried out by the third author (B. Sambugar collection).

Biodiversity

Data on the megadriles document the presence in Italy of 7 families (Criodrilidae, Hormogastridae, Lumbricidae, Megascolecidae, Ocnerodrilidae, Acanthodrilidae, Octochaetidae), 24 genera and 93 species. Lumbricidae account for 87% of the species, half of which belong to the genera *Octodrilus* (19), *Allolobophora* (12) and *Dendrobaena* (9). The status of *A. rosea*, a taxon including many genomic mutants that often occur together and show various degrees of reduction of the male and copulatory organs, is not comparable to that of a single species; the same can be said for *Dendrodrilus rubidus*. Therefore, it is convenient to indicate such taxa as complexes. The greatest species richness can be found in the Eastern Alps and Prealps, as well as in the Maritime and Ligurian Alps. The former harbour 45 species, some ubiquitous, some endemic and some of Balkan origin. The latter harbour 46 species, some ubiquitous, some endemic and some of Provençal origin. The fauna inhabiting the Po Plain and north of the Po up to the morainic hills (14 species) is rather poor: intense agriculture and the use of pesticides, deep ploughing and heavy farm machinery is reducing the number of species further yet. As for the rest of the peninsula and the islands, the faunas of Tuscany, Latium, Campania, Apulia, Sicily and Sardinia are well-known and diversified (Tuscany alone hosts 32 species), whereas those of Umbria, the Marches, Basilicata and Calabria (each with 10-15 species) appear to be poorer, partly because they are less studied. The



Italian earthworms fauna is altogether poorer than the French, Balkan and even Iberian faunas (Rota, 2004) all regions which are geologically older than Italy (Sardinia excepted) and were also spared by the glaciations.

The Italian freshwater fauna, within the six considered families (Lumbriculidae, Haplotaxidae, Tubificidae, Naididae, Parvidrilidae, Propappidae), comprises 101 species belonging to 39 genera. Naididae and Tubificidae are dominant, the first with 48 species and the second with 37. Moreover, in water environments it is possible to find species of Enchytraeidae which, as mentioned earlier on, are not treated here, and others of Lumbricidae and Criodrilidae. The Italian aquatic oligochaetofauna is rather well known in the north, whereas data regarding the south and the islands are wanting. Consequently, the species distribution outlined so far does not correspond to the real situation except for the Naididae, which have been studied thoroughly throughout the whole country. Recently, studies carried out in subterranean environments in Italy – mainly caves – have brought to the description of new species (Martínez-Ansemil et al., 1997; Sambugar et al., 1999) and to the first record for Italy of the Parvidrilidae (Martínez-Ansemil et al., 2002). The Italian freshwater oligochaetofauna is comparable, in number of species, to those of other European countries, as opposed to the terrestrial fauna.

Ecology

Among the Italian megadriles, *Criodrilus* is primarily aquatic, whereas *Eiseniella*, *Helodrilus* and *Eisenia spelaea* are secondarily adapted to life in fresh water. Some species of Lumbricidae are characterized by wide ecological tolerance. *Nicodrilus caliginosus* and *Allolobophora rosea*, for example, inhabit both Saharan oases and Icelandic pastures and both have been found at altitudes above 2000 m in the Alps. Such a wide tolerance may depend on specialized ecophysiological races, whose existence has been experimentally demonstrated (only for frost-resistance) in *Dendrobaena octaedra*. Resistance to low temperatures is widespread, and animals may be found active under a crust of ice. Less common is resistance to drought, which itself is dependent on the ability to undergo long periods of summer diapause; the large Hormogastridae are the most specialized in that sense. Lumbricidae generally prefer neutral or basic soils, although much variation for pH tolerance exists between species and even between populations. Among the Lumbricidae, many species of *Lumbricus* and most *Dendrobaena* feed on decaying plant material. The latter species live in the litter layer of both broadleaved and coniferous forests together with *Lumbricus castaneus*, whereas *L. terrestris* and other soil-dwelling species come to the surface for foraging, later re-entering the soil through old or new burrows. For this reason, *L. terrestris* and forms with a similar behaviour are called anecic

(from the Gr. *an-oikos* meaning “no home”, i.e. “without a specific habitat”), whereas the others are called straminicolous. *Allolobophora*, *Scherotheca*, *Eophila* and *Octodrilus* species feed on humus without abandoning their burrows, or by doing so only partly, while staying well anchored to the burrow with their robust caudal setae. The large calciferous glands possessed by these species secrete CaCO_3 into the intestine, thus buffering the acidity of the humus. *Pontodrilus* is a megascolecoid genus that lives amongst stranded *Posidonia* seagrass: it has disappeared from many seashores from which it had previously been recorded, but is still frequent along the coasts of Sardinia. *Eisenia fetida* tolerates high concentrations of nitrites and nitrates; its natural habitat is the particular humus (rich in feces of xylophagous arthropods) that accumulates within the cavities of rotting wood, but the species abounds in manure heaps and septic pits. A similar tolerance, though not as extreme, is shown by *Dendrobaena veneta* and *D. hortensis*. All three species are used in lumbriculture and organic composting systems. *Allolobophoridella eiseni* prefers living under tree bark, sometimes together with *Dendrodrilus rubidus*.

Microdriles can be found in all surface and subterranean freshwater environments, even those characterized by various degrees of trophic and by the presence of pollutants. Some species are very tolerant to pollution and extremely low concentrations of dissolved oxygen, and can proliferate out of all proportion downstream of waste water outlets, completely covering the substrate of the water body. During the assessment of the Extended Biological Index (EBI) of water bodies, the finding of a community composed solely of Oligochaeta, at most with chironomid larvae, indicates a high pollution level. Populations of Oligochaeta inhabit even artificial substrates and cleaning filters. Oligochaeta play a key role in the food chain by being mainly detritivorous, and constitute an important food source for invertebrates and fish. Stygobionts occur among the Tubificidae, Lumbriculidae and Parvidrilidae; Enchytraeidae are the most frequent and diversified family in subterranean and spring communities.

Zoogeography

Significant events for the history of the Italian megadrile fauna were the following: the drift, during the Miocene, of large fragments of the Alboran plate (and its autochthonous fauna) through the western Mediterranean; the Messinian transgression, during which most of the Mediterranean dried up and the species most resistant to long periods of drought were able to colonize the Tyrrhenian lands; the Quaternary glaciations, which allowed other species to cross areas that are now stretches of sea. The first event caused the Sardo-Corsican fauna to be essentially related to the Catalan and Provençal ones (e.g. the Hormogastridae, *Eumenescolex* (once *Eiseniona* partim), *Scherotheca* and *Proselodrilus*). The second event



caused a flow of species from the Sardo-Corsican system and the Near East to the other Tyrrhenian islands and the western and southern coasts of the Italian peninsula: *Hormogaster redii*, *H. samnitica*, *Scherotheca corsicana*, *S. targionii*, *S. januaeargenti*, *Allolobophora jassyensis*, *Dendrobaena pantaleonis*, *D. byblica* and maybe other *Dendrobaena*. The alternation of glaciations and warm periods, having caused the retreat of vast forests towards the south, followed by the return (northwards) of populations of litter-consuming Oligochaeta, explains today's discontinuous (so-called "leopard-spot") distributional areas of *Dendrobaena alpina*, *D. attemsi*, *D. veneta* and *D. hortensis*, all originally from Asia Minor (and the Balkans) and spread out along their way to Scandinavia.

Definitely endemic taxa are: (1) the subfamily Diporodrilinae from the Sardo-Corsican system, with three species of *Diporodrilus* living in southern Corsica, in Gallura and along the Sassari coast (Sardinia); (2) the genus *Eumenescolex* (once *Eiseniona partim*) from the Sardo-Corsican system and the Côte des Maures, with one endemic species in Sardinia, one in Corsica and one near Toulon; (3) *Proselodrilus festai*, endemic of Sardinia and known from one locality near Tunis; (4) *Octodrilus hemiandrus* and *O. damianii*, which occur along the Tyrrhenian coasts from the province of Savona to northeastern Sicily; (5) *Scherotheca targionii*, a probable descendant of *S. corsicana*, which is abundant on the Elba island, on the palaeo-islands of Tuscany and in part of the Maremma area, also in Tuscany; (6) *Eophila tellinii*, *E. asconensis*, *Microeophila marcuzzii* and many species of *Octodrilus*, which are endemic of the Alpine arch.

The species of microdriles occurring in Italy generally have wide distributional areas (Palearctic, Holarctic or Cosmopolitan), although Italian endemics are not altogether lacking, and have been found in subterranean environments. There are three such species: *Rhyacodrilus dolcei*, known of a cave in the province of Trieste; *R. gasparoi*, found in two caves in Friuli and one in Piedmont; *Akteredrilus ruffoi*, found in a spring in the Verona plain. Also, two endemics of the Italo-Slovenian karstic system are known: *Haber monfalconensis*, from the subterranean waters of Friuli Venezia Giulia and from two Slovenian caves, and *Sketodrilus flabellisetosus*, found in the subterranean waters of the same karstic system. The recent finding in Italy of *Parvidrilus spelaeus*, a new species of Parvidrilidae, a family previously known only from subterranean habitats of North America, expands the distributional area of this family to Europe. Moreo-

ver, because of ancestral features partly shared with the Gondwanian family Phreodrilidae, these families may have evolved from a common ancestor when Laurasia and Gondwana were separated by the Tethys sea. The findings of *Akteredrilus ruffoi* and *Abyssidrilus cuspis* (both belonging to marine genera) in Italian subterranean waters, together with other similar findings in Europe, indicate for some taxa that originally meiobenthic marine species may have colonized freshwater habitats through progressive adaptation to conditions of lower salinity.

Alien species

A typical feature of the Oligochaeta is the invasive power shown by a few species in almost all families. An example among the megadriles is the "odd couple" *Microscolex phosphoreus* and *M. dubius*, two Acanthodrilidae of South American or South African origin that have reached, since about 200 years ago, all the coasts of the Mediterranean including the small islands. *M. dubius* is the only parthenogenetic diploid species of the whole class Oligochaeta, whereas *M. phosphoreus* is an amphigonic diploid species. The introduction of the African *Ocnerodrilus occidentalis* may be as ancient as that of rice, whereas that of another Ocnerodrilidae, the originally South American *Eukerria saltensis*, is much more recent.

The invasive species of the *Pheretima* group (*Amyntas corticis*, *A. morrisi*, *Metaphire californica*, etc.), though of wide ecological amplitude, still prefer warm monsoon climates; thus, in Europe, they frequently occur mainly in greenhouses, and to a much lesser extent in well-irrigated cultivated areas. An opposite situation has been observed for some small-sized Octochaetidae of Ethiopian origin (*Dichogaster bolauj*, *D. annae*, *D. modiglianii*, *D. saliens*) which, after having been introduced together with tropical plants, have colonized the lukewarm sewage of many Scandinavian towns. In Italy only one of these species has been recorded: *D. modiglianii*, from the thermal water gutters of Abano in the province of Padua.

Conservation

All the endemic microdriles live in groundwater habitats, so it is very important that such environments should be preserved in order to protect their biodiversity. Particularly endangered habitats are the interstitial and phreatic ones of the Po Plain, due to the pollution of water bodies and to the strong anthropogenic disturbance present in the area.



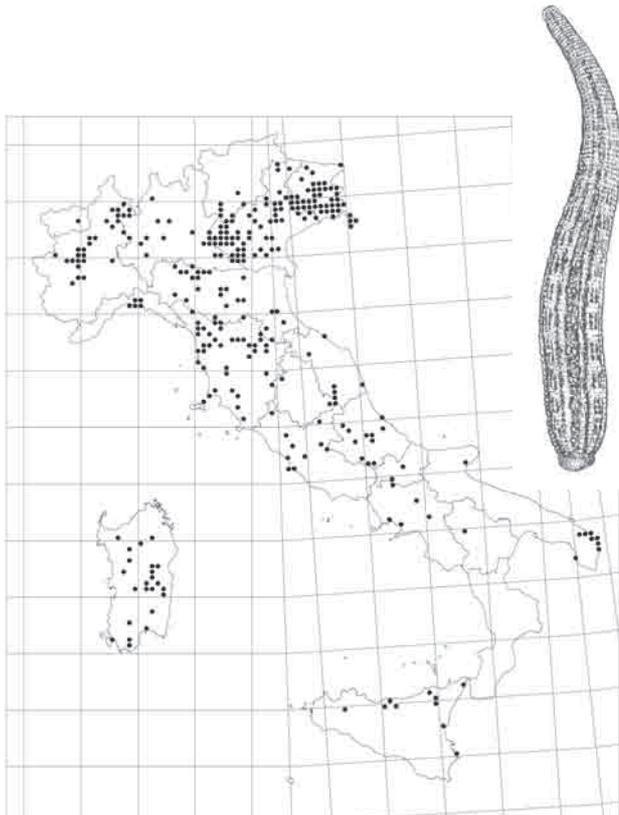
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Annelida Hirudinea

Alessandro Minelli



Hirudinea are a group of Annelida that are mainly found in freshwater environments, and include only a few marine or terrestrial species. General knowledge on the Italian Hirudinea is still patchy, both from a taxonomical (recent work carried out in other European countries, also using molecular techniques, has brought to the reevaluation of some nominal species having already undergone synonymization) and distributional point of view. The most problematic genera are *Glossiphonia*, *Piscicola*, *Hirudo* and *Dina*.

Material and methods

The filed data are based on the literature, particularly on Minelli's synthesis (1979a) and following papers, although unpublished records have also been included. Data on *Dina punctata* and *Hirudo medicinalis* must be considered as tentative, due to unsolved systematic problems.

Biodiversity

In the Italian fauna, terrestrial Hirudinea occur in one family only, the Xerobdellidae, with 2 species belonging to the genus *Xerobdella*. Instead, in freshwater habitats 5 families, 16 genera and at least 23 species are represented. This is a relatively poor fauna compared to those

of the Balkan peninsula and of central-eastern Europe, a situation that is in line with those of the respective fish faunas. In Italy, specific diversity decreases from north to south; only 4 and 8 species are known from Sicily and Sardinia, respectively.

Ecology

The terrestrial leeches of the genus *Xerobdella* live under stones and in the litter layer of beech woods and broad-leaved mixed woods, where they feed upon earthworms. The freshwater species are mainly found in surface waters, in both lotic and lentic environments. The non-marine species of Piscicolidae, ectoparasites of fish, are confined to running waters, and the same habitats are preferred by some species of Glossiphoniidae, which also inhabit the macrophytic belt of lakesides. Other species are more frequent in smaller water bodies. *Trocheta* species prefer the cold waters of mountain streams, but are not stenoxymbiotic. Populations of *Trocheta* and *Dina* have colonized subterranean waters, where one can also find (though only in Sardinia) *Batracobdella algira*, a parasite of the cave-dwelling newts of the genus *Hydromantes*.

Certain Glossiphoniidae feed on the body fluids of invertebrates, while others are temporary ectoparasites of amphibians, turtles or aquatic birds. Hirudinidae mainly feed on mammal blood, whereas Haemopidae and Erpobdellidae are predators, mainly of insect and crustacean larvae.

Leeches are usually preyed upon by fish, amphibians, marsh birds, as well as by large aquatic hemipterans, dragonfly nymphs and also other leeches.

Freshwater leeches are usually euryecious, showing a preference for beta-saprobic conditions, and are of little interest as bioindicators. At most they can be used for the zonation of large water bodies, in the same way as fish faunas are used.

Zoogeography

Of the two terrestrial species, one is an Italian endemic from the Prealpine belt between the Lessini Mountains and Carnia, the other has a wider distribution, although it is limited to the mountains of north-eastern Italy, Austria and Slovenia.

The freshwater species have wider distributional areas, and some reach outside Europe's boundaries. So far it has been difficult to evaluate the zoogeographic significance of *Italobdella ciosi* (known only from the river



Alessandro Minelli

Adda, but of uncertain taxonomical value) or of *Hirudo verbana* and *Erpobdella punctata*, only recently re-valued as valid species and in all likelihood more widespread, in various European regions, than is reported in the literature.

Alien species

The absence of Italian records for *Piscicola* prior to 1930 could justify the suspicion that they may have been introduced, possibly together with fish from foreign basins or rearing places. Should this suspicion be confirmed, it could also be extended to the Piscicolidae described in 1993 as *Italobdella ciosi*.

Relevant Literature

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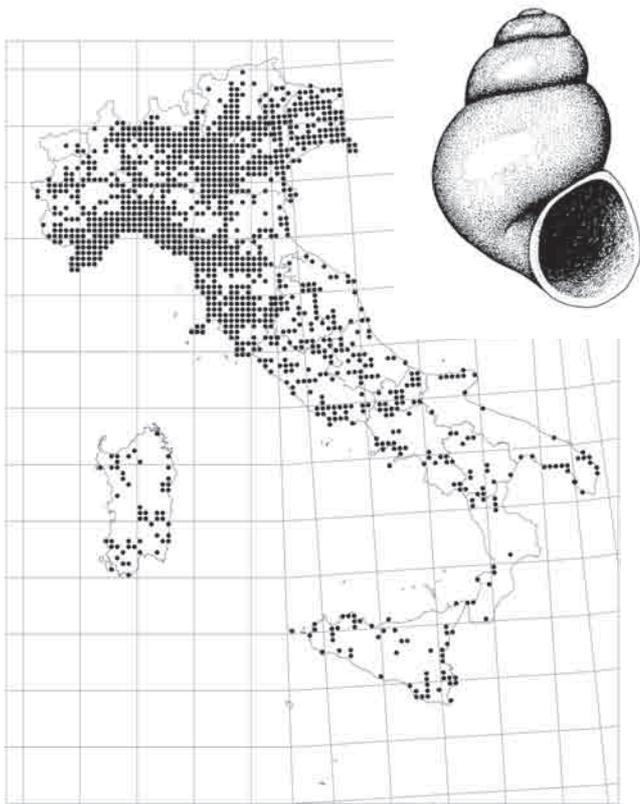
Conservation

The only Italian leech for which a significantly (or rather, dramatically) negative trend has been recorded is *Hirudo medicinalis*. Unfortunately, a reconstruction of its original distributional area and of the variation of the latter during the nineteenth and twentieth centuries is practically impossible. This because of the scarcity of correctly dated records, the non-distinction – until the present day – between *H. medicinalis* and the related *H. verbana*, and the possibility that some populations may derive (or may have derived) from leeches imported from other areas, according to the medical demand of the time.



Mollusca Gastropoda Prosobranchia and Heterobranchia Heterostropha

Marco Bodon, Simone Cianfanelli, Giuseppe Manganelli, Enrico Pezzoli, Folco Giusti



Italian freshwater gastropod molluscs belong to 14 families, 8 of which are in the subclass Prosobranchia (Neritidae, Viviparidae, Thiaridae, Melanopsidae, Bithyniidae, Hydrobiidae, Pyrgulidae, Emmericiidae) and 6 in the subclass Heterobranchia (Valvatidae, Physidae, Lymnaeidae, Planorbidae, Acroloxidae and Ancyliidae). This work is only concerned with prosobranchs and heterostroph heterobranchs (Valvatidae).

The level of taxonomical knowledge is good, except for the Bithyniidae, Hydrobiidae and Valvatidae. In the Hydrobiidae, supraspecific classification and the validity of many taxa described in the past need careful reconsideration. Recent genetic studies on a number of Italian taxa may make rearrangement of species necessary.

The list of taxa discussed was drawn from the Checklist of species of the Italian fauna (Bodon et al., 1995) and subsequent updates (Manganelli et al., 1998, 2000b). Taxa subsequently described or recorded were also considered (Pezzoli & Spelta, 2000; Bodon & Cianfanelli, 2002).

Material and methods

The list of localities was obtained from the literature, museum collections and the authors' collections. Since localities from the literature and from historical collections are often difficult to interpret, only those that could be georeferenced with some degree of certainty were mapped. When the same locality was quoted by more than one source in the literature, only the most recent one was included (especially if the collecting data was more precise than in previous sources), but in some cases only the first record was included (e.g. if the same data was reported subsequently).

Because the literature on freshwater molluscs is so vast, it was not possible to examine and record all papers. Most of the specialist literature was considered, except for a few minor, non-faunistic articles. Non-specialist papers (biological mapping of water bodies, fish mapping, etc.) in which species identifications needed to be checked were not included. As for the main museum collections, unpublished records were chiefly considered. Apart from data on the hydrobiids, which had already been collected and published by one of the authors [EP], it was only possible to record all the data on the other groups from the malacological collections of the Natural History Museum of Florence, the G. Doria Natural History Museum of Genoa, the Tridentino Natural Science Museum of Trento and the Natural History Museum of Milan (where only the specimens from the C. Alzona collection were examined). Finally, much unpublished data was included as a result of field work and observations by the authors and collaborators.

Records for molluscs are often based on empty shells. This may mean that an extinct population is erroneously indicated as present in a certain area. It is difficult to establish whether calcined shells or even apparently fresh ones truly indicate the presence of living populations. Many small-sized species are only easy to find in the debris of streams and rivers; in this case if water courses occupy more than one 10 x 10 km UTM square, it is impossible to be sure that the material was originally from the square in which it is collected.

In general, populations determined only tentatively were not mapped, so as not to include uncertain records. However, in the case of certain species, tentatively determined populations were considered so as not to omit areas already included in the distribution of these species (*Bithynia* cf. *leachii* for Sicily; *Pseudamnicola* cf. *conovula* for eastern Sicily and Calabria; *P.* cf. *moussonii* for



Sardinia; *Iglica* cf. *vobarnensis* for Veneto and *Hauffenia* cf. *tellini* for the Karst). Species exclusive to brackish and salt water were mapped solely with reference to brackish water sites.

Overall, precise mapping was only possible for the hydrobiids, for which many accurate records were available. For lacustrine and fluvial species, many records are vague and cannot be pinpointed. The distribution of many common and euryoecious species of Viviparidae, Bithyniidae and Valvatidae is therefore underestimated.

Biodiversity

The Italian fauna includes nearly a hundred known species of freshwater prosobranchs and heterostroph heterobranchs, most of which belong to the Hydrobiidae. However, this is an underestimate, because many hydrobiids are still being studied and some are still being described. The level of chorological knowledge for northern Italy is high. The freshwater malacofaunas of central and southern Italy and of the main Italian islands have been much less investigated, although recent studies have revealed that they are rich and varied.

Ecology

Many surface water prosobranchs and heterostroph heterobranchs frequent habitats with low or moderate currents, mostly water rich in aquatic vegetation. Many Italian hydrobiids are connected with spring and subterranean water habitats, others with thermal habitats; two species, *Hydrobia acuta* and *H. ventrosa*, only occur in brackish and marine coastal waters.

Zoogeography

A few species, such as the euryoecious ones of the genera *Viviparus*, *Bithynia* and *Valvata*, are widespread; others have smaller distributions. For example, *Sadleriana fluminensis*, *Pyrgula annulata* and *Emmericia patula* – three species with an Alpine-Dinaric chorotype – only occur in the Padano-Veneto area, the first two extending westward to Lombardy and the third originally extending to eastern Veneto.

The hydrobiids of spring and subterranean waters include a high percentage of endemic species. Northern Italy is characterized by a number of Alpine crenobiotic sub-endemic species belonging to the genera *Bythinella* and *Graziana*, which occur with some continuity from the Ligurian Alps to the Julian Alps, especially in the non-glacierized areas. Radiation is richest in subterranean waters. In the Friuli area species of Alpine, Alpine-Dinaric and Dinaric distribution occur, many of which are endemic; they belong to the genera *Hadziella*, *Iglica*, *Paladilhopsia*, *Hauffenia* and *Istriana*. They are replaced by endemic Alpine species of the genera *Bythiospeum*, *Paladilhopsia* and *Iglica* in the central Prealps. The Piedmont area of the Alps is poorer in species, with only a

few endemic and vicariant species of the genera *Iglica*, *Alzoniella* and *Pseudavenionia*, all with very reduced distributions.

The spring waters of the Apennines are colonized by *Bythinella schmidtii*, down to Campania. This species is substituted further south and towards the coast by *Pseudamnicola* species. Very localized endemics of the genera *Belgrandia*, *Alzoniella*, *Pauluccinella*, *Orientalina* and *Islamia* can also be found, as well as an Apennine-Dinaric species, *Litthabitella chilodia*, which only occurs in southern regions. The subterranean waters of Liguria and Tuscany are also rich in endemics, again very localized, of the genera *Alzoniella*, *Avenionia*, *Fissuria* and *Islamia*. Sardinia is the insular region richest in species, with both western southern-European elements and Sardo-Corsican ones. Many are endemics of the genera *Mercuria*, *Moitessieria*, *Sardopaladilhia* and *Sardohoratia*. In Sicily a single, endemic crenobiotic species occurs: *Islamia cianensis*.

Alien species

Potamopyrgus antipodarum (Hydrobiidae) and *Melanoides tuberculata* (Thiaridae) are two naturalized alien species. The former, native to New Zealand and first recorded in Italy in 1961, can now be found in nearly all regions, where it colonizes and densely populates rhithral and spring habitats (Favilli et al., 1998). In the former habitat type an ecological niche was vacant due to the absence of other prosobranchs, but in spring habitats it competes with and become a threat for rare endemics. The latter species is subcosmopolitan and colonizes warm waters; it has mainly established in Tuscany. Other prosobranchs once restricted to northern Italy (*Viviparus ater*, *Sadleriana fluminensis* and *Emmericia patula*), now occur in regions of the Apennines because of irrational fish management involving many Italian water bodies.

Conservation

The main threats are water pollution and eutrophication, destruction and alteration of habitats, indiscriminate captation of water, and introduction of alien species. Many endemics with reduced distributional areas, in spring and/or subterranean waters, are particularly threatened. The exploitation of spring and thermal waters can be a serious risk factor for freshwater prosobranchs such as *Melanopsis etrusca*. Stygobitic hydrobiids are protected against indiscriminate water captation by the fact that they inhabit subterranean networks, although here the principal threat is pollution of karstic aquifers, which in some cases has already caused major groups to disappear. Phreatobitic species that live in the alluvial table along rivers can suffer from disturbance of the river-bed such as digging and removal of gravel, which often drastically reduce the habitats of these spe-



cies, also by lowering the water table. Certain small fluvial basins such as those of the Era, an affluent of the Arno, and the Magra, which host particular endemics, are at major risk.

At present only one species, *Helobia spinellii* (of uncertain validity) has become extinct, and the distributions of others have contracted (Bodon et al., 1995; Manganelli et al., 2000a).

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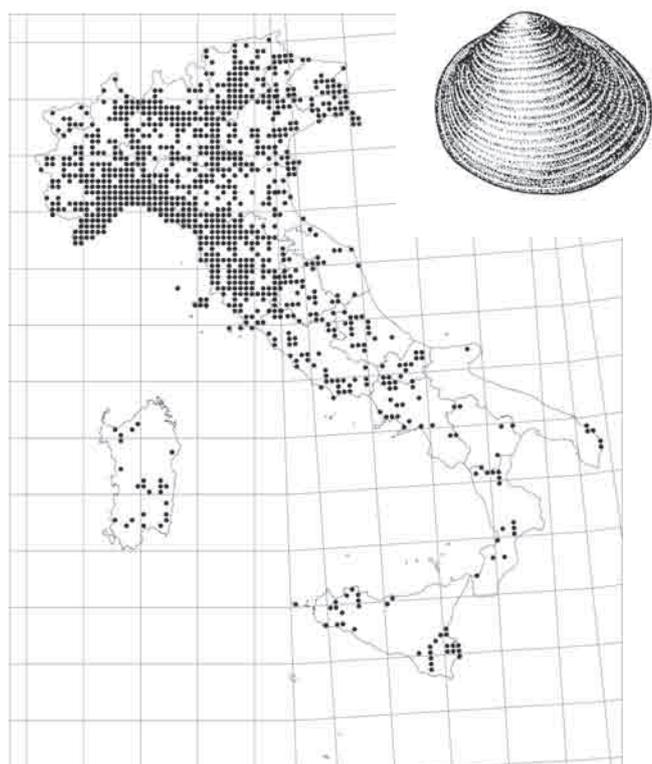
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Mollusca Bivalvia

Marco Bodon, Simone Cianfanelli, Giuseppe Manganelli, Lucio Castagnolo, Enrico Pezzoli, Folco Giusti



Italian freshwater bivalve molluscs belong to five families, two of the subclass Palaeoheterodonta (Margaritiferidae and Unionidae) and three of the subclass Heterodonta (Dreissenidae, Sphaeriidae and Corbiculidae). The list of Italian species is from the Checklist of the species of the Italian fauna (Castagnolo, 1995), and subsequent updates (Manganelli et al., 1998) and additions (Fabbri & Landi, 1999).

Taxonomical knowledge of the Italian freshwater bivalves is generally good, except for *Anodonta*, *Unio* and *Sphaerium* species. In particular, the many recent studies on allozyme polymorphism in *Anodonta* and *Unio* have not yet clarified the relationship between the Italian and European species and have not, therefore, enabled a satisfactory classification of the former. Here, all the autochthonous *Anodonta* are included under a single species (*A. anatina*), whereas *Unio* are attributed to two species: *U. pictorum* (those of the Isonzo basin) and *U. mancus* (those of the rest of the Italy). Finally, in the case of *Sphaerium* the Italian material has been assigned to a single species (*S. corneum*), until a revision clarifies which of the European species recognized today also occur in Italy.

Material and methods

See chapter on Prosobranchia and Heterobranchia Gastropoda for general aspects of method and problems regarding the material.

In the brief time available, it was only possible to consult a selection (more than 350 papers) of the vast literature which nevertheless included most of the specialist literature. In general, uncertain records and doubtful, unreliable identifications were not considered, although it was not possible to assess the degree of reliability of many of the listed records for *Pisidium* species, in view of the problems associated with their recognition. At least in some cases, therefore, the mapped distributions are smaller than those that would be obtained from the totality of records available in the literature.

Biodiversity

The 25 species of bivalve molluscs belong to a limited number of families, each including one or a few species. The only exception is the Sphaeriidae with 17, 15 of which are of the genus *Pisidium*. The Italian fauna is richer and more diversified in the northern regions, though the available data only provides rough coverage, despite the fact that most freshwater bivalve species are common and euryecious. Thus, chorological knowledge is good for some species only, and often in relation to very limited areas of Italy. This is true, for example, of species living in springs and small lakes of northern Italy.

Ecology

Nearly all freshwater bivalves occur in lentic habitats or habitats with moderate current, mainly lakes, the lower sections of rivers, and canals. Some species of *Pisidium*, such as *P. personatum* and *P. casertanum*, show a wider ecological amplitude, also inhabiting small water bodies, high-altitude pools and tarns, springs and even subterranean waters. Bivalves are not particularly sensitive to pollution; some species (*Unio*, *Dreissena*) are bioaccumulators and can be used to monitor pollutants.

Zoogeography

Most species are widespread and there are no endemics in Italy. Only *Microcondylaea compressa* is less widespread, having an Alpine-Dinaric distribution; it occurs in the Padano-Veneto area and along the western part of the Balkan peninsula, as far south as Lake Ohrid. Besides lower species richness, the southern and insular regions are only distinguished by the pres-



ence of *Pisidium annandalei*, a species with Asiatic and East Mediterranean distribution that occurs locally from Campania to Sicily, and by the absence of *Anodonta* on the major islands.

Alien species

Three species were recently introduced: *Anodonta woodiana*, *Dreissena polymorpha* and *Corbicula fluminea*. The first, of Asian origin, has colonized lentic habitats, mainly canals and artificial lakes of central-northern Italy, and is progressively expanding. *D. polymorpha* found since 1970 in Lake Garda, and has now colonized most of the major subalpine lakes and large portions of their effluents; in recent years it has been found in masses in water bodies of central Italy. *C. fluminea*, which was first recorded in certain canals in Emilia-Romagna, has recently spread to other canals, rivers and lakes of northern

Italy, and is likely to become considerably more widespread in the future.

Conservation

Some autochthonous species, particularly unionoideans, are in serious danger, not only because of the usual factors that jeopardize our freshwater ecosystems (pollution, water use, irrational and useless intervention in river-beds), but also because of the frequent introduction of fish, which may carry the larval forms (glochidia) of other populations (thus damaging the genetic identity of indigenous ones) or of alien species. Some taxa are already in general decline. One species, *Microcondylaea compressa*, has disappeared from part of its nineteenth century distribution. Another, *Margaritifera auricularia*, has been extinct in Italy since the end of the nineteenth century (Manganelli et al., 2000).

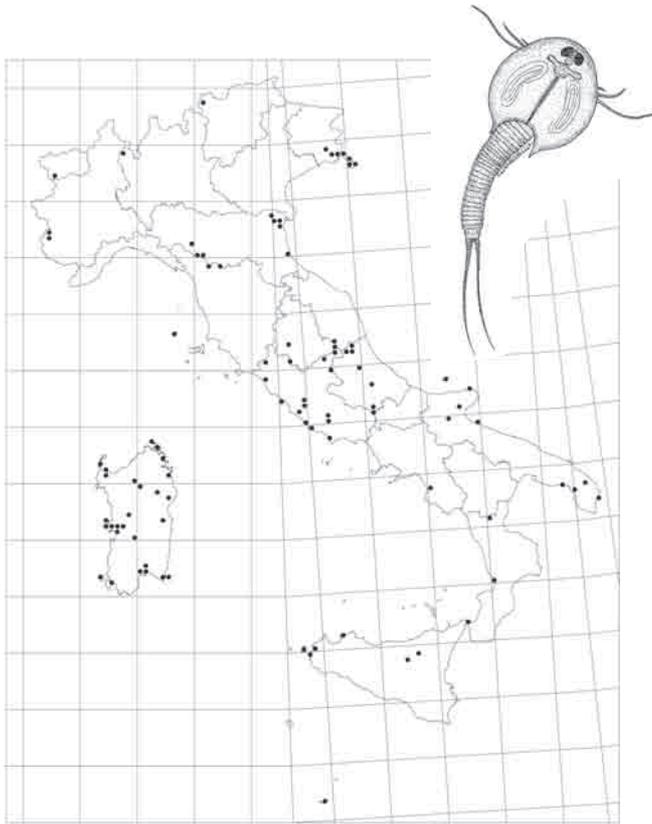
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Crustacea Branchiopoda Anostraca, Notostraca, Conchostraca

Graziella Mura



The members of these three orders are crustaceans that are associated with astatic freshwaters or hyperhaline waters. They are well adapted to life in temporary environments, because they possess particularly long-living forms of resistance that constitute, within the sediments, a reserve capable of reducing the impact of environmental adversities and of hatching as soon as favourable conditions appear. Conchostraca were recently split into Laevicaudata and Spinicaudata, only the latter of which occur in Italy.

Material and methods

The filling of data on species distributions is mainly based on post-1980s literature, and completed by data obtained from the more recent literature and field-sampling campaigns (Mura, 1999, 2001; Mura & Rossetti, 2002; Scanabissi & Tommasini, 1990, 1997).

Biodiversity

Altogether, the Italian freshwater fauna comprises 12 genera belonging to 9 families. Sixteen species of Anostraca, belonging to 6 genera (*Branchinella*, *Artemia*, *Branchipus*, *Tanymastix*, *Chirocephalus*,

Streptocephalus) included in 5 families, are recorded from Italy. The majority of these species are concentrated in central Italy and Sardinia; however, these are also the most-studied areas, whereas for the rest of the country much less information exists due to lack of research.

Italy counts 43% of the species occurring in Europe. The most species-rich and widespread genus is *Chirocephalus*, which comprises six species, three of which endemic (*Chirocephalus marchesonii*, *C. ruffoi* and *C. sibyllae*). Within *Branchipus* the validity of the species *visnyai*, which was recently questioned by some authors because of the extreme variability of the diagnostic features that separate it from the congeneric *schaefferi*, has still to be defined.

Notostraca are represented by a single family, the Triopsidae, comprising the genera *Triops* (2 species with 1 subspecies, *Triops cancriformis cancriformis*, that is very rare in central Italy) and *Lepidurus* (1 species with 1 subspecies). Conchostraca Spinicaudata include, in Italy, 4 species belonging to 4 genera (*Cyzicus*, *Leptestheria*, *Eoleptestheria*, *Limnadia*), which are included in 3 families.

As opposed to what is known for Anostraca, distributional data on the last two orders are rather poor and badly updated, reason for which the current picture of overall biodiversity does not reflect reality.

Ecology

All Anostraca occur in both plain and mountain water bodies, except *Branchinella spinosa* and *Artemia* species, which inhabit hyperhaline coastal waters.

Differently from Anostraca, which are all confined to temporary pools (only exception: *Chirocephalus marchesonii* from "Lago di Pilato", Marche), Notostraca and Spinicaudata include species that occur in permanent stagnant waters also (e.g. *Triops* species).

Zoogeography

The currently known endemic species of Anostraca appear to be limited to high-altitude aquatic environments of the Apennines (Mura, 1999). The only typically Alpine species is *Branchipus blanchardi*, which is also common in France. *Branchipus pasai* occurs in Sicily (Lampedusa), and has a North-African distribution. The remaining Italian Branchiopoda are either species with a European distribution (e.g. *Tanymastix stagnalis*, *Branchipus schaefferi* or *Triops cancriformis cancriformis*) or typically Mediterranean species (*Chirocephalus kerkyrensis*, *Lepidurus apus lubbocki* or *Leptestheria mayeti*).



Alien species

The nauplius larvae of *Artemia franciscana* are used as fish food in the many mariculture plants existing in Italy; this species has presumably spread in recent years and may have occupied the biotopes normally inhabited by the autochthonous species *A. salina*, as has already happened in France, Spain and Portugal. Further investigations on the subject are being carried out, to assess whether competition between these two species truly exists.

Conservation

Because they are colonizers of temporary habitats, Branchiopoda are among the organisms most threatened by human activities. General anthropization of the environment and the spreading of agricultural practices have caused the disappearance of a large number of biotopes and, as a consequence, the elimination of taxa of high interest. A striking example is the extinction of the Sardinian endemic *Tanymastix stellae* (Anostraca), which was wiped out following the destruction of the only

known site for this species: the rock pools near Orosei. Most Anostraca species apart from the endemic ones, which are all localized within protected areas and are thus theoretically not endangered, should be considered as vulnerable. The same goes for Notostraca and Spinicaudata, which count both rare and/or localized species among them (e.g. *Cyzicus tetracerus* or *Triops cancriformis cancriformis*), some of which are considered as pests because of their life habits and fought against by farmers. The adoption of correct conservational policies envisaging the protection of habitats rather than single species appears to be important not only for species of zoogeographical interest but also for others, more common, but nevertheless not widespread. An example of this is the drastic reduction of the number of populations of *Chirocephalus kerkyensis* (Anostraca), a species recorded only from Corfu and Latium, and recently discovered in Apulia (Mura & Belmonte, 2004), which were once numerous and are now restricted to a few protected areas, namely the Circeo national park (Latina) and the presidential estate of Castelporziano (Rome).

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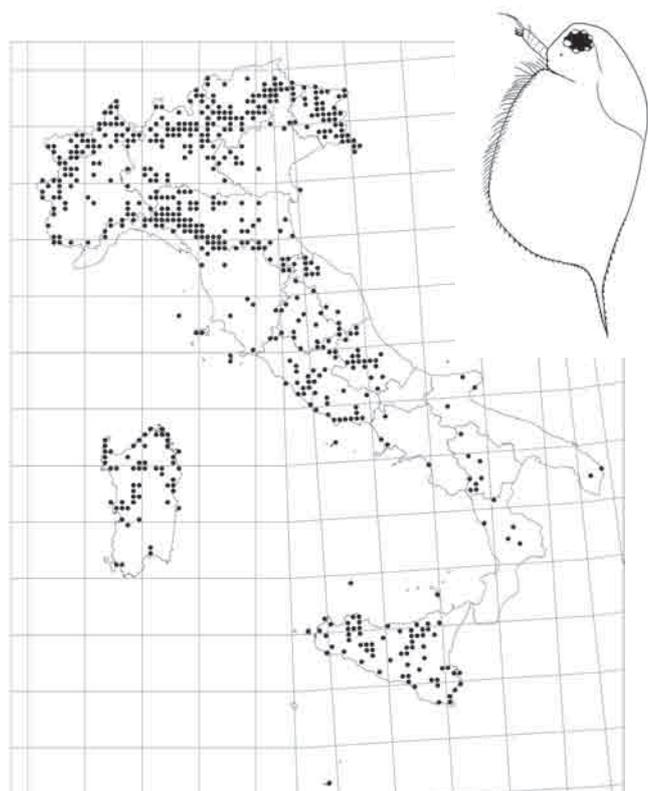
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Crustacea Branchiopoda Cladocera

Fiorenza G. Margaritora



Cladocera are an order of branchiopod crustaceans that are widespread all over the world. They include approximately 450 species, only about ten of which occur in marine or brackish waters. The others can be found in Italian freshwater habitats such as lakes, ponds, temporary pools and, generally with small populations, also slow-running watercourses and groundwater. The order is quite well investigated from a taxonomical point of view, although for some groups of species an accurate revision, both morphological and genetic, would be needed.

Material and methods

The filling of species and distributional data are based on a wide range of literature, on the most recent revisions (Margaritora, 1985; Alonso, 1996; Dumont and Negrea, 2002) and on the checking of material from various university and museum collections. Old data, anterior to the 1930s and not checkable, were only exceptionally taken into consideration. Unpublished data, which also include species new for Italy that were discovered through the determination of material collected by the author and other researchers, make up over 30% of the total.

Biodiversity

The Cladocera of the Italian inland waters include 45 genera and 111 species, besides about ten subspecies of the genera *Ceriodaphnia*, *Daphnia* and *Alona* the taxonomical status of which has still to be established. The systematics of some groups of species are complicated by the possibility of hybridization and the appearance of intermediate forms, as has been shown for *Bosmina* and *Daphnia* (Flössner & Kraus, 1986; Schwenk, 1997). The number of species, which appeared to be slightly lower than in other, well-investigated European countries (Spain, Northern Europe, Romania), has currently increased following the latest research works. The present work has highlighted a good species-richness, especially in the better-studied areas that refer to certain habitats. Thus, the highest diversity is found in the temporary pools of Sardinia (over forty species), along the coast of Latium, in Sicily, and secondarily in the rice-fields and lakes of the Alpine and Prealpine region and northern Apennines. Generally in lakes, the planktonic communities, which are rather monotonous, are considered. However, in cases where the littoral, sublittoral and benthic zones were investigated, an increase in the biodiversity of this group was observed. For instance, in lake Bracciano, the number of species increased from 6 to 21; in lake Candia, from 10 to 24. Research on the inland water environments of the central Apennines and the most southern regions is very poor and discontinuous. It would also be interesting to have more data on groundwater habitats, since those collected so far are restricted to Northern Italy.

Ecology

Cladocera are essentially distributed in continental waters and occupy all biotopes except for lotic ones with a strong current. Only 3 genera and 5 species are marine, and were not treated in the present work. Cladocera are both planktonic and benthic. The planktonic species, particularly the eulimnetic ones, occur in large populations and include widespread species such as *Daphnia hyalina*, *Daphnia longispina*, *Daphnia obtusa*, *Bosmina longirostris* and *Diaphanosoma brachyurum*. On the contrary, some species have limited distributional areas, like for example *Holopedium gibberum*, *Daphnia middendorffiana* and *Daphnia zschokkei*, which only inhabit high-altitude lakes, *Bythotrephes longimanus*, which occurs in deep lakes and *Eubosmina kessleri*, which inhabits the lakes of the North. Species living in biotopes that are rich in



vegetation, like most Chydoridae, are qualitatively more numerous. Few Cladocera are particularly specialized: *Ilyocryptus sordidus* lives very close to the sandy bottoms of lakes, down to a depth of 20 m; *Scapholeberis* is associated with the surface film (hyponeuston) in calm parts of lakes and ponds; *Anchistropus* lives on hydrae; *Pseudochydorus* occurs amongst vegetation, where it feeds on dead organisms. Some species are restricted to particular habitats: *Alona rustica* is associated with the acid waters of springs and moss-covered ditches; *Alona protzi* occurs in resurgences; *Moina salina* and *Ctenodaphnia mediterranea* are found in salty ponds; *Ctenodaphnia atkinsoni*, *C. chevreuxi*, *Ephemeroporus phintonicus*, *Pleuroxus latourneuxi*, *Alona azorica* and *Alona nuragica* inhabit temporary waters; *Latonopsis australis*, *Moina weissmanni* and *Wlassicsia pannonica* live in rice-fields. Certain planktonic species undergo complex, cyclic phenotypic changes known as cyclomorphosis, which make them difficult to determine. Cladocera are mainly phytophagous or detritivorous. They play an essential role in the food chain as consumers and stabilizers of primary production, and constitute the main direct food source for planktophagous fish in large lakes. The few predator forms, e.g. *Leptodora*, *Bytotrephes* and *Polyphemus*, also cover this last function. Therefore, planktophagous fish play an active part in controlling populations of the large-sized species, which are more easy to prey upon, sometimes causing them to strongly decline and/or to be substituted by smaller species. However, thanks to the cyclomorphic phenomena of some euplanktonic species and parthenogenetic reproduction, Cladocera are able to make up for predator attacks, even by invertebrates (Diptera larvae and Oligochaeta).

Most Cladocera have wide ecological range and are not, therefore, good environmental indicators; nevertheless, they show changes of behaviour in disturbed environments, with drastic drops in species numbers and concentrations at given levels for limnetic species. However, one cannot exclude that some species may disappear, due to the modification of lakeshores or following variations of the water regime in temporary biotopes.

Zoogeography

Cladocera are widespread throughout the whole world. This is due to the easy dispersion of ephippia by a variety of vectors: wind, migrant birds and indirectly, fish. The latter selectively prey upon brightly pigmented ephippia; these are neither digested by the fish nor by birds and small mammals that feed on fish, and are therefore expelled alive. Even man has contributed to the widening of the distributional areas of some species by importing seeds and by moving ships and so on from one area to another. The spreading of some species throughout Italy has been facilitated by the fact that this country is situated along some of the most important migratory routes of birds.

Sayciidae, Neotricidae and Ophryoxidae are missing in Italy, where representatives of nearly all the known genera occur however. Most Italian species are cosmopolitan, although this word is currently losing part of its meaning due to contrasting opinions on the subject, some of which talk of non cosmopolitanism of Cladocera. Studies carried out on such terms have brought to the creation of new species or subspecies, sometimes differing on the basis of minute characters, and which would need genetic verification.

Under a zoogeographical profile it is difficult to give a precise characterization of the fauna; because of the above-mentioned reasons, taxa are not always divided into typical, zoogeographically well-defined associations. Therefore, only few examples and data are provided here, that are so far the most reliable ones.

Temporary basins are the richest in species: those of Sardinia, given the geological history of this region, include both species with North African affinities such as *Ctenodaphnia chevreuxi*, *C. mediterranea*, *Pleuroxus latourneuxi* and circum-Mediterranean species also occurring in Spain such as *Moina salina*, *Ephemeroporus phintonicus*, *Alona nuragica*, *Alona azorica*, *Estatheroporus gauthieri*, but also Palearctic species like *Daphnia obtusa* and *D. curvirostris*, which equally occur along the coasts of Latium. In Sicilian astatic waters, species in common with Latium or Sardinia can be found, e.g. *Daphnia atkinsoni* (Euroturanic-Mediterranean), *Moina salina*, *Pleuroxus latourneuxi*, or species in common with both these areas such as *Daphnia obtusa*, *Alona nuragica*, *Alona elegans arcuata*.

Some Holarctic Cladocera, distributed in the Arctic regions, can be found only in a few small, high-altitude lakes. These are: *Holopedium gibberum*, which is considered a glacial relict and is associated with cosmopolitan species in Trentino; *Daphnia zschokkei* and *Daphnia middendorffiana* in the Western Alps.

Daphnia cucullata is a species of post-glacial origin, which occurs in the Alps and was recorded from high-altitude lakes south of the Alps until the 1950s. It was introduced in 1913 from a Danish lake to Lake Nemi, from where it disappeared around 1940; nevertheless, it has spread to various small and medium sized lakes of central Italy during the last sixty years. Since the 1980s it has been recorded from the medium sized and large lakes of the north (Lugano, Varese, Maggiore, Candia...), where it has given origin to intermediate forms together with *D. galatea* and *D. hyalina*, as well as from an artificial lake in Sicily (Lake Castello).

Many species that were once considered of limited distribution have proved to be more widespread. For instance *Daphnia curvirostris*, known only from Sardinia until the 1990s, is currently recorded all over Italy except in Sicily. *D. ambigua* is known since 1969 from Lake Endine, and is discontinuously distributed in about ten lakes



throughout the peninsula and Sicily. *Ceriodaphnia megops* was thought to be restricted to Friuli, but has been found in a rice-field in Emilia as well as in Lake Piediluco. *Bytrepes longimanus* is a North Palearctic species that occurs in deep lakes in Northern Italy; it was accidentally introduced in the 1970s from Lake Maggiore to Lake Bolsena, where it has adapted well.

In conclusion, the distribution of Cladocera in Italy appears to be influenced by ecological factors, which are not always easy to identify, rather than historical ones.

Alien species

Research carried out during the last fifteen years have brought to the discovery of 9 new species for Italy: *Latonopsis australis* and *Moina weismanni* in rice-fields of Emilia (1986), *Daphnia parvula* in Lake Candia (2002), *Ceriodaphnia rotunda* (1992) and *Alona protzi* (2001) in Friuli, *Simocephalus hejlongjiangensis* (1996) and *Wlassicsia pannonica* (1995) in a rice-field in Lombardy, *Camptocerus uncinatus* (1999) in Lakes Bracciano and Martignano, *Alona rustica* (1995) in the Aosta Valley.

Among these, only *Latonopsis australis* had probably already been observed in a rice-field in Lombardy in 1932, but was reported as *Latonopsis occidentalis*.

Moina affinis is a North American species that was introduced to Europe around 1960; in Italy it had already become well adapted in rice-fields of the north, but in recent years it has spread to lakes of Emilia and Tuscany. The species occurring in rice-fields were almost certainly introduced together with seed: they have adapted well in this sort of environment, and can be considered as a stable component of the rice-field heleoplankton.

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The ecological studies carried out so far on habitats where Cladocera occur have not always been very thorough and have hardly ever been long-term ones; therefore, neither the time of introduction of these species nor their impact on indigenous populations can be assessed with certainty.

Conservation

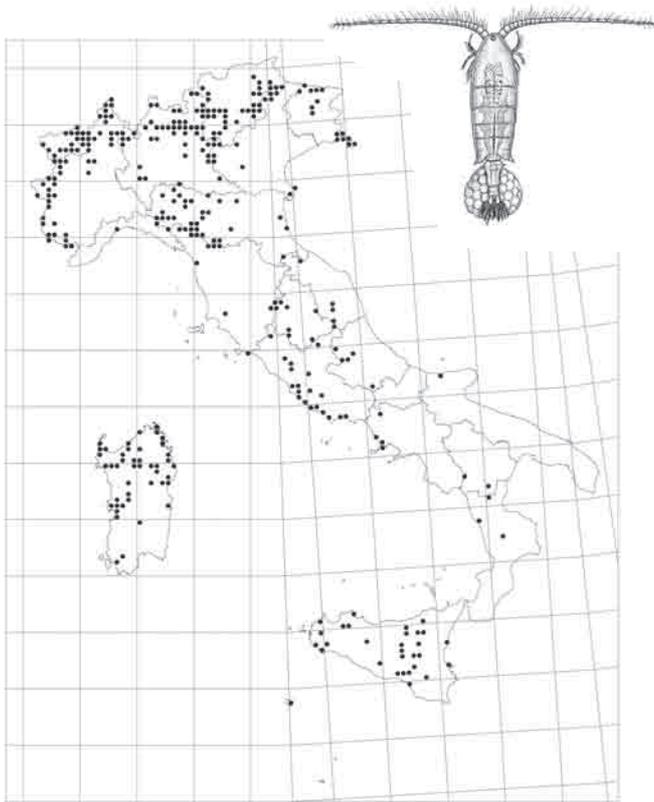
As far as is known, Cladocera generally have wide ecological amplitude and are able to adapt to environmental stress by changing their behaviour and producing ephippia, which can remain latent for rather long periods of time. This partly explains the disappearance and successive reappearance of species in lakes exposed to trophic changes or pollution.

However, there are species of Cladocera the evolution of which is marked by strong ecological specialization; they are associated with particular biotopes, and are therefore more sensitive to environmental changes. The danger of species disappearance is related to the anthropization of the land, which more and more tends to reduce the amount of small water bodies; these are important habitats of rare species, or of species that are interesting and characteristic from a systematic, biological or zoogeographical point of view. Changes made along lakesides, in order to boost recreational activities, cause a loss of microhabitats that are strictly necessary for the survival of the littoral species. Eutrophication brings to the development of algae that are not edible for the planktonic species that, as already mentioned, constitute an important level of the food chain; thus, delicate equilibria on which the functioning of aquatic ecosystems is based can be jeopardized.



Crustacea Copepoda Calanoida

Fabio Stoch



Calanoida constitute an order of mainly marine planktonic Copepoda; one family (Pseudodiaptomidae) includes a species that is exclusive to coastal lakes and ponds, while three families (Temoridae, Centropagidae and Diaptomidae) have colonized continental freshwaters. The order is quite well known in Italy from the points of view of taxonomy and distribution, although areas such as the Po Plain and central-southern Italy would deserve further investigations.

Material and methods

The filing of species distribution data is based on all the available literature, including limnological and ecological papers, as well as on unpublished data from the author's personal collection, the plankton bank of the CNR-ISE (Hydrobiology and Ecology of Inland Waters Branch, Pallanza) and the Stella Collection (Rome University).

Biodiversity

The Calanoida of the Italian continental waters include 28 species altogether, attributed to 12 genera and 4 fam-

ilies. The very high amount of records from lakes and pools of the Alpine chain is not coupled with high species diversity in these habitats, whereas greater species richness can be found in the Apennines.

Ecology

The totality of continental water Calanoida lead a planktonic life, and occupy the role of macro filter-feeders in the food chain; few species (e.g. *Hetercope saliens*) are predators.

One species (*Calanipeda aquaedulcis*) is associated with slightly brackish coastal ponds and lakes; another (*Troglodiptomus sketi*) is stygobitic, and is strictly associated with the great subterranean saturated karstic waters of the Trieste and Gorizia Karst; all other species are planktonic in lakes, ponds and temporary pools. Many of these produce quiescent stages in the form of resting eggs.

Zoogeography

Although the distribution of surface water Calanoida is well known in Italy, the wide ecological amplitude of most species does not allow for the individuation of a pattern of palaeogeographic interest. These species are spreading rapidly and have colonized lakes, ponds and pools in the post-glacial period; transportation of the quiescent stages leads to the continuous colonization of new environments. As far as distributional patterns are concerned, it is possible to distinguish: a) a group of boreoalpine species (primarily *Arctodiptomus alpinus*, *Hetercope saliens*, *Acanthodiptomus denticornis* and, secondarily, *Mixodiptomus tatricus*), which are strictly associated with small high-altitude lakes of the Alps; b) a group of species that are distributed in temporary pools on the coasts of Latium and Sardinia; c) a few species widespread in Italy, some of which are restricted to the northern regions (*Eudiptomus intermedius*, *Copidodiptomus steueri*), while others (e.g. *Eudiptomus padanus* s.l.) are distributed in the whole peninsula and Croatia; d) a species (*Copidodiptomus salinus*) that is present only in Sicily and Sardinia and another (*Arctodiptomus salinus*) known only from Sicily; e) a heterogeneous complex of species the distribution of which appears to be absolutely random in Italy. *Calanipeda aquaedulcis* is widespread in the coastal lakes and ponds of the peninsula and the islands, whereas *Troglodiptomus sketi* is endemic of the "classic" Italian, Slovenian and Croatian karstic regions.



Alien species

One species (*Boeckella triarticulata*), presumably native to New Zealand, was accidentally introduced to Italy by man in a few fish-breeding ponds of the Modena area, about ten years ago; according to recent observations the species is spreading throughout the western Po Plain.

Conservation

The surface water species of both large lakes and pools and ponds are threatened by eutrophication on one hand,

and by reclamations and the disappearance of small water bodies – nowadays reduced to a small number – on the other. The disappearance of pools, ponds and artificial water holes for cattle, and the spreading interest to transform medium-sized ponds into sports fishing lakes have caused species that were once considered as common to disappear from many areas. *Troglo diaptomus sketi*, the only species to occur in subterranean waters, is not currently threatened, although it can be defined as vulnerable due to the deterioration of water quality in some parts of its distributional area.

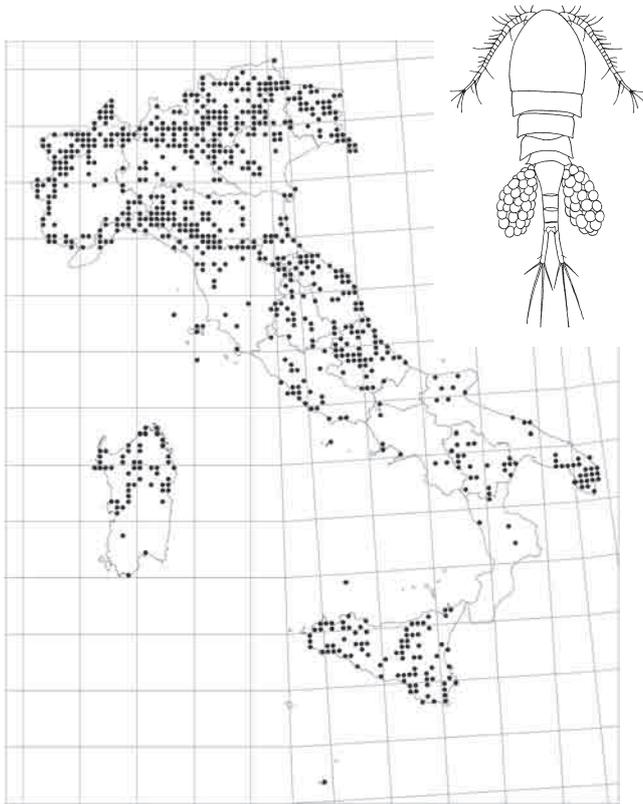
Relevant Literature

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STELLA E., 1984. Crustacea Copepoda: Calanoida (d'acqua dolce). Fauna d'Italia, XX. Calderini, Bologna: 1-101.



Crustacea Copepoda Cyclopoida

Fabio Stoch



Cyclopoida form an order of Copepoda including mainly marine families; some of these are commensals or parasitic of other invertebrates or vertebrates. A sole family, the Cyclopidae, has colonized continental freshwaters, nevertheless maintaining a few representatives in brackish habitats. Among the Copepoda of Italian continental waters, Cyclopidae are the family richest in species and the best-known one from a taxonomical and ecological point of view. However, some problems still persist concerning the distinction of *Cyclops* and *Diacyclops* species, the systematics of which are ever-evolving; fewer problems are caused by *Paracyclops*, which was recently revised. In these cases, the assignment of old citations from the literature to the species recognised today is rather problematic. As for the stygobitic species, the knowledge of their ecology and chorology is still patchy, and their total number is certainly underestimated.

Material and methods

The filing of species distribution data is based on all the available literature including limnological and ecological papers, and on the study of unpublished material from the author's collection. A number of colleagues

provided unpublished material and data, in particular D.P. Galassi and G.L. Pesce (University of l'Aquila), G. Rossetti (University of Parma), F.G. Margaritora (University of Rome) and G. Giussani (CNR-ISE, Hydrobiology and Ecology of Inland Waters Branch, Pallanza). Since modern taxonomical techniques require, for some groups of cryptic species, the analysis of minute characters by means of interferential microscopy, determinations reported in limnological works, not carried out by specialists, remain doubtful in some cases; in such instances the species name is followed by s.l. (sensu lato) in the list. Some species of uncertain validity, recorded from Alpine lakes, have been removed from the fauna; the same was done, after consultation with the authors, with some doubtful species of *Cyclops*, most of which were wrong assignments.

Biodiversity

The Cyclopidae of Italian continental waters include at least 101 species altogether, besides numerous subspecies of doubtful validity; 13 of these are firstly recorded for Italy in the present work and at least 5 others are new to science. Several species new to science belonging to the genera *Acanthocyclops*, *Diacyclops* and *Speocyclops*, which include many stygobionts, are in course of description.

Despite the good coverage of the country by the collected data, it is difficult to identify biodiversity hotspots in Italy, because Cyclopidae are dominated by ubiquitous species widespread in the peninsula and islands. As far as strictly stygobitic species are concerned, the highest species densities are recorded from the Trieste Karst, the Prealpine karstic areas and some parts of the Apennines (Gran Sasso, Alburni), which are well-studied and characterized by intense karstic phenomena. The distributional pattern of species of alluvial terrain waters is less clear, because these environments are still badly known; however, the number of species seems to be higher in central-southern Italy, which is for sure the better-investigated part of the country.

Ecology

Few species are exclusive to brackish waters (genera *Halicyclops* and *Neocyclops*), and occur in lagoons or river mouths, occasionally in caves.

The Cyclopidae of surface freshwaters are either planktonic or, in most cases, benthic; they have been collected in all kinds of habitat, and are possibly the animal group



having undergone the greatest adaptive radiation in continental waters. They include planktonic species of lakes (*Cyclops*, *Mesocyclops*, *Thermocyclops*), littoral benthic and deep, periphytic benthic species; many species are associated with astatic waters, while others occur in temporary pools (*Diacyclops bicuspidatus*, *D. bisetosus*) and some even in ephemeral puddles (*Metacyclops minutus*). Besides these, many species have been collected in hypotelminorheic habitats (*Graeteriella unisetigera*, *Speocyclops* spp.), mosses, sphagnum and acid peat bogs (various species of *Diacyclops*), in the subterranean waters of both alluvial (where the genera *Diacyclops* and *Acanthocyclops* predominate) and karstic terrains, which are very species-rich. Among the latter, some are associated only with the free-flowing waters of deep karstic systems, where they lead a planktonic life (*Metacyclops gasparoi*, *Metacyclops trisetosus*); others are associated with vadose waters and occur in micro-crevices in limestone and small drip pools (*Speocyclops*).

Many species associated with temporary waters are known to possess quiescent stages; this aspect is particularly well studied in *Cyclops* species as well as in *Diacyclops bicuspidatus*, which encysts as copepodid IV stage.

As far as feeding and role in the food chain are concerned, most species are detritivorous; some genera (e.g. *Eucyclops*) include phytophagous species that feed on microalgae; finally, many larger species (genera *Cyclops*, *Macrocyclus*, *Megacyclus*, *Mesocyclops* and some species of *Diacyclops*) are predators.

Little is known of the ecology of the immature stages (nauplius and copepodid) of Cyclopidae except for the planktonic species, the life cycle of which has been investigated in a number of works.

Zoogeography

Cyclopidae are presumably crustaceans of ancient marine origin. The exact period in which they colonized both surface and subterranean freshwater habitats is not known; the most ancient fossils of freshwater Cyclopidae are assignable to the Miocene, but the origin of the group is certainly much older. At the present state of knowledge it is presumable that nearly all the stygobitic species descended from freshwater ancestors (limnicoid stygobionts). The colonization of subterranean waters was followed by a great adaptive radiation, which is still continuing within the extremely species-rich genus *Diacyclops*.

Although the distribution of surface Cyclopidae in Italy is very well known, the wide ecological amplitude of most species (sometimes considered, rightly or wrongly, as cosmopolitan) does not allow for the individuation of a pattern of palaeogeographical interest. These species are spreading rapidly and have colonized numerous surface environments in the post-glacial period; the transportation of the quiescent stages, but also of active individuals by birds and other vectors, leads to the continuous colonization of new environments.

The situation of groundwater species is quite different; many species (particularly within the genera *Diacyclops*, *Acanthocyclops* and *Graeteriella*) widespread in Italy and Europe, can be found in alluvial terrains, whereas numerous species of *Speocyclops* and stygobionts of the genera *Eucyclops*, *Acanthocyclops* and *Diacyclops* are very localized and restricted to small, isolated karstic areas or to refuge massifs at the edges of the great Quaternary glaciers.

Alien species

No certain records of alien species exist for Italy.

Conservation

Surface water species do not present bad or urgent conservation problems; however, many Cyclopidae communities, both of large lakes and pools and ponds, are currently at risk because of eutrophication on one hand, and because of reclamations and the disappearance of wetlands – now reduced to a very low number – on the other. The disappearance of ponds, pools, water holes for cattle and peat bogs, due mainly to land management and to the abandonment of traditional agricultural and farming practices (for which ponds represented a resource), and the spreading interest to transform medium-sized ponds into sports fishing lakes, have made some widespread species become rare and locally at risk of extinction.

The situation in groundwater environments is quite different, because they host many endemics and are particularly exposed to organic and industrial pollution of aquifers, the pouring of waste water down karstic cavities and intensive agricultural practices, which have all caused a rapid eutrophication of alluvial subterranean waters and the rarefaction of many species that were once widespread in the great plains.



Crustacea Copepoda Cyclopoida

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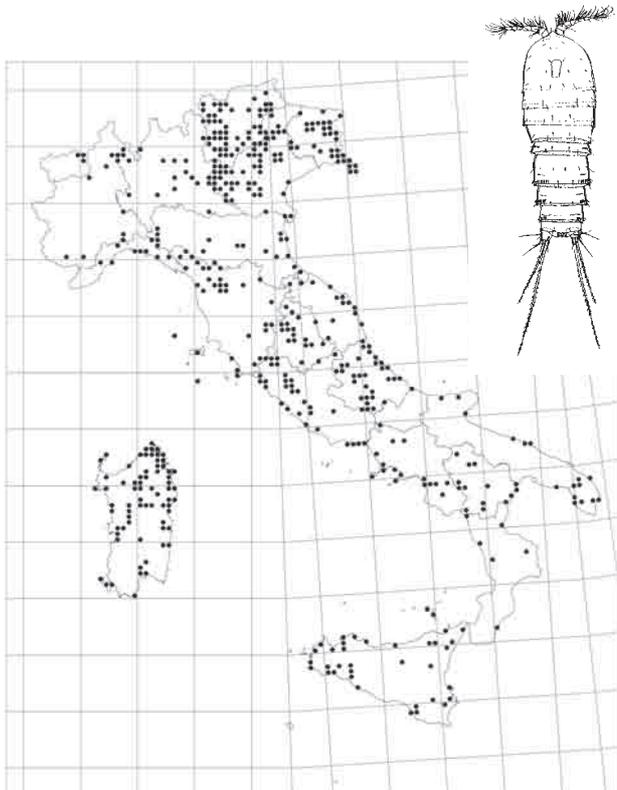
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Crustacea Copepoda Harpacticoida

Raffaella Berera, Vezio Cottarelli, Paola De Laurentiis, Diana M.P. Galassi, Fabio Stoch



The Harpacticoida is one of the ten orders of the subclass Copepoda, and mainly includes free-living benthic organisms; few species are planktonic or commensals. Harpacticoida ranges in size between 0.2 and 2.5 mm, and are ubiquitous in marine, brackish and freshwater meiobenthos, but they also occur in extreme environments such as semi-terrestrial habitats and glaciers.

The order comprises 54 families, though only Ameiridae, Canthocamptidae and Parastenocarididae are widely represented in freshwater environments, with over 1000 species and subspecies. Chappuisiidae and Phyllognathopodidae primarily inhabit freshwaters, whereas Diosaccidae, Ectinosomatidae, Latiremididae, Arenopontiidae and Psammopsillidae are essentially marine families, which only sporadically occur in freshwaters.

The taxonomy of the order as a whole is in state of flux and a polyphyletic nature is hypothesized for many families and genera (Galassi et al., 2002). Moreover, many cryptic species – that are often distinguishable only on the basis of micro-morphological characters – are hidden under some species, which are therefore in need of critical revision.

Material and methods

In order to gather information on species distribution, available literature and unpublished data from the authors' collections were used. Species collected in coastal brackish or anchialine environments were also included, as they are herein considered as continental waters.

Biodiversity

Italian Ectinosomatidae includes 5 genera, with mainly marine or brackish water species; an exception consists of 3 stygobitic species, one of which unpublished, of *Pseudectinosoma*, a genus including only 5 known species.

Italian Ameiridae includes a total of 31 species belonging to 5 genera, *Nitokra* and *Nitocrella* being the most species-rich groups; the highest diversity for this family is found in the Apennines.

The Canthocamptidae is the family with the highest species richness in Italian continental waters; they altogether include 85 species, 5 of which unpublished, belonging to 21 genera. The highest species density is found in the subterranean waters of the Prealpine area, from Lombardy to the Trieste Karst, where a large number of endemics occur as a consequence of fragmentation and isolation of karstic massifs; secondary biodiversity hotspots can be found in central and southern Apennines, in vast karstic aquifers.

The Italian Parastenocarididae are represented by the genus *Parastenocaris*, which is well distributed throughout the country with 33 species (20 in peninsular Italy, 2 in Sicily, 9 in Sardinia and 2 in the small islands off the coast of Sardinia). The new genus *Simplicaris*, recently discovered in Italian groundwater, is to be considered endemic to Italy (Galassi & De Laurentiis, 2004).

The remaining families all include few species in Italian brackish or fresh waters, except for Diosaccidae with 6 species of the genus *Schizopera* (2 of which unpublished), which are mainly diversified in the subterranean waters of southern Italy and Sardinia.

Ecology

Surface water Ectinosomatidae predominantly live in marine sediments, as epibenthic or interstitial organisms or as epiphytes on algal vegetation. Little is known of the ecology of the rare stygobitic species: the Italian species are associated with generally very isolated and deep karstic aquifers. They occur in very low numbers, and males appear to be rarer than females: only 5 specimens of *Pseu-*



dectinosoma reductum have been collected from type locality, despite repeated sampling campaigns carried out along 3 years; the male of this species is still unknown.

Among the Ameiridae, the genus *Nitokra* is well represented in freshwater benthos and brackish waters, with species showing high tolerance to strong variations in temperature, pH and salinity; on the other hand, *Nitocrella* and *Parapseudoleptomesochra* species are all stygobitic. *Nitocrella* species occur in both alluvial and karstic systems; while some of them (e.g., *Nitocrella psammophila*) show no preference for any particular habitat type, others show marked preferences (e.g., *Nitocrella pescei*, which is primarily associated with saturated karstic habitats and *Nitocrella kunzi*, which is a phreatobitic species, strictly associated with saturated porous habitats).

Italian Canthocamptidae are all benthic and frequently associated to lentic waters, although they are not rarely found in crenic and rhithronic stretches of watercourses. One of the most widespread species, *Canthocamptus staphylinus*, is known for having resting stages. Many species occur in springs or littoral habitats of Alpine lakes, even at high altitudes; a few species of *Hypocamptus* seem to be strictly associated with melting waters of snowfields and glaciers. In subterranean waters, Canthocamptidae are abundant in both karstic environments (one genus in particular, *Lessinocamptus*, is related to these habitats) and interstitial waters of alluvial aquifers; many species are muscicolous, and sometimes exploit interstitial environments and springs as secondary habitats. Within this family some semi-terrestrial species are known (e.g., *Epactophanes richardi*), which inhabit the superficial strata of humid soils (hypotelminorheic environment). As for species that are exclusive to brackish waters, these are mainly littoral benthic, sometimes phytal, in rare cases truly marine, although they can be found in lagoons or river mouths; some of these species are able to enter freshwater courses, and *Mesochra aestuarii* in particular is known from Lake Trasimeno; instead, species of *Itunella* are psammophile interstitial.

As for the Parastenocarididae, all the Italian species of *Parastenocaris* occur in hyporheic environments and lakeshore psammion, and rarely also in vadose karstic subterranean waters, phreatic waters and springs. According to the currently available data, *Parastenocaris* species seem to prefer shallow aquifers; however, the occurrence of some species in deep groundwater (*Parastenocaris ima* has been collected in a well at a depth of approximately 70 m) indicates a possible lack of information concerning these types of habitat. The genus nearly exclusively occurs in continental groundwater; however, some Italian species, which together with a species endemic to Spain (*P. andalusica* Enckell, 1965) constitute the *hera* group (Berera & Cottarelli, 2003), have been collected in river mouth ecotones, in fresh or slightly brackish waters.

Among the Arenopontiidae, *Arenopontia* (*Neoleptasta-*

cus) mainly includes interstitial marine species, with the exception of two Italian endemics, which occur in continental waters (*A. speluncae*, associated with the phreatic habitats of the mouths of small to medium-sized watercourses, and *A. phreatica*, which occurs in water table habitats). Among the Psammopsillidae, *Ichnusella* species are typically linked to river mouth interstitial environments, whereas *Schizopera* is the most species-rich genus within Diosaccidae, both in surface and subterranean (interstitial and phreatic) waters.

Zoogeography

The biogeographical knowledge of the Italian Ectinosomatidae is patchy, and data regarding coastal species are not updated; nevertheless, the importance of the genus *Pseudectinosoma* must be highlighted. It is a relict element and one of the rare relicts of an ancient Tertiary fauna that has now completely disappeared from the Mediterranean Sea. This genus is indeed represented only by a marine-brackish species with amphiatlantic distribution and by stygobitic freshwater species – true “spot” endemics – occurring in subterranean habitats of southern France and central and southern Italy. The genus is supposed to have disappeared from the Mediterranean Sea during the Messinian salinity crisis (late Miocene) and the few continental groundwater species seem to be the sole survivors of such event.

The current zoogeographical arrangement of the Ameiridae was determined, both on a local and global scale, by multiple colonizations of groundwater environments, followed by adaptive radiation (Galassi, 2000). The genus *Nitokra* is represented in Italy by species with cosmopolitan, Palearctic or European distribution, and the few endemic species are to be considered as doubtful because of their taxonomic uncertainty. A different situation is that of the genus *Nitocrella*, which is represented in Italy by stygobitic, mostly endemic species, sometimes known only from the type locality. Such limited distributions are counterbalanced by the wider distributions of *N. stammeri* (circum-Mediterranean) and *N. psammophila* (Alpine region).

The Canthocamptidae is presumably also of ancient marine origin, and its radiation in freshwater habitats probably took place through multiple colonizations; however, most subterranean Canthocamptidae presumably originated from freshwater-inhabiting ancestors. Many species of marine and surface fresh waters are widespread in Europe, and sometimes in the whole northern hemisphere; the cold-stenotherm species associated with high altitudes (*Hypocamptus*, *Maraenobiotus*, some *Arcticocamptus* species) are presumably boreoalpine or exclusively alpine elements; some of them occur in the Apennines as Quaternary glacial relicts, and are often confined to subterranean waters. On the other hand, nearly all the subterranean karstic species and most of



the interstitial ones are endemic, often with a very limited distribution, and are sometimes associated with single karstic massifs; some groups of species of the genus *Elaphoidella* – as well as entire genera (*Lessinocamptus*, *Morariopsis*, *Paramorariopsis*) – are endemic to the Pre-alpine karstic area, from Slovenia to Piedmont, and split up into several species within isolated karstic massifs; the almost complete absence of these species from the glaciated areas underlines their ancient, certainly pre-Quaternary origin. In particular, the stygobitic species of *Elaphoidella* – a genus including very few surface species in Europe but which is almost exclusively epigean in the tropics – may represent remnants of an ancient Tertiary fauna of warm and humid climates. Finally, a species associated with the soil fauna, *Epactophanes richardi*, is considered as cosmopolitan, but this is probably due to lack of in-depth taxonomical analyses.

The Parastenocarididae presumably represent a subterranean limnic group, which could be even more ancient, and which probably also originated from marine ancestors, the plesiotypic habitat being already interstitial. The cosmopolitan genus *Parastenocaris*, which includes few tropical species from epigean habitats, appears to be almost exclusive to continental groundwater. In Italy endemics species represent over 90% of the total: this is due to both low aptitude to dispersal, as well as to the isolation of the habitats where the species live. This condition may have led to vicariant events at a geological scale. Data concerning the distribution of the Italian species are patchy, and do not allow the reconstruction

of a complete biogeographical scenario; the genus is more widespread in Sardinia if compared to Sicily and peninsular Italy. This situation probably stems from the different levels of investigation of these areas.

Finally, among the Psammopsillidae, the genus *Ichnusella* is restricted to the coasts of Sardinia, Latium and Calabria; this distribution pattern also could be due a lack of research: the low population densities and the variability of river mouth ecotones often make fieldwork difficult.

Alien species

No species introduced by man are known so far from Italy.

Conservation

While no conservation problems generally exist for the euryhaline species and most of the surface freshwater species, many crenophilous species have turned out to be vulnerable in relation to the widespread practice of spring water exploitation. The numerous endemic stygobitic species should also be considered as vulnerable, in relation to the restricted distribution, often located in severely man-altered areas; vulnerable are also those species living phreatic and hyporheic waters, which are exposed in the pollution of urban or industrial settlements and intensive agricultural practices.

The situation of rare species that occur with very few individuals and endemic species with “spot” distributions is more difficult to define, but they should be considered at high risk of extinction.

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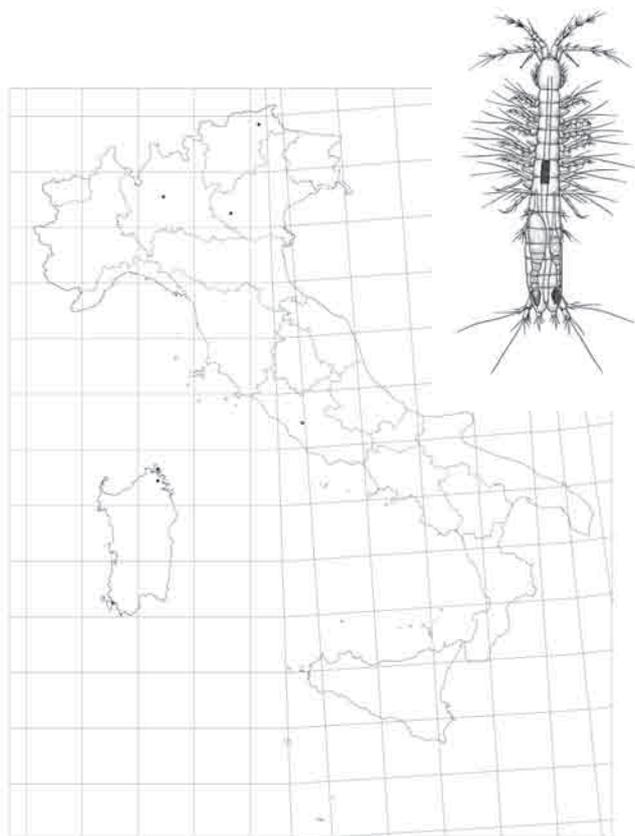
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Crustacea Malacostraca Bathynellacea

Sandro Ruffo



Bathynellacea form an order of Malacostraca Syncarida and are characterized by a long, worm-like body and the lack of a carapace, marsupium and free telson. They are probably of ancient freshwater origin. They are worldwide distributed and 170 species are known, all of which of small size (0.5–3.5 mm) and anophthalmic (Coineau, 1996).

Material and methods

The first Bathynellacea species of the Italian fauna was discovered in 1954 in the interstitial habitat of the Adige river near Verona. The chorology of these crustaceans is still poorly known for want of research and difficulties in

their determination. The data here reported refer solely to few bibliographical records.

Biodiversity

Currently, 5 genera of Bathynellidae and one of Parabathynellidae, each with a single species, are known from Italy. The Bathynellacea of the Italian fauna are certainly underestimated since their presence in some localities is already known, but the material has not yet been studied.

Ecology

Bathynellacea are all stygobitic and occur in the interstitial groundwater of hyporheic environments or drip pools formed by vadose water percolating in caves. They are often stenothermic, sometimes of cold waters, given they are known from relatively high altitude sites in the Alps.

Zoogeography

Among the few Bathynellacea known from Italy, three species are endemic of the country (two even as genera) with so far punctual distributional areas (Alto Adige, Venetia, Lombardy, Latium, Sardinia). The scarcity of data does not allow the highlighting of any significant zoogeographical characteristics, except that two genera of Bathynellidae and the only known Parabathynellidae from Italy occur in Sardinia.

Conservation

Like all stygobionts, Bathynellacea are probably at high risk of extinction due to pollution of groundwaters. A demonstration of this is that *Antrobathynella stammeri* has not been found in the interstitial sites of the Adige river since 1958. Given the habitat type they are strictly associated with, Bathynellacea can be considered as good indicators of groundwater quality.

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Crustacea Malacostraca Thermosbaenacea

Sandro Ruffo



Thermosbaenacea form an order of Malacostraca Peracarida, and possess a dorsal ovigerous marsupium formed by the carapace. Around 30 species are known, all of which anophthalmic, distributed from the Caribbean to the Mediterranean and from eastern Africa to eastern Asia and Australia in the Indo-Pacific Ocean.

Material and methods

Data on Italian distribution are based on the recent mon-

Relevant Literature

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ograph by Wagner (1994). It is necessary to point out that the state of knowledge of the Italian fauna is still patchy, the only known localities for Thermosbaenacea being a few sites in north-eastern Italy, Tuscany, Apulia and southern Sicily.

Biodiversity

Although only three genera and four species are currently known from Italy, this country has the most diversified Thermosbaenacea fauna; however, the chorology of these species is certainly still lacking data.

Ecology

Thermosbaenacea, of marine origin, are mainly associated with interstitial – oligohaline or fresh –groundwater habitats, almost always near sea coasts. The first-described genus, from North Africa, inhabits thermal waters.

Zoogeography

The distribution of Thermosbaenacea is nearly always punctual and of great biogeographical and historical interest, given they are species with a Tethyan type of distribution. Three of the four Italian species are endemic of Italy.

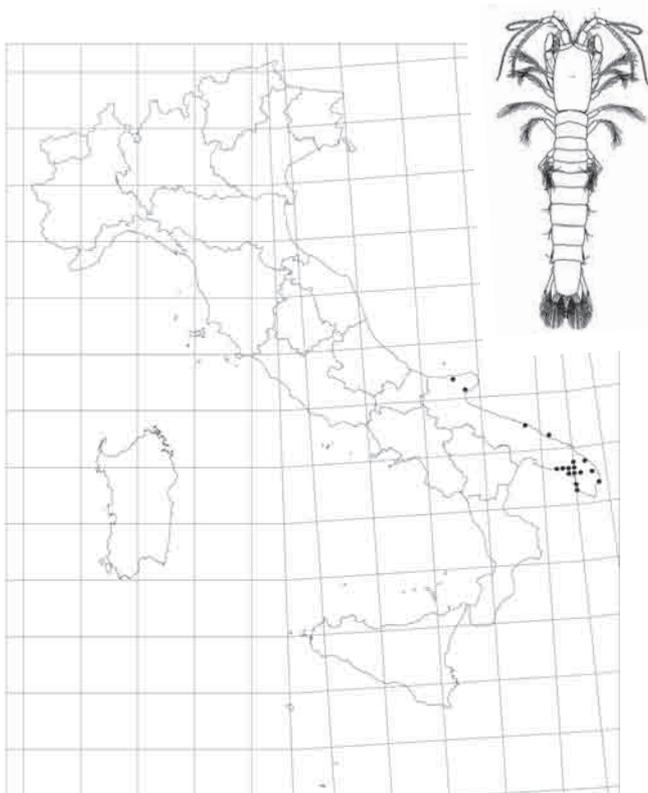
Conservation

Thermosbaenacea are probably all threatened by coastal pollution. Some localities of occurrence of *Monodella stygicola*, the first-discovered Thermosbaenacea in Europe and one of the most interesting elements of the Italian groundwater fauna, are particularly at risk; however, the distribution of this species, which could be present in the whole coastal karstic area of Apulia, should guarantee its conservation.



Crustacea Malacostraca Mysidacea from groundwaters

Salvatore Inguscio, Emanuela Rossi



Mysidacea are essentially marine Malacostraca crustaceans, which nevertheless comprise a few species inhabiting fresh or oligohaline subterranean waters. Only the two species associated with subterranean waters, *Stygiomysis hydruntina* and *Spelaeomysis bottazzii*, both known exclusively of Apulia, are considered here. Possibly, another *Stygiomysis* species occurs in Apulia, but it has not yet been described since it is known in a sole specimen.

Material and methods

The provided data were obtained from the literature (from the first works of the 1920s to the most recent studies), from personal unpublished research by the authors, and from careful sampling and checking work carried out in the sites already reported in the literature.

Biodiversity

The Italian stygobitic Mysidacea belong to two genera, *Stygiomysis* and *Spelaeomysis*, belonging to the families Stygiomysidae and Lepidomysidae, respectively. In the Mediterranean basin only one other stygobitic genus exists, *Troglomysis*, occurring in the Dinaric karst.

Ecology

The ecology of *Spelaeomysis bottazzii* is better known than that of *Stygiomysis hydruntina* as a consequence of the higher frequency of occurrence of the former, which has allowed for a higher amount of observations and research to be carried out. *Spelaeomysis bottazzii* is considerably euryhaline, and proves its tolerance towards high saline concentrations by also frequenting littoral phreatic environments. It is also a eurythermic species, having been observed in conditions with temperatures varying between 14 and 24.8°C. *Spelaeomysis bottazzii*, which is generally found in anchialine environments, inhabits both the still water of small hypogean lakes and slow-running phreatic water. This species cannot be considered an indicator of good water quality, having often been found in sites that are damaged from an environmental point of view. *Spelaeomysis bottazzii* is detritivorous and saprophagous and can be preyed upon by the troglobitic decapod *Typhlocaris salentina*. From a behavioural point of view its thigmotactism has been ascertained.

Stygiomysis hydruntina has been collected from a limited number of sites and sometimes in particular climatic conditions, such as after heavy rainfalls, when ground water is in a recharging phase. For this reason, it is believed to inhabit deeper and more isolated water systems. The very few findings of this species have up until now prevented considerations supported by valid ecological observations. Water temperature in habitats where it has been observed ranges between 14.9 and 18.5°C.

Both species have occasionally been found living together in the same site.

Zoogeography

Apulia has always been the object of speleobiological investigations and research, particularly in the Salento area. Areas situated further north such as the Bari province and the Gargano promontory have been focussed upon only since the 1980s and 1990s, respectively. *Spelaeomysis bottazzii* is distributed from the Gargano to Salento, most sites being concentrated in the province of Lecce where it is positively common and abundant; on the other hand, it is less frequent in the Murge area and difficult to come across in the Gargano. At population level consistent morphological differences exist between populations of the Murge and of Salento.

Stygiomysis hydruntina is known solely from the Lecce province and only from the Ionian side, between Porto Cesareo and Castro.



The occurrence in Apulia of these two genera, which also include members in Mexico, the Caribbean and East Africa, lets suppose that they are Tethyan elements having colonized subterranean waters during the Messinian. Possibly, the colonization of these habitats by *Stygiomysis* may have taken place in a more ancient phase compared to *Spelaeomysis*.

Alien species

The Italian fauna includes no alien species.

Conservation

The impoverishment of ground water, its pollution and heavy exploitation are threatening stygobitic Mysidacea populations, which in some sites have already declined or disappeared. Reliable data on the effects of heavy metal pollution or pollution due to other chemical waste are lacking. However, it has been ascertained that biological pollutants have no negative effect at least on the presence of *Spelaeomysis bottazzii*.

Nonetheless, environmental change should not be underestimated, especially concerning the problem of groundwater salinization. Despite its euryhalinity, *Spelaeomysis bottazzii* could be limited by an excessive increase of water salinity.

Relevant Literature

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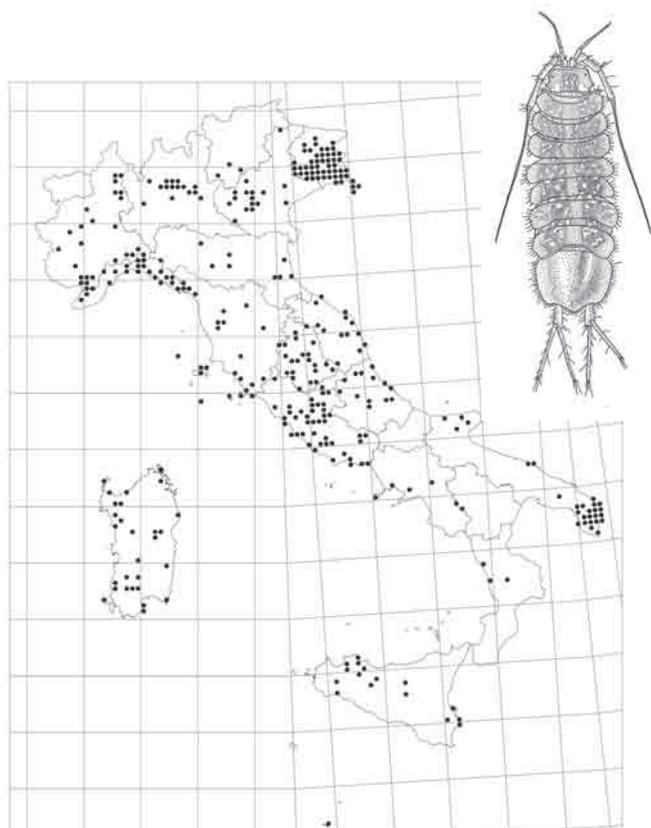
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Crustacea Malacostraca Isopoda

Fabio Stoch, Roberto Argano, Alessandro Campanaro



Isopoda are an order of Malacostraca Peracarida crustaceans widespread in the surface and subterranean freshwaters of Italy. The level of knowledge for this group can be considered as reasonably good. Although a vast literature on these organisms exists, new species and new localities for already known species are continuously being discovered, thus indicating that there is still a lot of work to be done. In particular, the use of electrophoretic and molecular biology techniques, alongside morphological studies, has recently brought to the clarification of the taxonomy of genera such as *Stenasellus* and *Typhocirrolana*, whereas others are still awaiting revision. As for the genus *Proasellus*, the most widespread in surface and ground waters, new technologies have brought to light a much more complicated situation than was supposed. A wide investigation plan has therefore been started, that will hopefully be able to clarify the status of various closely related taxa, as well as the distributional areas and ecological characteristics of each one of them.

Material and methods

The filing of species distribution data is based on the literature, the authors' collections, purposely carried out sampling campaigns and material from the museums of

Bergamo, Turin, Genoa, Verona, Udine and Trieste. Old citations were, as far as possible, checked. The unpublished data included in the database represent over 30% of total records. The truly marine genera were left untreated, even though some species inhabit lagoons and brackish ponds.

Biodiversity

The Italian freshwater fauna comprises, at the present state of knowledge, 11 genera belonging to 7 families. The known species are 44, besides approximately ten taxa belonging to the genera *Proasellus* and *Stenasellus*, the taxonomical status of which is still in course of definition; these taxa are currently individuated as a "group" and assigned to the morphologically closest species; a "group" can therefore correspond to one or more species. A reasonably high number of new species are still being studied and have obviously not yet been cited. The biodiversity pattern outlined in the present work does not reveal any particular species richness hotspots, due to lack of data from some areas. For instance, the examination of the distribution of a common epigeic species such as *Asellus aquaticus* shows how heterogeneous the sampling effort has been within its distributional area.

Ecology

Surface freshwater Isopoda mainly inhabit lentic environments (ponds, marshlands, lake shores), slow-flowing watercourses and river meanders, whereas they are less frequent in faster-flowing currents; they all belong to the Asellidae family, while members of the Janiridae occur in continental brackish waters.

Karstic system groundwater assemblages are characterized by species of *Asellus*, *Proasellus* and *Stenasellus*, some of which are still in course of description, as well as by *Sphaeromides* and *Monolistra* species. *Proasellus*, *Stenasellus* and *Monolistra* species occur in both the vadose – in drip rivulets – and saturated zones; the two currently known species of *Asellus* and *Sphaeromides* are, on the contrary, exclusive to the saturated zone, having been collected in siphons, small lakes or more rarely in watercourses directly in contact with the phreatic zone. Interstitial groundwaters of alluvial terrains are characterized by small-sized (2–5 mm) *Proasellus*, *Chthonasellus*, *Microcharon* and *Microcerberus* species; otherwise, *Angeliara phreaticola* and *Microcharon marinus* are associated with interstitial brackish waters. Asellota are all detritivorous or microphagous; *Monolistra* species are



micro filter feeders and possess specialized mouthparts for retaining food particles carried by the water current; the large-sized Cirolanidae are predators.

Zoogeography

Italian Isopoda include a large percentage of endemic species, which is near 100% in subterranean waters; even the few species which were supposed to have a wider distributional area (as within the genera *Proasellus*, *Stenasellus*, *Typhlocirolana*) have in fact turned out to be cryptic-species complexes according to recent molecular studies. Most endemics occur in the Pre-alpine area and Sardinia, although many endemic species are known from restricted areas of the Apennines. No stygobitic species or species endemic to glaciated areas of the Alpine chain are known, thus confirming a certainly pre-Würmian colonization of Italian karstic groundwaters by Isopoda.

Surface freshwaters are characterized by the presence of *Asellus aquaticus* and a few species of *Proasellus* of the *coxalis* group, the taxonomical status of which still needs defining. *Asellus aquaticus*, with its Asiatic-European distributional area, is widespread in the plain areas of northern Italy, becoming more and more scarce southwards along the peninsula, where it is substituted by *Proasellus* species of the *coxalis* group, which has a circum-Mediterranean distribution but is rapidly spreading throughout European inland waters. The two genera may locally occur together. The other epigeic species are endemics restricted to the flyschoid areas of Friuli Venezia Giulia and Istria (*Proasellus istrianus*) and of the Ligurian Apennines and Apuane Alps (*Proasellus micropectinatus*).

The groundwater assemblage is represented by stygobitic species having descended from freshwater-inhabiting ancestors (limnicoid stygobionts, such as the Asellidae) as well as from originally marine genera (thalassoid stygobionts, such as *Microcharon*, *Microcerberus*, *Sphaeromides*, *Typhlocirolana*, *Monolistra*, *Stenasellus*). The origin of Microparasellidae and Microcerberidae species seems to be strictly related to marine regressions, mainly of the Pliocene; the colonization of continental interstitial waters was, in this case, carried out by species inhabiting marine interstitial habitats. A more complex and discussed origin is that of species associated with karstic environments (Cirolanidae, Sphaeromatidae, Stenasellidae). In the case of *Monolistra*, and maybe also *Typhlocirolana*, active colonization of surface freshwaters by lagoon, brackish water species was followed by the iso-

lation of freshwater populations from marine ones as a consequence of the salinity crisis which took place in the Mediterranean during the Messinian; this event was followed by an adaptive radiation (maybe already in surface waters) and the colonization of the groundwater network according to the various karstification phases. Karstification caused the fragmentation of the distributional area of *Monolistra* and the isolation of numerous endemic species, which are currently distributed throughout the Pre-alpine arch, from the Slovenian border to the Como area. The stygobitic genus *Stenasellus*, the wide distributional area of which reaches Indonesia, is turning out to be of an even more ancient marine origin, dating back to the Tethys. As for the Italian species, it is necessary to refer to much later phases than the colonization of the Central European groundwater network, such as the rotation of the Sardo-Corsican microplate or, concerning the occurrence of *Stenasellus racovitzai* in Tuscany, the events which involved the Tyrrhenian continent.

The distributional area of the subterranean species is generally very limited; in many cases species are known from a single locality.

Alien species

No alien species of freshwater Isopoda are known in Italy. However, the problem of passive transportation is particularly stressed for *Proasellus* species of the *coxalis* group. Canalizations, aqueducts and freshwater transportations, also via the sea, create true difficulties during the reconstruction of original distributional areas.

Conservation

Italian Isopoda are rich in endemic species, particularly stygobionts. Therefore, they represent a natural heritage of high faunistic and biogeographical value that would demand, for its preservation, correct environmental management, particularly of groundwater, which is an important resource for human populations. Anthropization, intensive agricultural practices, pollution of surface watercourses and, as a result, that of the aquifers they supply, are the main sources of danger for alluvial areas, especially those of the Po-Venetian plain; urbanisation, mass breeding, spring water captation and the deterioration of karstic groundwater are the causes of the recently-observed decline of certain *Proasellus istrianus* and *Asellus cavernicolus* populations, besides that of *Monolistra* species in the Trieste Karst, the Verona Lessini mountains and the Brescia Pre-Alps.

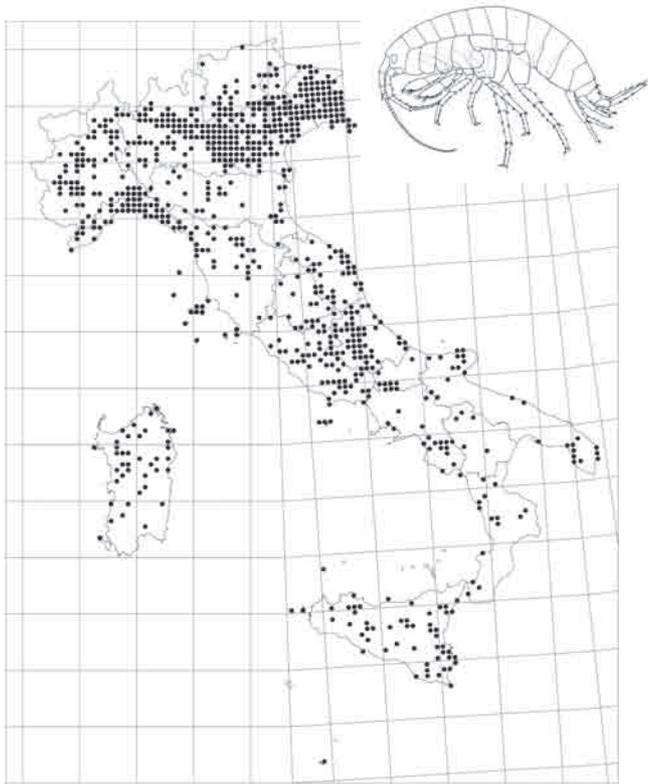
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Crustacea Malacostraca Amphipoda

Sandro Ruffo, Fabio Stoch



Amphipoda are considered an order of Malacostraca crustaceans: they are widespread in surface and subterranean freshwaters of Italy and are quite well known from the points of view of taxonomy and distribution. The use of molecular biology methods, together with morphological studies, has recently brought to the taxonomical clarification of *Gammarus* and *Orchestia*, whereas other genera are still awaiting revision; for instance, within *Niphargus* the distinction of species is still problematic.

Material and methods

The filing of species distribution data is based on literature posterior to the 1930s, particularly on the work by G. Karaman (1993), critically examined and supplemented by the checking of material from the Amphipoda collection of the Natural History Museum of Verona, the most complete one in Italy, as well as by the more recent literature. Old citations, particularly those referring to the genus *Niphargus*, were unusable in that their assignment to species today considered as valid was impossible. Unpublished data included in the database make up for over 40% of total records.

Biodiversity

The Italian freshwater fauna comprises 17 genera, belonging to 9 families of Gammaridea and 2 families of Ingolfiellidea. Three genera – *Echinogammarus*, *Gammarus* and *Niphargus* – make up for over 60% of all Italian species. Ninety-four species are known, besides approximately ten species of *Niphargus* the taxonomical status of which still needs to be defined. These taxa are currently individuated as a “group” and assigned to the morphologically closest species; a “group” can therefore correspond to one or more species. The number of Italian species is largely higher than those of the central-European countries (fifty odd species) and Great Britain (roughly fifteen); only the Balkan peninsula has a more diversified fauna compared to Italy. The biodiversity pattern outlined in the present work reveals greater species richness in the northern regions, especially in the Alpine and Prealpine region; however, one must admit that the Alps and Po Plain are the best-investigated areas. It would be especially interesting to carry out further studies in the subterranean waters of the most southern peninsular regions, Sicily and Sardinia.

Ecology

Surface freshwater Amphipoda mainly inhabit lotic habitats, more rarely ponds or marshes. Longitudinal zonation may be observed in watercourses: *Gammarus* and *Niphargus* occur in the upper stretches (crenal and epirhithral, as well as plain springs) and are substituted downstream by *Echinogammarus*; the 3 genera may locally occur together. Gammaridae may occur in lakes, even at high altitudes. In Lake Garda, large populations of *Echinogammarus stammeri*, as well as of *Synurella ambulans* and *Niphargus forelii* are present, and can be found even at depths of over 300 m. One species on the other hand, *Gammarus lacustris*, is a typical inhabitant of small, high-altitude lakes of the Alps and Apennines, even over 2000 m.

The karstic system groundwater assemblage is characterized by many species of *Niphargus*, sometimes of large size (over 3 cm), that have colonized an array of microhabitats including drip pools in caves. Interstitial groundwater of alluvial terrains is characterized by small species (3-4 mm) of the genus *Niphargus*, by the genus *Bogidiella* and, at least in part, by the genera *Rhipidogammarus*, *Longigammarus*, *Ilvanella*, *Salentinella* and *Hadzia*, which also comprise anchialine species.

Lastly, one species only, *Orchestia cavimana*, can be



considered as subterrestrial; it occurs along the edges of big lakes (Garda, Iseo) and rivers (Adige, Po, Arno) and wet plain areas.

Surface water Amphipoda play an important role in the food chain and represent an important source of food for fish. Their significance as water quality indicators is rather low however, given the tolerance shown towards organic pollution, although they seem to be more sensitive to heavy metals. Groundwater species are more revealing in this respect, particularly those of phreatic waters; some of these appear to have disappeared from near heavily anthropized areas.

Zoogeography

Italian Amphipoda include a high percentage of endemic species (over 60%). Most of these occur in the Pre-alpine zone, whereas secondary endemism hotspots can be found in Apulia and the central Apennines.

The surface freshwaters of the Alpine province are characterized by the genus *Gammarus* only in the central-eastern part; this genus appears to be missing from the western Alps, except for a small area of the Maritime Alps, where *G. pulex gallicus* – which is also present in southern France – occurs. Members of the genus *Niphargus* are widespread in Alpine subterranean waters, with many species distributed in the Pre-alpine karstic systems (from the Trieste Karst to the Lombard Prealps) which were not affected by the quaternary glaciations. The more internal areas of the Alps are inhabited by few, frigophilous *Niphargus* species, having probably differentiated from one another on the margins of the Quaternary glaciers and were confined, from the beginning of the Würmian, to either high altitudes (even over 2000 m) or the deep parts of subalpine lakes. The same phenomenon would explain the distribution of a boreal species (*G. lacustris*) that currently occurs, in Italy, in high-altitude lakes only.

The association of 3 species characterizes the surface watercourses of the Po province: *Echinogammarus stammeri*, *Synurella ambulans* and *Niphargus elegans*, whereas the phreatic and interstitial waters of the Po Plain alluviums host a certain number of *Niphargus* species, part of which endemic, alongside with *Bogidiella albertimagni*.

The Apennine province is altogether quite different. The running surface waters of the central-southern Apennines are populated by *Gammarus elvirae* (probably of western European origin) and by a certain number of *Echinogammarus* species, some of which are endemic. *Niphargus* species are less numerous in groundwater habitats than they are in the Alps, and decrease in number towards south: species of the *orcinus* and *stefanellii* groups are interesting endemics, and both these groups show trans-Adriatic affinities. The subterranean waters of the peninsula also host species of *Salentinella*, as well as genera

that are associated with Tyrrhenian palaeo-areas such as *Metacrangonyx* (Elba Island), *Ilvanella* (Elba Island, Tuscany, Latium), *Longigammarus* (Tuscan Archipelago), *Rhipidogammarus*, *Pseudoniphargus* and *Bogidiella*, which mainly include endemic species. The Apulian province is characterized by palaeo-Mediterranean *Hadzia* species and by an exceptional endemic, *Metaingolfiella mirabilis*, found only once in the Salento karst.

The Amphipoda fauna of Sicily and Sardinia is, on the other hand, very poor. *Echinogammarus* species, some of which endemic, occur in the surface waters of both these regions; in Sardinia, an endemic *Gammarus* species (*G. italicus*) equally occurs, with probable Iberian affinities. The subterranean waters of these islands are each characterized by an endemic *Tyrrhenogammarus* species, by *Pseudoniphargus* species (some of which endemic to Sicily), by several *Bogidiella* species (absent in Sicily), and by a species of *Ingolfiella* that is a Tyrrhenian endemic of Sardinia. The genus *Niphargus* is represented by very few species (maybe two) of the *longicaudatus* group in both Sicily and Sardinia.

Alien species

Two species of Gammaridae have recently appeared in the Italian fauna: *Gammarus roesellii* and *Dikerogammarus villosus*. The first species is widespread in central (where it reaches France) and eastern Europe (where it reaches Romania), and was first recorded from Italy in 1986 from the Bacchiglione river basin near Padua. Currently, its Italian distributional area has reached the Sile basin, and it appears to have substituted the indigenous *Echinogammarus stammeri* populations in some places. *Dikerogammarus villosus*, from the Danube basin, has invaded the middle-European region from Poland to the Netherlands and represents, through its aggressiveness, a grave problem for indigenous coenoses. In Italy it was first found in 2002 in southern Lake Garda. Recent surveys have shown that it is probably spreading all over Lake Garda and may have reached, through the Mincio river, the waters south of Mantua. Both these species may have been accidentally introduced from other countries together with fry. It would be advisable to monitor the two species continuously in order to control their spreading, while also preventing transfers of fish material from the already invaded areas.

Conservation

Italian Amphipoda, given the high rate of endemism by which they are characterized, represent a natural heritage of great biogeographical value; only the correct management of the habitats in which they live can preserve their integrity. Particularly endangered are the interstitial species of the Po region such as *Bogidiella albertimagni* and some endemic *Niphargus* species (*N. bajuvaricus grandii*, *N. pupetta*, *N. transitivus*, *N. longidactylus*, *N.*



duplus), which have nowadays become very rare. Anthropization, intensive agricultural practices and pollution of surface watercourses are the main causes of the disappearance of such species from large parts of the plain.

Gammarus lacustris is threatened by indiscriminate salmonid rearing carried out in high-altitude lakes, the main habitat of this species in Italy. It used to be cited in the literature from many alpine localities, from which it has cur-

rently disappeared. In order to preserve this species, the introduction of salmonids should be restricted by a study on feasibility and the historical absence of *G. lacustris*.

A threatened species in the big subalpine lakes is *Niphargus forelii*. This species seems to have disappeared from Lake Maggiore and Lake Lugano; it was recently collected in Lake Orta, where it appeared to be extinct, following the restoration of water quality.

Relevant Literature

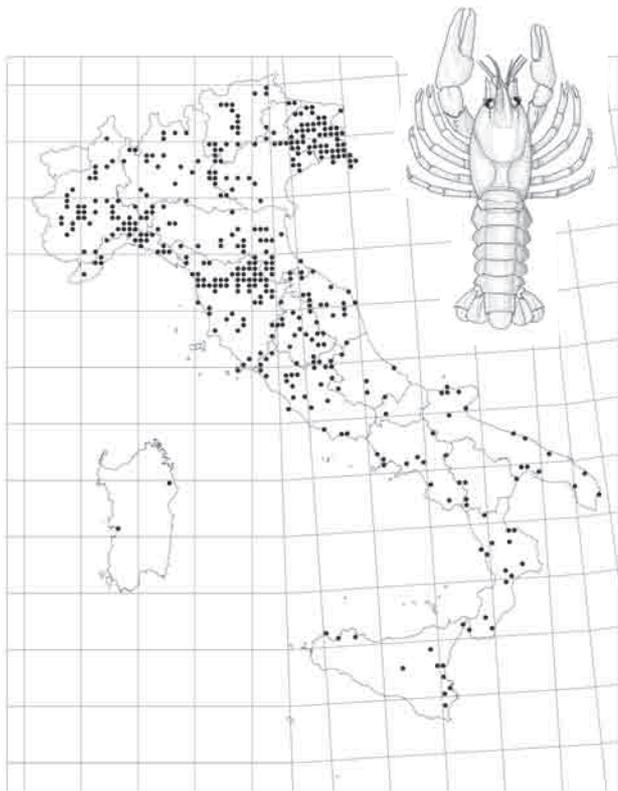
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Crustacea Malacostraca Decapoda

Carlo Frogli



The order Decapoda occurs in Italian surface and subterranean freshwaters in a limited number of species. The use of molecular biology has highlighted the possible existence of several taxa within some groups, such as *Austropotamobius pallipes* and *Troglocaris anophthalmus*, the distinction of which is complicated on a morphological basis.

Material and methods

Data on distribution of the species reported by Frogli (1978) and those subsequently recorded for Italy were obtained from the scientific literature, supplemented in some cases by recent grey literature and by the examination of the Decapoda collections of some Italian museums. Records found on the websites of natural reserves and parks were not used, for the impossibility of checking identifications. Since literature from the beginning of the last century was also utilized, species originally recorded from some localities may have disappeared today following habitat alteration. Until such time as the status of *Austropotamobius* taxa has been defined on a biochemical basis, these have been grouped together under *A. pallipes fulcisianus* (Ninni, 1886) [= *A. pallipes italicus* (Faxon, 1914)].

Biodiversity

In Italian freshwaters 12 species are currently recorded, belonging to 10 genera included in 6 families.

The lowest biodiversity occurs in Sardinia, from where only two species of Decapoda are recorded, one of which (*Palaemonetes antennarius*) was probably introduced in recent times following fish restocking operations and aquaculture.

The number of autochthonous Decapoda occurring in Italy is comparable to those of the southern European regions. The Italian Decapod fauna as a whole is sufficiently well known and the discovery of new taxa may occur as a result of the individuation of cryptic species through the use of molecular biology techniques, or by exploring peculiar habitats such as subterranean waters.

Ecology

The two largest species of autochthonous Decapoda – *Austropotamobius pallipes fulcisianus* and *Potamon fluviatile* – prevalently inhabit lotic environments, the former in upper stretches or resurgence zones and the latter in lower stretches. Both live in burrows excavated in the river bank or use stones, roots, etc. as refuges, and are mainly nocturnal. They are preyed upon by various aquatic vertebrates and were fished for in the past.

The Italian populations of *A. pallipes fulcisianus* were decimated during the second half of the nineteenth century following the spreading, in Italy like in the rest of Europe, of the so-called “crayfish plague”, caused by the fungus *Aphanomyces astaci*. *A. pallipes fulcisianus* prefers running and well-oxygenated water and is sensitive to organic and industrial pollution, so it is considered a good indicator of water quality.

Palaemonetes antennarius occurs in both lentic waters and lotic waters rich in vegetation, as well as in moderately brackish environments such as the more internal parts of coastal lakes.

Troglobitic Decapoda are only found in the two major Italian groundwater systems: a few species of the *Troglocaris anophthalmus*-group in Venezia Giulia and *Typhlocaris salentina* in Apulia.

Zoogeography

Italian freshwaters include all the Decapod families recorded from European freshwaters or the Mediterranean basin.

Among the Astacidae, *Astacus astacus*, common in continental Europe, occurs in a small area of Venetia (Bel-



luno province), probably as a result of its introduction in historical times; the torrent crayfish *Austropotamobius torrentium* is recorded from a single locality on the north-eastern border, beyond the Alpine watershed; the white-clawed crayfish *A. pallipes fulcisianus* occurs in the upper stretches of Alpine and Apennine watercourses down to Calabria, but is absent from all the Italian islands, as well as in all the Mediterranean islands. The presence of *A. pallipes fulcisianus* in Lake Vrana on the island of Cres (Croatia) is almost certainly due to its introduction there in historical times. Some populations of the white-clawed crayfish occurring in the watercourses of Piedmont and Liguria seem to be assignable to the nominal subspecies *A. pallipes pallipes*, which is distributed in France, continental Europe and England (Santucci et al., 1997).

The troglobitic species *Typhlocaris salentina*, which is localized in the Apulian groundwater system, is the only endemic one among Italian freshwater Decapoda. The Typhlocarididae, which were recently separated from the Palaemonidae, are endemic of the Mediterranean area and include two other troglobitic species, localized on the southern shores of the basin.

The crab *Potamon fluviatile* is distributed in Sicily and, in the Italian peninsula, from Calabria to eastern Liguria and southern Venetia (Lake Garda).

Among the Atyidae, *Atyaephira desmaresti desmaresti* occurs on the two major islands and in some watercourses of the western side of the Apennines; it has only recently been recorded also from some localities of the Colli Euganei and the lower course of the Piave river, whereas it seems to be absent from other rivers of the Adriatic side of Italy.

Alien species

The rarefaction of white-clawed crayfish populations has brought, in Italy also, to the voluntary or accidental introduction of two American Cambaridae – *Orconectes limosus* and *Pacifastacus leniusculus* – that are more resistant to the “crayfish plague”, but which facilitate its spreading. Moreover, carelessly carried out aquaculture experiments and uncontrolled introductions into the natural environment have caused, during the last ten years,

the spreading of the Louisiana crayfish (*Procambarus clarckii*) which, through its robustness, fast growing and voracity, represents a threat to autochthonous species of invertebrates and fish. The species is rapidly spreading throughout central Italy.

Another allochthonous species (*Astacus leptodactylus*), which is imported alive in Italy and is regularly found in many fish markets, has sometimes been the object of clumsy restocking operations having brought to the stabilization of a few populations in central Italy.

Conservation

The two largest species of Decapoda – *Austropotamobius pallipes* and *Potamon fluviatile* – were fished for in the past. The rarefaction of their populations, and the reduction and fragmentation of their distributional areas, have induced regional authorities to ban fishing of both these species, the former one also being listed in appendixes II and V of the 92/43/CEE Directive (Habitat Directive). The three European Astacidae species occurring in Italy are also listed in appendix III of the Bern Convention on the conservation of wildlife and the natural environment.

Considering the preliminary results of molecular biology studies, experiments aimed at the reintroduction of *A. pallipes fulcisianus* should be carried out with the greatest care, especially when choosing the areas from which to take individuals, in order to avoid further mixing of populations having probably already occurred in the past.

Other species, such as *Palaemonetes antennarius*, are so abundant in some areas (Po delta, Venetia) as to represent an important fishing resource in river mouth and lagoon environments; in other regions however (e.g. Tuscany), this species has become so rarefied as to induce local authorities to emit a ban on their fishing.

The troglobitic species, the distributional areas of which are limited, are particularly sensitive, and no information exists on population sizes.

Considering the invasive capacity of some allochthonous species (e.g. *Procambarus clarckii*), all the possible precautions should be taken in order to prevent their escape from rearing and their voluntary introduction into Italian watercourses.

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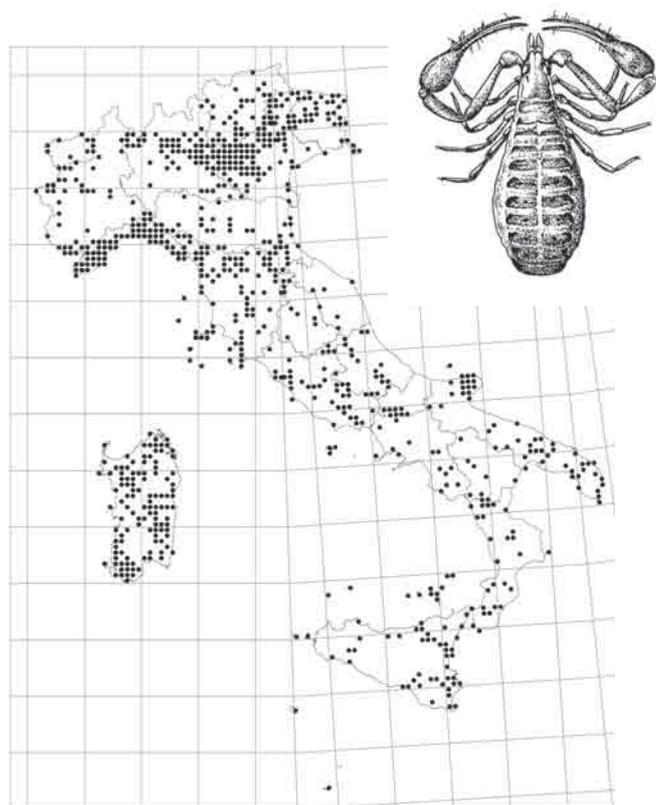
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Arachnida Pseudoscorpionida

Giulio Gardini



Pseudoscorpions are an order of arachnids widespread in epigeal and hypogean terrestrial environments. From both a taxonomical and a chorological point of view, the group is far from being sufficiently well known. Except for a few cariological studies on the Italian *Roncus* species, the alpha-taxonomical approach is still the most frequently used one for the study of pseudoscorpions. The most species-rich genera, *Chthonius*, *Neobisium* and *Roncus*, still want a revision, the distinction of species being particularly complicated within *Roncus*.

Material and methods

The filing of data on species distributions is based upon literature posterior to the work of Koch (1873), which was critically examined on the basis of the more recent literature reported by Gardini (2000). Old citations, which are virtually impossible to assign to any valid species, were not considered. No unpublished data were included in the database.

Biodiversity

The Italian pseudoscorpion fauna includes 37 genera belonging to 12 families. *Chthonius*, *Neobisium* and

Roncus account for 64% of the 215 species currently known from Italy, a number undoubtedly lower than reality and due to increase in the future, especially within the three above-mentioned genera, following the study of the huge amount of both epigeal and hypogean material, most of which unpublished, that has accumulated in private and museum collections throughout Italy during the past thirty years. Italy is the European country richest in species, and has certainly been the best-studied Mediterranean country during the past two centuries. Only the Balkan states – considered together – have a richer (276 species: Harvey, 1991) but equally diversified fauna, considering that the main contribution to biodiversity is given by those genera (*Chthonius*, *Neobisium* and *Roncus*) which, in this region also, have contributed to most of the colonization of hypogean environments. A poorer fauna is found in the Iberian peninsula (131 species: Harvey, 1991), less well investigated than Italy however, and in France where, Corsica included, 119 species are known (Harvey, 1991). The number of species occurring in Italy is, for obvious past and present climatic and geographical reasons, positively higher than those of the central European countries (102 species: Harvey, 1991), the Scandinavian area (37 species, including Denmark: Harvey, 1991) and Great Britain (26 species: Harvey, 1991).

The biodiversity model emphasized in this work reveals a greater species richness in regions – such as Sardinia, Venetia and Liguria – where more faunistic surveys have been performed, but which also possess important geological and paleogeographic features, as well as vast and diversified karstic phenomena.

Ecology

Pseudoscorpions are predator arachnids that occur in all natural and anthropized terrestrial environments, from sea level to altitudes over 3500 m in the western Alps. They are typical geophilous animals having undergone great adaptive radiation, which has allowed them to colonize an array of hypogean and epigeal biotopes with a high number of species. Most of the Italian species are related to the soil.

All the epigeal Chthoniidae and Neobisiidae belong to the edaphon, and some species of these families are characteristic elements of certain terrestrial animal communities. *Chthonius* (*C.*) *jugorum* and *Neobisium* (*N.*) *jugorum* are eualpine orophilous species known also from the external Alps; the latter, which detains the al-



titudinal record among Italian pseudoscorpions (3520 m on the Monte Rosa group), is also an element of the perinival fauna of some Alpine nunataks. *Neobisium* (*N.*) *fuscimanum* and *Microbisium* species are stenoecious, euryzonal taxa, related to humid soils and peaty formations. Instead, other species of *Chthonius* (*C.*) and *Neobisium* (*N.*) are widely euryoecious and euryzonal: they actually occur in the phytodetritus of plain, submontane and montane woodland formations of heliophilous and sciaphilous broadleaved trees and conifers, in xerothermophilous Mediterranean vegetational formations and also in meadow formations; they are often pholeophilous or sublapidicolous, with a tendency to occupy both natural and artificial hypogean habitats, and are sometimes synanthropic. Typical representatives of this group of species with such wide ecological amplitude are *Chthonius* (*C.*) *ischnocheles*, *C.* (*C.*) *tenuis* and *Neobisium* (*N.*) *carcinoides*. The edaphobic *Chthonius* species of the subgenus *Ephippiochthonius* and, among the Neobisiidae, the *Roncus* species, prefer, despite numerous exceptions, more xeric conditions; they constitute, together with the Geogarypidae, Cheliferidae and Chernetidae, the characteristic component of many meso- and xeromediterranean zoocoenoses.

The cavernicolous fauna of Italy is nearly exclusively composed of Chthoniidae and Neobisiidae of the genera *Chthonius* (29 troglobitic species), *Spelyngochthonius* (3), *Troglochthonius* (1), *Neobisium* (13), *Roncus* (20), *Acanthocreagris* (3) and *Balkanoroncus* (1), together with a few Syarinidae (5). This assemblage is extremely important, not only from a zoogeographical point of view, but also from an ecological one, because pseudoscorpions represent an ever-present and abundant portion of predators in the ecosystems of both temperate and cold Italian caves.

An interesting and little-studied pseudoscorpion assemblage is the halophilous one of the rocky and sandy coasts of Italy. *Paraliochthonius singularis*, *Garypus levantinus* (the largest Italian pseudoscorpion) and *Pselaphochernes litoralis* are characteristic species of the supralitoral and intercotidal belts of pebbly and rocky coasts, and owe their rarity and patchy distributional areas to inadequate research, which is also responsible for the poor state of knowledge of the psammo-halobiontic community, represented by *Chthonius halberti*, *Olpium pallipes* and *Garypus beauvoisi*.

Geogarypus among the Geogarypidae, *Minniza*, *Calocheiridius*, *Garypinus* and *Amblyolpium* among the Olpiidae and *Atemnus politus* among the Atemnidae, are typical representatives of the xeromediterranean animal communities of the low open maquis and garigue habitats of central-southern and insular Italy; in western Liguria *Geogarypus minor* and *G. nigrimanus* are characteristic elements of low maquis phytodetritus, and *Calocheiridius mavromoustakisi* is a common lapidicolous

species of the narrow, *Crithmum maritimum*-dominated coastal belt.

Cheliferidae and Chernetidae species, considered as the most evolved within the order, show mainly corticolous habits. *Dactylochelifer falsus* and *D. latreillii* inhabit brackish environments, but also occur (*D. latreillii*) in the flood beds and fossil dunes of the Po Valley rivers; *Hysterochelifer tuberculatus* is a typical species of evergreen Mediterranean formations, and is a characteristic element of subalpine xerothermic oasis assemblages; *Dendrochernes cyrneus* indicates balanced environmental conditions in mixed, oak-dominated forest systems of central-southern Italy, whereas *Chernes montigenus* is an orophilous corticolous and lapidicolous species of spruce and larch forests of the Alps. A few species of *Chernes*, *Lamprochernes* and *Lasiochernes* are phoretic on opilions, tipulid, syrphid and muscid flies or butterflies, and occasionally occur in mole and marmot burrows and birds' nests; other species (*Allochernes solarii*) are myrmecophilous, whereas *Lasiochernes siculus* is characteristic of the guanobious communities of caves in Apulia and Sicily.

The best-known synanthropic species, habitual unobtrusive guests of our houses, are *Cheiridium museorum* (the smallest Italian pseudoscorpion) of the Cheiridiidae and the cosmopolitan species *Chelifer cancroides* of the Cheliferidae. Together with the *Withius* (Withiidae) and *Allochernes*, *Pselaphochernes* and *Chernes* (Chernetidae), they also inhabit stables, rabbit hutches, pigeon houses and occasionally (*Chelifer*) apiaries, where they prey upon Thysanura, Psocoptera and the larvae of *Anthrenus* beetles, anobiid beetles and Microlepidoptera.

Zoogeography

Italian pseudoscorpions include a high percentage of endemics (over 56%). Most of these occur in the Prealpine area and Sardinia, together with the most ancient karstic systems; other, secondary centres of endemism can be found in the northern and central Apennines and in Apulia and Sicily.

The Trieste Karst area is characterized by some extraordinary troglobitic species, such as the Chthoniidae *Troglochthonius doratodactylus* and the Neobisiidae *Neobisium (Blothrus) spelaeum*, both of which with Dinaric affinities.

In the Triveneto region and in the Prealps of Lombardy, the epigeal and – most of all – the hypogean pseudoscorpion community is particularly rich in endemics. The Adige Valley and Mount Baldo act as a hinge, which tends to limit the distribution of recent cavernicolous species, and mark the boundary between the western and eastern Alps. The only species that occurs in both these sections is *Balkanoroncus baldensis*, which is probably a pre-Quaternary relict.

The western and Ligurian Alps constitute another section



of great zoogeographical importance, within which three separate faunistic components can be recognized: a west-Alpine one, a Provençal one and an Apennine one. The extraordinary richness and complexity of the fauna of this area are increased by the presence of palaeotropical relicts such as the Syarinidae of the genus *Pseudoblothrus*, ultra-evolved troglobitic species that also inhabit artificial, non-karstic cavities. The Ligurian Alps also host an amazing cavernicolous neobisiid, *Neobisium (Ommatoblothrus) zoiai*, with uncertain Pyrenean affinities.

The peninsular assemblage of species is quite rich in eastern Liguria, in the Apuane district and in the hills and mountains of the central Apennines, where cavernicolous and alticolous (high-altitude) endemics of the genera *Chthonius*, *Neobisium*, *Roncus* and *Acanthocreagris* occur, whereas the Preapennines and central-southern Apennines are strongly characterized by troglobitic *Neobisium* species of the subgenus *Ommatoblothrus*, related to the Sardinian ones.

Apulia has an altogether poor epigeal fauna, with just two endemic Neobisiidae: *Acanthocreagris italica* and *A. apulica*. The presence of the extraordinary troglobitic species *Hadoblothrus gigas*, a syarinid relict with Aegean affinities, nevertheless confirms the geological peculiarity of this region and the ancientness of its hypogean community.

The Sicilian fauna does not include any striking particularities, apart from a few North African species of *Miniza* and the East-Mediterranean *Garypinus dimidiatus*. Noteworthy are a few troglobitic endemics of the genera *Chthonius* and *Roncus*, and a recent cavernicolous species of Etna's lava caves (*Roncus aetnensis*).

Sardinia is the Italian region with the highest number of species: 72, of which 28 are endemic. The epigeal assemblage of species, despite the presence of some interesting elements and a few endemics among the genera *Chthonius*, *Neobisium*, *Roncus* and *Acanthocreagris*, is far more homogeneous compared to the hypogean one, which reflects, through its uniqueness and richness, the complex geological history of this region. The faunistic affinities with Pyrenean and Provençal elements are witnessed by three troglobitic species of *Spelyngochthonius*

and by the *Roncus* species of the Sulcis and Iglesias areas; resemblances with the Apennine fauna are witnessed by the *Neobisium* species of the subgenus *Ommatoblothrus*, which inhabit the cavities of Sopramonte di Oliena and Monte Albo.

Alien species

So far, no cases of introduction into Italy of allochthonous species are known.

Conservation

Italian pseudoscorpions, given the high percentage of endemics and the small distributional areas of many species, especially cavernicolous ones, represent a natural heritage of great zoogeographical interest, which can only be preserved through the correct management of the environment and of the singular habitats in which they live.

Particularly endangered are the many cavernicolous endemics of small limestone outcrops, to which human activity, in the form of exploitation and pollution, causes nearly immediate irreversible negative effects. *Chthonius genuensis*, a punctual endemic of the heavily-exploited Monte Gazzo dolomites near Genoa and *Chthonius zoiai*, of the Lama limestone formations of La Spezia, are two of the very many troglobitic species at risk of extinction. Anthropogenic disturbance of coasts, especially sandy ones, brings to the disappearance of characteristic elements of their delicate halobiontic zoocoenoses: *Paraliochthonius singularis* could be found at Boccadasse (Genoa) and Portici (near Naples) until the first decades of the twentieth century, but is now rare and limited to protected areas (e.g. the Tuscan Archipelago) or areas inaccessible to tourists.

Fires, which are too frequent and particularly afflict the narrow coastal belt occupied by Mediterranean maquis, cause a qualitative decline of the pseudoscorpion community, and the disappearance of the most ecologically and zoogeographically significant edaphobic and corticolous species (e.g. *Pselaphochernes lacertosus*), to the advantage of euryoecious and widespread species such as *Pselaphochernes scorpioides*.

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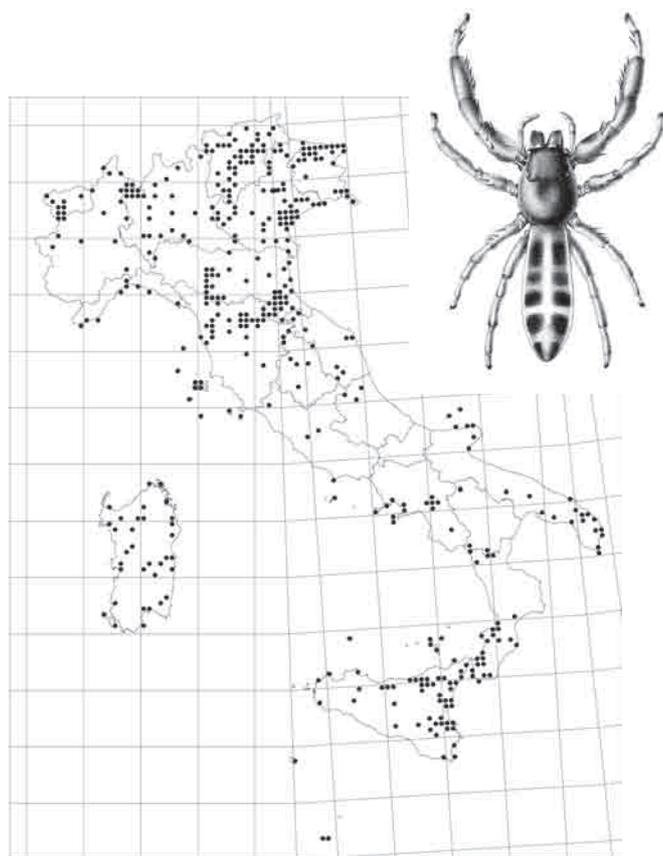
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Arachnida Araneae Salticidae

Harald Hansen



Material and methods

One of the obstacles with which one is confronted when preparing what is largely a compilative work is the reliability of determiners. In their defence, one must admit that in the past their task was not facilitated by descriptions that were brief or based on variable characters, and were seldom accompanied by illustrations. In order to reduce errors, past citations have been generally maintained for ubiquitous species and for species confirmed by a more recent citation. On the contrary, a certain number of old records considered as “critical” – e.g. citations that for biogeographical or ecological reasons (e.g. altitude) appeared to be doubtful – were re-examined, and in the case of erroneous determination of the only Italian record for a species, this was removed from the Checklist. The depository of such material is indicated in the database. Furthermore, in the case of single citations for which the material has become untraceable, the species name is followed by the phrase “presence needs checking” in the database. Besides these re-examined records, a fair amount of undetermined species from various regions were kindly made available by the “E. Caffi” Natural History Museum of Bergamo, by Italian

colleagues and by a German arachnologist, thus completing the picture. A previous work (Hansen, 1985), updated to 2002, was used as a bibliographical support. The nomenclature follows that of Proszynski (2003a).

Biodiversity

Currently, 123 species belonging to 38 genera can be considered as part of the Italian Salticidae fauna, while for 8 other species verification is needed (untraceable material or erroneous determinations). Unfortunately, despite recent works concerning the eastern part of the Mediterranean – e.g. Metzner (1999) and Proszynski (2003b) – the taxonomical knowledge of several genera (e.g. *Euphrys*) including species with a mainly Mediterranean distribution, still remains quite patchy.

As for species distribution in Italy, some areas in particular demand a thorough investigation. Sicily, with over 60 species, is the best-studied region (Alicata, Cantarella, 2000), followed by Venetia, Trentino-Alto Adige and Emilia-Romagna, each with between 54 and 58 species; Molise, without a single recorded species, is at the other extreme. A good number of species, from 30 to 40, are recorded from Sardinia, Calabria, Apulia, Umbria, Tuscany, Liguria, Lombardy and Friuli Venezia Giulia, whereas fewer are known from Campania and Piedmont, where 22 and 24 species are recorded, respectively. The low numbers of species (in brackets) recorded so far from the Marche (15), Basilicata (14), Abruzzo (4) and Aosta Valley (11) are indicative of a bad state of knowledge. However, a large quantity of material collected by the Museum of Bergamo in central-southern Italy is currently under study in Catania (Pantini, pers. comm.) and should, together with the Brignoli collection – which was being reordered and was therefore not available during the preparation of the present work – bring to an increase of these numbers.

Ecology

The general ecological requirements of the Salticidae, leaving out habitats such as caves or cellars, vary greatly from one species to another: some are ubiquitous and generalist, whereas others are stenoecious, usually of xeric habitats, but also of marshy ones. Moreover, little is known about possible changes of habitat of single species from the northern to the more temperate southern regions of Italy. An interesting case is that of *Sitticus zimmermanni*, the preferred habitat of which is limited to a certain altitudinal range (eastern Alps and Prealps, Pol-



lino massif, Mount Etna). Another unsolved question is represented by species that are active during summer in northern Italy, but undergo aestivation in southern Italy. The intricacy of the subject does not make it easy to define habitat fidelity of a number of species; nonetheless, at least for some species, available data confirm their strong association with a particular habitat (phragmiteta: *Marpissa radiata*, *M. pomiata*; low, marshland vegetation: *Sitticus caricis*; detritus, high-altitude scree: *Sitticus rupicola*, *S. longipes*; coastal sand dunes, sparse vegetation on sandy substrates, “magredi” grasslands: *Yllenus salsicola*, *Sitticus saltator*, *S. penicillatus*).

Zoogeography

The distributional spectrum is dominated by 37.7% of species with a vast distributional pattern (PAL: 13.9%; OLA: 6.6%; SIE: 6.6%; CAE: 3.3%; TUE: 2.5%; ASE: 1.6%; CEM, TUM, EUM and AIM: 3.2%), followed by species with a mainly Mediterranean (24.5%) and European distribution (20.5%). The Mediterranean species were not divided into WME and EME, given the existing lacunae. European elements, considered broadly, were nearly equal in number to those with a S-European distribution. The distributional pattern of 10.7% of species does not fit in with any of the above chorotypes, e.g. the cosmopolitan species of temperate zones. Endemic species (5.7%) are distributed as follows: 3 in Sicily and its islands, 1 in the Carnic Prealps, 1 along the southern Alpine arch, 1 in Calabria and 1 in Campa-

nia. The Alpine endemism has long been confirmed, but those from Campania and Sicily and islands – which are based on recently described species – should be considered as temporary. The species from the hill zone of the Carnic Prealps was described from females and belongs to a taxonomically complicated genus, so its validity would need confirming. Finally, the type material of the Calabrian species was lost during the Second World War, and the poor drawings that accompany the description imply a likely synonymy.

Conservation

To draw an outline of the status of conservation of the species would be premature, considering the insufficient data in our possession. For example, for at least 18 out of the 44 species (about 36% of the total) considered as “rare”, habitat data are missing. In any case, all the previously-cited stenoecious species can be indicated as potentially vulnerable except *Sitticus longipes*, which occurs at high altitudes, where it is less exposed to anthropogenic disturbance.

The spreading of agricultural activities and the drying up of humid areas, the pressure of tourism – in both coastal and mountain areas – and human intervention on watercourses (embankments, etc.), are often the cause of rarefaction or disappearance of Salticidae from the natural environment. The protection of humid areas, high-water beds, pebbly riverbanks and xerothermic biotopes, as well as dunes and dry meadows, would therefore be desirable.

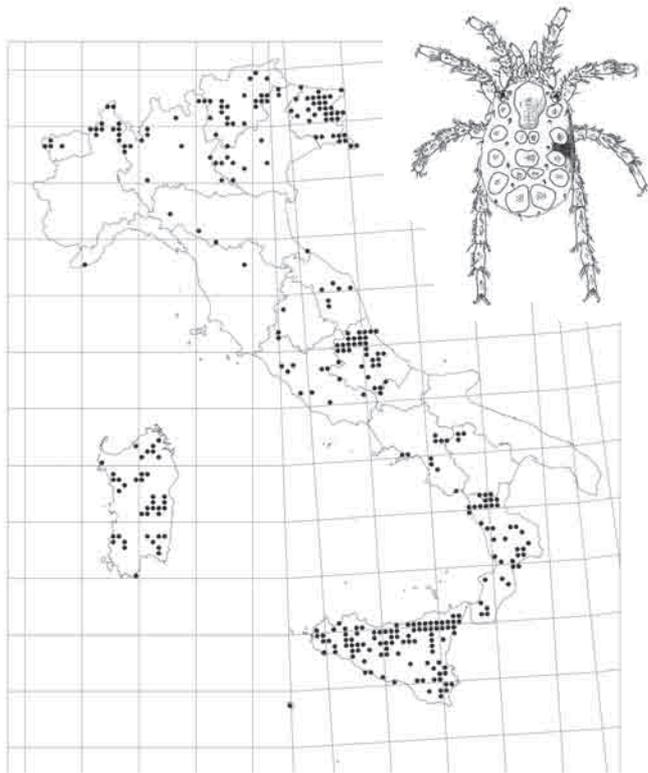
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Arachnida Acari Actinedida Hydrachnidia

Antonio Di Sabatino, Bruno Cicolani, Reinhard Gerecke, Paolo Miccoli



Among the various groups of Acari having secondarily invaded aquatic environments, Hydrachnidia (water mites) are certainly the most successful taxon in terms of diversification, adaptation and ecological specialization. Over 5,000 species are known worldwide, gathered together in 8 large superfamilies, 50 families and over 300 genera (Viets, 1987). Water mites belong to the order Actinedida (suborder or cohort Parasitengona) and are characterized by a peculiar life cycle, with a pattern of development similar to that of holometabolous insects. During ontogenesis, 6 developmental forms follow each other, 3 of which are mobile and active (larva, deutonymph and adult), and 3 immobile and inactive (pre-larva, protonymph and tritonymph). The larva is generally parasitic and phoretic on aquatic insects, whereas deutonymph and adult are predators on larvae and eggs of insects and small crustaceans (Di Sabatino et al., 2000, 2002).

Material and methods

The present work provides data referring to the Italian distribution of 150 species, belonging to 21 genera and 5 families (Hydrovolziidae, Hydryphantidae, Sperchontidae, Torrenticolidae and Arrenuridae). Information was

obtained from an electronic archive, developed by the authors, providing updated distributional data on the species of the Mediterranean basin. This archive was assembled on the basis of an accurate and thorough revision of all the literature on the subject, and also includes some unpublished data.

Biodiversity

The recent checklist of the Italian fauna (Bernini et al., 1995) reports the presence of 298 species of water mites, a number which decreases to about 240 if synonyms, uncertain or doubtful species and erroneous records are considered. Currently, the species occurring in Italy are over 380 (Cicolani and Di Sabatino, unpublished). These belong to 8 superfamilies, 31 families and 78 genera. The genera *Arrenurus* (46 species), *Lebertia* (30 species), *Atractides* (28 species) and *Torrenticola* (20 species) are the richest of species. The genera *Sperchon* (15 species), *Hydryphantes* (14 species), *Piona* (14 species) and *Unicolica* (12 species) are also quite diversified.

Compared with other European and non-European countries, information on the Italian distribution of Hydrachnidia is quite substantial, and amongst the most up-to-date and exhaustive.

In northern Italy the inland waters of Piedmont, Lombardy, Trentino and Friuli are quite well investigated, even though in the first two regions information mainly concerns lentic habitats; large gaps exist for Liguria, Tuscany and the Po Plain. In central Italy, Abruzzo has been well studied and substantial data is emerging for the Marches and Latium. A survey is currently being carried out to make up for the almost total lack of information for Molise. In southern Italy the level of knowledge is good for Basilicata, Calabria, Sicily and Sardinia, whereas little or no information exists for Campania and Apulia.

Ecology

Their great adaptive plasticity has allowed water mites to conquer the totality of both surface and subterranean freshwater environments. Their high ecological specialization, strict habitat/microhabitat dependence and extreme sensitivity to various types of pollutant make water mites efficient bioindicators of the quality of springs, watercourses and lakes (Di Sabatino et al., 2000), and justify their use in biological surveys of water bodies (Cicolani and Sabatino, 1991). Of the 5 families the distribution of which is given here, the Hydrovolziidae are represented by the genera *Acherontacarus* (with species



associated with groundwaters and springs) and *Hydrovolzia* (two species exclusive to spring habitats). Hydryphantidae occur in nearly all types of habitat. Some genera are essentially crenobiontic and are excellent bioindicators (*Partnunia*, *Tartarothyas*). Other Hydryphantidae are characteristic of the upper stretches of watercourses (*Thyopsis*, *Panisus*, *Protzia*), lentic or slow-running habitats (*Hydryphantes*, *Thyas*, *Euthyas*, *Diplodontus*), or show peculiar adaptations (elongated worm-like body, eye reduction) to the interstitial-hyporheic environment (*Wandesia*). Within the Spermantidae, most species are found in mountain torrents and streams; some more tolerant species also manage to colonize the lower stretches of rivers, even in proximity to the river mouth; others are exclusive to springs. Torrenticolidae are very good indicators of the integrity and stability of the hyporheic zone. Some species exclusively inhabit the interstitial environment, whereas others are strictly epibenthic. Nearly all the Arrenuridae are typical of lentic waters, although some species are exclusive to limnocrenic, helocrenic or small rheocrenic springs.

Zoogeography

Thanks to the considerable capacity of dispersion of the larvae during the parasitic/phoretic phase, most species are able to colonize quite large areas of distribution. Approximately two thirds of the species treated herein are widespread (5 are Holarctic, 60 Palearctic and 32 European). Smaller distributional areas pertain to 5 species of Alpine, 4 of Apennine, 3 of Tyrrhenian and 9 of Sardo-

Corsican distribution. Southern elements are 3 Sicilian endemics and 4 taxa of North African distribution.

Of the 150 species the distribution of which is given here, as many as 21 (14%) are endemic to the Italian fauna. Sardo-Corsican endemics prevail (8), followed by Apennine ones (4), Tyrrhenian ones (3) and Sicilian ones (3). Few species only are endemic of the Alpine region. The highest rate of localized endemics occurs among the spring and interstitial-hyporheic fauna. From this point of view the Italian fauna includes some precious examples of taxa with a disjunct distribution, which reflect very remote events of the earth's history. Two important examples of such taxa are *Momonides lundbladi* and *Parawandesia chappuisi*, both known from Sardinia and Corsica and belonging to two subfamilies with members distributed in other continents (Asia and Australia).

Alien species

No alien species has been introduced to the Italian fauna.

Conservation

One third of the treated species (51) are rare, and known in Italy either in single specimens or in relatively reduced populations, which may become abundant only locally. Sixteen species are extremely vulnerable and 9 are threatened by change of their original habitats, in that they exclusively colonize environments which are either disappearing or undergoing intense transformation processes (small marshes and littoral ponds, medium to low altitude springs, peat bogs).

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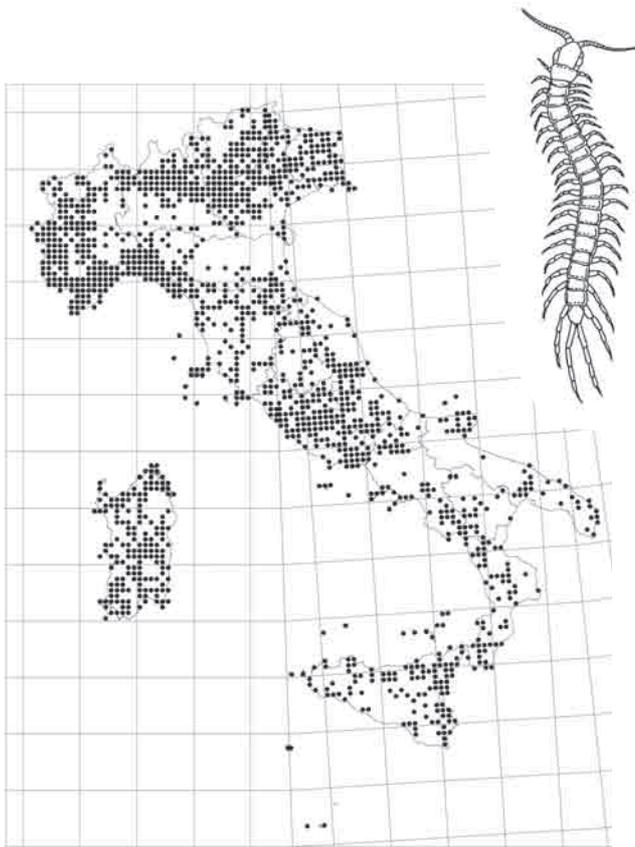
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Chilopoda

Marzio Zapparoli, Alessandro Minelli



Chilopoda, or centipedes, are a group of terrestrial arthropods which is well represented in Italy, and quite well known from a taxonomical and chorological point of view, even though a number of problems remain unsolved, especially within the geophilomorph genera *Schendyla*, *Henia*, *Geophilus* and *Strigamia* and in a few species groups within the large genus *Lithobius*. The value of some nominal taxa described in the past still needs verifying. The first taxonomical study on Chilopoda using genetic distances of gene-enzyme systems was in fact performed on Italian populations (Lithobiomorpha of the genus *Eupolybothrus*); however, it has remained an isolated attempt and molecular systematics have been so far used, in the study of European Chilopoda, only in problems regarding suprageneric phylogeny. Some species new to science have been described on Italian material during the past twenty years, and it is predictable that others may be added to the current list.

Material and methods

The filed data were obtained from a critical analysis of all the available literature, up to the year 2000, and a

vast quantity of unpublished material examined by the authors, mainly belonging to their personal collections and to numerous natural history museums.

Biodiversity

All four the orders of Chilopoda occurring in Europe and the Palearctic are part of the Italian fauna, and include 162 species altogether.

Scutigermorpha contain the single, anthropophilous species *Scutigera coleoptrata*.

The Italian Lithobiomorpha belong to 2 families (the Henicopidae, see below: Alien species, and the Lithobiidae), 4 genera and 83 species, most of which (71) are included in the vast genus *Lithobius*.

Scolopendromorpha are represented by 3 families, each containing a single genus: the Plutoniumidae (with the sole *Plutonium zwierleinii*, a species of relict distribution and one of the most interesting centipedes of the Italian fauna, even though it is not endemic), the Scolopendriidae (3 species of the genus *Scolopendra*) and the Cryptopidae (12 species of the genus *Cryptops*).

Lastly Geophilomorpha, which contain 62 species belonging to 6 families: the Mecistocephalidae (just including *Dicellogophilus carniolensis*), Himantariidae (6 species within 2 genera), Schendylidae (14 species within 4 genera), Dignathodontidae (8 species within 2 genera), Linotaeniidae (5 species of the genus *Strigamia*) and Geophilidae (28 species within 8 genera).

Compared to other European countries, the Italian centipede fauna is the richest in species, and hosts exactly one third of the total fauna of the continent (486), namely 25% of the 4 Scutigermorpha, 30% of the 276 Lithobiomorpha, 46% of the 35 Scolopendromorpha and 36% of the 171 Geophilomorpha.

Ecology

All centipedes are predators, though very little is known of their true diet. They mainly occur in humid places such as the litter layer of woods (particularly broadleaf), or belong to the cryptozoic fauna using stones, fallen trunks and detached bark as occasional refuges to be abandoned during the dark and cool hours of the night, when they search for food. Lucifugous animals, they are not rare in caves, where they are mainly represented – in the Italian fauna too – by Lithobiomorpha, some of which are troglobitic and greatly specialized, with eyes either reduced or missing completely, elongated antennae and legs, and a more or less marked depigmentation.



Zoogeography

The current list of Italian Chilopoda includes around 30% of endemic species, although this estimate is certainly in excess given the uncertain validity of some nominal taxa. Most endemics occur in peninsular Italy. Other areas of interest are the Alps, especially the western ones, and Sardinia.

The Alpine province assemblage is rather rich (102 species). In this area a sole endemic epigeal species is known (*Lithobius alpicosiensis*, western Alps), whereas a relatively higher number of endemics occur among cavernicolous species. Namely *L. scotophilus* in the south-western Alps, *L. electrinus* in the central Alps and *Eupolybothrus obrovensis*, which is characteristic of the Trieste Karst. Another endemic is *E. excellens*, known from epigeal and subterranean sites of the western Alps, and which also occurs in the Ligurian Apennines. The Alpine assemblage is also characterized by elements with a wider distribution in Europe (European, S-European, W-European), some of which reach, along the Ligurian Apennines, the Tusco-Emilian Apennines.

The Po area hosts a consistent number of species (58), none of which endemic. Mediterranean (e.g. *Scolopendra cingulata*, *Cryptops trisulcatus*) or Apennine thermophilous species occur in some xerothermic areas.

A relatively high number of species occur in the Apennine province (110), the richest in species together with the Alps. A characteristic species of this province is *Eupolybothrus fasciatus*, besides *Lithobius tylopus*, *Schendyla apenninorum* and *Geophilus romanus*, the latter two also occurring in xerothermic areas of northern Italy. Other species are restricted to the central or central-southern Apennines, e.g. *Eupolybothrus imperialis*, *Lithobius minellii* and *L. romanus*.

The Apulian province is rather poor of species (36). Among the most significant species are *Cryptops garganensis*, which is known from the Gargano and has also been collected in a locality of Abruzzo (Monte Tranquillo), and *Geophilus guanophilus*, recorded solely from Grotta Zinzulusa, a cave near Castromarina, Lecce. Noteworthy are also *Pleuroolithobius patriarchalis*, *Lithobius viriatus* and *L. peregrinus*, all distributed across the Balkans – the first from Anatolia to southern Italy, the other two from the Caucasus to south-eastern Italy – and which reach, in Apulia, the eastern limit of their primary distribution area.

Sicily and Sardinia host fifty-odd species each. The Sicilian fauna is characterized by a low number of endemics: probably only *Lithobius lagrecai* and *L. trinacrius*, the latter being known also from Malta. Species distributed in Maghreb and absent from the rest of Italy occur in Sicily (*Himantarium mediterraneum*, *Henia pulchella*, *Gnathoribautia bonensis*). Lampedusa is the only Italian locality for *Scolopendra canidens*. A higher number of endemic species/subspecies occur in Sardinia (8), most of which

(4) are associated with cave habitats (e.g. *L. doderoi*, *L. sbordonii*). The absence from the island of *Scolopendra cingulata*, a Mediterranean element that is widespread on the continent and in Sicily, is noteworthy.

Other characteristic elements of the Italian fauna are *Plutonium zwierleini*, a cryptozoic species known of few localities of Sardinia, Campania and Sicily besides a single Spanish locality, and the Geophilidae *Acanthogeophilus dentifer*, so far known only of two peninsular localities (eastern Liguria, Gargano).

Alien species

Two non-indigenous Chilopoda species are part of the Italian fauna, *Lamyctes emarginatus* and *Lamyctinus coeculus*, which were both firstly recorded at the end of the nineteenth century. They are both parthenogenetic and now widely cosmopolitan, and are members of a family (Henicopidae) that is mainly distributed in the tropics and southern hemisphere. Both species were probably introduced together with the earth of exotic ornamental plants. While for *Lamyctes emarginatus* even recent records exist from various localities, nearly all in artificial environments (urban settlements, nurseries, cultivated fields, etc.), the settlement of *Lamyctinus coeculus* in Italy appears not to have been confirmed.

Some indigenous species occur in localities that are not part of their primary distribution area, most probably as a consequence of accidental anthropogenic introductions. Such are for instance the records of *Eupolybothrus fasciatus* and *Lithobius romanus* from the Aeolian Islands, *L. dahlii* from Venetia, *L. peregrinus* from north-eastern Italy, *Pleuroolithobius patriarchalis* from the Egadi, Pontine and Campania Islands, and *Scolopendra cingulata* from near Milan.

Conservation

It is currently difficult to point out any Chilopoda the conservational status of which is “at risk” in Italy, primarily because of the insufficient amount of surveys carried out so far with this particular aim.

Data on the composition of taxocoenoses, particularly of Alpine and Apennine forest habitats, can nevertheless provide the elements for a first evaluation. Logging, the removal of the litter layer and dead wood, treading, grazing, habitat fragmentation and anthropization are certainly factors which threaten the integrity of the above communities, at the expense – at least locally – of the most specialized nemoral species (e.g. *Lithobius mutabilis*, *L. castaneus*, *L. validus*, *Schendyla* spp., *Strigamia* spp.) and to the advantage of the more generalist and invasive ones (e.g. *Lithobius forficatus*, *Scolopendra cingulata*, *Himantarium gabrielis*).

Besides forest habitats, particularly residual lowland ones (Po Plain, Tyrrhenian coast, southern Italy), the most significant environments in terms of centipede conservation



Chilopoda

in Italy are caves (in the Alps, central Apennines and Sardinia, where the few cavernicolous species known today

occur) and littorals (for halophilous Geophilomorpha such as *Hydroschendyla submarina*).

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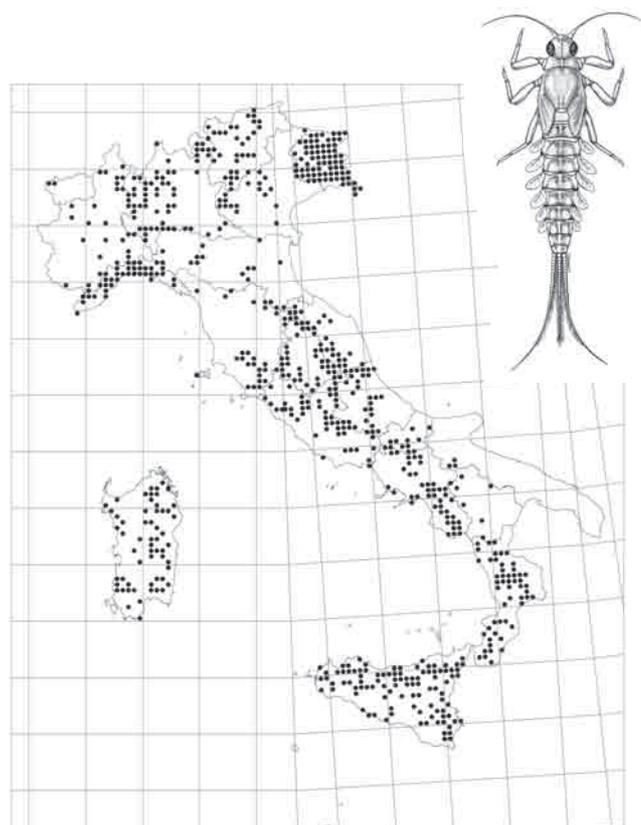
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Insecta Ephemeroptera

Carlo Belfiore



Ephemeroptera are an insect order with aerial adults and aquatic larvae, that is distributed in most freshwater habitats but is particularly important in rivers and streams, both in number of species and biomass. The taxonomical knowledge of the European species, which was quite complicated in the past, has considerably developed in recent years and, though not homogeneous across genera, can now be considered as relatively stable. Currently, the most discussed problems concern the assignment of species to genera, particularly within the families Baetidae and Heptageniidae. Knowledge of the Italian distribution of species is good in some areas (central and southern Italy, islands) and very poor in others (Alpine arch). Despite a much vaster and in detail state of knowledge compared to a few years ago, the probability of discovering new species and widening the distributional areas of the already-known species throughout Italy is still high.

Material and methods

Around 58% of the chorological data were unpublished and were obtained from the identification of material from private collections by Ephemeroptera specialists (26% C. Belfiore, 24% F. Desio, 8% A. Buffagni). Twen-

ty-five percent of data were taken from specialist publications having appeared in the 1990s, a period during which the faunistic study of Italian Ephemeroptera underwent a major increase. Another 12% was obtained from specialist works published during the two previous decades (1970-1990). The remaining 5% was recollected from older publications and from recent works by non-specialists, mainly inland water ecologists. In some cases of unequivocal interpretation, data taken from the literature were assigned to species different from those cited in the original work, in view of the most recently acquired taxonomical and nomenclatural changes.

Biodiversity

Italian Ephemeroptera are represented by 105 species included in 27 genera and 11 families. The Heptageniidae family is the richest in species (38%), especially due to the high number of species within the genera *Rhithrogena* (13%), *Ecdyonurus* (11%) and *Electrogena* (9%). The Baetidae family follows with 23% of species, more than half of which belong to the genus *Baetis*. Thirty percent of European species occur in Italy. The number of species recorded from Italy is considerably higher than those of the British Isles (51 species) and Scandinavian countries (Sweden 59, Norway 45, Finland 52), but lower than those of France and Spain (both with 141 species) and comparable to those of the Mittel-European countries, though with quite a different species composition. Within the Italian boundaries the number of species decreases from the northern regions (76 species) to the central (65) and southern (55) regions, Sicily (30) and Sardinia (21). It must be said that the Italian side of the Alps is the worst-known area of the country. An example of this is the low number (7) of Alpine species of *Rhithrogena* recorded from within the Italian boundaries, seeing it is a very species rich taxon. On the French side of the Alps there are 20 species belonging to this genus, while there are 18 in Germany, 25 in Austria and 20 in Switzerland.

Ecology

The larvae of most Ephemeroptera live in lotic environments, and occupy all microhabitats of watercourses, from the spring to near the mouth. Few species are characteristic of still waters (e.g. *Cloeon dipterum*, some species of the genera *Caenis* and *Ephemerella*). The upper stretches (epirhithral) of rivers generally host moderately rich communities, which are mainly composed of Heptageniidae (particularly *Epeorus* and *Rhithrogena*) and Baetidae



(species with a reduced paracercus such as *Acentrella*, *Baetis alpinus* and similar species). Members of the genus *Habroleptoides* are frequently found in shady areas, often at the higher altitudes. The intermediate stretches of watercourses, which show the highest variety of microhabitats and availability of energy, are those hosting the highest number of species: in places where the current is strong, Heptageniidae (*Ecdyonurus* and *Rhithrogena*) and rheophilous species of *Baetis* occur, together with the ever-present *Baetis rhodani* and the less frequent but just as euryecious *Baetis muticus*; other species occurring in such conditions are *Oligoneuriella rhenana*, which due to its peculiar phenology is only observable in spring, and *Ephemerella danica*, i.e. the only species of the genus to be characteristic of rheocrenic habitats. In sites where the current slows down and the amount of macrophytes or thin sediment increases, species of *Serratella*, stream dwelling species of *Caenis*, various Leptophlebiidae and a few species of Baetidae that are typical of this microhabitat (e.g. species of *Centroptilum* and *Procladius*) can be found. Some species are typical of very particular habitats and are difficult to find in places with different characteristics: all *Electrogena* species and some populations of *Siphonurus lacustris* live in calcareous streams with coarse gravel and pebbles, in good quality water where the current is practically absent, but close to fast-flowing stretches. On the other hand, other populations of *Siphonurus lacustris*, most probably belonging to a separate species that is indistinguishable at the moment using sole morphological features, occur in completely different habitats, which are often heavily polluted. In the potamal Ephemeroptera communities are generally much poorer, even though extremely large populations are sometimes found. Characteristic species of this zone are *Ephoron virgo* and *Ephemerella glaucops*, which are typical of soft substrates, where they dig tunnels. The importance of Ephemeroptera among watercourse invertebrates is stressed by their fundamental role in food chains. In fact, they represent a source of food for nearly all running-water predators. They are also among the most important taxa indicating environmental quality, and are among the most used in evaluation methods for their superiority in terms of biomass, homogeneous distribution along watercourses and the limited ecological tolerance shown by many species.

Zoogeography

Among the Italian species, 18 (17%) can be considered as strictly endemic. Five others are Sardo-Corsican endemics. Most of the remaining species (66) are widespread in Europe and the Palearctic Region. Some species, which were previously considered as Italian endemics, have recently been found in other countries, like *Electrogena grandiae* in France and *Caenis belfiorei* in Greece; the status of these taxa was only recently cleared out, and

their real distributions could be much wider.

Among the Italian Ephemeroptera, the situation of *Electrogena zebrata* is striking from a biogeographical point of view. This species, which is considered a Sardo-Corsican endemic, is in fact quite different from its congeneric species, and could easily be assigned to a new genus. The only similar species, so much so that the morphological distinction of the two is impossible, occurs in the Middle East, between Lebanon and Israel. This kind of disjunct distribution is not explainable at the moment by historical geological events, and among the hypotheses interpreting the current occurrence of this taxon in Sardinia is its involuntary introduction by the Phoenicians, together with drinking water reserves.

Until today, a sole attempt at elaborating chorological data on Ephemeroptera has been carried out (Belfiore, 1994), with the aim of defining homogeneous areas and transitional zones throughout the Italian territory: it is a work concerning peninsular Italy, from Tuscany to Sardinia, the results of which highlight a discontinuity and a narrow, north-westernly orientated transitional belt, which lies between the Metauro river and Sibillini mountains on the Adriatic side and Maremma and lower Latium on the Tyrrhenian side. Without further similar studies, one can suppose that other homogeneously populated areas are the Po Plain and the Alpine chain. In reality, since the increase of chorological knowledge from the 1990s, the greatest difficulties involved in the reconstruction of Ephemeroptera assemblages arise from the degradation of watercourses, especially in hill and plain stretches, the main effects of which – having progressively increased in recent years – are the simplification and degrading of communities.

Alien species

Apart from the already-mentioned *Electrogena zebrata*, which in any case appears to have established in Italy a few thousand years ago, the only case of species introduced by man would appear to be that of *Ametropus fragilis*, which was recently (1997) recorded from Italy and occurs in non-neighbouring Mittel-European countries. It was probably introduced during fish restocking carried out using material from Eastern Europe, and seems not to represent a threat for autochthonous Ephemeroptera.

Conservation

The sensitivity towards environmental changes shown by many species of Ephemeroptera means this order is particularly vulnerable from a conservational point of view. According to the available data, two species of *Rhithrogena* are likely to have become extinct during the past few years. The first species, which was collected in the 1980s near the mouth of the Tordino river in Abruzzo and was identified as *R. diafana* (although it was later



proved to belong to an undescribed species), showed features of high interest: i.e. the unusual habitat compared to congeneric species (which are typical of upper stretches) and the late-summer adult phenology. In 1995 an on-the-spot investigation in the site of collection of this species showed that no water was left, due to excessive exploitation. The second species is *Rhithrogena reatina*, which was described in 1984 on a large quantity of material from the Velino river, near Antrodoco. The repeated attempts at finding the species again after 1990 all failed. The cause of this disappearance seems

to have been the progressive worsening of water quality due to poor filtering. Yet other species have never been found again since their description, e.g. *Caenis valentinae*, described in 1951. Species that are characteristic of potamal should be counted amongst the most threatened ones, because they are generally more exposed to excess pollution, even though a likely greater resistance of some species to alteration has brought large populations to thrive in some rare well preserved sites (e.g. *Ephoron virgo* in the Tiber river).

Relevant Literature

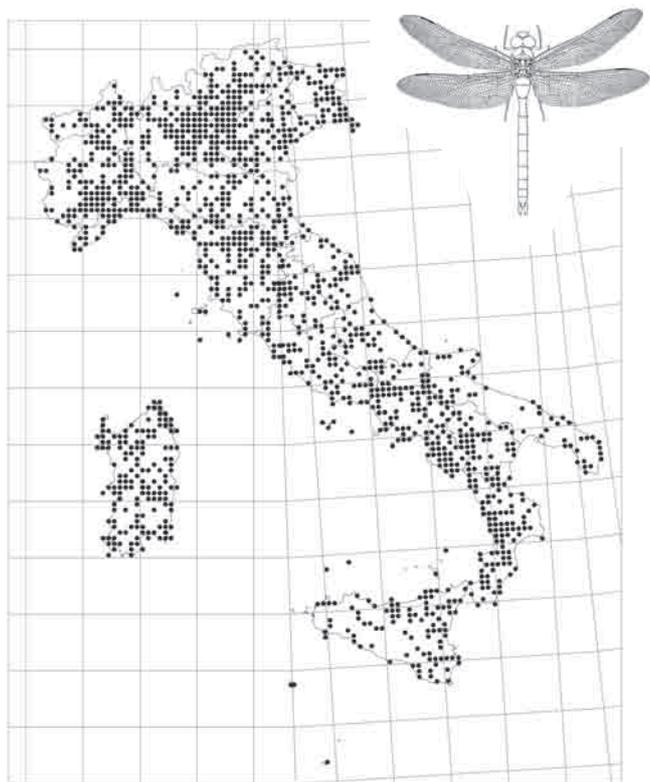
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Insecta Odonata

Costantino D'Antonio, Carlo Utzeri



Odonata (dragonflies and damselflies) are a very ancient order of heterometabolous (hemimetabolous) pterygote insects with aquatic larvae and aerial, flying adults, including approximately 5,300 living species. Two of the three suborders in which they are divided, Zygoptera and Anisoptera, are cosmopolitan and well represented also in Italy. They are feared in some places but are absolutely harmless insects, being free of poisonous apparatus and other structures capable of harming man.

Odonata are overall well-known due to their medium to large size, often bright colouration and the relative abundance of adults near water. They are easy to detect and relatively easy to study in the field; during the last decades, scientific publications on the Odonata have focussed on aspects regarding behaviour and behavioural ecology, thus greatly contributing to the understanding of the mechanisms of sexual selection.

The knowledge of Italian Odonata is satisfactory thanks to a few hundred papers, starting from the end of the eighteenth century.

Material and methods

Distributional data provided here are based on the analysis of all the available literature – save involuntary omis-

sions on behalf of the authors – and the impossibility of using some articles that were devoid of data useful to the implementation of the database. The inclusion of data from both private and museum collections was not possible, due to the enormous amount of preserved material and the unavailability of organized lists of such material.

Biodiversity

In the present work, 89 species are attributed to the Italian fauna (32 Zygoptera, 57 Anisoptera), grouped together in 36 genera and 9 families. However, one must point out that *Ischnura genei* and *Somatochlora meridionalis* appear to be no more than subspecies of *I. elegans* and *S. metallica* following recent studies based on the analysis of enzymatic proteins, that *I. graellsii* is known from Sardinia in a single record and that *Coenagrion ornatum*, *Gomphus pulchellus* and *Epitheca bimaculata*, which were recorded in ancient times, seem no longer to occur in Italy. Therefore, the current Italian odonatofauna may consist of 83 species. The 89 species cited in the checklist represent 70.6% of the European species (129), a high diversity compared to other European countries (e.g. 83 species in Germany, 52 in Great Britain). The regional distribution of species is well known, with species numbers ranging between 20 (Aosta Valley) and 63 (Lombardy), and well correlated to the size of the various regions.

Ecology

Virtually all types of water body (lakes, freshwater, slightly brackish, static and astatic ponds, peat bogs, rivers and streams) can host Odonata, generally in the shallower and slower-running parts. Some species are typical of running waters (genera *Calopteryx* and *Cordulegaster*), while others are typical of still waters, but the most species-rich families (Coenagrionidae, Libellulidae) include both species inhabiting running waters and species inhabiting still waters, as well as species that tolerate both types of habitat. Species having adapted to medium-high altitudes also exist (e.g. *Enallagma ciathygerum*, *Aeshna juncea*, *A. caerulea*, *A. grandis*, *Somatochlora metallica*, *Leucorrhinia dubia*, *L. pectoralis*, *Sympetrum flaveolum* and *S. pedemontanum*), together with species which are common at low altitudes and species with a wide altitudinal range. All adult Odonata are flyers and are generally well adapted to long-range dispersion, thus being among the first to colonize newly formed water bodies. The larvae live amidst vegetation or on the bottom, sometimes



buried in the sand, and breath through leaflike caudal (Zygoptera) or cloacal (Anisoptera) tracheogills.

Odonata are invariably predators, feeding on small crustaceans and insect larvae (but also on tadpoles and small fish) in the larval stages, and normally on insects as adults. The larvae capture their prey by a rapid, forward extension of their mouthparts, whereas the adults trap their flying prey in a "basket" formed by their appropriately extended legs. The larvae are preyed upon by common aquatic predators, whereas the adults are as a whole little disturbed, although newly emerged specimens (sometimes also mature ones) represent relatively easy prey for birds (mainly bee-eaters and small birds of prey), lizards, spiders, wasps and even larger dragonflies.

While some Odonata associations seem to be good indicators of particular habitats, the wide tolerance of most species towards water showing various degrees of pollution does not make Odonata good indicators of environmental quality.

Zoogeography

The Italian odonatofauna groups together species with wide Asiatic-European, Europeo-Mediterranean, Mediterranean and Afrotropical distributions. Endemism is scarce and mainly referable to subspecific taxa of the genera *Calopteryx*, *Coenagrion*, *Ceriagrion* and *Cordulegaster*, but problems of synonymy exist within *Calopteryx*; *Cordulegaster* would deserve careful re-examination. On the other hand *Cordulegaster trinacriae*, identified by some as *C. pictus trinacriae*, would appear to be exclusive to Sicily and (maybe) Sardinia, whereas *Ischnura genei*, save its possible identification as *I. elegans genei* (see above), also occurs in Corsica.

Alien species

Despite the recent, accidental introduction into some

countries (e.g. Great Britain) of allochthonous larvae together with ornamental plants, this phenomenon appears not to have occurred in Italy yet.

Conservation

It is widely perceived, amongst specialists, that during the past twenty years the populations of some specific and subspecific taxa have become rarefied in Italy (e.g. *Calopteryx splendens xanthostoma*, *C. virgo padana*, *Sympecma paedisca*, *Coenagrion mercuriale castellani*, *Nehalennia speciosa*, *Boyeria irene*, *Gomphus flavipes*, *Ophiogomphus cecilia*, *Lindenia tetraphylla*, *Cordulegaster bidentata sicilica*, *C. trinacriae*, *Somatochlora flavomaculata*, *Oxygastera curtisi*, *Orthetrum nitidinerve*, *Sympetrum depressiusculum* and *Leucorrhinia pectoralis*). Despite a lack of research focussed on this problem, the causes of such a decline can probably be attributed to industrial and agricultural pollution, water level control, dredging of watercourses and the elimination of riparian vegetation, all factors having proved to be ruinous to Odonata in other countries. Even the fact that the Mediterranean climate is naturally becoming drier, which causes a reduction of the amount of free water (especially small lowland water bodies), may play a part in the process. At least *Coenagrion ornatum* and *Epitheca bimaculata* (see above) may have become extinct through natural causes, while *Gomphus pulchellus*, recorded in a single specimen from Piedmont, might have been just an occasional colonizer.

Coenagrion mercuriale, *Cordulegaster trinacriae*, *Oxygastera curtisii*, *Gomphus flavipes*, *Lindenia tetraphylla*, *Ophiogomphus cecilia*, *Sympecma paedisca* and *Leucorrhinia pectoralis* are part of the Bern Convention (1979, appendix II). The same species are also included in appendices II (except *G. flavipes* and *S. paedisca*) and IV (except *C. mercuriale* and *S. paedisca*) of the Habitat Directive (92/43/CEE).

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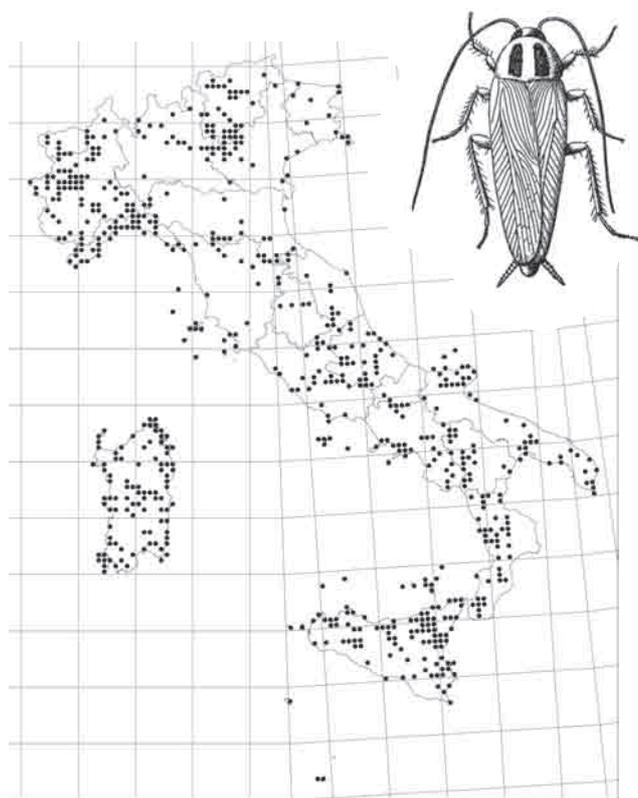
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Insecta Blattaria

Maria Carmela Failla, Angelo Messina



Blattaria are an order of terrestrial insects of nearly worldwide distribution, containing a bit less than 4,000 described species, most of which from the subtropical and tropical regions. Just over 70 species occur in Europe, belonging to 14 genera. In Italy this order, which currently includes 40 species, is sufficiently well known from both taxonomical and chorological points of view.

Material and methods

Nearly all citations previous to the 1970s were carefully re-examined by the authors. This was done in view of the considerable morphological homogeneity of these insects, which has rendered the individuation of good diagnostic features difficult, and caused many identification errors. In the 1970s, the present authors picked out a solid feature enabling specific identification: the overall morphology of the glandular hollow, an organ situated on the abdominal tergites of nearly all male Italian Blattaria. This brought to the discovery of almost half of the species currently recorded from Italy, and allowed for most records to be checked. Citations that were impossible to check due to loss of material and considered

improbable, were not considered as valid. Species distribution data were therefore mainly supplemented by the more recent literature and the study of material from various collections, mainly those of the present authors.

Biodiversity

The Blattaria species occurring in the Italian peninsula and islands are 40, most of which (85%) belong to the subfamily Ectoniinae, nearly all in the genera *Ectobius* and *Phyllodromica*. These are two widespread genera: *Ectobius* is distributed in the whole of Europe, middle and western Asia, and Africa except for the Sahara; *Phyllodromica* is distributed in all the circum-Mediterranean countries and western Asia. The remaining species belong to the Polyphagidae, with a single species that is restricted to arid environments of the southern regions of the peninsula, Sicily and Sardinia. The Blattidae, with the two synanthropic species *Blatta orientalis* and *Periplaneta americana*, and the Blattellidae, with *Loboptera decipiens*, *Supella longipalpa* and *Blattella germanica*, the last two occurring in houses.

Ecology

Blattaria are mainly terrestrial, lucifugous and hydrophilous animals. They occur in different habitats but show a preference for warm-humid conditions, where they can find abundant food as well as hideaways in which to escape from predators and light; in such habitats, these insects can be found under stones, amongst grass and dry leaves, underneath bushes, in the litter layer, inside rotten trunks, etc. *Polyphaga aegyptiaca*, the only Italian member of the Polyphagidae, is adapted to life in particularly arid environments. Some species are synanthropic and live inside buildings (*Blatta orientalis*, *Periplaneta americana*, *Blattella germanica*, *Supella longipalpa*, etc.). All are good runners and are mainly active at dusk or at night time, females and juveniles being more sensitive to light than males. Escape represents the main way of defence of Blattaria against predators, and they are helped in this task by the shape of their body, the cuticle of which is smooth and free of protuberances, their strong and robust legs, as well as their uniform and dull colouration, which mimicry them within the surrounding environment. Males are more active than females and, being usually winged, are able to fly for short distances as observed in *E. sylvestris* and *E. lapponicus*, which can be seen sunbathing on bushes near the forest's edge. Blattaria prefer warm conditions and, even at dusk, occur in places where the air



is warmer. These insects are constantly searching for optimal environmental conditions and availability of food resources, and can move from one territory to another through small migrations. These are mostly active movements by single species related to the adjacency of the areas involved, and are only important on a local scale. Vehicular transport, on the other hand, is passive and related to man and his means of transport such as ships and objects on which individuals of various easily adapting species can find easy refuge and food for themselves and their oothecae. These are synanthropic species of practically worldwide distribution, which occur away from man mainly in cold-climate territories.

Blattaria are omnivorous, essentially feeding on decaying animal or vegetal matter. They usually cause no harm, although the synanthropic species can cause consistent economic losses. They have a tendency towards gregariousness, at least in the juvenile phases. The importance of these insects as indicators of environmental quality is low, due to their particularly high tolerance to pollution, especially organic.

Zoogeography

Despite the reduced number of species, the Blattaria assemblage occurring in Italy and its islands appears as considerably composite from a zoogeographical point of view, since it includes species of various origins, and is enhanced by a high percentage of endemic species (50%); those belonging to the genera *Ectobius* and *Phyllodromica* are mostly located on single islands. Three of the remaining species, the least thermophilous among Italian Blattaria, are restricted to the northern parts of the country: *Ectobius lapponicus* is the only one to reach the northernmost borders of Europe and northern Siberia; *Ectobius albicinctus* is confined to the Alpine chain; *Ectobius erythronotus*, the most thermophilous of the three, reaches the centre of the peninsula. The remaining species are more widely distributed throughout Italy. Among these, the following are noteworthy: *Luridiblatia trivittata*, belonging to

a genus spread throughout the southern European territories during the Oligocene and lower Miocene, which occurred in both the Tyrrhenian and the Aegean lands, and gave origin to two species, one in the West Mediterranean, Italy included (*L. trivittata*), the other in the East Mediterranean (*L. beybienkoi*); *Capraiellus tamaninii*, a transatlantic species sporadically occurring nearly everywhere in peninsular Italy, Sicily and Greece.

Alien species

However well established they may be, *Blatta orientalis*, *Periplaneta americana*, *Blattella germanica* and *Supella longipalpa* are alien species having been introduced in historical times, and are of some importance, causing both problems with hygiene and economic loss. They are commensals of man and often settle in food supplies, ship holds and houses, where they cause considerable damage to food; additionally, when in contact with putrefying matter and pathogens, they can spread several dangerous diseases such as typhus, paratyphoid fever, tuberculosis, cholera, dysentery and so on.

Conservation

Italian Blattaria represent a natural heritage of high biogeographical significance, considering the high number of endemics and the occurrence of species witnessing the variegated palaeogeographic history of this country. Such species live in very particular microhabitats, which can be safeguarded only by careful territorial management. Particularly endangered are *Ectobius albicinctus*, a rare species occurring in few sites of northern Italy, *E. filicensis*, *E. tuscus*, *E. tyrrhenicus*, and *E. usticaensis*, all endemics that are confined to very small islands (Salina (Aeolian Is.), Capraia, Montecristo and Ustica, respectively). Other endangered species are *Lobolampra subaptera*, a rare species the chorology of which is very uncertain, and *Phyllodromica nuragica* and *P. pavani*, two endemics which are also very localized in Sardinia and the north-western parts of the peninsula, respectively.

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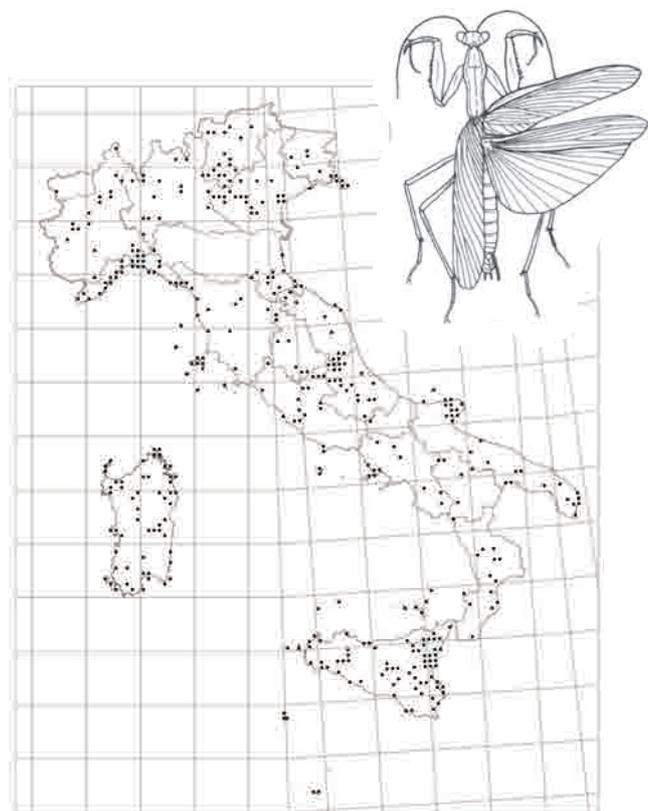
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Insecta Mantodea

Paolo Fontana, Filippo Maria Buzzetti, Andrea Cogo



Mantodea belong to the superorder Polyneoptera, also called Orthopteroidea, which contains 11 insect orders, 8 of which occur in the Italian fauna: Blattodea, Mantodea, Isoptera, Orthoptera, Phasmatodea, Dermaptera, Embioptera and Plecoptera. Orthopteroidea have a certain number of features in common: they are nearly all terrestrial insects with chewing mouthparts, and are characterized by gradual metamorphosis (heterometaboly); the juvenile instars (neanic stages and nymphs) lead the same life as the adults, with which they share feeding habits and ecological needs (paurometaboly). Mantids are predators, and are mainly distributed in tropical countries and countries with a warm climate. They are closely related to the Blattodea, so much so that some authors group them together in a sole order: Dictyoptera. They are highly mimetic insects of medium to large size with an elongated body. In many species the female devours the male during mating. Of the approximately 1,800 species extant worldwide, only 13 can be found in Italy.

Material and methods

The distribution provided for the listed species was obtained by examining most of the not very abundant ex-

isting literature – both Italian and foreign – which was critically considered and subjected to nomenclatorial update. Some of the main orthopterological collections were studied and filed, and most of the data presented here were unpublished.

Biodiversity

The Italian Mantodea fauna consists of only 7 genera and 13 species; these are relatively well known and, for several years now, no new taxa have been described or recorded. On the contrary, knowledge of the Italian distribution is still patchy for some species, including some of the most interesting ones from a biogeographical or conservational point of view. The number of species increases, in Italy, towards the south and the major islands, Sicily being the richest region, and also the best-studied one. Despite the small number of species, both island and Apennine endemics exist (30.76%). Only the genus *Ameles* is relatively species-rich, but it is also the most problematic due to the uncertain identification of females.

Ecology

Mantids are typically thermophilous insects and are mainly distributed in the tropical regions: this explains the scantiness of the Italian and Mediterranean assemblages. They are solitary predators, mainly diurnal, and stay immobile while waiting for their prey in ambush; taking advantage of their cryptic colouration, they fall onto their victims with rapid movements and seize them with their robust raptorial forelegs. They feed on insects and spiders, but some large exotic species may even attack small vertebrates. The local species live on shrubs or among grass, and frequent warm and sunny places, particularly maquis and garigue, where they can occur in conspicuous populations. One species, *Empusa fasciata*, is typical of coastal dune and back dune habitats of the upper Adriatic.

Italian Mantodea, though few, represent one of the richest assemblages of Europe. *Mantis religiosa* is widespread in Italy, although it is only locally distributed in the Pre-alpine and Alpine belts and the Apennines, according to the pedoclimatic conditions ideal to the species, which is in any case thermophilous. In northern Italy, besides *Mantis religiosa*, there are rare and sometimes old records for *Iris oratoria*, while species of *Ameles* are recorded from the coasts of Liguria and Friuli Venezia Giulia and, with doubt, from the Colli Euganei (Venetia). *Empusa fasciata* is a typical Balkan and East Mediterranean species,



occurring from Syria to the northern Adriatic, in Venetia and Friuli Venezia Giulia. Along the peninsula the genus *Ameles* is common, while *Geomantis* occurs only in the most southern regions, Sicily and Sardinia. The Italian mantid fauna is therefore markedly of the Mediterranean type, and includes: two endemics of the genus *Pseudoyersinia*, widely represented in the western Mediterranean and Canary Islands, a West Mediterranean *Rivetina* species, distributed from Spain to Saudi Arabia and Iran, and *Empusa fasciata*, with its East Mediterranean distribution. Also the endemic *Ameles fasciipennis*, known only from the type material, shows affinities with the oriental species of the genus.

Alien species

No species of sure alien origin occur in the Italian fauna; only a few exotic mantids are bred as terrarium animals by few enthusiasts.

Conservation

The conservation of Mantodea is related to the preservation of the habitats that they depend on, such as maquis,

garigues and coastal dunes in first place. Man, both through direct occupation or grazing and through arson, gravely threatens all these habitats. Since, as already mentioned, the knowledge of the distribution of most species is still patchy, only general guidelines concerning the conservational status of Italian Mantodea are available. For *Ameles fasciipennis* the only available data regard the type material. This species should therefore be considered as very rare and therefore potentially endangered. *Pseudoyersinia andreae* is known from only three Sardinian localities, which should be preserved if not already included in protected areas. *Empusa fasciata* is recorded from very few places in Italy, all situated within seaside resorts. This typical coastal species would deserve safeguard actions aimed at its conservation, at least in the few remaining sites in which it has not yet become extinct. Particular conservational problems exist concerning *Rivetina baetica tenuidentata*, which appears to have become excessively rare in Sicily in recent years. This species also is a typical coastal element, and is threatened by resort activities and unauthorized building.

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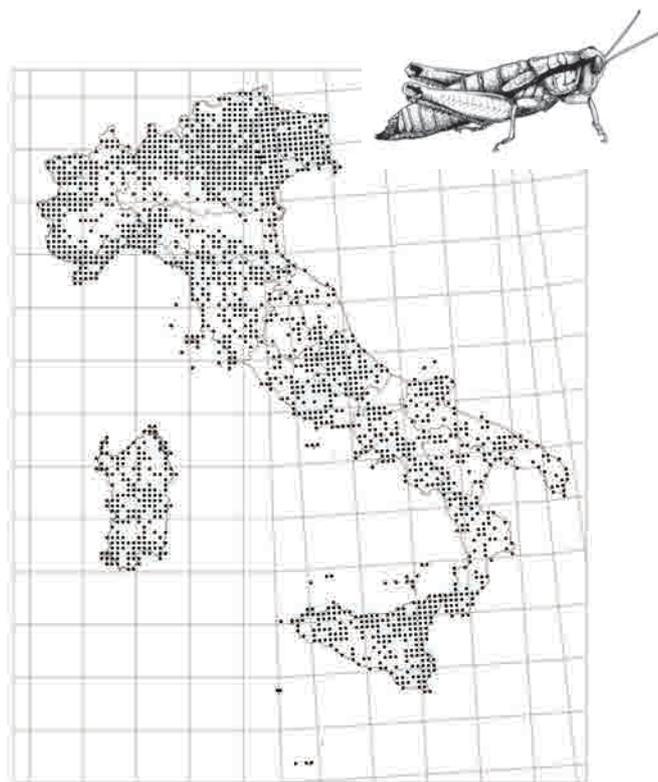
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Insecta Orthoptera

Paolo Fontana, Marcello La Greca, Roy Kleukers



Orthoptera, commonly known as crickets, grasshoppers, and locusts, belong to the superorder Polyneoptera, and to the Orthopteroid complex, with which they share their very ancient origin. In fact, Gryllidae were known from the Triassic and Tettigoniidae from the Jurassic, whereas Acrididae are well documented only from the Tertiary. The order is divided in two suborders, Ensifera and Caelifera, which are sometimes considered two different orders. Orthoptera have a peculiar average size, larger than the one of any other order of insects; they are also characterized by the hind saltatory legs, and by the presence of stridulant organs. In fact, the production of sounds is one of the most extraordinary characteristics of the Orthoptera. The sounds have different use, but all relate to mating.

Materials and methods

The species distribution data were obtained by the examination of the vast Italian and foreign literature, which was critically evaluated and upgraded with the most recent nomenclature. The most important collections were examined and filed as well; hence the data pre-

sent here are mostly unpublished. For several genera the identifications reported in the collections had to be verified. Some species were reported for the Italian fauna only as a generic record: this is the case of the records of *Praehippiger pacygaster* and *Glyptobothrus apicalis* for Sardinia. The reliability of the source of the citation for these two species, and the likelihood of the records, allowed us to keep them in the checklist.

Biodiversity

One-hundred and thirty-seven genera, with 353 species, are included in the Italian Orthoptera fauna which is, therefore, well-known. However, new species are continuously collected and described, indicating the high diversity of these insects in the Italian territory. Italy hosts about as many species as the Iberic and Balcanic Peninsulas: the Italian Orthoptera fauna is one of the richest of the western Palearctic region. The distribution of the species over the Italian territory is quite homogeneous: the Alpine and Apenninic regions, Sicily and Sardinia are all rich in taxa, even if the species composition differs. The number of species increases due to those present on the numerous small islands.

Ecology

Orthoptera are terrestrial insects, which mostly prefer warm climates with elevated sun radiation. Nonetheless, several species are lucifugous, being crepuscular or nocturnal, or hypogean in caves (*Troglophilus*, *Dolichopoda*, *Acroneuroptila*), and in galleries dug in soil (*Gryllotalpa*). Several species are typical of wetlands and live on riparian vegetation, (i.e. *Roeseliana*, *Zeuneriana*, *Conocephalus*, *Trignidium*, *Xya*, *Tropidopola*, *Paracinema*) and some are good swimmers (*Pteronemobius*, *Tetrix*, *Xya*). Several species live at high altitudes and are cryophilic (*Melanoplus*, *Aeropedellus*, *Aeropus*), whereas others are xerothermophilic (*Odontura*, *Pterolepis*, *Ctenodetcticus*, *Saga*, *Brachytrupes*, *Pamphagus*, *Pyrgomorpha*, *Dociostaurus*). Among the latter, some species (i.e. *Dociostaurus minutus*) live on sand dunes.

Few European species are typical of forested areas (*Barbitistes*, *Meconema*, *Cyrtaspis*); most of the species live in meadows, in the chaparral, or in ecotone habitats.

The feeding habits differ between Ensifera and Caelifera. The latter are almost exclusively phytophagous, they feed mostly on leaves and seeds. The few exceptions are represented by the Tetrigidae, that feed on mosses and liverworts, and on algae, which they collect from



mud in riverbanks and pools. Ensifera have a more varied diet: few species are zoophagous (among them *Sagapedo*, which prey on other Orthoptera, and species of *Meconema* and *Cyrtaspis*, which actively prey on defoliating caterpillars). Numerous Ensifera are polyphagous and animal food sources are always present in their diet. Some species are strictly related to some plants, which they use not so much as food, but as shelter. This is the case of species of the genus *Ochrilidia*, which live in the beachgrass *Ammophila*.

Some species of Caelifera (among which *Schistocerca gregaria*, *Locusta migratoria*, *Doclostaurus maroccanus*), have a singular characteristic: all the individuals of the species can have different morphologies if they grow as solitary or gregarious. The solitary (or sedentary) phase develops when the environmental conditions are not optimal. If the environmental conditions are optimal for a long period of time and the population density increases, then the individuals develop a different morphology and tend to aggregate, until they reach the gregarious or migratory form. Acridiidae invasions occurred in Northern Italy until the end of the XIX century, and in Southern Italy and Sardinia until half of the XX century. At present, only local populations are reported in Sardinia and Southern Italy, although these records have been increasing in the last few years.

The great majority of Orthoptera hibernate as eggs, and in several species the eggs can diapause for several years before hatching. Moreover, eggs from the same batch can hatch at different times, over a period of several years. Few species hibernate as juveniles (i.e. *Gryllus*, *Nemobius*, *Gryllotalpa*, *Pamphagus*) or adults (es. *Aiolopus*, *Anacridium*).

Zoogeography

Thirty-one percent of the 353 species and 40 subspecies of Italian Orthoptera are endemic for Italy (124 taxa). These endemic taxa are well-distributed in Italy: 16 are exclusive to Northern Italy (12%), 55 to Central and Southern Italy (44%), 13 to Sardinia (10%), 18 to Sicily (14%) and 8 of the small islands (6%). The remaining 14% has a different distribution.

In the Alpine region, Orthoptera are characterized by Euro-Sibirc genera, and by Occitanic taxa in the western section of the Alps (*Ephippiger*, *Anonconotus*) and by Balcanic taxa in the eastern section (*Isophya*, *Pachytrachis*, *Pholidoptera*). *Melanoplus frigidus* is a Holarctic species, distributed from the Alps to Siberia and to Canada.

The Apenninic fauna is characterized by western taxa as well, with few trans-Adriatic species. Sardinia and Sicily have some affinities with Northern Africa (*Odontura*, *Pte-*

rolepis, *Ephippigerida*, *Acinipe*, *Pamphagus*, *Ochrilidia*). Particularly noteworthy is a group of thyrrenic species (*Rhacocleis thyrrenica*, *Dolichopoda geniculata pontiana*, *D. aegilon* e *D. baccettii*) and one North-Adriatic (*Roeseliana brunneri*, *Zeuneriana marmorata*, *Chrysochraon dispar giganteus*).

The genera *Acroneuroptila* in the karst of Sardinia, *Italopodisma* and *Italohippus* in the high altitudes of the central and southern Apennines, *Corthopodisma* and *Pseudoprugna* in the Veneto and Trentino Alps, are endemic for Italy

Alien Species

The only alien species is the Raphidophoridae *Tachycines asynamorus*. This species originates in the Far East, but it is today cosmopolite. *Acheta domesticus* as well was probably not part of the Italian fauna: this species is today cosmopolite and its dispersal occurred in ancient times. When the extensive invasions of African Acrididae occur, swarms of *Schistocerca gregaria* can occasionally reach Italy, and they can establish local populations which do not last long and which, so far, have not caused any damage to Italian farming.

Conservation

The major causes of rarefaction or extinction of populations or species of Orthoptera are related to human activities: the soil use and the following destruction of natural habitats have drastically reduced the areas available for several species, and have fragmented the distribution areas, leading to the isolation of some populations. As a consequence of the genetic load, these populations are prone to extinction. Sixty-two of the 392 Italian species are endangered (E) and 197 are vulnerable (V). The populations at higher risks are (besides those with punctiform and restricted distribution) those associated with coastal brackish habitats, coastal dunes, and inner wetlands. The species typical of rivers and streams are today reduced to a few populations (as is the case for *Glyptobothrus pululus*), or might already be extinct in Italy (i.e. *Epacromius tergestinus ponticum*).

The cryophilic and orophilic species, which typically are represented by one or very few populations with restricted distribution, are endangered by human activities such as the construction of skiing tracks, the extension of pastures, the excessive number of cattle. The troglomorphic species are often represented by populations living in few natural caves, and therefore are endangered by the uncontrolled human access to those caves, which changes the biotic characteristics, and ultimately damages the Orthoptera biocoenosis.



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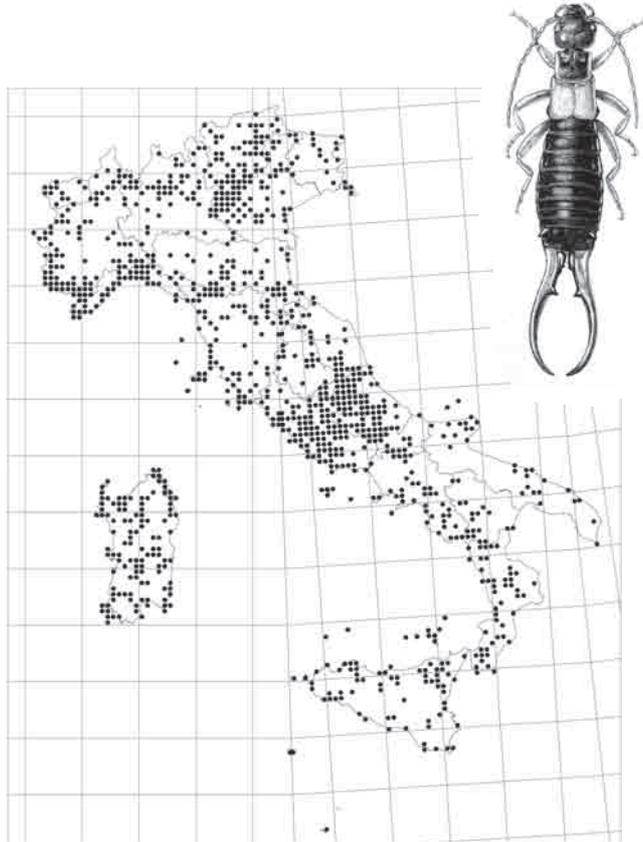
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Insecta Dermaptera

Augusto Vigna Taglianti



Dermaptera are an order of Polyneoptera insects that is well characterized and isolated within the Orthopteroidea in possessing short elytra, robust, non-segmented cerci (at least in adults), an often bifid copulatory organ and polytrophic ovarioles. Of the three generally accepted suborders (Hemimerina, Arixenina, Forficulina) only the third includes members in the Palearctic and European fauna, with 4 families occurring in the Italian fauna: the Carcinophoridae, Labiduridae, Labiidae and Forficulidae. These include species that are widespread and common in Italy, and also popularly well known (earwigs).

Material and methods

The filing of distributional data is based on the study of material preserved in the main Italian natural history museums and in the collections of most specialists, mainly that of the author, originated from over 40 years of research. All data available in the literature on the Italian fauna, starting from Gené (1832), were also included, critically examined and checked or anyhow considered as valid in the light of the most recent taxonomic revisions.

Unpublished data included in the database represent over 50% of overall records.

Biodiversity

Of the approximately 1,900 species of Dermaptera currently known worldwide, only 25 have so far been recorded with certainty in Italy. The order is indeed widespread in intertropical areas, and only few species occur in the temperate regions. The 25 Italian species form the most conspicuous assemblage in Europe (42 species altogether), which is only just superior to those of the Iberian (22 species) and Balkan (19 species) peninsulas, but much larger than the central and northern European faunas (6 and 4 species, respectively). The Italian Dermaptera belong to 11 genera, each containing 1 to 2 species except *Chelidurella* (7 species) and *Forficula* (6 species), which together comprehend over 50% of all species.

The number of species occurring in the separate Italian regions varies from a minimum of 6 (Apulia) to a maximum of 15 (Venetia, Abruzzo). Three biodiversity hotspots can be identified, located in S-western and S-eastern, and the central-southern Apennines.

Ecology

Dermaptera are phytophagous or predator insects that are widespread in intertropical regions, especially in rainforest. However, they also occur in extremely diverse habitats, ranging from rocky and pebbly seacoasts (*Anisolabis maritima*) and sandy beaches (*Labidura riparia*) to high-altitude steppes (*Anechura bipunctata*), cultivated steppes (*Forficula auricularia*), mesophilous or thermomesophilous forest (*Chelidurella* spp., *Pseudochelidura orsinii*, *Forficula silana*) and the nival horizon (*Pseudochelidura galvagnii*, *Forficula apennina*). Some species are eurytopic and euryzonal, and sometimes anthropophilous; they often show a marked capacity of dispersion and colonization, even if micropterous or apterous, being assisted by their wide ecological amplitude, high resistance to passive transport and environmental change (even sudden), adhesion to the substrate and parental care.

Zoogeography

The percentage of endemics is very high within the Italian Dermaptera, around 30%: 8 species are Italian endemics (or very limitedly occur in politically French or Slovenian areas of the Alps), one (*Chelidurella fontanae*) also oc-



curs in Corsica, and one (*Chelidurella aptera*) also occurs on the French side of the western Alps. As for species with a wider distribution, Italian Dermaptera are mainly representative of central-southern European (3 species), Asiatic-European (1 species) and Mediterranean (4 species) chorotypes, while 7 species are cosmopolitan or subcosmopolitan.

Alien species

At least 3 allochthonous species, of wide subcosmopolitan, intertropical distribution, appear to have been introduced to Italy together with crops: *Euborellia annulipes* (known since 1837, but having spread after 1930 also to minor Tus-

can islands), *Nala lividipes* (known since 1915 in Sicily and Sardinia, and since 1977 along the coasts of Latium) and *Euborellia stali* (found since 2002 in Lombard nurseries).

Conservation

The state of conservation of nearly all species, including the more localized endemics, forest and montane, of the Alps and Apennines, is altogether good. Only the two sea littoral species, *Anisolabis maritima* of rocky coasts and *Labidura riparia* of sandy beaches – which used to occur also alongside the principal rivers, reaching the Prealpine belt – are at risk, and recently many Italian populations of these species have become extinct.

Relevant Literature

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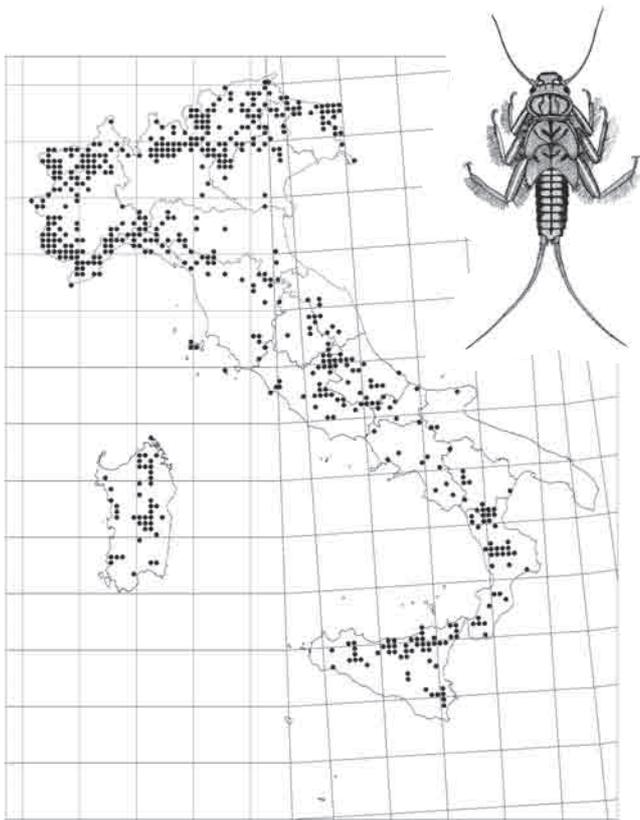
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Insecta Plecoptera

Romolo Fochetti



Plecoptera are a small order of hemimetabolous insects, with aquatic preimaginal instars and terrestrial or sub-aerial adults. They populate the whole of the Italian territory, from sea level to the limit of perennial snows. The larvae prefer cool and well-oxygenated running waters; very few species inhabit slow-running waters or lakes. They are relatively well known from a taxonomical point of view: recently, sibling species complexes have been discovered using biochemical and molecular approaches. The identification of the larvae is very difficult within some genera (*Protonemura*, *Nemoura*, *Leuctra*), if not impossible. In any case, when possible, identifications based on larvae should be corroborated by the examination of adult specimens.

Material and methods

The collection of records referring to Plecoptera is based on the analysis of recent literature (works by the author, C. Ravizza and E. Ravizza Dematteis, Milan and G. Vinçon, Grenoble), and on unpublished data provided by field collections by the above-cited authors or material collected by colleagues. Plecoptera from the author's and C. Ravizza's collections and that of the Zoology Museum of

Rome University "La Sapienza" (ex Consiglio collection) were examined. The scanty material preserved in the main Italian natural history museums had already been studied by C. Consiglio, to the work of whom (1955-1980) the present contribution owes a lot.

Biodiversity

The Italian plecopterofauna currently consists of 157 species, included within 22 genera and 7 families. The sole genus *Leuctra* contains 51 species representing over 30% of the total and, together with *Protonemura* (30 species), makes up for over half of the Italian Plecoptera fauna. *Nemoura* (17 species) and *Isoperla* (15 species) follow in descending order. A recent checklist reported 431 species of Plecoptera for Europe: the 157 species recorded from Italy therefore represent 35% of the currently known European fauna. A similar number of species is reported for the Iberian peninsula (142, Tierno de Figueroa et al., 2003), whereas a much less diversified fauna exists in Scandinavia (42 species) and Great Britain (33 species). The Plecoptera fauna of central Europe is, though less rich, more comparable (e.g. 115 species in Austria, 112 in Poland). Lastly Greece, with only 66 species, goes against the observed trend of an increase in species numbers from north to south across Europe. However, it must be said that in the Hellenic peninsula, but most of all in the Greek islands, ideal habitats for Plecoptera are rare, besides the fact these areas are much less studied.

In Italy the northern regions are much richer in species, while in the south generally much less diversified Plecoptera faunas can be found, even in well-studied regions (e.g. Sardinia), thus revealing a natural impoverishment due to the scarcity of suitable habitats.

Ecology

As already mentioned, Plecoptera inhabit lotic environments, preferring the cold and well-oxygenated waters of streams and mountain torrents. However, some species show a preference for other habitats: *Tyrrhenoleuctra zavattarii* has adapted to the temporary watercourses of Corsica and Sardinia, where it occurs from sea level to altitudes exceeding 1,200 m; *Nemurella pictetii* can be found in medium and high altitude oligotrophic lakes. *Protonemura ruffoi* also inhabits watercourses with high concentrations of salt in Sicily, while *Nemoura fulviceps* lives in boggy streams, also in Sicily.

As for the longitudinal zonation of watercourses, few



species are characteristic of spring habitats: of these only *Isoperla saccai* can be defined as crenophilous. Most Plecoptera live in the upper-medium stretches of watercourses and can be classified as rheophilous-orophilous. Lastly, a small assemblage of species lives in the potamous stretches of rivers: e.g. *Perla bipunctata*, *P. burmeisteriana*, *Xanthoperla apicalis*, *Taeniopteryx schoenemundi*, *T. stankovitchi*, and *B. monilicornis*. Some of the species belonging to this category have become vulnerable, endangered or more or less threatened due to their particular ecological preferences (see paragraph on conservation).

Plecoptera are commonly part of the diet of freshwater fish, and play an important role in the food and functional chains of running waters, both as prey and predators.

Given they are generally stenoecious and show little tolerance towards alterations of water quality, Plecoptera are a group of good environmental quality indicators. As such, they are included as a key-group in the main evaluation and monitoring indexes of running water quality.

Zoogeography

Narrow and specific ecological needs strongly reduce the capacity of dispersion of the larvae. Furthermore, adults show reduced activity and poor ability to fly. As a consequence, Plecoptera include a high amount of endemics of more or less confined areas, while widespread species are uncommon. Forty-nine out of 157 species, i.e. over 30% of the whole plecopterofauna, are Italian endemics. Genera that are particularly rich in endemics are *Protonemura* (16 out of 30 species) and *Leuctra* (21 out of 51 species). Stenoendemics are numerous: *Isoperla zwicki*, *Taeniopteryx mercuryi*, *Nemoura lucana*, *N. oropensis*, *Protonemura helenae*, *P. julia*, *P. italica* and *Leuctra canavensis* are known from the sole type locality.

Endemics appear to be evenly distributed throughout the peninsula, and no particular endemism hotspots stand out, even though the Alpine arch hosts a higher percentage of endemics due to its richness in water and therefore also habitats. The continuity of the Apennines somewhat levels the central-southern endemics, whereas Sardinia of course deserves special attention in possessing, together with Corsica (thanks to the well-known palaeogeographical events), a high percentage of

endemics within an otherwise not particularly differentiated plecopterofauna.

Alien species

No alien species are recorded in Italy.

Conservation

Many species of Plecoptera are nowadays threatened or in danger of extinction in Italy, due to the growing pollution of running waters and the general narrow ecological needs of many species. This situation is obviously critical for the endemic species. Many species are reduced to small, isolated populations and others are probably already extinct. The whole category of river Plecoptera can be considered at risk of extinction in Italy, as elsewhere in Europe. *Isogenus nubecula* was once very common in the major European rivers, but has now disappeared from western and central Europe. It was recorded in Italy from a couple of places towards the end of the nineteenth century, apparently shortly before becoming extinct. *Brachyptera trifasciata* used to be so common in Val Sesia that bushes would bend over under the weight of newly emerged adults; it has now disappeared from Italy and most of its distributional area. *Isoperla oscura* and *Taeniopteryx nebulosa* also appear to be extinct, while *Besdolus ravizzarum*, *Perla bipunctata*, *P. burmeisteriana*, *Taeniopteryx schoenemundi*, *T. stankovitchi* and *B. monilicornis* are reduced to a few, remnant populations. *Xanthoperla apicalis* has resisted to some degree thanks to Sardinian populations, while it has practically vanished from peninsular Italy. Another case is that of *Isoperla ilvana*, an Elba Island endemic, which is seriously threatened by surface water captation. The situation of the species mentioned earlier on, which are known only from their type localities and should therefore be intrinsically considered as fragile, must also be added to this overall picture.

Briefly, about 30 species out of the 157 reported for Italy can be considered at risk or threatened of extinction. A similar situation exists in other parts of Europe: for instance, 44 species are reported in the "Red List of Plecoptera" in Germany, and 23 species out of a total of 142 are reckoned to be endangered in the Iberian peninsula.



Insecta Plecoptera

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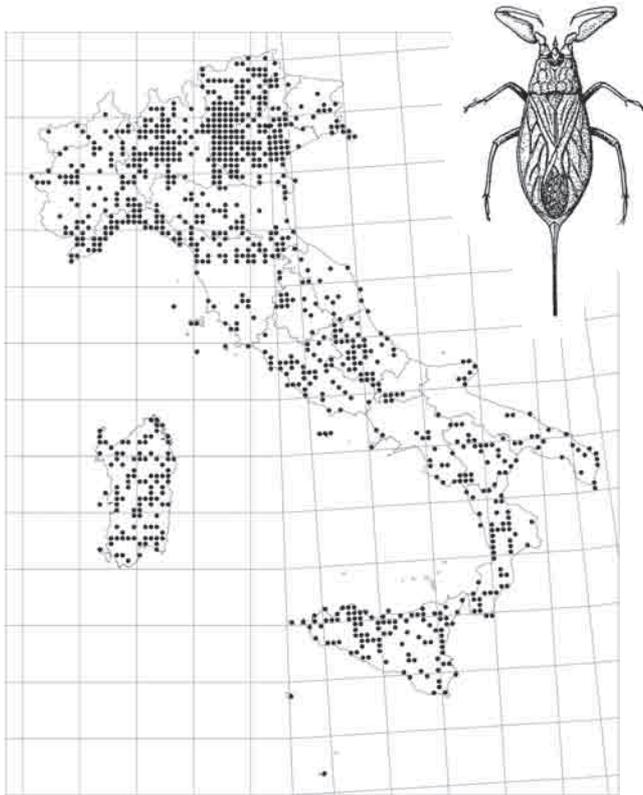
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Insecta Heteroptera Nepomorpha and Gerromorpha

Ivan Bacchi, Massimo Rizzotti Vlach



Water bugs, as they are familiarly called, include species which are widespread in the fresh and brackish waters of Italy, and taxonomically belong to the infraorders Nepomorpha and Gerromorpha; this of course if Heteroptera are considered a suborder, as there are discrepancies between the opinions of specialists regarding their systematic rank. Systematic knowledge of the group can be considered good, since important revisions at the level of genus (*Velia* and, recently, *Aphelocheirus*) exist, which allow for sure morphological identification. Uncertainties regarding the taxonomical value of some species occur only within *Hebrus*, for which only data from the literature were reported; despite the many examined specimens (also personally collected ones), it was impossible to solve the systematic problems concerning two taxa: *H. franzi* and *H. eckerleini*.

In some cases, recently-gained genetic information (Di Giovanni et al., 1998; Scholl and Zimmermann, 1993) has confirmed previous interpretations of morphological and biogeographical features.

Material and methods

The filing of species distribution data is mainly based on the re-identification of material (over 16,000 specimens) preserved in the Natural History Museum of Verona (general collection and Servadei collection), in Rovereto (Tamanini collection), in the Natural History Museums of Milan (general collection and Filippi collection) and Venice, in the "G. Doria" Natural History Museum of Genoa (general collection of Corixidae, Nepidae and Gerridae), in the Natural History Museum of Morbegno (Sondrio), in the Museum of Zoology of Rome University "La Sapienza", in the "E. Caffi" Natural History Museum of Bergamo, in the personal collections of B.G. Osella (University of L'Aquila), F. Buzzetti (Vicenza), F. Stoch (Trieste) and in the authors' personal collections, as well as on data kindly provided by A. Carapezza (Palermo).

Only a small proportion of data from the literature were included, always after careful screening, in order to omit publications preceding the systematic revisions so essential to species identification. The main works used for the re-identification of material are Jansson's (1986) revision of the Corixidae and Di Giovanni et al.'s (1996) revision of the *Sigara* s. str. genus for the Nepomorpha, and Tamanini (1979), as well as Zimmermann and Scholl's (1993) work on the genus *Aquarius*, for the Gerromorpha.

Biodiversity

According to the examination of the above material, the Italian Nepomorpha and Gerromorpha fauna currently consists, with certainty, of 26 genera and 86 species and subspecies. Two families (Corixidae with 40.7% and Gerridae with 16.3%) make up for 57% of Italian species, the genus *Sigara* accounting for over 18% of the taxa recorded for the peninsula. If such results are compared with those from other European countries, it must be noted that the number of species occurring in Italy is higher than that of central European countries (77 species), the British Isles (63 species) and the Iberian peninsula (68 species). The biodiversity pattern outlined in the present work reveals, like for other invertebrate groups, a greater species richness in the northern regions, but also proves the wide distribution of at least 50% of species throughout the peninsula. The analysis of the distribution throughout the country of the collecting sites included in the present work, particularly of species such as *Sigara lateralis*, *S. n. nigrolineata* and *Gerris lacustris*, which are very common in lentic or feebly lotic habitats, and *Aquarius najas*, which is equally common in lotic ones, can provide a composite picture of



the Italian areas in which this group has been most intensively studied. These are for instance the northern regions and Sicily, whereas other areas – e.g. the whole of the Apennines – still await more thorough research. Lastly, it must be said that some species occurring in the northern regions are restricted to only a few marginal sites close to the political border (*Callicorixa p. praeusta*, *Sigara striata*, *Velia c. caprai*).

Ecology

Nepomorpha, which are zoophagous or phytozoophagous in the case of Corixidae, and Gerromorpha, which are zoophagous, are subsurface swimmers (except *Nepa* and *Ranatra*, that should be considered as “walkers”), occurring in samples taken from the macrobenthos, and surface-dwellers, respectively. They are associated with freshwater and only few species have adapted to life in brackish habitats (*Sigara selecta*, *S. mayri* and *S. stagnalis*). Nepomorpha are common in ponds and marshes, or feebly lotic habitats near the bank; the only exception is *Aphelocheirus aestivalis*, which is associated, though only in summer, with markedly rheic habitats where it reproduces, then migrating in late summer to deep slacks of rivers and lakes, where it hibernates. The behaviour of this species lets suppose that both the microhabitat types alternatively used by the insect coexist in areas in which it occurs.

Different Nepomorpha assemblages have been observed in springs, following one another in simplified successions according to the accumulation of organic matter (Bacchi et al., 1998). For instance, *Sigara italica* is able to colonize drinking troughs shortly after cleaning operations and thereby in total absence of organic matter, a feature which is also found in other habitats frequented by this species, such as temporary pools alongside rivers or the Po Plain canals. On the contrary, *S. fossarum* (which arrives after *S. italica* in drinking troughs) and most of all *Cymatia coleoptrata*, an extremely localized species in Italy, occur in water bodies that are rich in organic matter. Other Nepomorpha, such as *Plea m. minutissima* and *Nepa cinerea*, seem to be less tolerant toward habitat factors (e.g. oxygen, salinity, depth and type of bottom), even though *Ilyocoris cimicoides* has often been observed as the only Nepomorpha occurring in highly eutrophic plain habitats.

Gerromorpha occur in both lentic habitats with vegetation (*Gerris lacustris*, *Mesovelgia* spp.) and more open water bodies (*Aquarius p. paludum*), as well as in lotic habitats (*A. najas*, *A. cinereus*), close to the banks in the case of *Velia*; lastly, *Hebrus* species are often found amongst bryophytes, chiefly in peat bogs.

These species are altogether insignificant as indicators of habitat quality, due to their high tolerance of organic pollution, and even in *A. aestivalis* the physical gill stops functioning only in the presence of relatively high concentrations of surfactants.

Zoogeography

The percentage of endemic species is 11.6 (10 species), which is not a very high value in absolute terms but is significant when related to the widespread distribution of many Heteroptera. However, as already mentioned, the taxonomic status of two of these endemics (*Hebrus franzi* and *H. eckerleini*) needs clarifying, and they are here reported only on the basis of records from the literature. Most (4 species) are Sardo-Corsican endemics (*Sigara servadeii*, *Micronecta leucocephala*, *Nepa sardiniensis* and *Velia sarda*) which, together with another taxon generically reported for Sardinia and not included here, characterize the not particularly rich inland waters of Sardinia. Broadly speaking Apenninic species such as *Velia gridellii* and *V. muelleri* are very often found together with *Velia currens*, but these two endemics are excellent differential elements within the Italian lotic water assemblage. *Sigara basalis* is another, only recently acknowledged, Apenninic species, which is even relatively common and sometimes occurs in very large populations; it can be considered as vicariant, along the peninsula, of the closely related *S. dorsalis*, with which it shares similar ecological trends. An endemic species characterizing the lentic habitats of northern Italy, also because of frequent findings in the Po Plain, is *Sigara italica*; this species, not considering the recent record from the literature of *S. falleni* for Tuscany, could be considered a vicariant of this European species in Italy.

Lastly, noteworthy characteristics of the Italian water bug fauna are: the presence of Maghrebi species in Sicily (*Parasigara favieri*, *Velia concii*), that of relict European elements (*Notonecta lutea*) along the Alpine chain, and the recent finding of *Lethocerus patruelis*, a Turano-Mediterranean species and the largest Heteroptera of the European fauna.

Alien species

The presence of no alien species is recorded.

Conservation

If on one hand the above-mentioned endemics are not rare within their distributional areas, on the other the situation of many stenotopic taxa in northern Italy is worrying; in fact, no recent findings exist of the very rare microthermic species *Limnoporus rufoscutellatus*, which was probably confused with other species in the past (e.g. *Gerris costae* s.l.), nor of *G. lateralis*; the quoted localities for these species are of a purely historical value, since surveys personally carried out in Trentino-Alto Adige during the past three years have produced no results, partly also because of environmental change. Particular attention should be paid to the only Italian population of *Notonecta lutea*, chiefly considering the characteristics of the peat bog in which it has been collected, which is almost completely covered by soil.



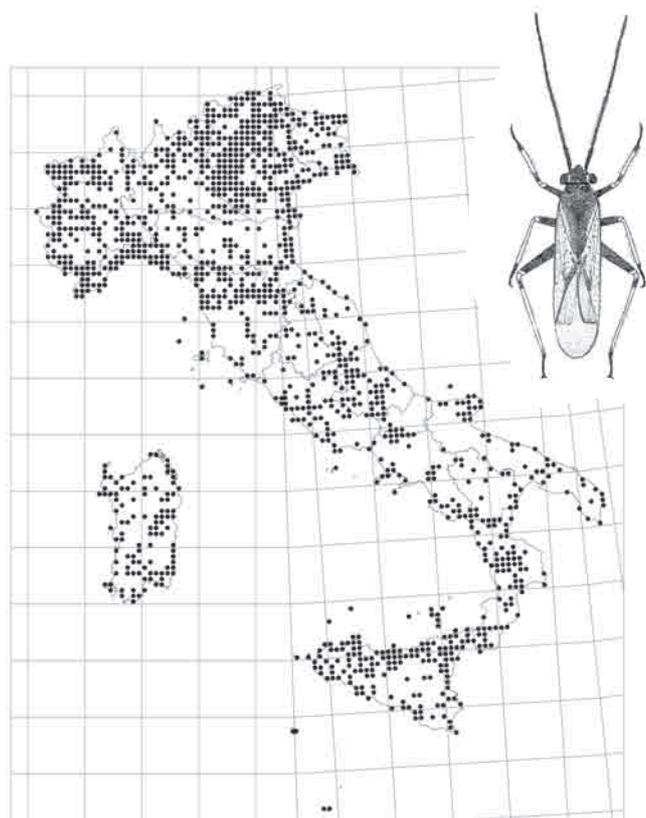
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Insecta Heteroptera Leptopodidae, Saldidae, Miridae (partim), Tingidae

Attilio Carapezza, Franco Faraci



Miridae are the family of Heteroptera richest in species, both on a worldwide and a national scale. They include species of medium to small size (2-10 mm), which occur in practically all Italian terrestrial environments; in Italy they can be considered as relatively well known from a taxonomical point of view, less so from a chorological point of view. Tingidae, which are also terrestrial insects of small size (2-5 mm), are the second Italian family of Cimicomorpha after the Miridae in number of species, whereas the Saldidae and Leptopodidae are two small families containing essentially ripicolous species. These three families are taxonomically well known thanks to the recent revisions by Péricart (1983, 1990), while they would deserve further research from the point of view of their distribution, which is incompletely known.

Material and methods

The job of filing species distribution data was carried out in two phases. During the first phase, chorological literature concerning the studied species was critically examined, and only data considered as certain were used, mainly the more recent ones. For some groups of species

(e.g. within the genera *Saldula*, *Dimorphocoris* and *Psallus*) of difficult distinction and having undergone recent revision, the contribution of data from the literature was basically none. During the second phase, material preserved in a certain number of public and private collections was directly checked. Unpublished records make up for 70% of total Miridae records and 60% of total Tingidae records in the database.

Biodiversity

Italian Tingidae include 81 species belonging to 22 genera/subgenera, Saldidae include 27 species grouped together within 7 genera, whereas Leptopodidae species are only 4, belonging to 3 genera. Filing work included one hundred-odd species of the 540 Miridae, belonging to 160 genera, currently recorded for Italy. At least twenty-odd previously omitted, newly-recorded or newly-described species should indeed be added to the 517 listed in volume 41 of the Checklist of the species of the Italian fauna. In order to cover a representative sample of the various groups composing the family, and contemporarily have systematically homogeneous groupings, the subfamily Deraeocorinae (22 spp.), the tribe Halticini of the subfamily Orthotylinae (37 spp.) and a group of genera of the subfamily Phylinae (*Psallus*, *Psallopsis*, *Livopsallus* and *Lepidargyrus*, for an overall 40 spp.), were considered.

The Italian fauna, like those of the Iberian peninsula, France and the Balkan peninsula, contains all the European species of Leptopodidae, whereas countries of central-northern Europe host the sole *Leptopus marmoratus*; in the case of the Saldidae, the Italian fauna is still the richest in species, but shows much less marked differences due to the greater variety of frequented habitats. The number of Miridae species occurring in Italy is way higher than those occurring in central and northern Europe; on the other hand, this fauna is less diversified compared to both the Balkan and Iberian peninsulas. As for the Tingidae, the number of species occurring in Italy is slightly higher than in central and northern Europe, practically identical to that of France, and slightly inferior to that of the Balkans.

The biodiversity pattern outlined in the present work shows, in the Miridae, a generally greater species richness in the central-southern regions, which is certainly due to the thermophily of most species. An opposite trend can be observed in the Leptopodidae, Saldidae and Tingidae: in all three cases the highest diversity occurs in



the northern regions, with a minimum registered in the central Apennines. However, as can be deduced by the considerably lower number of citations (2,341 vs 785 vs 1,084 for the north, centre and south, respectively), these values are certainly influenced by different levels of investigation in different parts of the country.

Ecology

Leptopodidae and Saldidae include predacious species and some necrophagous species (*Salda littoralis* and *S. muelleri*), which generally frequent xerothermic biotopes and ripicolous fluvial, lake and marine habitats, respectively; among the ripicolous Saldidae, some species (e.g. *Halosalda lateralis*, *H. concolor*, *Salda adriatica*, *Saldula nitidula*, *S. palustris*, *S. pilosella*, *S. sardoa*) are strictly halophilous and typical of brackish lagoons.

Miridae are strictly associated with vegetation, which is why they are familiarly called “plant bugs”. Of the Italian species considered here, the Deraeocorinae are predators, whereas all the others are phytophagous; all are characterized, with few exceptions, by relatively narrow monophagy, which allows them to live on groups of plants, often a single genus or even a single plant. This association selects for habitats in which the Miridae can live. Among the Deraeocorinae for instance, species of *Alleotomus* occur in high mountain areas on *Pinus*, and *Deraeocoris annulipes* occurs on *Larix*, also at high altitudes; other *Deraeocoris* species can be found at lower altitudes on broadleaved trees (*D. serenus*) or shrubs (*D. punctum*), while *D. martini* occurs on *Tamarix* and other shrubs in extremely arid environments. Another indicative example is that of the genus *Dimorphocoris*, which is composed of very localized northern species living on Poaceae (often *Festuca*) in high mountain areas above the tree line, such as *D. poggii*, as well as of more widespread southern elements such as *D. debilis*, living in low altitude arid habitats. Lastly, the Tingidae are all phytophagous and, like the Miridae, are largely characterized by a basic monophagy, varying from the members of one or two families to a single species, such as for instance *Tingis (Neolasiotropis) marrubii* on *Marrubium vulgare*. Members of this family show a generalized preference for not particularly humid or even dry habitats, but species of *Acalypta* live exclusively amongst bryophytes.

Zoogeography

The Italian Leptopodidae do not include striking elements from a zoogeographical point of view, all four species showing essentially Centralasiatic-Mediterranean distribution patterns. Saldidae, on the other hand, are more interesting, and include two endemics: *Macrosaldula madonica* and *Saldula sardoa*, known respectively just from Sicily and Sardinia. Although these two species only represent 7.4% of the species occurring in Italy, they are nevertheless a characteristic component of the

Italian fauna, since most species of Saldidae are widely or very widely distributed. Indeed, 5 species are Holarctic s.l. and 12 others are Asiatic-European and Sibirop-European; to these, also *Pentacora sphacelata* should be added, a Neotropical species occurring, probably after having been introduced a long time ago, not only near Cagliari but also along the Spanish Mediterranean coasts and the Moroccan and Iberian Atlantic coasts.

The Miridae species considered here include a relatively high number of endemics, distributed as follows: the western Alpine arch (*Dimorphocoris poggii*), the Trieste Karst (*Halticus henschii*), the northern Apennines (*Dimorphocoris concii*), the central-southern Apennines (*Schoenocoris flavomarginatus*), southern Italy (*Dimorphocoris debilis italicus*), southern Italy and Sicily (*Psallus hartigi*), Sicily (*Plagiotylylus ruffoi*).

The other species can be grouped together in the following categories: species widespread in the Holarctic region and in most of Italy (*Deraeocoris serenus*); Sibirop-European species occurring only across the Alpine chain (*Orthocephalus brevis*) or throughout most of Italy, but only on mountains (*Euryopicoris nitidus*); species widespread within the Holarctic region, which occur only in the most northern regions of Italy (*Deraeocoris punctulatus*); species of European distribution, which occur only in the northern regions of Italy (*Psallus flavellus*) or only across the Alpine arch (*Orthocephalus coriaceus*); European species with an Alpine-Apennine distribution in Italy (*Orthocephalus vittipennis*); species of European distribution occurring throughout most of Italy (*Lepidargyrus ancorifer*); species with a South-European distribution which occur, in Italy, only in the peninsular regions (*Deraeocoris schach*), sometimes reaching Sicily (*Psallus punctulatus*); Mediterranean species occurring in the southern and insular regions (*Orthocephalus proserpinae*), or in the peninsular and insular regions (*Pachytomella passerinii*); East-Mediterranean species occurring in the peninsular regions and Sicily (*Psallus helena*); West-Mediterranean species occurring in the southern and insular regions (*Deraeocoris punctum*); West-Mediterranean species occurring only in Liguria (*Deraeocoris cordiger*); Tyrrhenian species occurring only in Sicily (*Liviopsallus tamaninii*); Afrotropical-Mediterranean species occurring only in Sicily (*Deraeocoris martini*) or Maghrebi-Sicilian species (*Psallus siculus*).

Within the Tingidae, besides widespread species such as the almost Holarctic *Corythucha ciliata*, which occurs in Europe from the Iberian peninsula to Russia, the Palearctic species *Dictyla echii* and *Tingis (Tingis) cardui*, and 15 Sibirop-European species, also species with reduced distributional areas can be found. These include Alpine (*Acalypta visolensis*), Alpine-Apennine (*Acalypta finitima*) and Sardo-Corsican (*Copium teucris intermedium*, *Dictyonota albipennis*) elements, as well as a Sicilian endemic (*Copium clavicornis siculum*). Noteworthy



are also those species which meet one of their distributional limits in Italy, such as *Agramma nigrum*, *Catoplatus olivieri*, *Galeatus major* and *Tingis (Tropidocheila) trichonota* (eastern limit) and *Tingis (Tropidocheila) hellenica hellenica* (western limit).

Alien species

There are no introduced species among the Leptopodidae, Saldidae and Miridae, whereas among the Tingidae there are *Corythucha ciliata* and *C. arcuata*. Both these species are native to the United States: the first one, which is associated with *Platanus*, was first found in Europe in 1964 in Padua, from where it rapidly spread across Italy and to many other European countries (Slovenia and Croatia in 1970, France in 1974, Hungary in 1976, Spain in 1980 and, more recently, Austria, Germany, the Czech Republic and Russia). The second species, which is associated with *Quercus*, arrived to Europe more recently, having first been found in Lombardy in 2000; further studies

have revealed its presence in a vast area also including a part of Piedmont.

Conservation

Due to the high number of species they include, many of which have a specialized ecology, the Miridae represent a significant biodiversity heritage. Considering the strict relationship existing between Miridae and vegetation, their safeguard can only be assured by protection of the habitats in which they live. Species at particular risk of extinction are those associated with relict plain woodlands of the Po Plain area and of the peninsular and insular littorals, as well as those related to coastal brackish environments, the protection of which is of vital importance for the preservation of the communities of Saldidae which they host. Lastly, among the Tingidae, the *Acalypta* species associated with mosses would deserve protective measures.

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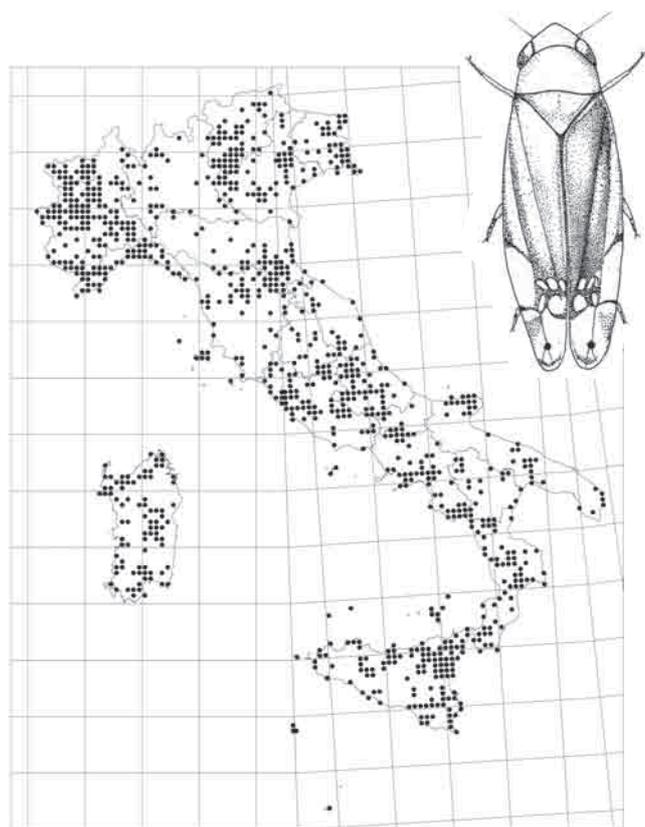
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Insecta Homoptera Auchenorrhyncha (partim)

Vera D'Urso, Alberto Alma



Auchenorrhyncha are generally considered a section of the suborder Homoptera, order Rhyncota or, according to the classification followed by American authors, a suborder of the order Homoptera. In recent years, studies based on the cladistic analysis of morphological characters and molecular biology studies have questioned the monophyly of the Homoptera, particularly of the Auchenorrhyncha. Auchenorrhyncha are a group of phytophagous insects of worldwide distribution including over 26,000 species belonging to over twenty families, and occur in all ecosystems and agrosystems, where they have a role of primary importance.

Despite their high number and importance from an ecological and economic point of view, both the systematics and chorology of Auchenorrhyncha are still poorly known, and so is their role as plant pathogens.

Material and methods

Currently, the level of knowledge of the Italian Auchenorrhyncha fauna can be considered sufficient, though not yet altogether satisfactory. Data are not equally distributed among families; in fact, Cercopidae and Cicadel-

lidae are quite well known, Delphacidae are relatively well known, whereas other families such as the Cixiidae, Issidae, Cicadidae and most of all the Tettigometridae, are still rather incompletely known.

On these grounds, it was decided to preliminarily choose the taxa to be treated. Cicadidae and Tettigometridae were excluded. For the remaining families, only the more homogeneous genera were considered, i.e. those containing species which were sufficiently well known from the points of view of systematics and distribution throughout the country. The classification of only few of the treated species is doubtful.

Besides critically examined data from the literature regarding the Italian fauna, data from the "Carlo Vidano" collection (Typhlocybini), the authors' collections, the collections of various museums (namely the Servadei, Ferrari and Costa collections) and those of colleagues (who are warmly thanked) were personally checked and also used. Dr M. Asche (Berlin), Prof. A. Arzone (Turin) and Prof. A. Guglielmino (Viterbo) kindly provided data from their personal collections. Many of these are still unpublished, some are being prepared for publication and others are in press, such as those of the Guglielmino collection (Guglielmino et al., in press), referring to central Italy.

Biodiversity

The Checklist of the species of the Italian fauna (D'Urso, 1995) reports 867 species, belonging to 298 genera and 14 families; subsequent updates until 1999 had brought the number of species to 882 and of genera to 299 (D'Urso, 2000). There has since been a further increase of about ten species, consisting of new records and species new to science; this number is due to increase further, given that the level of knowledge of Italian Auchenorrhyncha is still far from complete. These gaps are due both to unevenness of research throughout the country and to the fact that these insects are generally of small size and highly diverse, and usually occur in small populations which can easily be missed if not thoroughly searched for; moreover, many taxa have yet unsolved taxonomical problems. It is realistic to say that currently, 70-80% of the species occurring in Italy are known. Nonetheless, the number of species recorded so far represents an excellent indicator of the variety of the Italian faunistic composition, which is in line with data referring to other groups.

Compared to other European countries, the diversity of



the Italian Auchenorrhyncha assemblage is particularly high; in fact, the species occurring in Italy represent nearly 50% of all European ones, and are similar in number only to those occurring in France (D'Urso, 2000).

The analysis of the species richness of various areas of Italy, following the regional subdivision used in the Checklist, clearly shows that the best-known areas are the north and Sicily; this is mainly due to a lack of faunistic surveys carried out in central-southern Italy and partly also in Sardinia.

The Italian Auchenorrhyncha fauna is characterized, in the same way as the whole European fauna is, by a clear dominance of two families, the Cicadellidae and Delphacidae; for instance, the Cicadellidae make up approximately two thirds of the total.

Ecology

Auchenorrhyncha are rigorously phytophagous, and can be mesophyllomizic, phloemomizic or xylemomizic; some species show very narrow food preferences by being associated with a single host-plant species, others feed on few plant species or are widely polyphagous, feeding on a variety of plant species, even belonging to phylogenetically very distant groups. Auchenorrhyncha can cause damage to plants, both directly and indirectly. Direct damage consists of feeding bites (which can cause depigmentation, necrosis, desiccation, malformations and toxæmia) and oviposition wounds (which cause tissue injuries); indirect damage is caused by species carrying plant pathogens (viruses, bacteria, phytoplasmas, fungi), which induce serious crop damage (Arzone and Alma, 2000).

Many species can be used as bioindicators due to their particular ecological needs and because they are often associated with specific habitats, often of high quality; however, it is the Auchenorrhyncha community as a whole which characterizes the habitat.

The Italian Auchenorrhyncha assemblage, with species occurring from sea level right up to the limit of herbaceous vegetation, features a high percentage of thermophilous, markedly Mediterranean taxa, a characteristic that can be related to the geographic position and particular conformation of Italy, which allowed for the survival and subsequent spreading of pre-Quaternary thermophilous stocks. This is particularly evident in the coastal areas of the south and the islands. Cooler climate elements (Siberian, continental European and part of the Euro-Mediterranean species) are obviously more numerous in the northern regions, in Alpine and Prealpine environments, whereas further south they are confined to the Apennines (e.g. *Mongolojassus*) and to the high altitudes of Mount Etna and the Madonie.

Zoogeography

The zoogeographical analysis, carried out on all taxa of the Italian fauna the distribution of which is quite

well known, shows that species with a Mediterranean sensu lato distribution form the most numerous group of Italian Auchenorrhyncha (around 30% of the total). Among them, endemics are the most abundant, making up for approximately 30%; two species occurring in the border zone between Italy, France and Switzerland (*Erythria pedemontana* and *Jassargus bobbicola*) were also included amongst these endemics, over 30% of which occur in Sicily and the islands surrounding Sicily. Some genera, such as *Jassargus* and *Adarrus*, show a high microevolutionary rate, and five of the ten Italian species of the latter genus are endemic. Another large group of Auchenorrhyncha (making up for 23% of the total) is that of the widespread species, including those widespread in the Palearctic region. The European s.l. species and those of mainly Centralasiatic or Turanic distribution all stand around 16%, while there are a few less Euro-Mediterranean s.l. species. Lastly, species of a mainly Siberian distribution (less than 3%) and introduced species (1%) form the smallest assemblages.

Alien species

Some species introduced to Europe during the course of the years from the Nearctic region occur in Italy. These are *Metcalfa pruinosa*, *Stictocephala bisonia*, *Scaphoideus titanus*, *Graphocephala fennahi* and *Japananus hyalinus*. They appear to be widely polyphagous in the Old World, but also attack plants of economic interest (*M. pruinosa*, *S. bisonia*), are associated with ornamental plants (*J. hyalinus*, *G. fennahi*) or strictly associated with *Vitis* spp. (*S. titanus*). This last species is a vector of the phytoplasm causing golden flavesces, an epidemic disease which causes severe economic loss in the northern Italian regions (Arzone et al., 1987).

Among the various exotic species introduced at different times, *M. pruinosa* is the most polyphagous and has spread all over the peninsula and islands in the course of the years. It also attacks ornamental plants in large numbers and causes damage to its hosts by taking away elaborate lymph, but also by producing large quantities of honeydew attracting other glyciphagous insects. This enhances the growth of epiphyte fungi, which cause the blackening of branches and leaves, the so-called sooty mould.

Conservation

Auchenorrhyncha are characteristic of all habitats in which vegetation occurs, and therefore represent a natural heritage that should be protected as a whole, not only the single species which are particularly interesting from both an ecological and a systematic/zoogeographical point of view. The greatest threat to Auchenorrhyncha consists of the continuous landscape transformations carried out by man, which often turn natural landscapes into crop fields in which insecticides are used; monocultures are the most dangerous in that they favour the



euryphagous species, often the most common ones, and degrade the fauna as a consequence.

The most directly threatened species are those living in habitats at risk of disappearance, i.e. habitats occupying a limited area or habitats becoming more and more anthropized (e.g. coastal and riparian ones). *Adarrus lesei* is at risk of extinction, being confined to a small habitat of the Iblean plateau (Sicily); *Ommatissus binotatus* is threatened

by the destruction of its host plant, the dwarf palm. Two endemic *Malenia* species are also at risk, being associated with the riparian environment or needing particular conditions of humidity; it has been suggested that *M. sicula*, a Calabro-Sicilian endemic, should be included as a priority species within the Bioitaly project for the monitoring of areas of naturalistic interest, both for its rarity and because it is considered an excellent environmental quality indicator.

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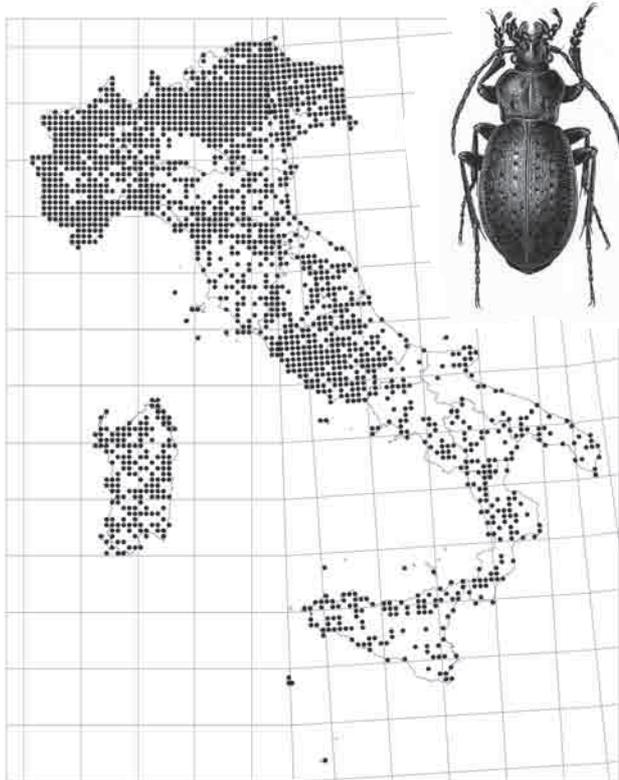
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Insecta Coleoptera Carabidae

(Carabini, Cychrini, Trechini, Abacetini, Stomini, Pterostichini)

Achille Casale, Augusto Vigna Taglianti, Pietro Brandmayr, Giorgio Colombetta



With over 35,000 species described so far worldwide, Carabidae form an extremely numerous family of terrestrial Adephaga beetles (Geadephaga) widespread in all continents and all environments. Normally these beetles are easily recognizable by the elongated shape of their body, typical of agile predators, their long cursorial legs and filiform or moniliform 11-segmented antennae. The tribes treated in the present work include species which largely correspond to these features. However, forms that are more or less modified in order to meet with particular adaptations (termitophily, myrmecophily) or different feeding habits (phytophagy) are not missing throughout the family. As a whole, Carabidae can be considered as well known in Italy, both for their taxonomy and chorology. As can be detected from the large changes made to the database during the few years having passed since the publication of the Fauna d'Italia and the Checklist of Italian Carabidae, the number of newly-discovered and newly-described taxa is continuously increasing in Italy, and some genera or species groups are still under critical

revision. Even the nomenclature has undergone, in time, a good deal of modifications (Löbl and Smetana, 2003).

Material and methods

The filing of chorological data is based on literature distributed across a fairly long period, and particular attention was paid to catalogues and local faunas published throughout the twentieth century. An inalienable source of information was the topographic catalogue of Magistretti (1965); part of the Fauna d'Italia series, this work is in many ways outdated but is nevertheless still of fundamental importance. The registered data were obviously submitted to a critical examination and discarded when unreliable or clearly wrong. For the Carabini and Cychrini much information was gained from many other, more recent contributions (Casale et al., 1982).

Some of the tribes treated in this work, i.e. Carabini and Cychrini (subfamily Carabinae), Trechini (Trechinae) and Abacetini, Stomini and Pterostichini (Pterostichinae), deserve to be separately commented on. The first two include many of the largest, most conspicuous and well-known Carabidae species of the Italian fauna. As such, they have been and still are a source of interest for amateur entomologists and collectors, who often cite collecting data in brief articles published in minor journals, which are difficult to consult. Moreover, because they are easy to collect, some species are also very often cited in applied works (ecological, agrarian or forestry). On the other hand, members of the Trechini are of small to very small size and include hypogean forms that are often depigmented and blind, and typical mountain species even of extreme environments. However, this group also has been the object of a vast amount of literature, often published by speleologists or amateur biospeleologists. In both cases, for the same reasons mentioned above, the inclusion of all the literature published on these groups would have been impossible. Therefore, in order to guarantee adequate chorological coverage of the country, the authors chose to include just the most important taxonomic and faunistic works, nevertheless extending the analysis to the numerous museum or private collections capable of filling gaps in distribution having come to light throughout the study. The authors' specialist collections also provided an important part of data, including unpublished data, so the distributions of many species, represented on maps, can be considered satisfactory or



virtually complete. The same can be said of the Pterostichini, even though they have been the object of a more specialized and less vast type of literature in Italy; chiefly for this group, many of the listed records were obtained from sampling carried out during recent studies on Carabidae community ecology (taxocoenoses).

Biodiversity

The Italian carabid fauna, with over 1,300 species known so far, is incomparably richer in terms of both quantity (number of generic and specific taxa) and quality (number of endemics and species of extraordinary biogeographical interest) than all the central and northern European faunas (400 species in Fennoscandia, around 350 in the British Isles and 763 in the whole of central Europe), as well as those of neighbouring Mediterranean regions (about 1,150 species in the Iberian peninsula, 900 in the Balkan peninsula and 1,000 in Anatolia) (Vigna Taglianti, 1999). The species occurring in political Europe were 3,594 in 2002 (Fauna Europaea database). The tribes treated herein are a particularly good example for illustrating this state of affairs.

Among the Carabini (Calosomatina and Carabina), the sole genus *Carabus* (sensu lato) numbers 53 species in Italy, including as many as three stenoendemics of very small areas of the peninsula (*C. olympiae* and *C. cychroides* of the western Alps, *C. planatus* of northern Sicily), an Apennine endemic occurring throughout most of the peninsula (*C. rossii*), and many euryendemics that are often also partly present in neighbouring countries (e.g. the Sardo-Corsican *C. genei*, *C. italicus*, which also occurs in the French Maritime Alps, the Canton Ticino and Slovenia, and some Alpine species of the subgenus *Orinocarabus*, which reach the transalpine side of the chain). The genera *Calosoma* and *Campalita* include 6 species altogether; 4 of these are more or less widespread in the Palearctic region, while 2 (*Campalita algerica* and *C. olivieri*) are eremic, only marginally reaching central-southern Italy and its islands from Maghreb. The helicophagous *Cychnus* species are altogether 9, a number which is considerably higher than in any other country of the West Palearctic. One of these (*C. italicus*) is an Italian endemic only partially occurring in the French Maritime Alps, while a second (*C. cylindricollis*) is a stenoendemic confined to refuge areas of the Lombardy and Venetia Pre-alps.

The Trechini (Trechodina, Perileptina and Trechina) are an incomparably interesting and diverse component of the Italian carabid fauna. Of the 17 genera occurring in Italy, as many as 6 are endemic to the peninsula and at least 80% of the over 200 currently known Italian species (a number that is still steadily increasing year after year) are Italian endemics, which also include some stenoendemics confined to mountain massifs or isolated subterranean systems. The highest concentration of species

within the treated groups can be found in the Alpine and Prealpine areas. Many endemics are however restricted to small areas of the peninsula and major islands.

Lastly, the Abacetini, Stomini and Pterostichini (which include Poecilina, Pterostichina, Myadina and Molopina) include 125 species in Italy, belonging to 23 genera or 40 well-characterized genera and subgenera. Four of these (*Tapinopterus* subg. *Crisimus*, *Typhlochoromus*, *Speomolops* and *Tanythrix*) should be considered as Italian endemics (even though *Tanythrix* also occurs in Canton Ticino), and so should nearly 30% of the species. These tend to be concentrated in the main Alpine and Prealpine refuge massifs from the Ligurian to the Julian Alps, even though the species with most limited distributional areas appear to be the hypogean ones, among which the extremely isolated (both geographically and phylogenetically) *Speomolops sardous* stands out.

Ecology

Carabidae beetles are one of the groups of terrestrial invertebrates most focussed upon in the past decades by researchers in autecological and synecological studies. Being quite well known from the point of view of taxonomy, easy to “handle” and be quantitatively surveyed through the use of standardized replicate methods (pitfall traps), sometimes easy to rear and widely represented in the animal communities of nearly all types of environment, these predatorial insects have represented excellent working material not only for basic ecological studies, but also applied ones (Pizzolotto and Brandmayr, 1999) in the fields of ecosystem evolution, plant community characterization, landscape ecology and environmental impact assessment studies.

The tribes treated here include many species which are significant in this respect. The large-sized Carabini and Cychnini form a conspicuous component of the soil taxocoenoses of the whole of the Italian peninsula. The genus *Carabus* includes some eurytopic and euryzonal species (distributed from sea level to the alpine horizon, in plain and mountain forest, high-altitude grassy formations and even agro-ecosystems: e.g. *Carabus germanii*), but also stenoecious species of very limited distribution or restricted to biotopes that risk disappearing all over Italy (e.g. the hygrophilous *Carabus clatratus*). Many orophilous species, particularly Alpine ones (such as some members of the subgenera *Orinocarabus* and *Platycarabus*), inhabit high-altitude grassland and scree as sublapidicolous or perinival elements, reaching over 3,000 m a.s.l in often extreme conditions. All species of the genus are brachypterous or micropterous except two (*C. granulatus* and *C. clatratus*), with rare macrop-terous individuals capable of flying. The genus *Cychnus* includes sylvicolous or strictly mountainous species, all specialized helicophages, some of which with short phenologies. Species of *Calosoma* and *Campalita*, which



are sometimes arboricolous, can occur in large numbers during invasions of the defoliating caterpillars on which they feed, and are a good control agent of the latter in forest ecosystems. The life cycles of these species (with three-instar larval periods) are also strongly influenced by environmental conditions, reproduction occurring in spring (spring breeder) or autumn (autumn breeder), sometimes with a two-year developmental period and a more or less prolonged summer or winter diapause.

Trechini, with the exception of a few ripicolous (*Perileptus areolatus*, *Thalassophilus longicornis*) or relatively eurytopic species (few members of the genus *Trechus*, such as *T. quadristriatus* and *T. obtusus*), are represented in Italy by species with a more or less specialized ecology, i.e. sylvicolous, orophilous or hypogean. This last assemblage is particularly important, because many species and entire genera are associated with shallow or deep subterranean habitats which include ultra-specialized forms having adapted to extreme life conditions, often confined within single or limited hypogean systems. They represent an important part of the hypogean communities of many Italian caves, and are the object of still fully evolving biospeleological surveys.

Within the treated Pterostichini, all transitions between the winged, often small-sized forms adapted to instable riparian habitats or grassy formations (Poecilina) and the larger forms with reduced or vestigial wings (Pterostichina, Myadina and Molopina), can be observed. The latter are considerably more frequent in forest, especially montane, though quite a few species have colonized alpine grassland (*Pterostichus*, *Oreophilus*) or scree debris (*Pterostichus schlaschli*), where they are particularly abundant in endemic plant formations.

Forms that are strictly associated with particular types of soil are not missing among the hygrophilous species. *Phonias diligens*, for instance, mainly occurs in peat bogs, whereas *Ph. ovoideus* is more related to suspended water table soils, *Platysma macrum* is exclusive to clayey soils of plains, and *Omaseus aterrimus* is typical of humic soils on the edges of eutrophicated pools.

A smaller group of forms of nemoral origin has colonized calcareous hypogean habitats rich in cracks (*Typhlochoromus*) or macrocavities (*Speomolops*). The genus *Abax*, particularly the most widespread species *A. parallelepipedus* (frequently cited as *A. ater*), is often dominant in forest. An Apennine endemic of the Poecilina, *Poecilus (Metapedius) pantanellii*, shows a strict relationship with the clayey, slightly salty vertical soils of ravines.

Zoogeography

Carabidae beetles have represented, during the history of entomology, an outstanding source of material for zoogeographical studies. This group is indeed rich in brachypterous or micropterous species sometimes living

underground and showing little or no capacity of dispersal, and has served better than others to illustrate the historical components – scarcely influenced by recent ecological factors – of assemblages of different areas, both on a worldwide scale and at the level of confined local faunas. Italy, at an advantage due to its geographic position in the centre of the Mediterranean, shows – as mentioned above – a carabidofauna which is incomparably richer than those of the contiguous Euro-Mediterranean areas. The Italian peninsula is isolated, but is however connected with central Europe by the Alps, projected towards North Africa between the Iberian and the Balkan peninsulas, enriched by two major islands and by an array of smaller islands, and was involved during the last 20 million years in all the main events having marked the palaeogeographic and biogeographical history of the Mediterranean (fragmentation and migration of the circum-Mediterranean microplates, Messinian salinity crisis, Pliocene transgressive phases, Plio-Pleistocene climatic deterioration, quaternary anathermic and catathermic phases). Therefore, this country has been ideal for zoogeographical surveys, in which Carabidae have played a key role.

The tribes treated here provide many elements that help to understand and confirm distributional patterns (chorotypes) and assemblage origins having already been discussed in numerous other works (cf. Vigna Taglianti, 1999 for a synthesis). In particular, the following components can be distinguished:

1. A more widespread component of Palearctic, Sibiro-European or Asiatic-European elements, resulting from relatively recent, Plio-Pleistocene populations. This component includes both forest and hygrophilous species such as *Carabus clatratus*, *C. granulatus*, *C. intricatus*, *Cychrus caraboides*, *C. attenuatus*, *C. angustatus*, *Trechoblemus micros*, the genus *Platysma*, numerous Poecilina and many others, and orophilous and microthermic species, which are mainly concentrated in the Alps and Prealpine belt (such as *Carabus* species of the subgenera *Orinocarabus* and *Platycarabus*, very many *Trechus* species and a number of *Pterostichus* species, particularly in the subgenera *Platypterus*, *Pterostichus*, *Alecto* and *Oreophilus*). The former are usually not or scarcely differentiated from central European conspecific populations; the latter, on the contrary, have given rise to conspicuous speciation, semi-speciation and subspeciation phenomena, and now contribute to the enrichment of the extraordinary biological diversity of the southern Alps. A third group of species, of palaeo-stepic, Pleistocene origin, is only badly represented in the groups treated herein. However, this group includes a conspicuous central Apennine species, *Carabus cavernosus variolatus*, which is only little differentiated from the conspecific Balkan populations. Probably nearly coeval assemblages, of elements which are now distributed



in the Apennines but are of trans-Adriatic, circum-Adriatic or trans-Ionian origin (and were once believed to be much more ancient), are those formed by *C. violaceus picenus*, *C. coriaceus mediterraneus*, *C. preslii neumeyeri* and even *C. lefebvrei*, the latter being certainly more closely related to the Balkan-Dinaric forms of *Chaetocarabus* than to the Alpine and central European populations of *C. intricatus*.

2. A Mediterranean component, more varied and heterogeneous but certainly richer in palaeo-endemics, even of remote origin, often of difficult interpretation, and a relict of tropical and subtropical tertiary faunas. This component includes Oligo-Miocene elements with both Angarian (such as for instance *Carabus solieri* and *C. olympiae* in the western Alps) and Gondwanian affinities, some of which were involved in the migration of the Sardo-Corsican plate from the Alboran plate (or Tyrrhenid) to its current position in the western Mediterranean (extraordinary examples among the hypogean Trechini associated with the Jurassic limestone of the Nuoro region are *Duvalius sardous* and the Sardinian endemic genus *Sardaphaenops*, both with Baetic-Pyrenean affinities). A very interesting group, now recognized as being of Messinian origin and related to the colonization phenomena enhanced by the drying up of the Mediterranean, includes Sardo-Corsican species such as *Carabus genei* and maybe also the Sicilian endemic *C. planatus*, both akin to typically Maghrebi groups. Among the palaeo-Mediterranean groups of Pterostichini, some species and genera of Molopina stand out, such as *Speomolops sardous* – a species with Baetic-Pyrenean affinities the most numerous population of which occurs in the Bue Marino cave near Dorgali – and the conspicuous lapidicolous *Percus* species the overall distribution of which, from the Balearic Islands to north Africa and from Liguria to Sicily across the western Apennines, has been defined as “palaeo-Tyrrhenian”. On the other hand, the genera *Typhlochoromus*, *Tapinopterus* and *Speluncarius*, which may be considered more akin with an ancient line of Balkan and Anatolian origin, can be attributed to a more oriental, “Aegean” assemblage.

3. Lastly, and partly comparable to the previous component, there is a whole series of genera of Trechini (many Italian endemic, but in some cases also occurring in the Dinaric Alps) of pre-Quaternary origin having descended from lines which had early adapted to subterranean life. Today, these genera are distributed in a discontinuous way along the calcareous belt of the central and eastern Prealps (e.g. *Boldoriella*, *Allegrettia*, *Italaphaenops*, *Lessinodytes*, *Typhlotrechus*), or confined within refuge districts of the western Alps (such as *Doderotrechus* in the Monviso massif); they were all subjected to speciation and subspeciation phenomena during the climatic deterioration phases of the Plio-Pleistocene, due to isolation within more or less restricted areas.

Alien species

The groups treated herein include only a very reduced number of alien species: as said earlier on, most Carabidae show low or no “dispersal power” (meaning not only the capacity of reaching areas situated outside a well-established distributional area, but also that of successfully colonizing them).

Within the genus *Carabus*, a recently recorded (2000) species from the Alps of Trentino (Monte Bondone) (*C. montivagus*) has been interpreted – based on morphological features of the population, which appears to be closer to the autochthonous forms of the northern Balkans – as a result of an introduction by the Austro-Hungarian troops during the First World War. However, the species has shown no tendency to widen its distribution to neighbouring areas, and the above locality remains the only one for this species within the political boundaries of Italy.

A species that did not used to occur in Italy, but which has been recorded on and off during the past twenty years for Sicily and Tuscany, is the large sized *Campalita algerica*, an eremic species having undoubtedly reached Italy from Maghreb through active flying, favoured by warm southerly winds and the particularly propitious climatic conditions of recent years. These are probably events repeated in time, the effect of which will have to be verified.

The introduction of allochthonous Carabidae species to Italy in the near future cannot be excluded: within the groups here treated, species of wide Palearctic or Asiatic-European distribution (such as *Carabus granulatus*, *C. nemoralis*, *Calosoma sycophanta* and *Trechus obtusus*) have showed excellent dispersal and colonization capacities in the Nearctic region following anthropogenic introduction. The occurrence of *Carabus morbillosus* in areas in which it had not been previously recorded, together with its well-established presence on small islands of the Mediterranean having been involved during the past millenniums in the exchange of people and goods, confirm a dispersal capacity of some species which cannot be underrated.

Conservation

Carabidae beetles occupy an important part of Conservation Biology literature: in all European countries (Italy included) in recent years, many researchers have paid a great deal of attention to this group of Geadephaga, which can be highly informative of territorial evolution and the progressive disappearance of natural or near-natural habitats (Turin et al., 2003). On the other hand, at an empiric level, mentions of the “extinction” because of excess collecting of particularly localized and conspicuous species, very sought-after by collectors, date back to the first decades of the last century: in Italy, the cases of *C. olympiae* in the Biella Prealps, *C. cavernosus variola-*



tus in Abruzzo and *C. planatus* in Sicily are all too well known examples. Fortunately, in the course of the years, such notifications turned out to be untrue. However, the three above species and *C. cychroides* are nowadays virtually protected in park areas and *C. olympiae*, already declared a protected species by a special law of the Piedmont Region, is included in the EU Habitats Directive.

The condition of some non-orophilous plain species related to highly anthropized environments is much more critical: habitat destruction, the fragmentation of the distributional areas of species that are very little vagile and the use of pesticides in agriculture, often acting together with the evolution of populations which are naturally of a small size, are recognized as being the main causes of decline of a number of species. The evolution of agricultural practices in itself, with the appearance of mass mechanization has affected, in recent years, species which until a few decades ago were common, widespread and well-adapted to traditional agroecosystems (e.g. *Carabus italicus*). It has been demonstrated that some sylvicultural practices, involving an excess of forest cleaning (cleaning of the understorey and removal of felled and rotting trees, which represent a hibernating refuge for both adults and larvae) can act negatively upon the life cycles of strictly sylvicolous species. Moreover, the disappearance of many humid areas and the pollution of water systems have affected the strongly hygrophilous species: in Italy, *Carabus clatratus* now shows a reduced and very patchy distributional area, and *C. nodulosus* (which is declining also in the rest of Europe) appears to be extinct in the only-known Italian localities.

Less well investigated are the consequences of human activity on groups that are in many ways still poorly

known from an ecological point of view, such as members of the tribe Trechini. While species associated with forest habitats or high altitudes show, at present, no signs of decline, some populations of hypogean species are declining in caves (especially small sized ones), due either to excess collecting by collectors (with negative effects on small populations) or site transformation for uses incompatible with the preservation of these fragile and particular habitats: some "type localities" of Italian Trechini of great interest, such as *Allegrettia pavani* in the Lombard Prealps or *Duvalius jureceki* in Tuscany, have by now been destroyed from a biological point of view by cave transformation for tourist use. Species associated with shallow or deep subterranean habitats, which are sometimes exclusive to large karstic systems, have so far showed no particular sensitivity towards karstic aquifer pollution or other surface human activities. However, the presence of such species is indicative of the degree of "naturalness" of their respective habitats, and the monitoring of these situations is necessary in order to preserve one of the most interesting natural heritages of Europe.

Among the Pterostichini, besides a small number of forms favoured by human activities such as *Platysma melanarium* (sometimes cited as *P. vulgare*), widespread in central European crops, a majority of species can be considered as indicators of good or high habitat naturalness. These include both plain elements, preferably associated with humid, marshy or even peaty soil and orophilous species typical of beech, fir and spruce forest, of the montane and subalpine horizons as well as of the summit horizon, alpine grassland and perinival scree. In these biotopes their presence alone indicates good soil quality.

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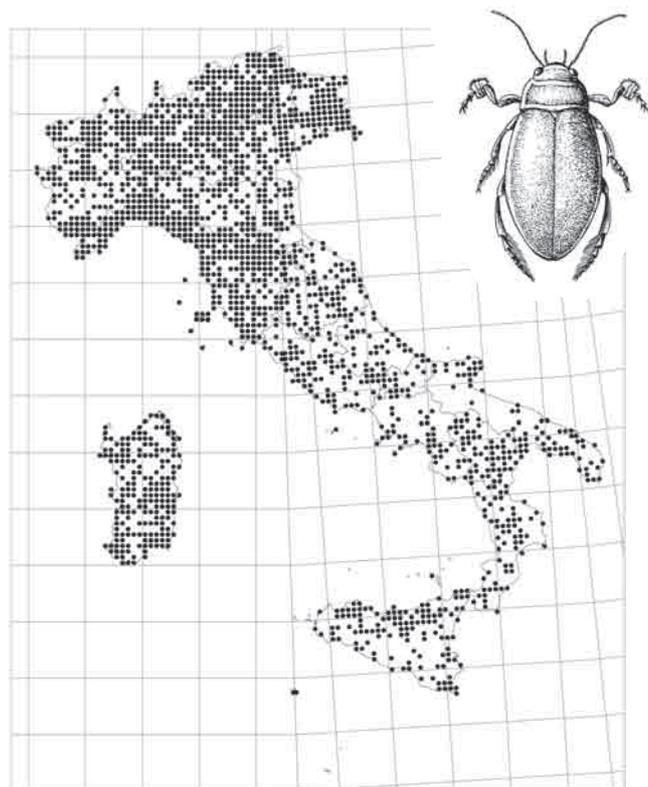
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Insecta Coleoptera Hydroadephaga

Saverio Rocchi



The name Hydroadephaga (less commonly the name Hydrocantharidae is also used) refers to a few families of water beetles numbering over 5,000 species worldwide; the following families occur in Italy: Haliplidae, Hygrobiidae, Gyrinidae, Dytiscidae and Noteridae. The group does not have a precise systematic identity, though the term Hydroadephaga is widespread for indicating aquatic Adephaga. The Noteridae have, in the past, often been considered a subfamily of the Dytiscidae, whereas they are now generally considered a family.

Taxonomical knowledge can be considered as altogether good in Italy, even though some problems still exist within the subgenus *Haliphus* (Haliplidae) and within some genera of the subfamily Hydroporinae (Dytiscidae).

Material and methods

The filing of species distribution data is based on the following sources: a) consulted literature (405 works); in many cases it was necessary for the mentioned taxa to be correctly interpreted. Many records are taken from the works of Franciscolo (1979) and Angelini (1984), who at the time grouped together a large quantity of data from public and private collections; b) the author's collec-

tion; c) part of the material preserved in the collections of the "La Specola" Zoology Museum of Florence and the Natural History Museum of Milan; d) specimens received for examination from a number of colleagues and now preserved in their collections; e) records signalled by colleagues.

Altogether, over 23,000 records (around 23% of which unpublished) were included: 2,604 of Haliplidae, 110 of Hygrobiidae, 1,574 of Gyrinidae, 18,299 of Dytiscidae and 539 of Noteridae.

It is worth pointing out that some records may refer to a taxon the name of which is different to that reported in the cited bibliographic source, following critical examination or nomenclatorial and/or systematic updates. Some old records, even if subsequently unconfirmed, were retained as valid in that they were considered plausible for the period in which they were collected. The works of Franciscolo (1979), Holmen (1987), Pederzani (1995) and Nilsson (2001) were referred to for systematics and nomenclature, except in some particular cases.

Biodiversity

The Hydroadephaga of the Italian fauna, as already said, include the following families: Haliplidae (3 genera, 21 species), Hygrobiidae (1 genus, 1 species), Gyrinidae (3 genera, 13 species), Dytiscidae (37 genera, 189 species) and Noteridae (2 genera, 4 species).

There are therefore 228 species altogether, plus a few subspecies; the most species rich genera belong to the Dytiscidae, namely *Hydroporus* with 33 species and *Agabus* with 27.

The Italian Hydroadephaga fauna is, when compared with those of other European countries, the most diversified, though only slightly. Species richness reaches an appreciable level in most regions; in fact, faunistic knowledge is high throughout the whole of Italy except for a few areas of the Marche and Molise. Locally, biodiversity can reach very high values where there are still large expanses of stagnant water (e.g. Macchia di Migliarino and Padule di Fucecchio in Tuscany or Pinete Ravennati in Romagna). In general, biological richness is considerably higher in lentic habitats than in lotic ones.

Ecology

Hydroadephaga (both larvae and adults) live in both lentic and lotic freshwater environments, from sea level to quite high altitudes (records from as high up as 2,850 m are known from the Aosta Valley). The biotopes frequent-



ed are ponds, peat bogs, pools, marshlands, hygrophilous woods, slacks of watercourses, ditches, canals, small lakes, springs, torrents and streams; some of these host absolutely peculiar species. The highest number of species occurs in lentic waters; Hygrobiidae (mostly in ponds with a clayey bottom) and Noteridae, three quarters of Haliplidae and Gyrinidae species and about two thirds of Dytiscidae species occur in this type of habitat. The number of species preferring lentic waters is about double compared to those preferring lotic waters; numbers of individuals are also generally higher in lentic rather than in lotic habitats. Many Hydroadephaga (around 60% of species) can be considered as bioindicators, especially in the wider sense of habitat fidelity.

Zoogeography

The Italian Hydroadephaga as a whole include a considerable number of widely or vastly distributed taxa (approximately 70% of all species and subspecies); the remaining 30% comprises those more or less widespread in the Mediterranean, among which 27 (species and subspecies) are either Italian endemics or taxa with a very limited distribution (1 Haliplidae and 26 Dytiscidae).

Among the widespread taxa, the largest component is that of the Sibiro-European elements (over 20% of all taxa).

Of the 27 endemics, 12 exclusively occur in Italy (i.e. within its political boundaries), whereas the other 15 also occur in the non-Italian areas of the Alps and in Corsica; *Hygrotus sanfilippoii*, *Scarodytes halensis fuscitarsis* and *Potamonectes martinii sardus*, despite being included within the Sardo-Corsican chorotypes, were considered amongst the exclusively Italian endemics, as they are known with certainty only from Sardinia. Altogether,

endemics make up for just over 11% of total taxa. Most of these 27 endemics are species and subspecies mainly occurring in running waters and generally stenoeccious.

Alien species

No introduced species are known so far.

Conservation

Hydroadephaga, being associated with water during all the stages of their life cycle, are potentially sensitive to water pollution; many species are nowadays missing in sites from which they had been recorded in the last century, having strongly felt the negative effects of reclamations and other alterations of their habitats.

Among all Hydroadephaga taxa, 4 (*Hygrotus versicolor*, *Agabus subtilis*, *A. labiatus* and *Dytiscus latissimus*) can by now be considered as extinct in Italy, around 25% are to be considered as threatened, just over 10% as vulnerable and just over 20% as rare; however, it is obvious that any species can become locally at risk from the moment its habitat is destroyed or, in some cases, simply altered.

In fact, environmental alterations are able to cause considerable modifications within a biocoenosis by impoverishing and degrading its biodiversity, even when the habitat is not completely destroyed.

Aquatic environments therefore need strongly defending from all polluting and/or altering factors and subjected, when necessary, to determined initiatives for their preservation, obviously aimed not only at Hydroadephaga, but at all forms of life occurring in these habitats, connected to each other by precise and often very restricting biological roles.

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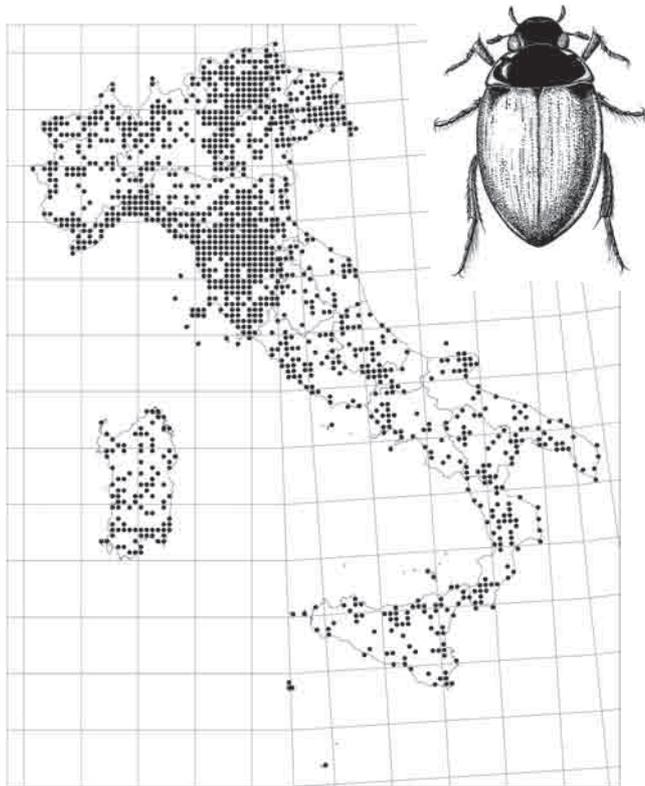
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Insecta Coleoptera Hydrophiloidea

Saverio Rocchi



Hydrophiloidea are a superfamily the members of which were once indicated with the name Palpicornia, due to the fact that many genera possess maxillary palpi that are longer than the antennae. *Sensu lato* (around 4,000 species worldwide) they include the following families in Italy: Helophoridae, Hydrochidae, Hydrophilidae, Sphaeridiidae, Spercheidae, Hydraenidae (recently included within Staphylinidae) and Georissidae. In the present work only the first five are considered. Some authors consider the Sphaeridiidae as a subfamily.

In recent years the systematics of Hydrophiloidea have undergone considerable changes; important revisions at a European or Palearctic level have been carried out for some genera (e.g. *Helophorus*, *Hydrochus*, *Berosus*, *Chararthria*, *Enochrus*, *Laccobius*, *Anacaena*), with descriptions of new species also from Italy. Currently, taxonomic knowledge can be considered good, although a closer examination would be advisable for *Cercyon* species.

Material and methods

The filing of species distribution data was done according to the following sources: a) consulted literature (281

works); in many cases it was necessary for the cited taxa to be correctly interpreted; b) the author's collection; c) the collection of Aldo Chiesa, preserved at the Natural History Museum of Milan; d) part of the material preserved in the collections of the "La Specola" Zoology Museum of Florence and the Natural History Museum of Milan; e) specimens received for examination from a number of colleagues and now preserved in their collections; f) records signalled by colleagues (in particular the very many ones provided by Giorgio Ferro).

In the literature, not many records are accompanied by a precise indication of locality, whereas a considerable amount of records exist at the level of region; for this reason, but also to provide an accurate distributional picture, it was thought necessary to consider also the generically georeferenced indications, which were therefore systematically filed. Altogether over 13,000 records were included (35% of which unpublished): 2,734 of Helophoridae, 666 of Hydrochidae, 6,550 of Hydrophilidae, 2,993 of Sphaeridiidae and 90 of Spercheidae.

It is worth pointing out that some records may refer to a taxon the name of which is different to that reported in the cited bibliographic source, following critical examination or nomenclatorial and/or systematic updates. Moreover, the systematics of some genera have undergone a great deal of change during the past few years and the existence of species very closely related to each other has sometimes made the specific assignment of records published before such changes difficult (and probably not altogether certain). Some old records, even if subsequently unconfirmed, were retained as valid in that they were considered plausible for the period in which they were collected. The works of Chiesa (1959), Pirisinu (1981), Hebauer and Klausnitzer (1998) and Hansen (1999) were referred to for systematics and nomenclature, except in some particular cases.

Biodiversity

In Italy the Helophoridae contain 1 genus and 31 species, the Hydrochidae 1 genus and 7 species, the Hydrophilidae 16 genera and 68 species, the Sphaeridiidae 7 genera and 38 species, the Spercheidae 1 genus and 1 species. Therefore, there are 145 species altogether, plus a few subspecies within the Hydrophilidae of the genus *Laccobius*. The most species rich genera are *Helophorus* with 31 species, *Cercyon* with 26 and *Laccobius* with 17. The Italian Hydrophiloidea fauna is, in Europe, one among those more diversified. The species richness in Italy can be considered at a good level in nearly all regions, even though it



is not always supported by exactly georeferenced distributions. The most investigated regions are Emilia-Romagna, Tuscany, Sicily and Sardinia, while the least investigated ones are the Marche, Abruzzo and, most of all, Aosta Valley and Molise. Additionally, distributional data regarding the genus *Cercyon* are generally poor.

The biodiversity level is particularly high in places where vast marshlands have been maintained, above all the area of Padule di Fucecchio in Tuscany.

Ecology

Most species of Hydrophiloidea are associated with the aquatic environment, even though some species are terrestrial. The larvae of *Helophorus* species, for instance, live in soil close to the water, while the adults prevalently inhabit lentic waters, except in the subgenus *Empleurus* (larvae and adults in soil near the water); both larvae and adults of Hydrochidae, Hydrophilidae, Spercheidae and Sphaeridiidae (with the sole genus *Coelostoma*) mainly live in lentic habitats; the other Sphaeridiidae go through their life cycle in dung, decomposing organic matter, humid detritus, etc. They are sometimes attracted to light.

Besides in lentic habitats, aquatic Hydrophiloidea often occur along watercourses, though always near the edges or in the calmer and more marginal parts; quite a few of them (around 42% of species) can be considered as bioindicators, at least in the wider sense of habitat fidelity.

Zoogeography

The Italian Hydrophiloidea as a whole include a considerable number of widely or vastly distributed taxa (approximately 78% of all species and subspecies); the remaining 22% comprises taxa more or less widespread in the Mediterranean, among which 14 (species and subspecies) are either Italian endemics or taxa with a very limited distribution (3 Helophoridae, 9 Hydrophilidae and 2 Sphaeridiidae).

Among the widespread taxa, the largest component consists of European and Sibirop-European elements (around 16% and 10% of all taxa, respectively).

Of the 14 endemics, 9 exclusively occur in Italy (i.e. within its political boundaries), whereas the other 5 also

occur in the non-Italian areas of the Alps and in Corsica; *Laccobius gracilis sardeus*, despite being included within the Sardo-Corsican chorotypes, was considered amongst the exclusively Italian endemics, as it is known with certainty only from Sardinia; the genera including the highest number of endemics are *Helophorus*, *Enochrus* and *Laccobius*. Altogether, endemics make up for approximately 10% of total taxa.

Alien species

Four species have been introduced to Italy: *Sternolophus solieri* (Hydrophilidae), *Pelosoma lafertei*, *Cercyon laminatus* and *Cryptopleurum subtile* (Sphaeridiidae). The first 2, which possibly arrived by ship transport, seem not to have adapted to the local climate, having never been found again since their introduction; on the contrary, the other 2, which probably came from Japan and have been signalled in Europe since the last fifty years, are by now widespread in many countries of the Palearctic region.

Conservation

The most endangered Hydrophiloidea are those living in aquatic environments, where they are easily exposed to the negative effects of the various forms of water pollution; many species have become locally rare or appear no longer to occur in sites from which they were recorded in the last century (e.g. *Helochaeres nigritulus*, *Enochrus ragusae* and *Hemisphaera seriatopunctata*). Among all the Hydrophiloidea taxa related to aquatic environments, about 5% can be considered as threatened, about 12% as vulnerable and 25% as rare; however, any species can become locally at risk from the moment its habitat is altered or destroyed.

In underlining the importance of preserving all types of aquatic environment, the necessity of avoiding disastrous reclamation operations of marshlands and the alteration of riparian zones of lakes and watercourses is stressed, these being preferred habitats of many species. Hence the need for advisable and determined actions aimed at the safeguard of aquatic environments, which represent a life source for a whole series of animal and vegetal organisms biologically linked together.

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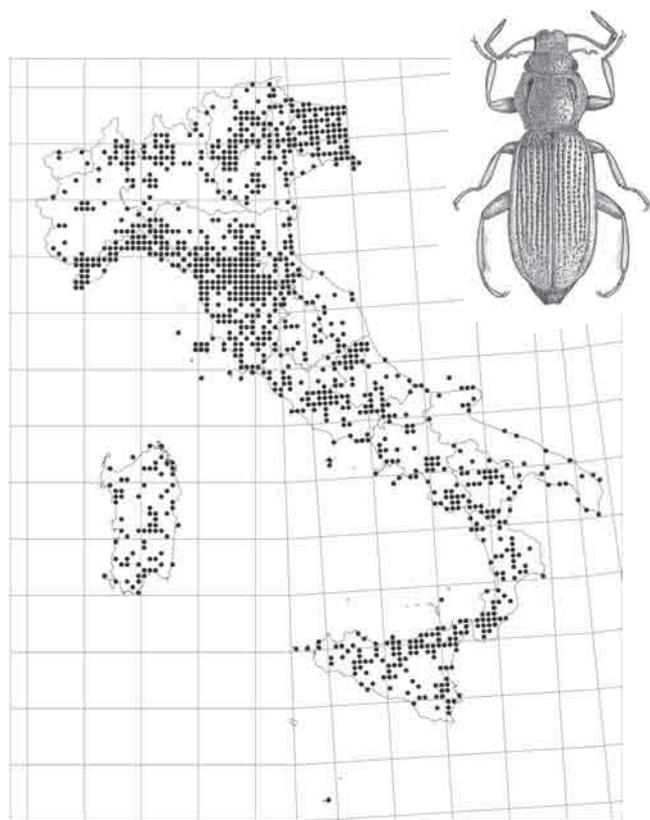
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Insecta Coleoptera Hydraenidae

Paolo Audisio, Alessio De Biase



The family Hydraenidae belongs to the coleopteran sub-order Polyphaga, group Staphylinoidea, where this family has a relatively isolated position (Jäch e Diaz Pazos, in press). The present intra-family systematic recognizes at least 4 subfamilies (Hydraeninae, Ochthebiinae, Orchymontinae and Prosthetopinae) in the world fauna. The subfamilies Hydraeninae (Limnebiinae included) and Ochthebiinae are the only one present in the Italian fauna. The present taxonomic and faunal knowledge of the Italian Hydraenidae are still quite heterogeneous as it regards to the family systematic and geography. The electronic database indicates how some areas have not been sufficiently sampled. The picture is quite clear for some genera such as *Haenydra* and *Hydraena* in the Northern and Central regions (Audisio et al., 1995a), whereas it is fragmented and incomplete for other genera, such as *Ochthebius* and *Limnebius*, mainly in Central and Southern Italy. The taxonomy of *Ochthebius* and *Limnebius* is still in state of flux and subject to continuous revisions, particularly for some species-groups of the genus *Ochthebius* (Jäch e Diaz Pazos, in press). For several species, the distribution in Italy is more reduced than the distribution known in literature (Pirisinu, 1981). This is due to the fractioning of the species in several distinct taxa

(both sympatric and vicariant), to the past misidentification with similar species, or to the impossibility of confirming some old data which refer to species-complexes or species-groups recently reviewed.

Material and methods

Notwithstanding the limitations described above, we filed most of the collections of the main Natural History, and Zoology museums in Italy and Europe, and personal collections of scientist studying this family. We also included all data from literature which we personally checked and which we considered correct on the basis of the most recent taxonomic revisions available.

Biodiversity

Italy has the richest fauna of Hydraenidae of all the Euro-Mediterranean countries, with 151 known species. Only Turkey has a higher number, estimated in more than 200 species. For the whole Europe, Anatolia and Caucasus excluded, there are 395 species reported, 38% of which in Italy.

If *Hydraena* s.l. is used as a species-model, four hot-spots can be identified for Italy (Audisio and Vigna Taglianti, 2005): Eastern Friuli, Ligurian and Maritime Alps, Tuscan-Emilian Apennines, and Central Apennines.

Ecology

All Italian Hydraenidae are aquatic at larval and adult stages although the larvae of several species (for instance, of several *Hydraena*) colonize the littoral of rivers and ponds, whereas the adults live in the deeper parts of rivers and ponds. The adults of *Hydraena* and *Haenydra* are mainly rheophylous and colonize the lower side of submerged stones, or the aquatic mosses. These genera are present in streams and rivers from sea level to about 2000 m a.s.l., although several species live in ponds and marshes. Numerous species of *Ochthebius* are typical of running water as well, but they colonize mainly submerged substrates in riparian marginal habitats, and in ponds, marshes, and other lentic freshwater (rarely brackish) habitats. Several species of *Ochthebius* and *Limnebius* are typical of hygropetric habitats. Some species of *Ochthebius* (subgenera *Calobius* and *Cobalius*) live in hyperhaline pools of rocky shores, where larvae and adults can survive extreme high salinity and temperature. Most of the species are microphagous, feeding on unicellular algae (diatoms). Only a few tropical and subtropical genera include species living in soil, not



in water. Almost all the Hydraenidae can be considered good (and in some cases, excellent) bioindicators of the waterbodies they colonize. Only a few species of *Hydraena* s.str., *Limnebius* and *Ochthebius* are more tolerant, and can tolerate high organic loads.

Zoogeography

Italian Hydraenidae show high endemism. About 23% of the species (35 over 151 total) are endemic for Italy, without counting the species endemic for the Sardinian-Corsica, and Tuscany-Corsica regions, or those which just pass the Italian border in France, Switzerland, and the Northern Balkans (about another 20% of the 151 total). Hydraenidae is therefore one of the Coleoptera families with the highest endemism rate in Italy. Those species with wider distribution have chorotypes typical of the West-Palearctic fauna; the Italian Hydraenidae have mostly south-European, West-Mediterranean, Central-European, and East-Mediterranean chorotypes. In Italy, the areas with higher diversity are those corresponding to zoogeographic boundary (Eastern Friuli, Western Alps), and those with cold and permanent waterbodies (Northern and Central Apennines) which host rich taxocoenoses of Hydraenidae. Here, local populations were able to survive for long periods of time, originating new species.

Alien species

To our knowledge, exotic species were never introduced into Italy.

Conservation

The conservation of the different species varies according to the habitats to which each species belongs. The

most interesting species, which are at the same time the most endangered ones, are the rare endemics and sub-endemics linked to relict microhabitats such as small springs and temporal creeks. Canalisation, reclamation, and pollution endanger these microhabitats. Species which belong to these group are *Hydraena aethaliensis* (Elba Island), *H. subacuminata* (Capraia Island and Corsica), *H. fiorii*, *Haenydra sanfilippo* and *H. bononiensis* (Northern Apennine), *Haenydra czernohorskyi* (Trieste area and Istria), *H. tarvisina*, *H. carniolica* (hills of Southern Veneto), *H. decolor* and *H. bensae* (Western Liguria and Var Region in France). Similar threats endanger some endemic or sub-endemic species of *Ochthebius* linked to hygropetric habitats, such as *O. gestroi* (Ligurian coast and some islands of the Tuscany Archipelago) and other species of *Ochthebius* endemic or sub-endemic of Sicily or Sicily-Maghreb, which live in peculiar hyperhaline riverine and sub-coastal habitats of southern Sicily. Even some particularly interesting species with a wide European distribution, living in ponds and planitial and mountain bogs, are strongly endangered because of the disappearance of their habitats. *Hydraena britteni* (submountain bogs in Trentino), *H. palustris* (Northern Italy wetlands), and mainly *H. rugosa* (originally collected in ponds in Piedmont, but never collected again in the last century and probably already extinct in Italy), belong to this group. A particular case (Ferro et al., 1996) is represented by the extremely rare halophilous Ochthebiinae *Micragasma paradoxum*, which was known only from Corfu Island (Greece), and was collected about one century after it was described in a small coastal *Salicornia* prairie near Taranto. The protection of this area might be paramount to avoid the total extinction of this species.

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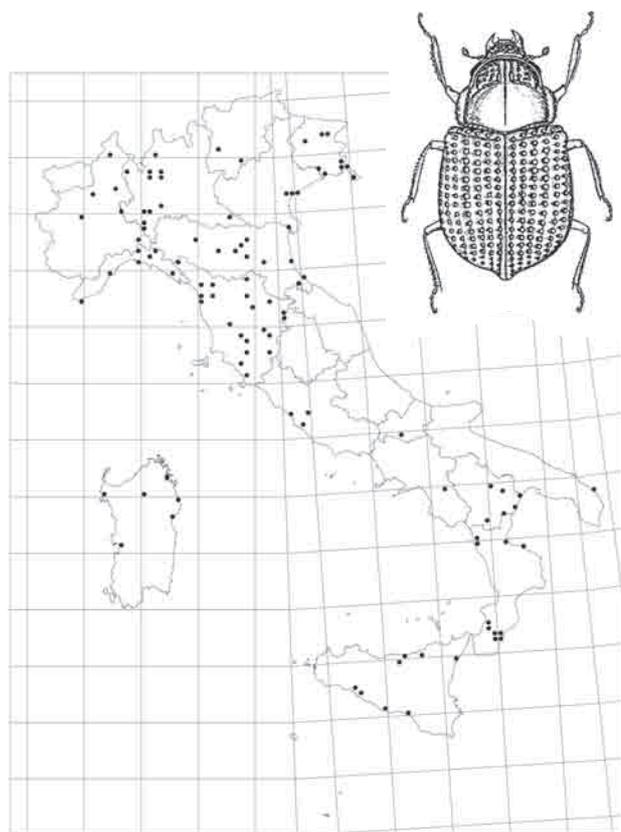
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Insecta Coleoptera Georissidae

Alessandro Mascagni



Georissidae include beetles which are morphologically very similar to one another. Of the approximately 80 species distributed in all continents, only 5 occur in Europe as well as in Italy. While taxonomical knowledge is quite good for these 5 species, their distribution throughout the country is still badly known; the members of this family are in fact always very little represented in both public and private collections.

Material and methods

The filing of species distribution data is based on the following sources:

- the literature: all works concerning the Georissidae of Italy were consulted, although such works are unfortunately rather few;
- specimens from the author's collection and 6 other private collections;
- specimens preserved in the collections of 8 Italian museums.

Altogether, about 250 records were included (many of

which unpublished) for a total of over 2,000 specimens examined by the author. Data on specimens studied by the author, having subsequently been published, were reported separately (reference and museum location). Porta (1929) and Audisio et al. (1995) were referred to for systematics and nomenclature.

Biodiversity

The Italian Georissidae fauna is among the richest in Europe, since it includes all 5 European species. The best-known Italian regions are Tuscany (44 records), Friuli Venezia Giulia (21 records), Piedmont and Lombardy (15 records each) and Emilia-Romagna (12 records) (Mascagni, 1993, 1995), but even in these regions large gaps exist regarding the distribution of species throughout the territory; therefore, one can imagine how scarce information is for the remaining regions.

Ecology

Georissidae are very small beetles (between 1.0 mm and 2.1 mm) living in damp soil on the banks of rivers and other water bodies; since they are associated with well-defined habitats, they are also good bioindicators. Little is known of the larvae, and the biology of these insects is partly unknown. Bameul (1989) discovered a curious mimetic behaviour of these beetles, which collect grains of sand and cement them to their pronotum and elytra using an oral secretion as glue; their black body colour is masked in this way, and they are practically invisible to predators.

Zoogeography

The 5 Italian species of Georissidae belong to taxa widespread in the Holarctic region (80%) and Europe (20%). To be precise, 3 species are Turano-European (*Georissus caelatus*, *G. costatus*, *G. laesicollis*), one is Sibiro-European (*G. crenulatus*) and one European (*G. substriatus*).

Alien species

No introduced species are known.

Conservation

Since they are associated with humid places near water bodies both as larvae and adults, Georissidae are very sensitive to all kinds of alteration of aquatic habitats. *Georissus caelatus* and *G. substriatus* are the rarest of the 5 species, and are therefore at greater risk of extinction.



Alessandro Mascagni

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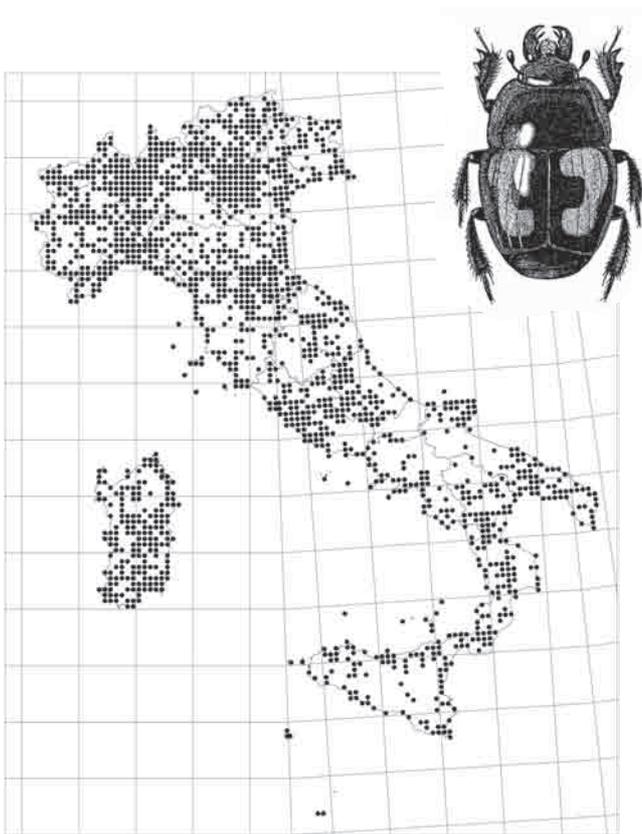
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Insecta Coleoptera Histeridae

Fabio Penati, Pierpaolo Vienna



Histeridae are beetles of medium to small or very small size, which are nearly exclusively zoophagous and are of worldwide distribution; currently, just less than 4,000 species representing 350 genera are known, most of which occur in the tropics.

Until today, the presence of 157 species (160 including subspecies) belonging to 44 genera (57 counting subgenera) has been ascertained in Italy. This makes the Italian fauna the second richest in Europe after that of Spain, with its 165 species of Histeridae.

Of the 157 censused species, as many as 9 (5.73%) are known only from old, sometimes generic data from the literature, and their actual presence in Italy needs confirming: *Abraeus* (*Postabreaus*) *parvulus*, *Chalcionellus* *prolixus*, *Pholioxenus* *schatzmayri*, *Hypocacculus* (*Hypocacculus*) *elongatulus*, *Margarinotus* (*Stenister*) *graecus*, *Margarinotus* (*Paralister*) *uncostratus*, *Margarinotus* (*Promethister*) *marginatus*, *Hister* *grandicollis* and *Atholus* *paganettii*.

Moreover, some "groups" of species (*Acritus* spp., *Gnathoncus* spp., *Saprinus calatravensis* - *chalcites* - *georgicus*, *Saprinus aegialius* - *aeneus* - *immundus*, etc.) are

of difficult identification due to poor morpho-anatomical differentiation and have often been confused with one another in the past. Their distributions will be easier to define only after careful and thorough examination of the specimens preserved in collections and vast collecting campaigns.

Material and methods

The filing of species distribution data is based on the critical examination of 109 works representing all the faunistic literature on Italian Histeridae known to the authors (some nineteenth century "catalogues" were purposely left out in that they were not very reliable or contained non-checkable data), as well as on the personally carried out study of specimens kept in 74 collections, both public and private. In the case of historical collections, current depositories were reported in brackets. All this work brought to the filing of approximately 13,000 records, covering a period of over 140 years, which form an extremely detailed picture of the currently known distribution of Italian Histeridae.

Biodiversity

According to the filed data a greater species richness can be found in regions with a high degree of environmental diversity (sea, hills, mountains), such as Tuscany and Sicily and, more in general, peninsular Italy; this agrees with the mainly thermophilous nature of the Histeridae as a whole. Moreover, the faunas of Aosta Valley and numerous central-southern regions (Marches, Umbria, Abruzzo, Campania and Molise) are clearly underinvestigated. However, the knowledge of the biodiversity of the Italian Histeridae fauna as a whole is more than satisfactory.

Ecology

Histeridae are mainly predacious on insect eggs and larvae, above all those of Diptera. Some extremely small species seem to feed on fungal spores. They can be found wherever there is decaying organic matter (carrion, excrements, manure, vegetal detritus, fungi, nests and borrows, caves, etc.), under the bark of dead or dying trees and in ants' nests. On the whole, Histeridae are generalist predators and few species are associated with peculiar habitats. Nonetheless, it is possible to divide them into a few morpho-ecological groups (Yélamos, 2002):

a) Dendrophiles: these include species which, living in tree trunks (inside the tunnels of xylophagous insects or under the bark), are characterized by a cylindrical (*Cyl-*



ister, *Teretrius*, *Plegaderus*, *Eubrachium*) or more or less flattened shape (*Hololepta*, *Paromalus*, *Platylomalus*, *Platysoma*, *Platylister*, *Eblisia*).

b) Geophiles: this group comprises the majority of species, of generally oval or elliptic shape, with strong, swollen fore tibiae armed with robust teeth that are used for digging and moving within the substrate. Geophilous Histeridae can be again divided into:

- saprophiles: these include all the coprophilous, necrophilous, phytosaprophilous or free-hunting species, which are mainly of medium size (*Hister*, *Margarinorus*, *Pactolinus*, *Pachylister*, *Atholus*, etc.);

- psammophiles: they comprise some *Saprinus* species and many other small to very small Saprinae (*Hypocacculus*, *Hypocaccus*, *Exaesiopus*, *Xenonychus*, *Halacritus*), which normally occur at the base of plants typical of sandy soils and under stranded detritus on beaches;

- pholeophiles: they comprise species more or less strictly associated with birds' nests and borrows of reptiles and mammals (*Gnathoncus*, *Onthophilus*, *Carcinops*).

c) Myrmecophiles: they include species either strictly inhabiting ants' nests (*Haeterius*, *Sternocoelis*, *Satrapes*, *Myrmetes*) or occurring near ants' nests or together with ants on tree trunks (*Dendrophilus*, *Kissister*, *Epiurus*, etc.).

d) Troglobionts: in Italy they are represented by the blind endemic genera *Spelaeabraeus* (with 4 species in the north-eastern Prealps) and *Sardulus* (with the sole *S. spelaeus* in Sardinia).

Zoogeography

The results of a chorological analysis carried out on the 160 taxa (species + subspecies) of the Italian Histeridae fauna show a dominance of taxa widespread in the Holarctic region (67 = 41.88% of the total), followed by those widespread in the Mediterranean basin (34 taxa = 21.25%) and those widespread in Europe (30 taxa = 18.75%). There are 8 cosmopolitan or subcosmopolitan taxa (= 5%), and 7 Afrotropical and Oriental ones (= 4.38%). Italian endemics are 9 (= 5.63%), i.e. *Spelaeabraeus agazzii agazzii*, *a. cavallensis*, *a. ciaurlecensis*, *S. georgii*, *S. infidus*, *S. tormenei*, *Sardulus spelaeus*, *Bacanius (Neobacanius) solaris* and *Sternocoelis puberulus* [a Sicilian endemic erroneously cited also from Sardinia and Corsica by Vienna (1980)]. *Atholus debeauxi* (Sardo-Corsican endemic) and *Hister pustulosus* (Sicilian-Sardo-Corsican endemic) also show very limited distributional areas, which are not restricted to Italy however. On the other hand, the true distribution of *Gnathoncus cerberus* still needs defining; this species was described in 1923

of Sardinia and had always been considered a Sardinian endemic until it was recently recorded for Bulgaria (Thomas and Secq, 2000).

Times and modes of diffusion in Italy of the presently occurring Histeridae are not known, since no palaeogeographic studies have so far been carried out concerning these beetles, neither in Italy nor elsewhere.

Alien species

Just one alien species has recently appeared in Italy: *Saprinus lugens*, a species widespread in the Nearctic region having only recently been introduced to Europe, where it has become established also in France and Spain (Yélamos, 2002). Until now, it has been found in Abruzzo and Apulia; in any case, there are no reasons why it should represent a threat to the autochthonous Histeridae fauna. Occasionally, exotic species having arrived together with various sorts of goods (timber, sand, etc.) can be found, but they are unable to adapt to local conditions. In the past, while examining material sent to them by various entomologists, the present authors have identified specimens of the Afrotropical species *Macrosternus lafertei* Marseul, *Pachycraerus cyanescens* (Erichson), *Platysoma (Platysoma) leconti* Marseul and *Hypocacculus (Nessus) cupreolus* Vienna, all found in the surroundings of ports (e.g. see Penati, 1999).

Conservation

Among the Italian Histeridae, the most endangered species are the psammophilous and dendrophilous ones. The first are threatened by the destruction of both marine and freshwater sandy habitats (coastal dunes, banks, etc.), due to anthropization of beaches and the spreading cementation of large watercourses. The second are threatened by quantitative and qualitative impoverishment of forests, caused not only by logging and fires but also by reforestation using exotic species and bad management practices (cutting, clearing, etc.) which, through the removal of old trunks and dead wood, impoverish the lignicolous invertebrate fauna. Lastly, the negative effect of the reduction of bovine grazing on the distribution of coprophilous species in plain and lowland areas should not be underrated. For example, the abandonment of grazing in the central-western Po Plain has caused the disappearance of *Pactolinus major* (last records date back to the beginning of the twentieth century) and, more recently, also of *Pachylister inaequalis* (last records date back to over thirty years ago).



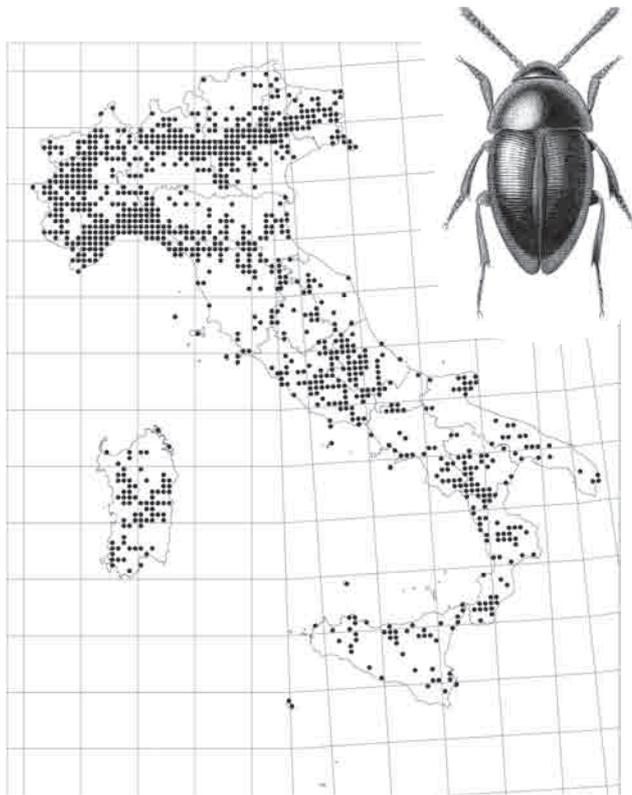
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Insecta Coleoptera Cholevidae and Platypsillidae

Stefano Zoia, Leonardo Latella



Cholevidae, a group now considered by many authors a subfamily of the Leiodidae, and Platypsillidae are Staphylinoidea beetles of small to medium size (between 0.8 and 6 mm in most cases). The Italian fauna of these two families can be considered as quite well known. However, while for the Platypsillidae (synonym: Leptinidae) a recent study of Besuchet (1980) on the Palearctic fauna of the genus *Leptinus*, only representative of the family in Italy, is available, some important gaps exist within the Cholevidae. The revision of some groups of species or genera would be needed: for instance, careful and complete studies on the Apennine *Bathysciola* species would be desirable in that they would allow, through the revision of the already described species, to systematically classify the various undescribed species already present in the examined entomological collections. The genus *Pholeuonidius* would also deserve an accurate study. Except for revisions of some groups – *Parabathyscia* (Zoia, 1986), the *Boldoria* phyletic series (Vailati, 1988), Anemadini (Giachino & Vailati, 1993) – there have been no comprehensive works to update the studies of Jeannel (1924, 1936) with the numerous subsequent systematic

and faunistic contributions having brought the total of taxa occurring in Italy to about 320.

Material and methods

For the filing of species distribution data all the available literature was used, starting from the original descriptions of species, each time evaluating the reliability of data. However, it was not possible to use many data from past literature due to the confusion having characterized the taxonomy of various groups of Cholevidae (starting from the genera *Choleva* and *Catops*) at least until the beginning of the last century. Unpublished data from the authors' collections (in particular all the S. Zoia collection), Pier Mauro Giachino's collection and from identifications carried out during the course of many years on material from various public and private collections (particularly those of the Natural History Museums of Milan, Verona and Genoa, the Zoology Museum of Rome and the Angelini collection) were also included, causing an over 100% increase of data from the literature.

Biodiversity

Cholevidae occur in Italy with 5 subfamilies (Nemadinae, Ptomaphaginae, Anemadinae, Cholevinae and Leptodirinae) distributed all over the country. The Leptodirinae, distributed with very few exceptions in the West Palearctic region, are the largest group, thanks also to their endogeic habits, low capacity of dispersion and strong differentiation through isolation, with consequently high rates of endemism. Within this subfamily the Italian fauna is the most diversified and species rich after that of the Balkan peninsula, considered the centre of diffusion of the group. The Italian fauna numbers 47 genera at the present state of knowledge; among these, the most important ones in number of species are *Bathysciola* (with 43 taxa currently described for Italy), *Parabathyscia* (31), *Boldoria* (24, which occurs in Piedmont and Lombardy), *Pseudoboldoria* (16, in Lombardy and Venetia) and *Neobathyscia* (11 in the sole Venetia). A greater species richness, often with limited or punctual distributional areas, exists in the Prealpine area and in any case in Northern Italy, whereas less species occur along the peninsula, many of which epigeic or relatively widespread, belonging to the genera *Bathysciola* and *Parabathyscia*. Further studies will certainly bring to an increase of the already high number of known taxa within this subfamily, especially those focussing upon the still relatively poorly investigated fauna of the Apennines.



The other subfamilies of Cholevidae include species that are generally widespread – although there are also many endemic taxa – normally winged, often with a good capacity of dispersion. Their number is relatively low (76 taxa), but is probably close to the number of species truly occurring throughout the Country.

Platypsillidae are represented by just 2 species belonging to the genus *Leptinus* (*Leptinus seriatus* and *Leptinus testaceus*). This genus, of Holarctic distribution, occurs in the Palearctic region with 6 species.

Ecology

Leptodirinae, depigmented and normally wingless and anophthalmic, are associated with the soil and either occur in the more superficial, humic strata (where members of *Bathysciola*, *Parabathyscia*, *Pholeuonidius* and *Sphaerobathyscia* can be found) or in deeper strata or caves, where they show both morphological and biological adaptation to hypogean life conditions, sometimes brought to an extreme (e.g. *Patriziella*, *Cansiliella*, *Viallia alfanoi*, *Leptodirus*). Still little is known of the capacities of dispersion of these subsurface insects, even though studies carried out in this respect indicate they are capable of quite a lot of movement both vertically, in relation to local conditions (mainly humidity but sometimes also the level of the water table) and horizontally, through micro- and macro-cracks showing microclimatic characteristics suitable to the life of these organisms.

Many Leptodirinae communities generally depend on the presence of decaying organic matter, mostly of animal origin, which, due to the presence of particular moulds, represents their basic source of food; specimens have exceptionally been observed preying upon other invertebrates, while excessive quantities of food (e.g. accumulations of guano, large vertebrate carcasses) are generally repellent, as their fermentation and putrefaction are probably not tolerated by Cholevidae. However, the most limiting factor for Leptodirinae is their need for a high degree of environmental humidity; in this respect, the presence of these animals can represent an index of good overall conditions of the hypogean environment.

Many Ptomaphaginae and Cholevinae are normally attracted to corpses of small vertebrates and invertebrates, as well as to pieces of larger animals. They are often good flyers, with a particularly acute sense of smell, ubiquitous and resistant to various climatic conditions. Some species are regularly found in the nests and borrows of vertebrates, some associations appearing to be obligate (*Catops joffrei* in marmot borrows, *C. dorni* in those of *Talpa europaea* and *T. subterranea*). Little is known of the ecology and biology of many Cholevidae: many Ptomaphaginae, Anemadinae and Cholevinae can be collected by sieving detritus at the base of trees or rocks in woodland environments, others (*Nemadus*, various *Choleva*) sometimes occur at the entrances of

caves – most of all in Northern Italy – or in borrows and nests of vertebrates (*Choleva*, *Catops*). Their significance as environmental indicators is difficult to estimate and probably scarce given their capacity of dispersion and limited need for habitat quality.

Worth pointing out, among the Leptodirinae of the genus *Parabathyscia* and the Cholevinae *Attumbra*, *Philomessor* and *Catopomorphus*, is the presence of various myrmecophilous species the biology of which has never been studied in depth and which are associated, as far as is known, with the nests of *Messor* and *Aphaenogaster* ants.

The Platypsillidae of the genus *Leptinus* live in the nests of various species of small rodents and insectivores. The adults feed on various types of detritus of animal origin (hairs, skin, excrements), whereas the larvae are necrophagous and coprophagous. They can often be found in natural and artificial cavities, where they arrive after their hosts.

Zoogeography

Leptodirinae, almost totally represented by species with a very restricted or punctual distributional area, are a group of great biogeographical interest. Only *Parabathyscia wollastoni*, distributed in central-western Liguria and which also occurs in the north of France and south of England, and *Bathysciola pumilio*, which occurs in the south of the Aosta Valley, in Piedmont, Liguria and parts of Emilia and Tuscany, are relatively widespread. A hypothesis justifying the distribution of *Parabathyscia wollastoni* is that of passive transport together with traded pot plants and gardening compost.

With the exception of *Phaneropella lesinae* in the Gargano, a trans-Adriatic species belonging to a genus from the Southern Balkans, only *Bathysciola* and *Parabathyscia* occur in peninsular Italy. *Bathysciola* is rather widespread in the Mediterranean area and the Near East, although it is considered polyphyletic by many authors and the species groups it contains should be considered separately. It occurs in Sardinia with a few taxa considered related to co-generic species from the Apennines; transgressive periods and periods in which Sardinia was closest to mainland Italy are often referred to when explaining the presence of this genus on the island. In this zoogeographical context, the absence of *Bathysciola* from Corsica is just as significant.

Contrary to *Bathysciola*, the closely related genus *Parabathyscia* is distributed in southern Piedmont and Liguria, where it is most differentiated, peninsular Italy and Corsica, whereas it is missing in Sardinia.

The Sardinian fauna is of particular biogeographical significance. Besides the already-mentioned *Bathysciola* species, it includes members of the genus *Speonomus*, otherwise distributed in the Pyrenean region only and therefore a witness of the detachment of the Sardo-Corsican plate from some part of the Mediterranean coasts of Spain



and France, and the endemic genera *Ovobathysciola* and *Patriziella*. The latter are closely related to each other and have surely descended from a common ancestor, but their affinities are not too well defined: it is thought they may also belong to a group of Pyrenean origin, possibly related to taxa of the *Anillochlamys* phyletic series.

In Northern Italy the situation is relatively complex, with the occurrence of different assemblages east and west of the Adige river. Only *Bathysciola*, with few species and a strongly fragmented distributional area, occurs in various parts of the Prealpine area.

In the western regions various groups of "pentamerous Infraflagellata" stand out, belonging to the genera *Parabathyscia* (southern and western Piedmont, Liguria), *Bathysciola* (Aosta Valley, Piedmont, Liguria), and to the phyletic series of *Dellabeffaella* and *Boldoria* in the sense of Vailati (1988). These last two groups, which also include some highly specialized species of pholeuonoid appearance (*Canavesiella* spp., *Viallia alfanoi*), show distributional patterns that follow the line of maximum spreading of Pliocene glaciers; in Vailati (1988), a model is proposed which tries to dynamically establish the influence of the Pliocene climatic changes on the differentiation and distribution of these Leptodirinae. *Pholeuonidius pinkeri* is the only member of a more easterly-distributed group in this part of northern Italy.

East of the Adige a more complex and also richer situation can be found, due to the coexistence of diverse and more differentiated groups of species with mainly oriental affinities; the only known exception to this trend is *Monguzziella grottolei*, the only member of the *Boldoria* phyletic series to occur east of the Adige. Here, only two genera in common with the western part of Northern Italy can be found: *Bathysciola*, with a single species in Venetia, and *Pholeuonidius*, with a few species in Venetia and Trentino. The genera *Leptodirus* (related to the Slovenian *Astagobius* and *Ceuthmonocharis*) and *Sphaerobathyscia*, the affinities of which are not yet clear, occur near the border with Slovenia.

Many authors have underlined affinities between the genera *Aphaobius*, *Pretneria*, *Orostygia*, *Oryotus* and *Cansiliella*, which include hypogean species in Venetia, Trentino, Friuli and Slovenia, and the genera *Bathysciotes*, *Neobathyscia*, *Halbherria*, *Aphaotus* and *Lessiniella*, the distributional areas of which are partly overlapping with those of the first group.

Leptinus species (Platypsillidae) are of Holarctic distribution, but most of the known species (6) occur in the Palearctic region. In Italy, *L. testaceus* is widespread in the whole of the peninsula and Sicily; *L. seriatus* is distributed in Northern Italy only (Aosta Valley, Piedmont), and reaches Switzerland in the Mount Generoso area.

Alien species

No alien Cholevidae species appear to have been introduced to Italy; however, one must not forget the successful naturalization of *Bathysciola derosasi*, a species known only from a few caves of the Argentario area (Tuscany), in the Patrizi cave near Sasso (Rome), and the presence of *Parabathyscia dematteisi casalei* in the Bossea cave (Piedmont, val Pesio) following the escape of a few specimens from the laboratories situated in the same cave. In the first case, 50 years after the introduction quite a large and stable population exists, without further chances of spreading however, due to the characteristics of the place in question; on the other hand, the recent introduction of *Parabathyscia dematteisi casalei* in the cave of Bossea would need an accurate study to establish the capacity of dispersion of this species in a theoretically open environment, apparently free of other hypogean Leptodirinae.

Conservation

Given the high rate of endemism, especially within the Leptodirinae, and their biogeographical significance, Cholevidae represent a heritage of great interest within the Italian fauna. Very little can be said regarding the current status of the populations of the various species, besides a more or less regular occurrence and abundance of individuals in accessible habitats, caves in particular; their conservation can therefore only be obtained through correct management of the typical habitats of these animals, particularly forest and hypogean ones. Deforestation, groundwater pollution, quarrying, lowering of the water table, damaging of underground cavities and consequent drying out of habitats are all factors strongly jeopardizing the presence of forms inhabiting the soil and subsurface, eventually causing their disappearance. Therefore, yet again, the necessity of controlling human activities throughout the territory emerges, in order to preserve the forest heritage and the integrity of subterranean habitats.



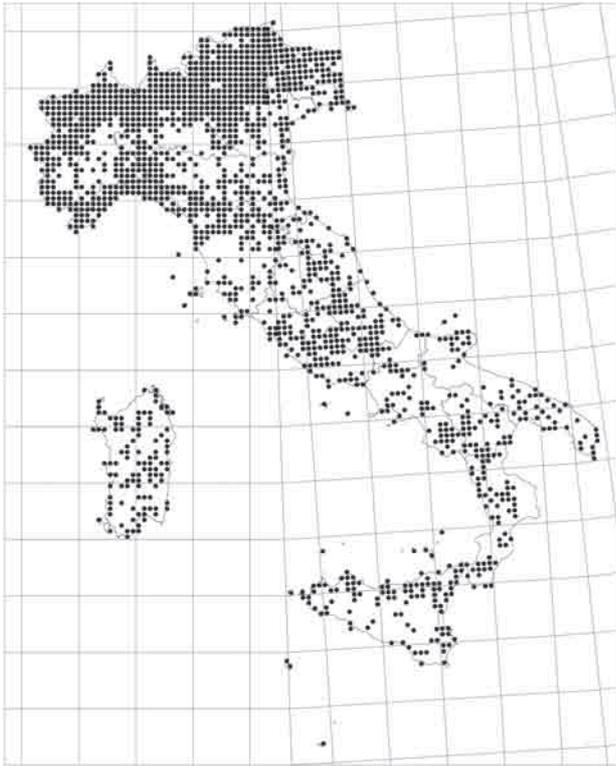
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Insecta Coleoptera Staphylinidae

Adriano Zanetti



Staphylinidae are one of the largest families of beetles, as well as of the whole animal kingdom. Data from the year 2000 refer to approximately 46,000 valid species names existing in the literature, over 2,500 of which have been recorded for the Italian fauna, if Pselaphinae are included. There has been disagreement among specialists concerning the limits of the family, but the current opinion is that the Staphylinidae of classic authors are a substantially monophyletic group also including the Pselaphinae, Dasycerinae and Micropeplinae, so far treated as subfamilies or as separate families (e.g. in the Italian Checklist). Many specialists do not agree with the inclusion of the Pselaphinae,

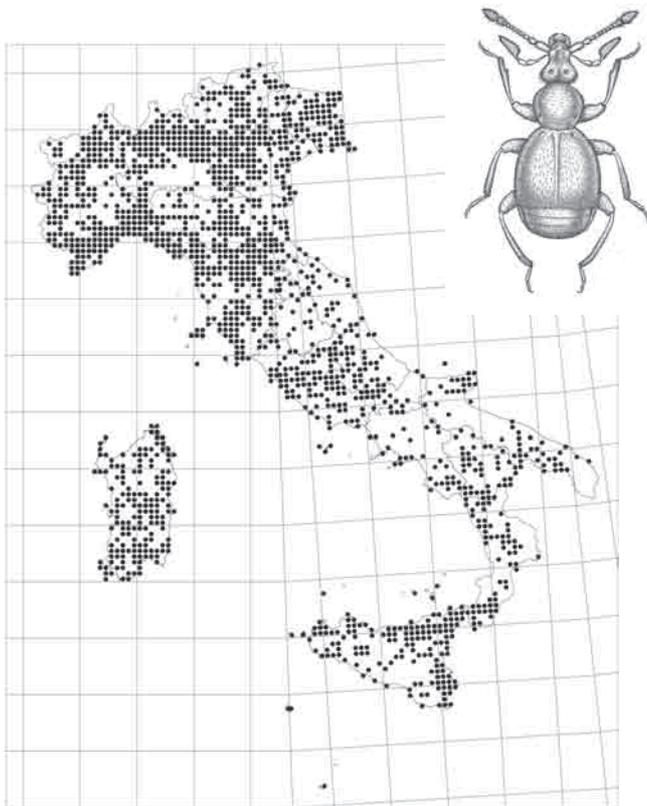
particularly important to the size of the group.

The treatment and maps provided in this work concern about 800 species occurring in Italy. These belong to two entire subfamilies, the Pselaphinae and Omaliinae, of wide ecological range and sufficiently well known in Italy from a taxonomical and faunistic point of view, the Staphylinina, a subtribe of Staphylininae including all the largest Staphylinidae occurring in Italy, many of which are interesting bioindicators, and the large genus *Lep-tusa* of the subfamily Aleocharinae, of extreme biogeographical interest, being nearly exclusively formed by endemic and subendemic species.



Insecta Coleoptera Staphylinidae Pselaphinae

Roberto Poggi, Giorgio Sabella



Since 1995, Pselaphidae are no longer considered a separate family (Pselaphidae) within the Staphylinoidea, but a subfamily (Pselaphinae) of the Staphylinidae.

The group includes about 8,900 species and 1,200 genera worldwide, particularly concentrated in the tropical regions and becoming less and less towards the higher latitudes. The larval forms of only about twenty species are known.

Material and methods

In order to prepare the present work all the old citations from literature concerning the Italian fauna were carefully screened, except those that could not be referred with certainty to a given species. The more recently collected material was also considered, whereas collections from the main Italian museums were only partly examined, mainly due to lack of time.

The knowledge of the Italian pselaphidofauna can be considered relatively good, even though there are still new species to be described and revisions to be completed. In the last thirty years reliable regional lists have been defined some geographical areas (Venetian Lagoon,

Lombard Prealps, Liguria, Tuscany, Sicily), although the problem of the extremely poor state of knowledge for some regions of central and southern Italy (e.g. Marche, Umbria, Campania and Molise) and also the Aosta Valley remains. These problems can only be partly solved by purposely carried out specialized sampling campaigns.

Biodiversity

As for the European fauna, general knowledge is now quite high with about one thousand cited species. There are 351 species currently recorded in Italy (without considering subspecies), which means it is the European country richest in Pselaphinae.

Ecology

Pselaphidae occur in Italy from sea level up to over 2,500 m; essentially predators, particularly of Collembola and Acari, they can be found in an array of situations such as littoral cane thickets, beech forests, alongside rivers, in caves, under bark, in ants' nests, in tree holes, in flight, in the superficial litter layer and the deepest cracks in the soil, on the edges of brackish ponds and under stones in Alpine pastures.

Zoogeography

Besides species widespread in Europe, there is a fair assemblage of species with a general Mediterranean distribution; however, the most interesting datum of all is the high number of endemics, which makes up for over half of the species recorded for Italy (183 out of 351, i.e. 52%). Among the endemic forms those of Apennine (64, i.e. 35%) and Alpine (53, i.e. 29%) distribution are dominant, followed by the outstanding Sardinian assemblage (35, i.e. 19%) and the Sicilian assemblage (21, i.e. 12%), and the smaller Tyrrhenian (7, i.e. 3.5%) and Alpine-Apennine (3, i.e. 1.5%) ones. If endemic subspecies were also considered, the above data would increase further.

Alien species

No introduced species are recorded.

Conservation

It cannot be said that there are any endangered species, but many are certainly vulnerable due to human activities. The cavernicolous species can be affected by tourist use of caves or their use as dumps, while the paludicolous ones or those anyway associated with swampy habitats are sensitive to the pollution of watercourses,



spring captation and the progressive elimination of ponds and marshes considered as “unhealthy”. The fires periodically affecting vast areas of Italy are not without consequences for the more superficial humicolous fauna, and forest exploitation does not aid the development of old dying trees under the bark of which many species

find their ideal habitat. Lastly, the intense agricultural use of the land, mainly monoculture, and human settlements of various types (houses, industries, tourist and sports resorts) have destroyed hundreds of microhabitats characterized by peculiar communities, leaving only the most common, generalist and euryoecious species.

Relevant Literature

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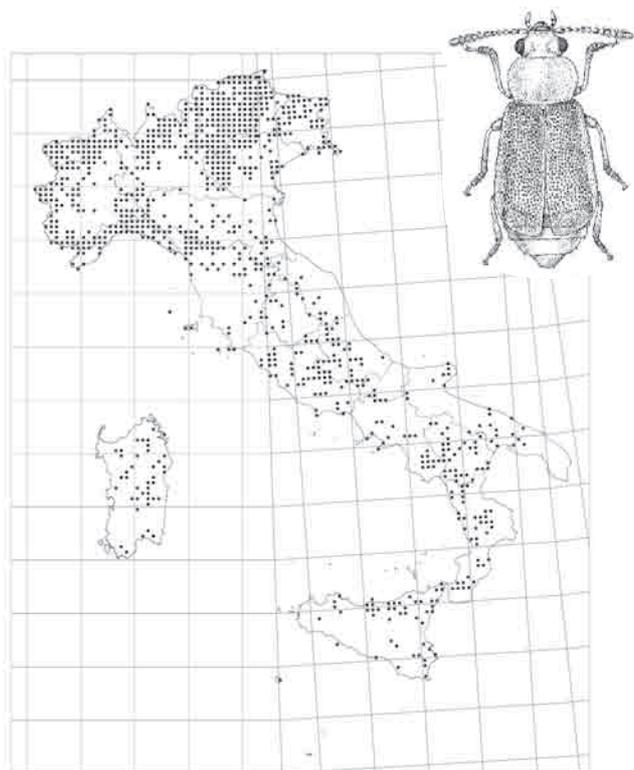
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Insecta Coleoptera Staphylinidae

Omalinae

Adriano Zanetti



The subfamily Omalinae is a monophyletic group of small-sized beetles with a generally flattened body, longer elytra than in the average Staphylinidae and nearly always with a pair of ocelli on the vertex of the head. The eighth urite of the abdomen is connected with a sternal glandular complex. They are considered among the most primitive of all Staphylinidae, mainly for possessing a pair of ocelli.

Material and methods

The largest part of data was taken from volume 25 of the Fauna d'Italia series (Zanetti, 1987), which treats the subfamily in the form of a monograph. Most localities were also drawn from those filed during the preparation of the volume and only partly reported therein, which were mainly obtained from the collections of the Natural History Museums of Genoa, Milan, Verona and Rome, as well as from the author's collection. Subsequently gained data mostly refer to private collections, i.e. the Angelini (Francavilla Fontana, Brindisi), Assing (Hanover) and Zanetti (Verona) collections and the Kahlen collection, now preserved at the Museum of Innsbruck.

All data from the literature which were reliable both for origin and date of publication were included. As for new records for Italy the first reliable datum (provided by a Staphylinidae beetle expert), which was checked or checkable, was given as date of recording.

Biodiversity

The subfamily Omalinae currently contains about 1,500 species worldwide, 190 of which occur in Italy. The level of knowledge for this country can be considered as relatively good, even though there are certainly still some undescribed taxa and variations that are difficult to understand, probably intraspecific, have been observed. At a faunistic level, northern Italy can be considered as quite well known. In Apennine Italy the state of knowledge is rather patchier throughout, mainly in Tuscany, the Marches, Umbria, Molise and Campania.

Ecology

The Omalinae show wide ecological range, though they prefer primary habitats, particularly woodland, shrubland and alpine grassland, and are thus good environmental indicators. The preferred microhabitats of adults are vegetal detritus, flowers (*Eusphalerum*) and leaves (*Anthophagus*), though halophilous, ripicolous (*Lesteva* and *Geodromicus*) and corticolous species also occur, besides species inhabiting tree holes, mycetophilous, coprophilous, nidicolous (in mammal and bird nests), troglophilous and anthropophilous species.

Zoogeography

The Omalinae are a group mainly associated with the temperate and cold-temperate regions of the planet, particularly of the northern hemisphere. They often occupy rather wide distributional areas, but within some large genera such as *Eusphalerum* and *Anthophagus* there is quite a high rate of endemism. This is demonstrated by the fact that as many as 45% of the Omalinae occurring in Italy are endemic to the Alpine-Apennine area, 15% being exclusive to the Alps and 14% to the Apennines. The European assemblage is also important and includes 35% of taxa. The component of species with a wide Palearctic-Holarctic distribution is smaller (16%).

Alien species

A single species is introduced and naturalized: *Paraphloeostiba gayndahensis*, native to Australia, the first mentions of which date back to the end of the 1980s and which is



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now distributed all over Italy as a phyto-saprophile.

Conservation

None of the Italian Omaliinae species appear to be de-

clining in number, except maybe for *Omaliium riparium impar*, related to sandy coasts. The conservation of Omaliinae essentially depends on the management of forest and spring habitats.

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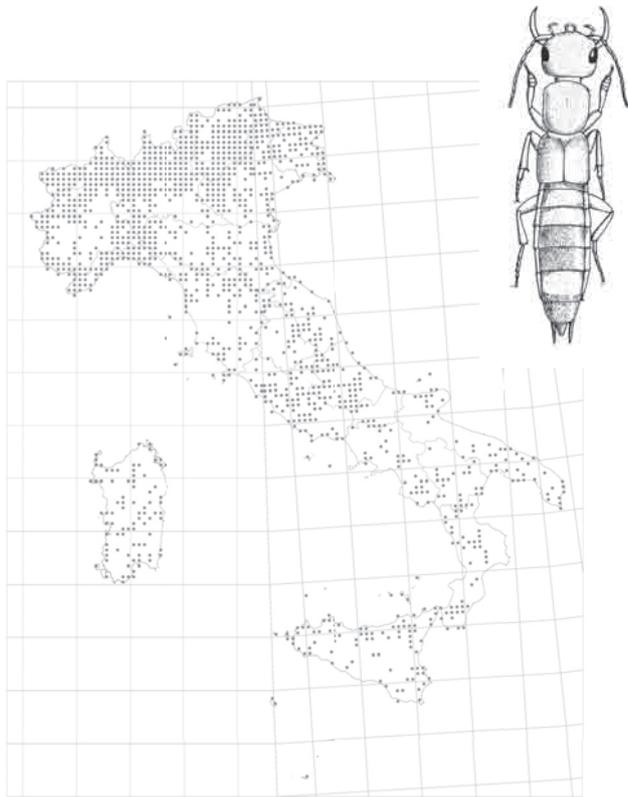
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Insecta Coleoptera Staphylinidae

Staphylininae

Nicola Pilon



Staphylinina are a subtribe that is widespread and common in all areas of Italy; they can be considered a well-known group from both a taxonomical and chorological point of view. The only unsolved systematic problems are those concerning *Ocypus picipennis* and subspecies. Within some *Ocypus* species the identification of just the females can be very difficult.

Material and methods

The collection of data on species distribution was carried out through the study of material preserved in the main museum and private Italian collections; a few recent specialist works (after the 1960s) and particularly that of Pilon (1998), also based on the examination of many museum collections, were also considered.

Biodiversity

The group includes 9 genera and 47 species in Italy. The highest species richness is found in the northern regions, where many endemics of the Alpine and Apennine areas as well as elements of mainly northern distribution occur besides the widespread species; the fauna of the

southern regions is poorer, particularly that of Sardinia, where species missing from all other parts of the country occur however. Even though research effort has not been the same throughout the country, the overall picture obtained is likely to be quite complete and realistic.

Ecology

Staphylinina live on the ground and occur in nearly all terrestrial habitats. They are particularly abundant in forest habitats, but there are also pratinicolous species associated with steppic habitats, sea coasts and alpine grassland. A certain number of species (10 in all, including the whole genus *Ontholestes*) are strictly related to temporary microhabitats (dung, vertebrate carcasses, decaying matter).

They are zoophagous both as adults and larvae, mainly showing non-specialized predation; an exception to this are the coprophilous and necrophilous species, which appear to be somewhat specialized: *Ontholestes* and *Creophilus* species are specialized towards adults and larvae of Diptera, *Dinothenarus* species towards Scarabaeidae beetles of the genus *Onthophagus*; *Dinothenarus fossor* seems to be a specific predator of ants of the genus *Camponotus*.

Most species are unable to fly due to total or partial reduction of the metathoracic wings. In any case few species regularly use flight as a means of locomotion, except for the coprophilous and necrophilous species, which are excellent flyers and actively search for their preferred microhabitats. Their strong stenotopy, limited capacity of dispersion and the reduced distributional areas of many species (particularly of the genera *Ocypus* and *Tasgius*), together with the fact they are relatively easy to catch and altogether quite well known, renders members of the Staphylinina interesting as bioindicators.

Zoogeography

The most conspicuous assemblage of Italian Staphylinina is that comprising species with a mainly European s.l. distribution (25 species out of 47, i.e. 53%). Less numerous are the species widely distributed in the Palearctic (10, i.e. 21%). At species level, strictly following the political boundaries, only one (*Tasgius trictinus*) can be considered as endemic; however, considering the species with a limited distributional area also reaching neighbouring countries, this number increases to 7 (15%), thanks mainly to endemics of the Alpine region.

The trans-Adriatic–trans-Ionian component is reduced



compared to other groups, with the sole *Ocypus mus*. The Alpine areas as well as some parts of the Po Plain represent the southern limit of distribution of various northern-distributed species: *Ontholestes tessellatus*, *Staphylinus erythropterus*, *Tasgius melanarius*, *Ocypus aeneocephalus*.

Alien species

No introduced species are recorded.

Conservation

The Staphylinina as a whole are of great biogeographical and ecological interest. Particularly some large endemic, sylvicolous and brachypterous species (*Ocypus*

solarii, *O. pedemontanus*, *O. rhaeticus*, *Tasgius tricinctus*) should be considered vulnerable; however, forests do not appear to be decreasing in size within their distributional areas. *Staphylinus erythropterus* is associated with untouched riparian woodland formations in the Po Plain, especially in marshy areas; these habitats have certainly become more and more reduced during the last decades and are still threatened of further reduction and fragmentation. Two species, *Ocypus brunnipes* and *Dinothenarus fossor*, common and widespread in the northern regions north of the Po, also occur in few montane populations in very isolated small areas of the central and southern Apennines, which would therefore deserve much attention.

Relevant Literature

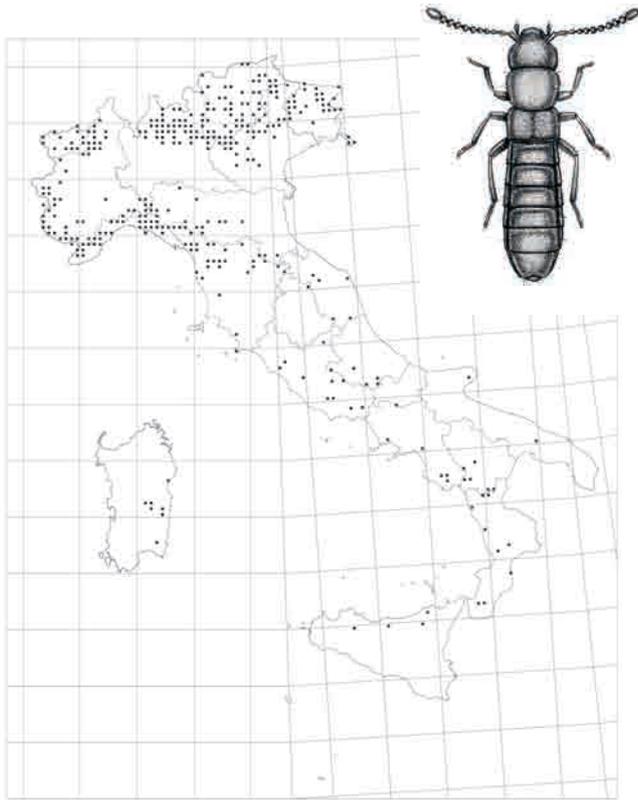
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Insecta Coleoptera Staphylinidae

Aleocharinae (genus *Leptusa* Kraatz, 1859)

Roberto Pace, Adriano Zanetti



The genus *Leptusa* Kraatz, 1859 comprises over 300 species of small-sized Staphylinidae of the subfamily Aleocharinae, tribe Bolitocharini, with a 4-4-5 tarsal formula and entire ligula, distributed in the cold-temperate regions of both hemispheres, particularly on mountains. Most species are characterized by being wingless, microphthalmic and with a tendency towards endemism. The taxonomy of the group is mainly based on external morphology and on that of the male copulatory organ (Pace, 1989).

Material and methods

The main source of data was the monograph of the genus (Pace, 1989), which includes the material preserved in all the main museums of the world, primarily the Museum of Vienna, supplemented by data from the private collections of Assing, Angelini, Pace, Rosa and Zanetti, as well as of the Museum of Innsbruck (Kahlen collection). No data preceding the monograph were used, being largely unreliable.

Biodiversity

The genus *Leptusa* currently comprises just over 300

species worldwide, as many as 116 of which are known for Italy. It is therefore a very large genus, of great biogeographical and ecological significance, the knowledge of which for the Italian fauna is quite good concerning the Alps. For the Apennines, especially the central-southern ones, the scarcity of data is partly due to lack of research, but mostly to the scarceness of habitats suitable to these Staphylinidae and maybe also to historical reasons, i.e. the lower impact of glaciations in the area.

Ecology

A large majority of Italian *Leptusa* species are characteristic of the soil communities of the Alps. The environmental optimum of these species occurs in the subalpine and alpine horizons, in both the relatively evolved soils of *Rhododendron* and *Alnus viridis* shrub formations and the more primitive ones of pioneer vegetation turf. Lower horizons generally host species with a wider distributional area, whereas higher horizons, e.g. *Dryas* sods, host strongly endemic species, often with punctual distributional areas. The geological substrate seems to have no particular influence on the presence of *Leptusa* species, even though a strong increase in diversity can be observed on Prealpine limestone massifs, probably for both historical and microenvironmental reasons (presence of deep micro-cracking). *Leptusa* are certainly more sporadic in the hill and montane planes, which nevertheless host a reasonable number of species both on the Alps and Apennines. Only two species occur on plains, and are probably becoming strongly rarefied due to modern agricultural practices. A limited number of winged corticolous species can be found in a variety of habitats. *Leptusa* species can be considered as characteristic of the subalpine soil fauna.

Zoogeography

The majority of the nearly 120 *Leptusa* species occurring in Italy are endemic and only ten-odd species are of mainly European distribution. The Alps host as many as 100 endemics, 3 species have an Alpine-Apennine distribution, 10 are Apennine, 3 Sardinian and one trans-Ionian. Some areas of the central-eastern Prealps represent hotspots for the genus, with about ten species living in sympatry.

Alien species

No introduced species are recorded.



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Conservation

Most *Leptusa* species occur in Alpine habitats with relatively low anthropogenic impact and they are generally considered not endangered. Only the species associated

with very restricted distributional areas (summits) could be destroyed or jeopardized by actions with a strong environmental impact such as the installation of telecommunications antennae.

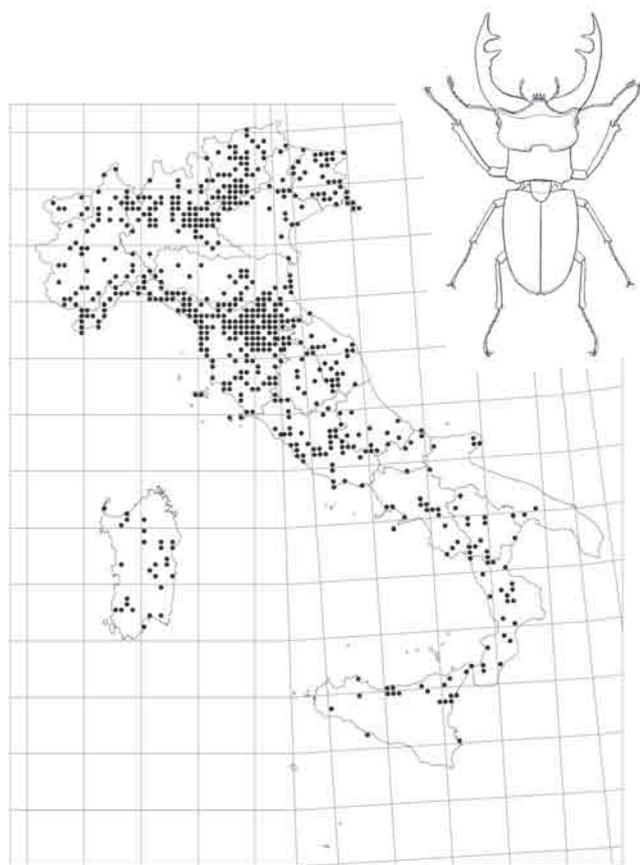
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Insecta Coleoptera Lucanidae

Luca Bartolozzi, Laura Maggini



The family Lucanidae includes about 1500 species, with worldwide distribution. The family is mostly tropical, but several species inhabit temperate regions, Italy included. The family belongs to the order Coleoptera, sub-order Scarabaeoidea. The last segments of the antennae are characteristically lamelliform, but in this family the segments can not fold each other. The family is sexually dimorphic: the mandibles are more developed in males than in females. The common name of this species, “stag beetle”, derives from the male’s large mandibles which resemble the antlers of a deer. In some species individuals may vary in size, the males ranging from very small to gigantic proportion. The largest males of *Lucanus cervus* can reach 8 cm in length, this is the largest European beetle. The knowledge of this family is good.

Material and methods

The distribution files are based on published records, and data from the main Italian museums, from the authors’ collections, from private collections and records made by naturalists, as well as from websites.

Biodiversity

The Italian fauna includes 6 genera of Lucanidae, with 9 species, one of which (*Aesalus scarabaeoides*) is present in Italy with two subspecies. The Italian fauna is similar to that of Europe. A great number of synonymies characterise the taxonomy of Lucanidae, due to the great individual variability in some species, and to the great sexual dimorphism.

Ecology

Lucanidae typically live in woods, since their larvae are xilophagous and develops in the dead wood of conifers and broad-leaved trees. The larvae of some species can live for several years, whereas the adults life is short, lasting only a few weeks in spring-summer. This family is distributed from low to high elevations; for instance *Sinodendron cylindricum* lives in mountain beech woods. Some species, such as *Lucanus cervus*, are usually active at sunset or at night, although at times they do fly during the day. They are prey to several birds (magpie and crow) and mammals (fox and marten).

Zoogeography

Some species are common and abundant, distributed over most of peninsular Italy; other species are very rare with a limited distribution. *Aesalus scarabaeoides scarabaeoide* lives in a few stations in the Alps and one on the Latium coast, whereas the subspecies *meridionalis* has only been collected in Basilicata. *Sinodendron cylindricum* and the two species of *Platycerus* live in peninsular Italy, although they are not very common. *Ceruchus chrysomelinus* as been reported from a few locations in the Alps and – according to a very old record - the Central Apennines. *Lucanus cervus* occurs over the entire Italian peninsula, whereas *L. tetraodon* is a southern species, collected from Tuscany southwards, Sicily included. *Dorcus parallelepipedus* is the most common species, widespread in Italy, whereas *D. musimon* is a North-African species, only present in Sardinia. The only endemic Lucanidae is therefore the subspecies *Aesalus scarabaeoides meridionalis*.

Alien species

There are no alien species in the Italian fauna.

Conservation

Lucanus cervus is included in Appendix II of the EU directive CEE/92/43, this species is protected in Italy by



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several regional laws. The species is endangered in all Europe by habitat loss, due to deforestation and fires. Other species of Lucanidae (such as *Sinodendron cy-*

lindricum, *Platycerus caprea*, *P. caraboides*, *Lucanus tetraodon*) are protected by regional laws, e.g. Tuscany Regional Law 56/2000 (app. A and B).

Relevant Literature

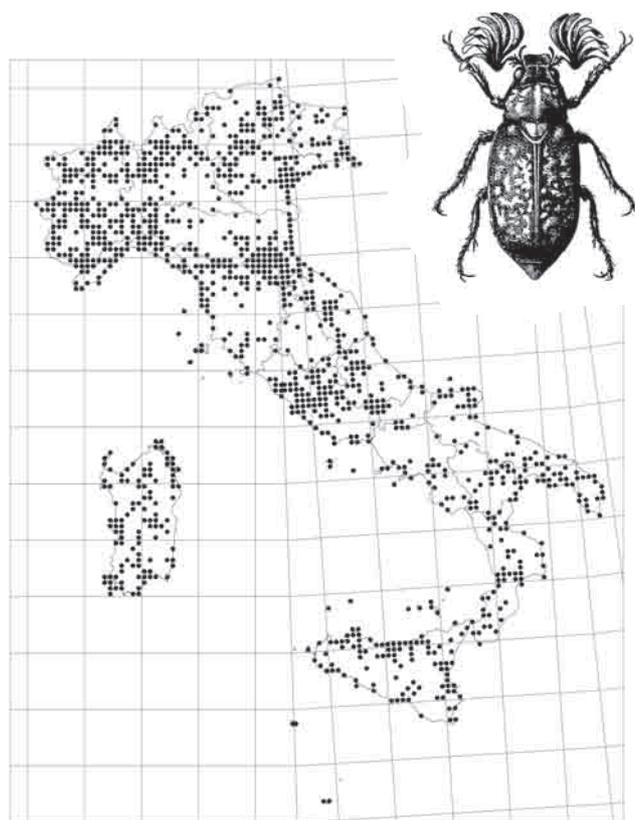
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Insecta Coleoptera Scarabaeoidea

Giuseppe M. Carpaneto, Emanuele Piattella, Laura Valerio



Scarabaeoidea are a large superfamily of beetles mainly characterized by the shape the antennae, the distal portion of which consists of lamellar segments. The geographic distribution of the superfamily as a whole includes all zoogeographic regions, all biomes (from the tundra to rain forests and deserts), and covers a wide altitudinal range from sea level to the alpic belt of the Himalayas. The overall number of described species worldwide can be estimated around 32,000.

Within food chains, Scarabaeoidea beetles occupy an array of ecological niches including primary consumers (phyllophages, anthophages, carpophages, rhizophages, xylophages, meliphages), secondary consumers (necrophages, myrmecophages) and decomposers in the wide sense of the term (saprophages and coprophages). Such ecological diversity has brought to considerable morphological differentiation and to a whole series of adaptive convergences, making the systematics of the superfamily rather complex and much discussed: the more traditional authors include all the groups within few families (e.g. the Lucanidae, Trogidae and Scarabaeidae s.l.); others tend to identify a more or less high number of families. In the present work, we follow the “splitter” idea, i.e. the one considering the highest number of families, al-

though this does not mean we are totally in favour of this view rather than the other. Our choice is motivated as follows: (1) it is the same systematic classification used in the most recent monographs on European Scarabaeoidea, e.g. that of Baraud (1992), which represents the basic reference for studying the Italian fauna; (2) it better reveals the diversity of these beetles, making reference to the various groups within a general context easier; (3) it was used in the Checklist of the species of the Italian fauna (Carpaneto and Piattella, 1995).

Compared to other beetle families, Scarabaeoidea can be considered quite a well-known group, both taxonomically and chorologically.

Material and methods

This work is based on the critical analysis of all literature, including both specialist works (systematic revisions and faunistic studies on Scarabaeoidea) and generic entomological works such as catalogues (Luigioni, 1929; Porta, 1932; etc.) and regional faunas. This brought together approximately 17,000 records. Because of such a large amount of data from the literature, it was impossible to also include the abundant unpublished Scarabaeoidea material which is present in museum and private collections. This would have meant the investment of a large amount of time, since the certain identification of many species requires the examination of genitalia. However, we did consider the records from our own collections, as well as those from the collections of the main Italian specialists having kindly answered our request for information. This allowed us to verify the occurrence in Italy of a few rare or localized species and confirm our opinion on the probable absence of some species having been wrongly recorded for the country. Some species mentioned in the past from some regions, which were listed with doubt in the Checklist (Carpaneto and Piattella, 1995), are presently eliminated from the Italian fauna.

Biodiversity

According to the present study (which does not include the Lucanidae but includes the Trogidae) the Italian Scarabaeoidea fauna is composed of 358 species belonging to 82 genera and 14 families. The families can be classified within the two traditional taxonomic categories Laparosticti (9 families, 40 genera, 223 species) and Pleurosticti (5 families, 42 genera, 135 species). It must be reminded that, within the Aphodiidae, the genus *Aphodius* is an artificial taxonomic category that should be divided into



many genera, and therefore needs an overall revision. Such revision is a particularly demanding one, and has been started by Dellacasa et al. (2001). Here we have chosen to maintain the traditional classification, so as to be in line with the Checklist and other European monographic works, until such time as a world revision is carried out in which all species are assigned to subgenera. It must be added that some taxa are of uncertain validity (e.g. *Trichiorhyssemus setulosus*, *Haplidia attenuata*, *Amphimallon montanum*), others will soon be definitively synonymized (e.g. *Ochodaeus cychramoides*) or split into several species (e.g. *Rhyssemus* species of the *arenarius/plicatus* group) and yet others are erroneously recorded for Italy or represent isolated cases of introduction (*Omorgus melancholicus*, *Chiron digitatus*, *Euonitellus intermedius*, *Peritryssus excisus*).

The number of species occurring in Italy corresponds to about 36% of the European fauna, which comprises approximately 1,000 species. In general, the number of species increases along a north-south gradient: the number of Italian species is indeed much higher than those of central Europe (176 in Germany) and Great Britain (100 species), while it is outnumbered by that of the Iberian peninsula (around 440 species). The numerical superiority of this last region compared to Italy is due to various factors, among which its greater surface area, the greater extension of pastures and lower territorial anthropization, as well as the fact Italy is strongly affected by the peninsular effect caused by its long and narrow shape. Comparison with the Balkan area is difficult, for in this region there are many faunistic gaps and taxonomic problems that still need solving. Within Italy a greater species richness and more endemics can be found in the central and southern regions; nevertheless, the Alpine and Prealpine communities also host a considerable number of species, thanks to the diversity of habitats occurring along an altitudinal gradient.

Ecology

Scarabaeoidea occupy all the habitat types present in Italy, from coastal dunes to the nival belt. Coastal dunes host psammo-halophilous species, more or less exclusive to this habitat: many are detritivorous, living in association with the roots of psammo-halophytes (e.g. *Psammodyus basalis*, *P. nocturnus*, *Brindalus porricollis*), others are coprophagous (*Scarabaeus semipunctatus* in particular) and yet others are phytophagous (*Anomala devota*, *Calicnemis latreillei*). Other *Psammodyus* species live in sandy substrates alongside rivers, together with other Aphodiidae (genera *Rhyssemus*, *Trichiorhyssemus*, *Diastrictus*, *Platytomus*, *Psammoporus*). The two species of the family Pachypodidae, both phytophagous, are related to back dune environments, between the dune and Mediterranean maquis. Forest habitats, especially deciduous broadleaved ones (oak, beech, chestnut, etc.), host vari-

ous species of Cetonidae (e.g. *Osmoderma*, *Gnorimus*, *Potosia*, *Eupotosia*, *Cetonischema*) and Lucanidae (*Ae-salus*, *Ceruchus*, *Sinodendron*, *Platycerus*, *Dorcus*, *Lucanus*), which are all phytophagous as adults and saproxylophagous as larvae. Moreover, forests host several mycophagous, coprophagous and/or saprophagous species of Geotrupidae (*Odonteus*, *Anoplotrupes*, *Trypocopris*) and coprophagous Aphodiidae species (e.g. *Aphodius borealis*, *A. uliginosus*, *A. zenkeri*, *Oxyomus silvestris*). The genus *Chaetonyx* also occurs in forest environments or pastures resulting from recent deforestation, either in the litter layer or under stones. However, most Scarabaeoidea occur in open situations, particularly in pastures and ecotone environments such as clearings inside forests. This is where most of the coprophagous species belonging to the Aphodiidae, Scarabaeidae and Geotrupidae occur, besides the phytophagous Melolonthidae and Rutelidae species, which are associated with herbaceous and shrubby vegetation. In this wide mosaic of open habitats and forested areas, many species of Cetonidae, the adults of which are anthophilous and are often encountered in the shrubby forest-pasture ecotone, also occur (*Trichius*, *Valgus*, *Cetonia*, *Oxythyrea*, *Potosia*, *Netocia*). Equally occurring in pastures are phytophagous and saprophagous species of Dynastidae (*Pentodon*, *Phyllognathus*), Geotrupidae (*Thorectes*), Orphnidae (*Hybalus*), Ochodaeidae (*Ochodaeus*) and Trogidae (*Trox*). The species composition of pasture communities varies according to altitude: there are Mediterranean stenotopic, more thermophilous species which are exclusive to low altitude pastures, and alpine-subalpine stenotopic species that are typical of high-altitude pastures. Additionally, a high number of eurytopic and oligotopic species occur within a more or less wide altitudinal range. The summit habitats of the Alps mainly host some detritivorous *Aphodius* species (subgenera *Agolius* and *Neagolius*), which can be found in spring-summer on patches of snow. In general, species richness in pastures decreases according to a basal plane–alpine grassland gradient, alpine grasslands hosting a considerably lower number of species than lowland and hill pastures. Sometimes, an apparent reversal of this general trend can be observed, when more species are found in hill pastures compared to lowland ones: this is due to the greater anthropogenic alteration of the latter through activities such as intensive agriculture and urbanisation, whereas the hill belt better preserves its naturalness. Lastly, it must be said that there are data concerning the diet of most phytophagous species, neither of adults nor larvae. Information on very few species exists in the literature, mainly those of agrarian interest (e.g. *Melolontha*).

Zoogeography

In general, the coprophagous species (Scarabaeidae, Aphodiidae and Geotrupidae) show wider distributional



areas compared to the phytophagous ones (Melolonthidae, Rutelidae, Cetoniidae and Orphnidae). Most families display maximum diversity in the tropical and subtropical regions, with few representatives in Europe.

Of the Italian endemics (53, i.e. 14.8%) only 11 (3.07% of all Scarabaeoidea) belong to the Laparosticti, i.e. to the group of families in which a coprophagous diet is dominant, whereas as many as 42 (11.7%) belong to the Pleurosticti, which are phytophagous. In fact, most endemics (41.7%) belong to the Melolonthidae (*Trio-donta*, *Hoplia*, *Haplidia*, *Rhizotrogus*, *Amphimallon*). The number of endemics (both species and subspecies) is much higher in the southern and insular regions. All these considerations are made according to the political boundaries of Italy, and lose their value if approached in zoogeographical terms: indeed, many species of the Italian fauna not included within the endemics are in truth subendemics. This means that most of their distributional area falls within the political limits of Italy, except for minor portions situated outside. This is the case of some Alpine species (e.g. some *Aphodius* species of the subgenus *Neagolius*), which are mainly distributed in the northern Italian regions, but are also present in small areas of the French, Swiss and Austrian Alps. The same goes for *Aphodius laticollis*, which is distributed in the Apennines but reaches the Maritime Alps towards north. Moreover, there are many Sardo-Corsican endemics (*Thorectes sardous*, *T. geminatus*, *Aphodius franzinii*, *Rhyssemus sardous*, *Hoplia pubicollis*, *Rhizotrogus bellieri*, *R. fossulatus*, *R. genei*, *R. rugifrons*, *Hemichaetoplia pallidipennis*, *Netocia sardea*) which, from a zoogeographical point of view, are true Italian endemics. A special case is that of *Ceratophyus rossii*, a rare and localized species belonging to an ancient genus including very few relict species, restricted to isolated areas of the Holarctic region. Currently, apart from an old and uncertain record for Corsica, this species appears to occur only in the protected areas of the Tuscan littoral between Livorno and Pisa; an isolated specimen was found in the Province of Grosseto, in the WWF Oasis of Lake Burano.

Unfortunately, this species cannot be considered an endemic due to this never-confirmed record for Corsica. On the contrary, *Aphodius franzinii*, which was first considered a Sardinian endemic and was reported as such in the Checklist of the Italian fauna, was subsequently collected also in Corsica. The Sardinian endemics are generally related to species of the Iberian peninsula (e.g. *Typhoeus hiostius*, *Melolontha sardiniensis*, *Elaphocera emarginata*, *E. erichsoni*). The Sicilian endemics can also be related to Iberian elements (*Aphodius siculus*), but also to North African (*Hybalus benoiti*, *Hoplia attiloi*, *Geotrogus sicelis*), Balkan (*Aphodius ragusae*) and even Anatolian ones (*Gnorimus decempunctatus*). Interesting affinities are shown by *Heptaaulacus rasettii*, which appears to be an endemic of the Tuscan littoral and is

related to an Iberian species. Lastly, the strange case of *Aphodius crovettii* is worth mentioning: this species was described from the island of Sant'Antioco and never again found; the holotype (only known male, females being hard to identify) may in fact have been collected in North Africa and been wrongly labelled. Indeed, this species shows a close relationship with species from Libya (e.g. *A. hamricola*, *A. segonzaci*).

Alien species

Fortunately and strangely enough, there are no alien populations of Scarabaeoidea beetles in Italy. In some cases single specimens of Afrotropical species have been collected, but these have generally been interpreted as isolated cases of involuntary and accidental introduction by means of ships. Namely, the following species are reported in the Checklist of the species of the Italian fauna: *Chiron digitatus* (only member of the Chironidae to have been found in Italy, i.e. an ancient record for Sicily); *Omorgus melancholicus* (an Afrotropical species of Trogidae), for which a record from the 1970s exists, also of Sicily, from Foci del Simeto; *Euoniticellus intermedius* (an Afrotropical coprophagous Scarabaeidae), for which an ancient record for Campania exists. Moreover, also *Peritryssus excisus*, a South American species of the Melolonthidae, was cited on the basis of an old, erroneous record or based on a specimen brought to Sicily by ship. The revision of the Checklist has brought us to maintain the first two species (which could be remnants of autochthonous populations at the northern limit of their distributional areas) and delete the last two.

Conservation

No quantitative data exist concerning the status of Italian Scarabaeoidea populations. The only information available to us has originated from observations of an anecdotic type, especially verbal communications between specialists, referring to the apparent abundance or scarcity of the various species throughout the years. The analysis of the data collected for the implementation of the database, as well as many unpublished records known to us but which were not included in the database, highlights the rarefaction of some species, the local extinction of which has been in some cases hypothesized. For instance, let us examine the status of populations of telecoprids (rollers) (*Scarabaeus*, *Gymnopleurus*, *Sisyphus*), which construct small dung balls and roll them until they reach a suitable spot for burying them. Despite the global warming which should represent an advantage for them, given they tend to prefer – unlike endocoprids (dwellers) – warm-arid climates, these species have become alarmingly rarefied all over Italy, even in the many areas where semi-wild grazing still exists. Species having declined more than others are those of the genus *Gymnopleurus*. *Gymnopleurus flagellatus* in particular still occurred in some parts of the



Roman littoral until the beginning of the 1970s. Despite intensive surveys carried out in this area in recent years, individuals of this species were no longer observed. Similarly, *G. mopsus* and *G. sturmi* were two common species in the Roman countryside, from which the last specimens were collected in 1969. These species seem to have become extremely rare (if not even extinct) in all regions of central Italy. *Scarabaeus* species have also strongly declined, especially the larger ones, such as *S. sacer* and *S. typhon*. A strong rarefaction can also be observed within the genera *Onitis* and *Chironitis*. *Onitis belial* in particular, a large species, was last observed in 1979 in a coastal site of Liguria which is now deeply altered. There are not enough elements to explain the causes of the rarefaction of the large coprophages in Italy. Nevertheless, a series of concomitant causes can be picked out, having certainly each played a part in the decline of their populations: 1) the decrease of semi-wild grazing, mainly of ovines, the excrements of which particularly suit their feeding habits; 2) the decrease of land surface dedicated to grazing, following re-forestation and the spontaneous growth of native woodland; 3) the increase of crow populations, particularly of the hooded crow (*Corvus corone*), which shows a particular tendency to prey on large Scarabaeidae as they quite visibly crawl across the shortly-cut grass of pastures. In general, we can hypothesize that the rarefaction of many coprophagous and phytophagous Scarabaeoidea, associated with grassland habitats, is due to the abandoning of pasturing and the consequent comeback of woodland vegetation or spreading of intensive agriculture. On the contrary, the rarefaction of phytophagous species with phytosaprophagous larvae is due to the disappearance of old-growth deciduous forests, everywhere substituted by coppices and artificial plantations in which trees are regularly cut down and removed. This has brought to

a lack of food resources for the larvae, which are associated with old trunks or fallen trees. This is the case of many Cetoniidae (*Osmoderma*, *Gnorimus*, *Cetonischema*, *Eupotosia*, *Potosia*).

A different matter is that of the psammophilous species living on sandy dunes or fluvial beaches, namely those of the genera *Psammodius*, *Rhyssemus* (Aphodiidae) and *Calicnemis* (Dynastidae), *Scarabaeus semipunctatus* (Scarabaeidae) and *Anomala devota* (Rutelidae). These species are extremely vulnerable, because they can disappear locally following the destruction of their habitat. Lastly, particular attention is due to the endemic and subendemic species with small distributional areas and scanty populations, especially those living in coastal and subcoastal environments and therefore more sensitive to anthropogenic alteration. Particularly endangered are *Typhoeus hiostius*, *Ceratophyus rossii*, *Thorectes sardous*, *Hybalus benoiti*, *Heptaulacus rasettii*, *Aphodius sicus* and *Calicnemis sardiniensis*, all species which are not listed in the Habitat Directive. Many phytophagous species with saproxylophagous larvae should be added to these, such as some rare and localized Cetoniidae: *Gnorimus decempunctatus*, *Eupotosia mirifica* and *Cetonischema aeruginosa*, these also inexplicably omitted from the Habitat Directive.

A few guidelines for the conservation of Italian Scarabaeoidea are: 1) to create protected areas in places where the most rare and localized species occur; 2) to bear in mind the requirements of these species during the management of already existing protected areas; 3) to enhance wild grazing in all vegetational horizons, nevertheless maintaining an adequate density of grazers in proportion to the capacity of pastures; 4) to enhance the growth and natural ageing of forests; 5) to protect dunes and coastal habitats.

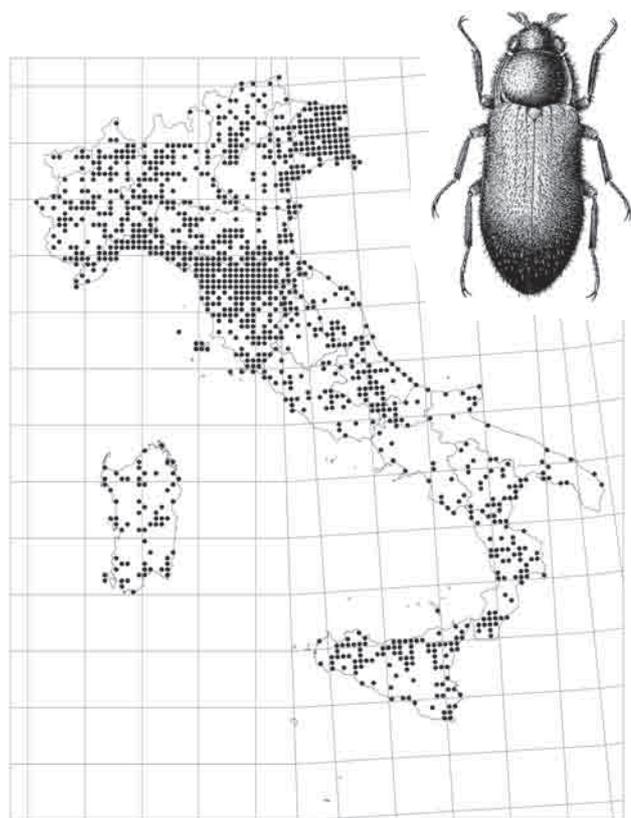
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Insecta Coleoptera Dryopoidea

Alessandro Mascagni



The superfamily Dryopoidea is represented, in Italy, by 5 families of mainly aquatic habits. The taxonomical and chorological knowledge of the Dryopoidea is relatively good within the Heteroceridae, Dryopidae and Elmidae, less so within the Psephenidae and Limnichidae, the distribution of which throughout the country is badly known, also because they are scarcely represented in public and private collections.

Material and methods

The filing of species distribution data is based on the following sources:

- a) the literature: over 120 works, both old and modern, were consulted; among these, the two most important ones on the Dryopidae and Elmidae are those of Olmi (1976, 1978), whereas for the Heteroceridae there are two papers by Mascagni (1988, 1992) regarding some geographic areas of Italy;
- b) specimens from the author's collection and 30 other private collections, both Italian and foreign;
- c) specimens preserved in the collections of 29 Italian and foreign museums.

Altogether, over 6,700 records were included (many of which unpublished) for a total of over 40,000 specimens examined by the author. Data on specimens studied by the author, having subsequently been published, were reported separately (reference and museum location). Old records were also considered, as long as their presence was plausible or at least possible at the time of publication. Olmi (1976) and Mascagni and Calamandrei (1992) were referred to, except in some cases, for systematics and nomenclature.

Biodiversity

The Italian Dryopoidea include Psephenidae (1 genus, 1 species), Heteroceridae (3 genera, 18 species), Limnichidae (3 genera, 9 species), Dryopidae (2 genera, 18 species) and Elmidae (9 genera, 28 species). The species are therefore 74 altogether, with the addition of 3 subspecies; the genera richest of species belong to the Dryopidae (*Dryops*: 17 species) and Heteroceridae (*Heterocerus*, 9 species and *Augyles*, 8 species). The Italian Dryopoidea fauna is, together with the Iberian one, the most diversified among European countries. The best-known Italian regions are: Tuscany, Friuli Venezia Giulia, Lombardy, Liguria, Venetia, Emilia-Romagna, Apulia, Sicily, and Sardinia.

Ecology

Despite the fact Dryopoidea occur in aquatic environments or habitats close to the water, it is preferable to treat each family separately.

Psephenidae: larvae are aquatic and live in torrents, lakes and ponds, where they feed on various vegetal matter; adults frequent humid places near watercourses.

Heteroceridae: both adults and larvae live in damp mud, even in large numbers, near watercourses, lakes and freshwater and brackish ponds, where they feed on vegetal detritus and microalgae found in the soil.

Limnichidae: both adults and larvae live alongside watercourses, sometimes in large numbers, on the edges of lakes and marshes, immersed in the mud or damp sand under half-submerged stones; some species can equally be found amongst mosses and vegetal detritus near the water.

Dryopidae: according to species, adults and larvae frequent the running waters of rivers, torrents and streams or the still waters of ponds and marshes; they feed on microalgae or rotting vegetal matter.

Elmidae: both adults and larvae live in highly oxygenated running waters such as those of springs, streams, torrents and, less frequently, rivers, where they feed on micro-



algae, mosses, aquatic plants and sometimes Bryozoa. Adult Dryopoidea are good or very good flyers. Because of the obvious habitat preferences shown by several species, most taxa can be considered good bioindicators.

Zoogeography

Italian Dryopoidea as a whole include a considerable amount of species with a wide distribution, accounting for 79.22% of all species and subspecies (41.56% in the Holarctic region and 37.66% in Europe); the remaining 20.78% is equally divided into taxa widespread in the Mediterranean (10.39%) and endemics (10.39%). Among the widely distributed taxa, most are Turano-European (15.58%), European (15.58%) and Central-European (14.28%). Interesting differences stand out between the 3 main families:

a) Species widespread in the Holarctic region:

Heteroceridae: 57.89%; Dryopidae: 38.90%; Elmidae: 26.67%

b) Species widespread in Europe:

Heteroceridae: 26.31%; Dryopidae: 33.33%; Elmidae: 56.66%

c) Species widespread in the Mediterranean basin:

Heteroceridae: 10.53%; Dryopidae: 22.22%; Elmidae: 0%

Relevant Literature

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d) Endemic species:

Heteroceridae: 5.27%; Dryopidae: 5.55%; Elmidae: 16.67%

The only exclusively Italian endemics are a subspecies of Heteroceridae (*Heterocerus fuscus etruscus*) and a species and subspecies of Elmidae (*Esolus berthelemyi* and *Limnius sulcipennis sulcipennis*).

Alien species

At present, no alien species appear to occur in Italy, except *Dryops prolifericornis* Fabricius (Luigioni, 1923 sub *D. laevigatus laevigatus* Baudi) (Dryopidae), which was reported from Rome but was never found again.

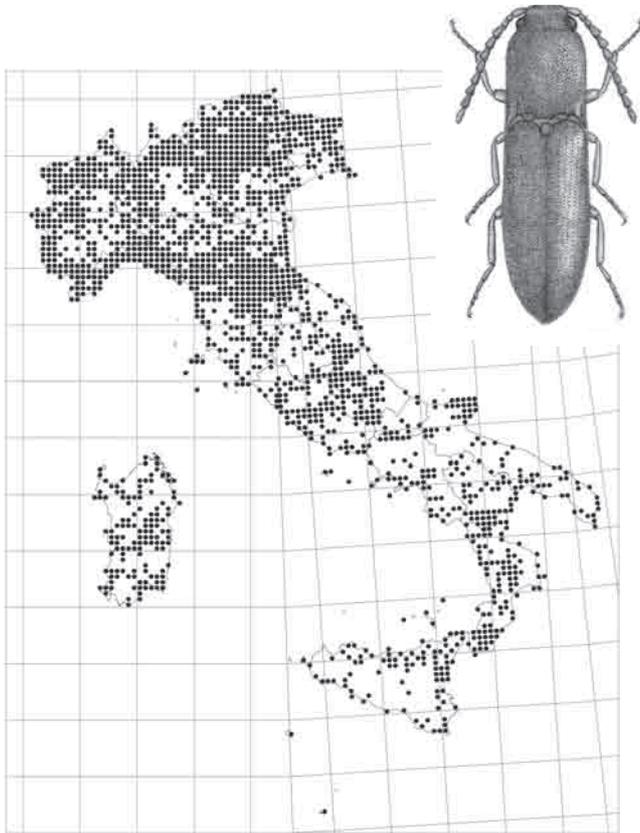
Conservation

Since Dryopoidea are strictly associated with the aquatic environment, they are very sensitive to environmental change caused, as often happened in the past, by the reclamation of marshy areas or interventions on watercourses. Therefore, old records having never been reconfirmed should be considered valid only for the time of their collection. Some species of Limnichidae, Heteroceridae, Dryopidae and Elmidae are rare and, as such, potentially at risk of extinction, at least in Italy.



Insecta Coleoptera Elateridae

Giuseppe Platia



Elateridae are a family of beetles of worldwide distribution, with over 10,000 described species mainly concentrated around the equator.

The level of knowledge of the species belonging to the Italian fauna is good as far as the systematics and distribution of the adults are concerned, whereas many gaps still exist concerning the life cycle and ecology of most species. Very little information on the larvae exists, except for those of agrarian importance belonging to the genus *Agriotes*. The larvae of all endemic species except one are still undescribed.

Material and methods

Most data on species distribution were obtained from the examination of over 80 collections, including the author's one and those of all the most important Italian Natural History Museums, as well as some foreign ones, where the collections of the best-known Elateridae specialists (Binaghi, Müller, Candèze, Pic, Reitter), who described many species of the Italian fauna, are preserved. Many data drawn from the literature were also included in the database, and were critically examined in cases

of uncertain determinations and species with a poorly known distribution.

Unpublished data, added after the basic works of the Fauna d'Italia (Platia, 1994) and the Italian Checklist (Platia, 1995), are numerous: they include three recently described species and two new records for Italy.

Biodiversity

According to the present data, the Italian fauna of Elateridae is the richest in Europe and numbers 238 species belonging to 69 genera; an extra three species from Corsica may also occur in Sardinia.

Alongside species widespread in the Palearctic and sometimes also the Nearctic region, there is an interesting number of endemics: 1 genus and 33 species (14%), which would reach 36 if the 3 Corsican species were added. The genus richest in endemics is *Athous* with 12: 6 of the Alpine and subalpine areas, 4 of the central-southern Apennines, one of Elba Island and one of Sardinia. *Anostirus*, with 4 Alpine and Apennine species, comes second; then come *Cardiophorus* with 3 species (central-southern Italy and Sicily), *Ctenicera* with 2 species (Alps), *Agriotes* with 2 species (central-southern Apennines and Sicily), *Ampedus* with 2 species (central-southern Apennines), *Adrastus* with 2 species (central-southern Italy and Sardinia). Lastly, with one species each: *Harminius* (central-southern Italy), *Megathous* (Sicily), *Stenagostus* (Sardinia), *Brachygonus* (Tosco-Romagnolo Apennines); *Oedostethus* (Prealps) and *Idiotarmon* (central-southern Italy and Sicily). The monospecific genus *Idiotarmon* is so far endemic to Italy.

Ecology

The Elateridae have colonized all terrestrial habitats, from sea shores to the highest peaks and glacier margins; the highest concentration of species occurs in non-degraded forest areas in which a variety of environments such as clearings and humid areas can be found.

Adults occur in a variety of colours, often displaying bright colours or metallic reflections, and are generally recognizable by their elongate shape (ranging between 0.5 mm and 25 mm in species of the Italian fauna) and capacity to jump; if they are lying on their back or trying to escape predators, or again if they are disturbed in some way or picked up, they are capable of leaping back into their natural position, emitting a sharp clicking sound at the same time, reason for which they are commonly called "click beetles". It is interesting to point out



that their capacity to jump does not pertain to their legs like in other insects, but to particular thoracic structures. They can be found at all times of the year and are active in the most southern regions even in autumn and winter, whereas they remain inactive in hibernation cells in colder areas. This is the case of species that develop under bark or in tree holes, the adults of which emerge in the autumn. However, most species are active in spring (even in mid-summer in mountain areas) in broad daylight, and can be collected by sweeping meadow vegetation or beating trees and shrubs, or observed on flowers, on the ground, under stones, and so on; others are crepuscular or nocturnal and are attracted to artificial light. The rarity with which some species (e.g. *Odontoderus antigai*, *Athous luigioni*) are observed seems exclusively due to late emergence in autumn, from mid-September to October, a period in which research activity is generally reduced or suspended. Adult life is generally very brief, lasting no more than a few months after reproductive activity; their diet is not very well known, but appears to mainly consist of pollen, nectar and sugary liquids; cases of adults preying upon other insects are reported in the literature.

The larvae, known mainly to farmers by the name of wireworms, have a cylindrical to flattened elongate, often strongly sclerotized body, robust mouthparts of the chewing type, and vary in colour from rust brown to whitish. Their life cycle includes various developmental stages and can either be annual or last several years.

As far as the Italian fauna is concerned, the larvae of all the species of some genera (e.g. *Lacon*, *Ampedus*, etc.) develop inside the cavities of decaying trees, where they are mainly zoophagous; on the other hand, the larvae of many other genera develop in the ground and forest humus, displaying a variety of feeding habits ranging from rhizophagy and necrosaprophagy to detritivory; lastly, the larvae of some genera (e.g. *Agriotes*) mainly occur in cultivated areas, heavily damaging crops.

Zoogeography

From a zoogeographical point of view, data referring to species finding one of the limits of their distributional area in Italy are interesting: western limit in the north-eastern regions for species such as (the most significant ones) *Cardiophorus discicollis*, *Athous angulifrons*, *Athous austriacus*, *Athous ganglbaueri*, *Athous plagipennis*, *Adrastus montanus*, *Dima elateroides*, *Melanotus brunripes*, *Melanotus cinerascens*; southern limit in the Alpine area for *Fleutiauxellus* and *Oedostethus* species of the subfamily Negastrinae and *Sericus subaeneus*; eastern limit in Liguria for *Spheniscosomus sulcicollis* and *Peripontius rutilipennis*; *Campylomorphus homalisinus*,

distributed along the Apennines from Piedmont to Umbria. Two Cardiophorinae species (*Cardiophorus ruficruris* and *Dicronychus rubripes*) mainly occur in Apulia and are of trans-Adriatic distribution. The number of Sarde-Corsican endemics is particularly high: 12 altogether, 6 of which shared by the two islands and 3 exclusive to each one; among them, the genus *Elathous* with the sole Italian species *E. perrisi*. Particularly interesting is the presence as glacial relicts of typically Alpine species in some areas of the central and southern Apennines: *Hypnoidus riparius*, *Actenicerus siaelandicus*, *Paraphotistus impressus*, *Selatosomus melancholicus*. Lastly, *Lanelater notodonta*, a species which is common in the African intertropical belt right to Arabia, is worth mentioning; it used to be found, until the 1920s, exclusively near the hot springs of Termini Imerese in Sicily, but is now considered extinct having since never been found again. Debate among entomologists concerning its origin remains open: was it relictual in Sicily or imported?

Alien species

According to current knowledge, no alien species are present.

Conservation

Many species of Italian Elateridae are greatly threatened and others are in danger of extinction. This alarming situation is confirmed by the extreme rarefaction of some species, which have either not been collected in Italy for years or are only sporadically encountered in areas that are too small to allow for positive genetic exchange. The species the larvae of which develop in cavities of old, perishing trees in forests, alongside rivers and torrents or in city streets and parks, are particularly endangered. These species belong to the genera *Danosoma*, *Lacon*, *Calambus*, *Hypogonus*, *Denticollis*, *Dima*, *Diacanthous*, *Megathous*, *Stenagostus*, *Ampedus*, *Brachygonus*, *Reitelerlater*, *Ischnodes*, *Ectamenogonus*, *Megapenthes*, *Procaerus*, *Podeonius*, *Elater*. The systematic elimination of cavity-trees should be prevented (wherever they do not jeopardize the safety of people) in order to preserve this rich natural heritage also in the future. Most of the endemic species are not immediately endangered in that they nearly all possess terricolous larvae, and many live in little-frequented montane habitats that are in some cases protected; however, their distributional areas may be reduced in the future by the spreading of human activities and agriculture. On the contrary, some pest species of *Agriotes* (*brevis*, *litigiosus*, *sordidus*, *ustulatus*) appear to be spreading despite the mass utilization of insecticides; the reasons for this could be related to intensive monocultures and irrigation.



Relevant Literature

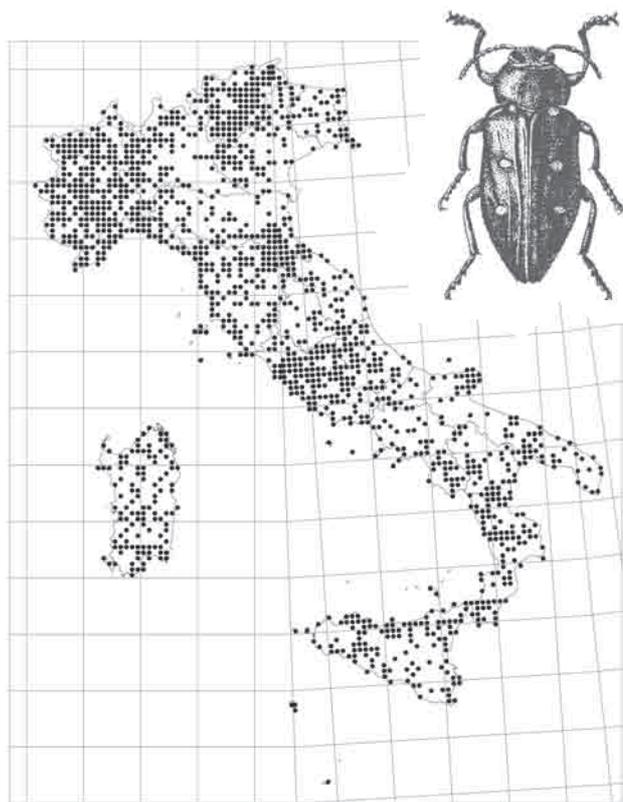
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Insecta Coleoptera Buprestidae

Gianfranco Curletti



With over 12,000 extant species worldwide, Buprestidae are a medium-sized family of beetles. Thermophilous and mainly diurnal (in the Palearctic the sole genus *Melanophila* also shows nocturnal habits, related to the search for burned wood in which its larvae develop), Buprestidae are principally distributed round the equator and in the tropics, and strongly decrease in numbers towards the poles.

The beautiful colours and elegant shape of the Buprestidae have attracted the interest of specialists ever since the beginning of modern systematics. Therefore, the nomenclature within this group is continually evolving, also in order to meet with the new rules of the International Code.

Despite the well-known larval biology and ecology of some species (particularly those of agrarian interest), there is still much work to be done in the study of larval morphology, especially in the identification of species.

Material and methods

The listed data are the result of personal research carried out in the most important Italian and European museums,

as well as private collections; whenever possible, these were supplemented by data from the literature concerning the Italian territory. The basic reference was without a doubt the catalogue of Curletti (1994), which lists over fifteen thousand distributional records and represented the guideline for the present work. The systematic order follows that of the Checklist of the species of the Italian fauna (Gobbi, 1995), subsequently updated by Curletti (2000).

Biodiversity

The state of knowledge of Buprestidae in Italy can be considered sufficient, especially if compared to that of beetles in general. However, some geographic areas and the taxonomy of some groups would require further studies capable of adding new data to the Italian fauna. Thirty-two genera of Buprestidae are represented in the Italian fauna, comprising over 200 taxa, a number which varies slightly according to the taxonomic views of different specialists. Indeed, not all described taxa are universally considered valid and some may therefore be omitted from lists. This is the case of *Anthaxia (Haplantaxia) scutellaris semireducta*, of *Anthaxia (Melantaxia) giorgioi* or, on the contrary, of *Agrilus (Agrilus) suvorovi populneus* which was recently synonymized with the typical form, a proposal not accepted by the present author. Other cases are those of species wrongly attributed to the Italian fauna, such as *Sphenoptera (Sphenoptera) circe*, *Trachys dichrous*, *Agrilus (Agrilus) antiquus oxygenus*.

Most of the Italian fauna is represented by 2 genera accounting for 44% of the total: *Anthaxia* with 43 taxa (20.5%) and *Agrilus* with 49 (23.5%). The high amount of species belonging to this last genus largely agrees with the faunistic situation on a world scale. *Agrilus* is indeed distributed in all continents and, with around 2,800 described species, is considered the largest genus of the animal kingdom.

Ecology

Buprestidae are phytophagous insects, generally phyllophagous as adults and wood borers as larvae. In some cases the larvae are poeophagous (genera *Aphanisticus*, *Cylindromorphus*, *Paracylindromorphus*, a few species of *Meliboeus* and *Agrilus*) or leaf miners (genera *Trachys* and *Habroloma*). The larva of a single species is not related to plants and lives freely in the ground, probably as an adaptation to subdesertic conditions: *Julodis onopordi* ssp. *lampedusanus*, relegated to the island of Lampedusa. The



family is of great importance in forestry, since it includes primary hosts capable of damaging forests and tree plantations. Pest species are however a minority, and most taxa are considered as secondary hosts attacking weak, dying or recently dead trees. Some species show high habitat selectivity and may become important bioindicators in the location and protection of peculiar forest sites. This is the case of some rare species, such as *Eurythyrea quercus* and *Kisanthobia ariasi*, which depend on the survival of old-growth oak forests, *Eurythyrea austriaca*, associated with ancient autochthonous silver fir forests, and *Scintillatrix solieri*, related to old elms in Mediterranean forests.

Zoogeography

The faunistic component of the Italian Buprestidae assemblage is among the richest in Europe (probably only outnumbered by the Greek fauna), and mainly includes species with a Mediterranean distribution (about 43%) followed by European ones (33%) and by a smaller group of Sibirop-European ones (10%). There are a high percentage of endemics (12%), whereas Holo-Palearctic species are just over 2%. With the exception of a sole Alpine endemic (*Agrilus cytisi*), all endemics occur in the southern regions and major islands.

The Italian Buprestidae fauna can be divided into three separate geographic areas: a boreal area represented by the Po Plain and the Alps and characterized by a massive occurrence of Sibirop-European elements; a central area, the richest from a faunistic point of view, including the Adriatic and Tyrrhenian peninsular regions and characterized by a strong presence of Mediterranean elements; lastly, a southern and insular area – the most particular one – comprising the Ionian regions and characterized by trans-Ionian, Baetic-Rif and endemic species.

Relevant Literature

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The Adriatic side of the peninsula is altogether poorer, with less Mediterranean taxa spreading northwards. The Apennines play an important role in the geographic distribution of species. They form a barrier for the cold Balkan currents, thus favouring the presence of the more thermophilous species on the Tyrrhenian side and the arrival of taxa of occidental origin, such as *Chalcophora massiliensis*, *Anthaxia dimidiata*, *Meliboeus amethystinus* and *Meliboeus gibbicollis gibbicollis*. Not for nothing is Tuscany the region richest in species.

Alien species

The importation of timber from other countries is one of the main causes of introduction of exotic species. At the present state of knowledge, only two species have been accidentally imported, though no proof of them having adapted exists. These are *Buprestis aurulenta*, recorded for Piedmont following the importation of Douglas fir from Canada, and *Buprestis dalmatina*, of Balkan origin and recorded for Romagna.

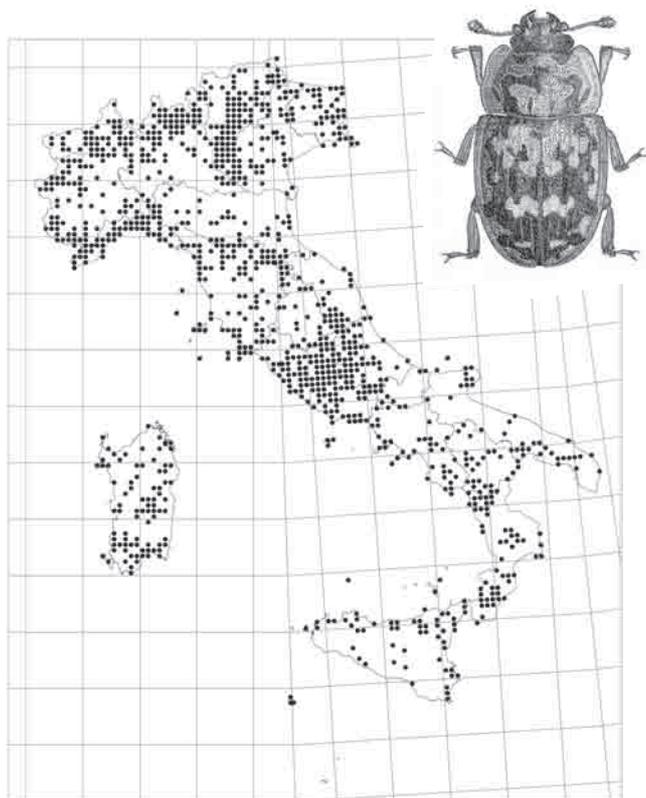
Conservation

Given they are strictly related to their food plants, it is clear that the protection of Buprestidae depends upon the conservation of their habitats. Four species are particularly vulnerable and can be considered as umbrella species: *Buprestis splendens*, associated to the loricated pines and silver firs of the Pollino Massif, *Anthaxia kochi*, an endemic which is confined to the relict silver fir formations of the Pollino Massif and Aspromonte, *Agrilus meloni*, an endemic of the humid areas of southern Sardinia (Molentargius pond), and *Acmaeodera revelierei*, an endemic of Corsica and Sardinia the biology of which is still partly unknown.



Insecta Coleoptera Nitidulidae

Paolo Audisio, Alessio De Biase



The family Nitidulidae belongs to the superfamily Cucujoidea, suborder Polyphaga, and it is close to other Clavicornia such as Cateretidae, Cybocephalidae (the latter are sometimes considered a very specialized subfamily of Nitidulidae) and Smicripidae (Audisio, 1993). The recent infra-family systematic recognises 9 subfamilies in the world fauna (Calonecrinae, Mainipeplinae, Nitidulinae, Cillaeinae, Carpophilinae, Epuraeinae, Meligethinae, Mystropinae, Cryptarchinae); all these subfamilies except Calonecrinae, Mainipeplinae, Cillaeinae (which are occasionally introduced in Italian ports with imported exotic wood), and Mystropinae, are part of the Italian fauna. The taxonomic knowledge for most of the subfamilies and genera are good, specifically for Italy and the rest of Europe. Because specialists are scarce, research is reduced, the taxonomy of some taxa is difficult, knowledge of Italian species is not yet complete (mostly for Sardinia and Sicily fauna). A small number of taxa has been collected and described very recently (Audisio and De Biase, 1999, Audisio et al., 2001, 2003, 2005). Beside some unexpected cases (Audisio et al., 2003), these are mostly cryptic species, belonging to groups with dif-

ficult taxonomic status, which have been identified and characterised from similar species with biometric and biomolecular techniques. At least 15 very rare and difficult to collect taxa, which are known for areas adjacent to Italy (mainly the Alpine area and the main islands) could be collected in Italy in the future.

Material and methods

Most of the data reported for Italy refer to collections developed by the authors and some other Italian and foreign entomologists in the last 30 years. We were able to file *ex novo* and thoroughly only some of the non-abundant museum data, which refer to the most common and widespread species. However, the great amount of unpublished data from the most recent collections provides a very detailed knowledge of Italian Nitidulidae. Even with the limitations mentioned above, we filed the collections of the main Italian and European Museums of Natural History and Zoology, and the specialists' collections. We also included all data from literature which we checked personally, and which we considered reliable on the basis of the most recent taxonomic revisions.

Biodiversity

Nitidulidae are particularly relevant as synthetic descriptors of local biodiversity because of their varying trophic roles, even though in Italy there are less than 200 recorded species (most likely 176, divided in 21 genera), and in Europe less than 250 species (242, divided in 25 genera, excluding species from Caucasus and Anatolia), (Audisio, 1993; Audisio and Jelínek, 2004). Italian fauna includes 73% of the known European species, and it is the most diverse of the continental faunas, Turkey included (about 160 species). The two dominant genera for Italian fauna are *Meligethes* (subfamily Meligethinae), with about 100 species, and *Epuraea* (subfamily Epuraeinae), with about 40 species. The Alpine area is the richest in species, followed by the Central and Southern Apennines.

Ecology

The Nitidulidae have a very heterogeneous ecological and trophic role. Almost all the Carpophilinae, Epuraeinae, and Cryptarchinae, and most of the Nitidulinae are phytosaprophagous or microsaprophagous both at larval and adult stages. They are mostly associated with decomposing vegetal or fungal matter (fruits, fermented lymph, fungal fructiferous bodies, exc.) even if there are species associated with dens of mammals, and subterranean nests



of social insects; some species are even more specialized. Among the Nitidulinae there are several mycobioint genera (for instance, *Cyllodes*, *Cychramus*, *Thalycra*) and Epuraeinae (*Epuraea*), associated with the gleba of the fructiferous bodies or with the subcortical mycelium of higher fungi. Few species among the Nitidulinae (for instance *Nitidula*, *Omosita*) are zoosaprophagous, associated with decomposing bones and large vertebrates in pre-skeletal status, or phyllophagous (for instance *Xenostrongylus*, *Anister*) with larvae associated with the leaf parenchyma of brassicaceans. Several species of Epuraeinae are anthophagous in their larval stage, as are most of the Meligethinae in both larval and adult stages. Meligethinae, mostly with the large genus *Meligethes*, are particularly interesting for their high trophic specialisation: several species are strictly monophagous (at least at the larval stage, but sometimes also at the adult stage) on flowers of a single species. In Europe and in Italy, Nitidulidae are present in all kinds of habitat, from littoral dunes to the high altitudes of the Alps and Apennines (up to about 3000 m). The mycetophagous and phytosaprophagous species, which are autochthonous for Italian forests, are excellent bioindicators of the conservation status of their natural habitats. Other species (mostly Carpophilinae, and few sub-cosmopolitan, synantropic and acclimated species of Epuraeinae and Nitidulinae) are good indicators of stress and “faunal pollution” of forested areas. Meligethinae, thanks to their low mobility (due to their association with the host plants in the larval stage), and to the great number of Italian species, are good bioindicators of open habitats, such as prairies, chaparral, rocky areas, riparian areas, wetlands, and dunes.

Zoogeography

Several known chorotypes of the West-Palaearctic fauna are typical of Nitidulidae mostly the Euro-Siberian (17%), South-European (12%), European (10%), West-Mediterranean (9%), Asiatic-European (7%), cosmopolite or sub-cosmopolite (7%), Holarctic (6%), Central-European (5%), Palaearctic (5%), Turanic-European (4%) and East-Mediterranean (4%) (Audisio, 1993, with 2003 updates). Endemics are scarce, as it occurs in Europe for this taxon. Only two species are strictly endemic, and represent about 1% of the total: *Meligethes paschalis* in Southern Italy, and the mysterious *M. salvan* in the Maritime Alps, which is known only from one locality near the Italy-France border (Audisio et al., 2003). A few more species (*Meligethes angustatus*, *M. oreophilus*, *M. spornrafti*, *Xenostrongylus arcuatus*) pass the Italian border in France, Switzerland, or the Balkanic region.

Alien species

Several exotic species of Nitidulidae of tropical and subtropical origin have successfully colonized Italy (living mainly in the Central and Southern Regions) in the last

centuries. These are mainly phytosaprophagous species, whose survival is linked to the availability of fallen, ripe fruit: these species live in cultivated, or at least anthropized areas. Some of these species have been able to subsequently colonize forested area of high environmental quality, losing the need of cultivated lands. The diffusion and acclimation of phytosaprophagous exotic species increased greatly in the last 15-30 years, when tropical fruit was imported in South Europe and Italy (Audisio, 1988). It can be estimated that almost each year some “new” species of Nitidulidae are introduced in Southern Europe and Italy, which could potentially become acclimated there. In the ten years after the publication of the “Fauna d’Italia” (Audisio, 1993), at least 3 exotic species are successfully acclimated (*Epuraea ocularis*, *E. sp. cfr. luteola* and *Stelidota geminata*). In the majority of the cases the exotic species are harmful to agriculture, being primary and secondary carpophagous especially in their first years of acclimation and diffusion, whereas their possible harm to indigenous entomofauna of natural habitats does not seem to be relevant.

Conservation

The conservation status of Italian species is quite heterogeneous. The former of the two endemic species mentioned above (*Meligethes paschalis*), being strictly dependent on Lamiaceae of the genus *Lamium* woods, has a fragmented distribution and it is rare in Central Italy (Latium and Abruzzum) whereas populations in Southern Italy (Campania, Basilicata, and Calabria) are numerous and abundant almost everywhere. The latter species (*Meligethes salvan*) is known on the basis of two specimens collected at the beginning of last century in the mountain part of the Argentera Massif (Maritime Alps), and has never been found again. It might even be extinct (Audisio et al., 2003). The biology of this species is unknown. The most interesting species are some *Meligethes* of relict wetlands in plains areas, associated with hygrophilic Lamiaceae. These species are now very rare in southern Europe due to the rarefaction and destruction of their habitats (*Meligethes ochropus*, *Meligethes hoffmanni*, *M. ovatus*). They survive in very few locations in Italy, and are at risk of local extinction. Some other rare and vulnerable taxa such as *Meligethes devillei*, *M. caudatus*, and the above-mentioned *M. oreophilus*, have a very fragmented range, and are associated with Lamiaceae or Campanulaceae of medium and high elevation prairies in the Alps and in the Apennines. Other endangered taxa are associated with littoral dunes of good environmental quality (Audisio, 1993; Audisio et al., 2002, 2005), or to psammophyte Leguminosae. In the former group the West-Mediterranean species *Meligethes opacus* and *M. varicollis* are known in Italy from a few littoral areas in Western Sardinia. In the latter group, *M. thalassophilus*



is a West-Mediterranean species, associated with *Matthiola* spp. (Brassicaceae), and present in a few locations on the Tyrrhenic and Ionic coasts of peninsular Italy. A different threat endangers several subcortical and mycetophagous species of the genus *Eपुरaea*, *Cylloides ater*, some *Glischrochilus*, and representatives of

other genera such as *Cryptarcha*, *Pityophagus*, which are all associated with mature and scarcely disturbed forests, particularly conifers and broad-leaved woods in mountain habitats. The survival of these taxa is linked to the maintenance of forestry activities which can allow the local saproxilic fauna to survive.

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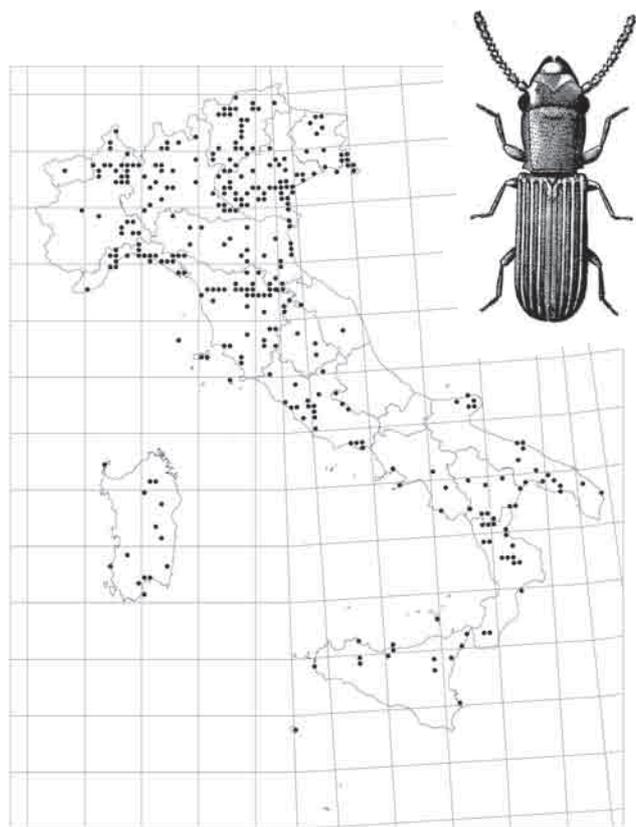
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Insecta Coleoptera Cucujidae

Enrico Ratti



A small family of beetles including nearly 500 species distributed in all biogeographical regions of the globe; it comprises two subfamilies, Cucujinae and Laemophloeinae, considered as distinct families by some authors. Concerning the European and Italian faunas, taxonomical knowledge of the adults is good thanks to the works of Lefkovitch (1959) and Vogt (1967), whereas the larvae are still poorly known (Uliana, 2003). The only unsolved taxonomical problems concern the Mediterranean populations possibly wrongly attributed to *Cryptolestes* (*Leptophloeus*) *alternans*, and the rank of the subgenus *Leptophloeus*, considered a genus by many authors.

Material and methods

Italian distributions were drawn from the complete or partial examination of about ten public beetle collections and fifty-odd private collections, as well as from data personally collected by the author.

With respect to the still incomplete analysis of material preserved in the Italian collections, a particularly thorough bibliographic research was carried out (Ratti, 2000),

which was constantly updated through the screening of the main Italian entomological journals.

Recent methodical studies carried out in Italian forest environments, such as for example that on Bosco della Fontana near Mantua, have also provided interesting new chorological data.

Biodiversity

The family is represented by 35 species in Italy, all of which monotypic; 7 of these have been exclusively intercepted (on one or more occasions) near ports or on vegetal products of exotic origin, and have seemingly not become established, at least so far, in this country.

The occurrence of *Laemophloeus muticus* within the Italian borders (southern Tyrol) is only reported by nineteenth-century literature: the ascertained presence of this rare central-northern European species in neighbouring regions (eastern Tyrol, Carinthia) makes this record possible, at least as a marginal element. Also, the occurrence of *Pediacus fuscus* in Italy (cited by Luigioni, 1929) was not confirmed by any specimens in the examined collections: it is a Holarctic species of northern distribution, and its presence in Italy is not very likely.

The knowledge of the geographic distribution of Italian Cucujidae is strongly unbalanced in favour of the northern regions, which alone provide for over 60% of records. Gaps in knowledge progressively increase in central, southern and insular Italy. The best-known regions are Venetia in the north, Tuscany in the centre, Apulia in the south and Sicily among the islands. Virtually unexplored regions are Aosta Valley, the Marches, Abruzzo, Molise, Umbria and, very little known, Campania. Regions that would certainly deserve much more thorough research are Latium, Calabria, Sicily and Sardinia, especially the Apennines and insular mountains.

Ecology

Cucujidae, which are generally fully winged and good flyers of a more or less flattened appearance and small to medium size (1,5–25 mm), mainly live under the bark of broadleaved and coniferous trees. Most Italian species are sylvicolous, associated with stable and mature woods, or dendrophilous, also associated with isolated trees; more rarely, they are related to shrubs or occur among cereals and other stored foodstuffs.

They display a main morphological form (elongate and more or less strongly flattened body) as a result of specialization to life under the bark of tree trunks, and a sec-



ondary one (more or less subconvex, long and subcylindrical body, exclusive of some *Cryptolestes* s.l. species) as a result of adaptation to life inside tunnels excavated by xylophagous beetles (mainly Scolytidae) or twigs and woody stems of shrubs.

Few species are exclusively or almost exclusively associated with conifers (*Cucujus haematodes*, *Cryptolestes abietis*, *C. corticinus*, *C. weisei*, *C. alternans*), others are only or nearly only associated with broadleaved trees (*Lathropus sepicola*, *Laemophloeus* spp., *Notolaemus* spp., *Cryptolestes duplicatus*), yet others show no preferences for a particular host species. The trunks of shrubs are more or less regularly frequented only by *Cryptolestes* (*Cryptolestes*) *spartii* (broom), *C. (Leptophloeus) clematidis* (*Clematis vitalba*) and *C. (L.) perrisi*.

Normally, no strict association with a given species is shown (nor with a particular xylophage): some cucujid-plant species-(scolytid) relationships are common however, such as *Cryptolestes (Cryptolestes) abietis-Picea excelsa*-(*Dryocoetes autographus*), *Cryptolestes (Leptophloeus) clematidis-Clematis vitalba*-(*Xylocleptes bispinus*), *Cryptolestes (Leptophloeus) hypobori-Ficus carica*-(*Hypoborus ficus*).

Congeneric species frequenting the same tree species may display allotopy, preferring different parts of the same tree (e.g. trunk and large branches – terminal twigs) and living as a consequence with different species of xylophages.

It has recently been demonstrated that many species previously believed to be predacious on xylophagous insects (e.g. *Lathropus sepicola*) are actually mycophagous (Uliana, 2003), feeding on inferior fungi (Ascomycetes, fungi Imperfecti, moulds, etc.). The presence, in some genera, of vestigial mandibular cavities in the adult (interpreted as structures used for storing and carrying fungal spores) or of mandibles with a well-developed molar in the larva, has induced to consider mycophagy in a subcorticolous environment as an ancestral character within the Cucujidae.

Only *Cucujus* species have been shown to have an exclusively zoophagous diet (though knowledge of it is still poor); some species have been described as having a mixed diet (mycophagy, facultative predation), others as being exclusively phytophagous (spermophagy, with a secondary adaptation to stored foodstuffs). In any case fungi, moulds or yeasts regularly appear in the diet of most species.

At the present state of knowledge, it is difficult to make out the value as bioindicators of single species. Anyhow, the following species, all precious sylvicolous elements, are good indicators of mature forest or relict woodland formations: *Cucujus* spp., *Pediacus* spp., *Laemophloeus* spp., *Notolaemus* spp., *Cryptolestes (Cryptolestes) abietis*, *C. (C.) weisei*, *C. (Leptophloeus) alternans*.

Zoogeography

Cucujidae are generally widespread, although in some cases their distribution is patchy or clearly relict. Over half of the Italian species (18 species) show chorotypes pertaining to the European group (only 3 species are limited to southern Europe); 11 species (including the alien ones) are either subcosmopolitan (5) or non-Palaeartic (6). Scarcely represented are the Palearctic and Holarctic (2), Sibiro-European (2) and Mediterranean (2) chorotypes.

If the analysis is restricted to the autochthonous or naturalized species, then the European component accounts for 64% of chorotypes, compared to a 7% Mediterranean component. No endemic or subendemic species occur in Italy.

Alien species

Despite the facility with which many Cucujidae are passively introduced together with foreign vegetal products (mainly timber and foodstuffs), only very few alien species, all associated with stored foodstuffs, have so far been able to adapt to local conditions in Italy.

Of sure exotic origin and ancient introduction are *Cryptolestes (Cryptolestes) turcicus* and *C. (C.) pusillus*, once strictly anthropophilous in Italy, but which have recently been repeatedly found in open air situations. The few records of *C. (C.) pusilloides* (native to the southern hemisphere) are not sufficient to testify the stable establishment of this species in Italy, even though it generally appears to be spreading.

The subcorticolous alien species (*Laemophloeus* spp., *Placonotus* spp.), which have so far been intercepted in Italy only on exotic timber in ports or timber yards, seem incapable of either becoming established or spreading, and therefore do not represent a problem for the indigenous fauna. A few other exotic species (*Cryptolestes* spp., *Passandrophloeus* spp.) have been intercepted in similar situations in Italy, but are still unidentified and therefore not considered in the present work.

Conservation

There are no endemics in Italy, but some species appear to be extremely rare and in all likelihood vulnerable and threatened. However, the lack of specialized research does not allow to distinguish with certainty the threatened species from the elusive ones.

Cucujus cinnaberinus is included in appendixes II and IV of the Habitats Directive emitted by the European Union and, like its congeneric *C. haematodes*, appears not to have been collected in Italy during the last 30 to 40 years. The situation of *Laemophloeus muticus*, known only from nineteenth-century citations, has already been mentioned. *Pediacus depressus* seems to be extremely rare in Italy, and so do *Laemophloeus kraussi*, *Cryp-*



tolestes (*Cryptolestes*) *abietis* and *C. (C.) weisei*, this last species having been collected only once in Alto Adige. Also *Cryptolestes* (*Leptophloeus*) *perrisi* is very sporadic, with few recent records.

Many species are associated with mature Alpine, Apennine and lowland forest formations: their rarity and dis-

continuous distribution witness the environmental transformations, disappearance of primary woods and progressive anthropization of the territory, which favours the settling of the more common and generalist species. Not for nothing have many recent findings of rare species occurred in protected woodland areas (nature reserves).

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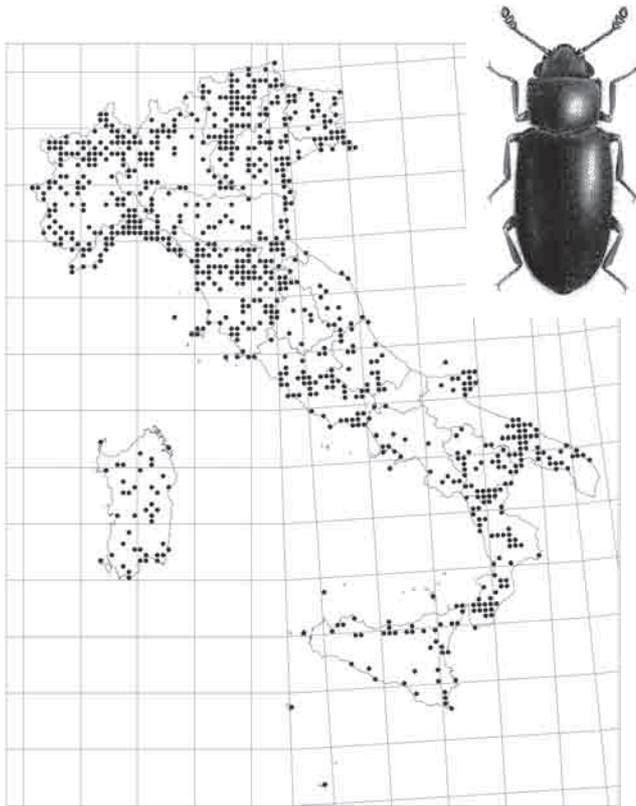
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Insecta Coleoptera Cryptophagidae

Fernando Angelini



Cryptophagidae are distributed all over Italy and occur in a variety of habitats, ranging from sea coasts to around 2,500 m above sea level; this family is only partly known from a taxonomical and chorological point of view, since the taxonomy of the genus *Atomaria* needs further investigation and faunistic research has so far left out entire regions (Molise) and provinces, while very few data exist for many other areas.

Material and methods

Distributional data for each species were obtained from all the published literature, which was critically examined, and from the examination of numerous private collections and nearly all public collections, as well as from material personally collected by the author; unpublished data account for about 90% of the total.

Most data were obtained from the study of material preserved in the museum collections of Genoa, Florence, Milan, Rome, Verona and Venice, and from the following private collections (sometimes kept in museums): the author's collection, those of Binaghi and Mancini

(Museum of Genoa), Migliaccio, Pescarolo (Museum of Carmagnola) and Luigioni (Museum of Rome).

It must be said that despite the large quantity of material examined, no records were found for 5 entire provinces (Benevento, Caltanissetta, Enna, Lodi and Rimini), while only single records were found for many other areas. Moreover, very little information exists for a number of species; this situation is due to the scarcity of specialized research carried out in these areas, and not to true rarity of this family. Data referring to the following 6 species, previously not recorded for Italy in the Checklist of Italian beetles, are provided: *Micrambe longitarsus*, *Cryptophagus escolai*, *Atomaria elongatula*, *A. wollastoni*, *A. rhenana* and *Curelius japonicus*.

Biodiversity

The first certain records of Cryptophagidae in Italy are those published by Gredler (1863), who listed as many as 23 species for Alto Adige. In 1936, the year of Bruce's revision on the European *Cryptophagus*, 105 species were known from Italy; most (18) of the 26 remaining species were recorded during the 1990-2000 decade, and another 3 taxa are firstly recorded for Italy in the present work.

Altogether, 134 species are recorded for Italy (3 of which uncertain: *Cryptophagus montanus*, *Atomaria bicolor* and *A. basalis*), belonging to 14 separate genera. The genera *Cryptophagus* and *Atomaria* are the richest in species (53 and 55, respectively). The number of species occurring in the various regions and provinces is strictly related to the intensity of research carried out during the years; not for nothing are a majority of recent new records from southern Italy. Considering the ecology and general distribution of the group, and given the situation of research so far carried out, there would be no point in mentioning the regions richest in species. Indeed, specific surveys carried out in peculiar microhabitats (e.g. various sorts of vegetal detritus) or using particular techniques (e.g. vinegar traps) at particular times of the year, can bring the collection of many, often very interesting species. Such systems have rarely been used, and even more rarely has the material referring to Cryptophagidae been preserved and/or studied and results been made available.

Only the following 4 species are Italian endemics *Cryptophagus demarzoii*, *Cryptophagus gonzalezi*, *Cryptophagus montemurroi* and *Atomaria parvula*. A fifth species, of the genus *Caenoscelis* (collected by the author in Basilicata), is in course of publication.



Ecology

Cryptophagidae, which are phytophagous or phytode-tritricolous, occur in an array of different situations: on flowers of aquatic plants, bushes and trees (broadleaved or coniferous), on the crowns of trees and shrubs, in the vegetal detritus of woods, meadows, etc. (dead leaves, tree holes, piles of dry grass, rotting fruits, etc.) or carried by floods. Only a few species occur exclusively or prevalently at high altitudes (*Cryptophagus baldensis*, *C. bedeli*, *Atomaria grandicollis* and *A. ornata*) or in dune detritus (*Cryptophagus fasciatus*). Others are associated with fungal carpophores or rotting tree trunks, or occur on herbaceous vegetation, in caves, in cells and nests of hymenopterans, mammals and birds, in bat guano, moss, near the shores of marshes, in the dung of herbivores, under stones in humid grassland.

As for the diet of adults, all species are phytophagous except *Paramecosoma melanocephalum*, which is considered saprophagous.

Zoogeography

The 134 species of Cryptophagidae ascribed to the Italian fauna are classifiable within 5 main chorotypes and 12 categories. In particular, 119 species, corresponding to 88.8% of the total, may be attributed to widespread Holarctic chorotypes (47 species: 24 Holarctic, 14 Sibiro-European, 7 Centralasiatic-European and 2 Europeo-Mediterranean) and widespread European chorotypes (72 species: 40 European, 14 Central-European, 17 S-European and 1 W-European); the 15 remaining species are either cosmopolitan (6 species), distributed in all or part of the Mediterranean basin (5 species) or endemic (4 species).

Alien species

No introduced species are present.

Conservation

Thanks to their feeding habits, their capacity of occupying various types of habitat, often very degraded ones, their generally wide distribution and capacity of dispersal, no true problems seem to threaten Italian Cryptophagidae.

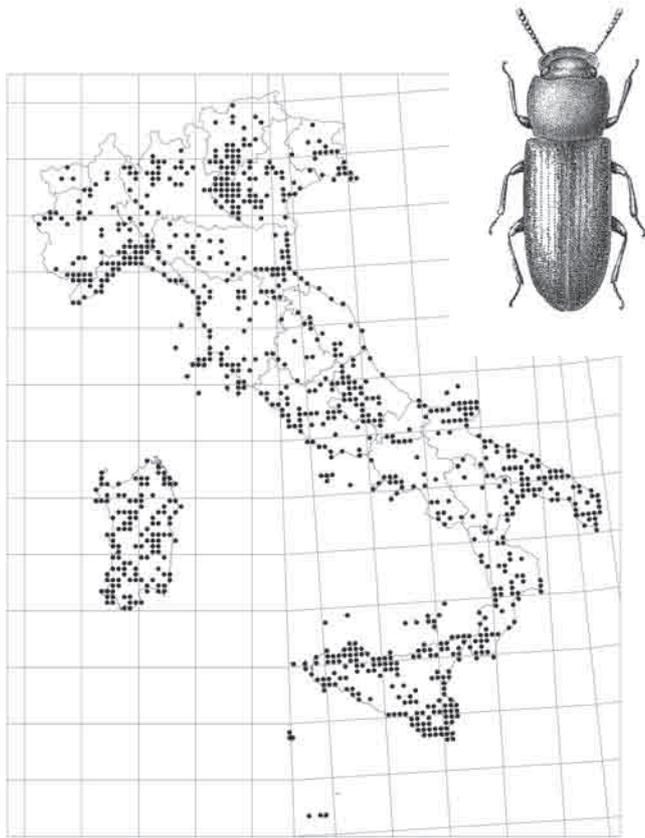
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Insecta Coleoptera Tenebrionidae

Giulio Gardini



Tenebrionidae are a family of Polyphaga beetles mainly distributed, in Italy, in the southern and insular regions. Except for a few critical genera (*Stenosis*, *Dichillus*, *Asida*), which still await revision and within which the distinction of species is often complicated, the family is on the whole well known from both a taxonomical and chorological point of view.

Material and methods

The 88 species comprised between the genus *Erodius* and the genus *Blaps* were filed. The filing of species distribution data is based on the literature considered reliable, from 1884 to the present day. Many old citations, particularly those referring to the genera *Stenosis*, *Dichillus* and *Asida*, could not be used because their assignment to the species currently considered as valid was impossible. It was also impossible to outline the distribution of *Dichillus corsicus*, a Sardo-Corsican endemic, on a bibliographic basis, since the synonymy with *D. pumilus* proposed by Soldati and Soldati (2002) is not acceptable. No unpublished data were included in the database.

Biodiversity

The Italian Tenebrionidae fauna (including the Lagriinae and Alleculinae) comprises 131 genera and a total of 316 species (107 genera and 253 species if the Lagriinae and Alleculiinae are excluded). Despite the clear taxonomic difficulties occurring within some genera, no great increase of the fauna should be expected in the future, since the family is well known and well represented in Italian collections. For number of species, Italy is the third richest region in Europe after the Iberian and Balkan peninsulas. Members of this family, which mainly includes thermophilous species, are known to decrease in number towards higher latitudes. Such a trend is clearly shown by the 88 species treated herein: most of the Italian assemblage is concentrated in the central-southern regions and islands. Few species of melasomic Tenebrionidae reach the northern Tyrrhenian and Adriatic regions, only one (*Asida sabulosa*) reaches the mountains of the Alpine arch, whereas nearly all the synanthropic *Blaps* species are widespread throughout the country.

Ecology

Tenebrionidae are mainly saprophagous, feeding on a wide variety of both vegetal and animal organic remains. The species treated here live in arid habitats and the adults, except for those of *Erodius*, *Tentyria* and *Pimelia*, are nocturnal. Species of *Erodius*, *Zophosis*, *Pachychila*, some *Tentyria* and *Stenosis* species, *Eutagenia* species and some *Pimelia* species are typically psammo-halobious, occurring in the supralittoral and extralittoral zones of sandy coasts. *Dichillus* species are myrmecophilous, often associated with ants of the genera *Pheidole* and *Messor*. The Asidini of the genera *Alphasida* and *Asida* are generally typical of garigues, Mediterranean steppic grasslands and also crops; some species (*Asida glacialis*, *A. pirazzolii*) are associated with submontane and montane grasslands of the Apennines and islands. *Elenophorus collaris*, some *Akis* and *Scaurus* species and the *Blaps* species are synanthropic.

Zoogeography

On the whole, the Tenebrionidae are geophilous and scarcely vagile animals showing a high rate of endemism, and occur in all zoogeographic regions mainly at low and medium latitudes. Of the 88 taxa here considered, 31 species and 29 subspecies are endemic. The Italian fauna includes components with West-Mediterranean (the complex *Tentyria*, *Asida* and *Pimelia* Sardinian assemblage), East-Mediterranean (*Zophosis punctata*, the species of



Giulio Gardini

Eutagenia, *Dichillus* (*Dichillocerus*) *pertusus*, *Trachyderma lima*) and North African affinities (*Erodius audouini*, *Himatismus villosus*, *Machloopsis doderoi*, *Microtelus lethierryi*, *Sepidium siculum*, *Scaurus aegyptiacus*).

Alien species

The current distributions of *Akis italica*, *Pimelia grossa* and, maybe, of *Blaps nitens mercatii* suggest they may have been introduced by the Romans from North Africa.

Relevant Literature

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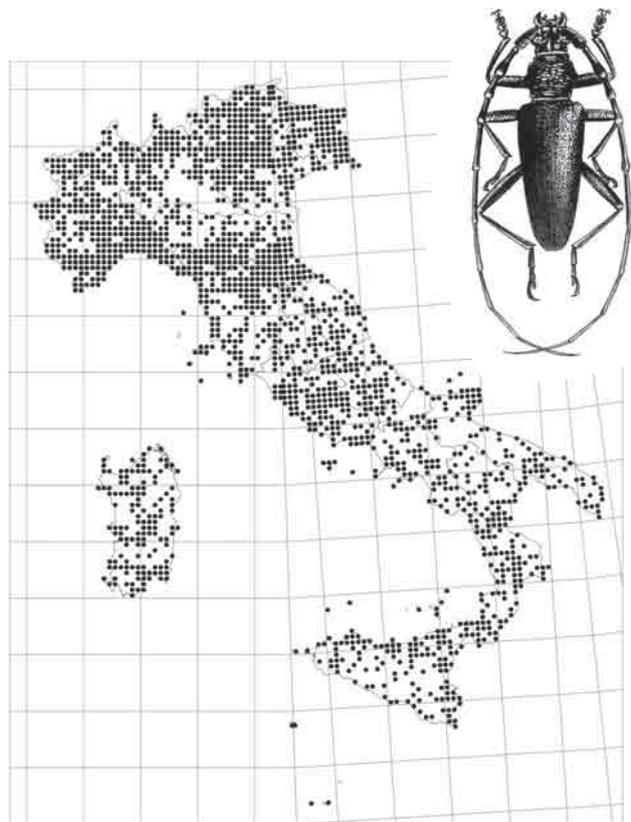
Conservation

The populations most seriously at risk are those associated with sandy coasts. The distributional areas of *Erodius siculus* and *Pimelia bipunctata* have become drastically reduced in size from the second half of the twentieth century onwards due to the industrial and tourist use of Italian coasts. Fires and excessive grazing destabilize populations of lapidicolous species of Mediterranean and montane grasslands.



Insecta Coleoptera Cerambycidae

Gianfranco Sama



Cerambycidae (longhorn beetles) are a family of beetles widespread in all temperate and hot regions of the planet. They are phytophagous without exception and occur where any kind of arboreal, shrubby or herbaceous vegetation is present. It is thought that there are between 20 and 30 thousand described species worldwide, but it is impossible to establish how many species are still to be discovered since entire African, central and South American tropical regions remain virtually unexplored. Furthermore, the normally encountered (e.g. on flowers or walking along the ground) species or those usually collected with normal methods (including light traps and sugary baits) represent only a small portion of the species living in a diversified biotope such as a forest rich in plant species. As far as Italy is concerned, the state of knowledge for Cerambycidae is currently quite satisfactory, both from a taxonomical and chorological point of view. It is true to say, however, that some regions are still poorly known (Marches, Molise, Campania, Apulia, Basilicata, Calabria, Sardinia), though research has been intensified also in these regions during the past twenty years, particularly following the publication of the cata-

logue of the Italian fauna (Sama, 1988), which seems to have strongly stimulated the new generations of Italian entomologists. Currently, Italian Cerambycidae do not cause great problems from a taxonomical point of view, although critical genera do exist, such as *Cortodera*, *Pedestredorcadion* and *Parmena*, for which traditional methods based on morphology seem inadequate. For these groups (and maybe for other, apparently less problematic ones) the use of molecular techniques could be necessary.

Material and methods

The study of Italian Cerambycidae, which lies at the base of the new Checklist and the mapping of the Italian fauna, started with the preparation work for the Fauna d'Italia catalogue of 1988. On that occasion, the totality of citations from the vast literature concerning the fauna of Italy were critically revised; a series of works preceded the publication of the catalogue, with the object of updating the nomenclature and taxonomy of Italian Cerambycidae on one hand (in the framework of a revision of the West Palearctic fauna), and that of verifying the reliability of uncertain citations (and the accordance of the cited taxa with current ones) on the other, always by trying to retrace the original sources and, when possible, the material on which the citations were based. The collections of nearly all Italian and European museums and universities, as well as all private collections made available for direct study, were examined; this brought to the study and identification of several hundreds of thousands of specimens from nearly 16,000 localities and belonging to several hundreds of collections. The data included in the present database are over 20,000.

In the past 15 years, the nomenclature of Cerambycidae has undergone considerable change; the one used in the topographic catalogue for the Fauna d'Italia (Sama, 1988) was partly updated in the Checklist of the Italian fauna (Sama, 1995) and a following work (Sama, 1999). The nomenclature used in the present database, which is again updated due to new homonymies and synonymies or recent revisions, should not undergo important changes in the near future. In the present work, it was not considered appropriate to adopt the splitting of the Cerambycidae into 2 separate families (Cerambycidae and Vesperidae), recently proposed by Svacha and Danilevsky on the sole basis of probably overestimated features of the larval morphology.



Biodiversity

The Italian fauna currently numbers no less than 285 taxa of Cerambycidae (274 species and 11 subspecies), belonging to 119 genera; this number is the highest in Europe and is second only to Turkey amongst the Mediterranean countries. This is a remarkably high biodiversity considering the limited extension of the Italian peninsula compared to other Mediterranean peninsulas, especially Turkey. It is even more significant considering the high amount of taxa of Dorcadiini (only 5 species in Italy) occurring in countries such as Spain, Greece and Turkey (61, 67 and over 150, respectively). The biological richness of Italy is determined (or at least certainly enhanced) by its longitudinal extension, central position within the Mediterranean and the presence of highly diversified habitats, both from a geological and climatic point of view; that of the Cerambycidae however, due to their particular biology, could be a direct consequence of the richness and variety of plant species occurring in Italy. Alongside a conspicuous assemblage of European and Sibiro-European species (in the Alps and Po Plain, but also importantly influencing the Apennine fauna), the Italian fauna also includes a considerable number of species and palaeo-endemisms of Baetic-Rif, Maghrebi-Sicilian, trans-Adriatic, trans-Ionian and Pontic-Illyric origin.

The northern regions (first of all Venezia Giulia and Piedmont) appear to be the richest from a faunistic point of view, not only because of high habitat diversification, but also because they are the best-studied due to intensive research by specialists. A demonstration of the importance of quality of research is the fact that Romagna, with its 150 currently known species, is the first region for number of species in relation to surface area, despite the large areas taken away from the insect fauna by intensive agriculture and mass tourism.

Although some species are rather tolerant towards disturbing elements such as human presence and human activity, Cerambycidae are generally very sensitive to any kind of habitat alteration, therefore representing good indicators of the state of conservation of biodiversity. The main problem is to pick out and apply the right kind of technique for ascertaining the presence of the most significant species, which are normally also the more elusive ones. An excellent example of naturalistic catalogue is the one recently applied to Bosco della Fontana, in the Mantua area. The abundance of species such as *Prionus coriarius*, *Leptura aurulenta* and *Plagionotus detritus* in this plain woodland undoubtedly testify its good state of health.

Ecology

Cerambycidae are distributed in all biotopes in which a minimum of vegetation is present. Indeed, as is known, their preimaginal instars develop, without exception, in

the tissues of herbaceous and arboreal plants, with highly diversified modes of attack and feeding. Normally, the larvae dig tunnels inside or under the bark of trunks and branches of various size, either dead, weakened due to various stress factors or perfectly sane. The larvae of some species (e.g. within the genera *Cortodera*, *Vadonia*, *Vesperus*, *Dorcadion*) attack the rootlets or external parts of herbaceous plants and trees, moving through tunnels excavated in the ground. Some species are mycophagous: the larvae of *Pseudovadonia livida*, for instance, dig tunnels in the ground in their search for the hyphae and mycelia of *Marasmius* fungi; on the other hand, species of *Grammoptera* excavate their tunnels under the bark of branches attacked by *Vuilleminia comedens*; the larvae of *Xylosteus spinolae* feed on dead *Corylus* and *Fagus* wood in strict association with moulds that cover the walls of the larval galleries and are propagated by the females during oviposition; those of *Necydalis maior* and *N. ulmi* are associated with fungi of the genus *Inonotus*. Many species feed on perfectly sane vegetal tissues rich in lymph: all Fiteciini, some *Oberea* and some *Plagionotus* species attack herbaceous plants, whereas *Saperda populnea* and *S. carcharias* cause damage to poplar and willow plantations. Some of the species which attack live plants avoid contact with the lymph or limit its circulation by making one or more annular incisions, which cause the weakening or drying of the wood on which they subsequently feed. The life cycle of Cerambycidae is extremely variable in length. Species that feed on live tissues go through the whole cycle within about 12 months, during which two periods of larval feeding trophic activity take place, one in summer-autumn and one in spring. Some Fiteciini of the genus *Musaria* show a very short trophic period: the adults are formed within the pupal cells already 3 to 4 months after oviposition, but emerge only during late spring of the following year. Species that feed on dead wood or even dry timber usually have a 24-month life cycle, sometimes even a 36-month one. In exceptional cases, larval life is prolonged for several years; the present author has observed emergences after 6 years (*Rhamnusium graecum italicum*), but in the literature case of larval life exceeding 10 years are reported.

Zoogeography

The chorological analysis of the 285 Italian Cerambycidae species highlights a diversification of assemblage types: 27 taxa (16 species and 11 subspecies), i.e. just over 10%, are Italian endemics; 7 are endemic of Sicily (only one with Maghrebi affinities), 2 of Sardinia (one with Baetic-Rif affinities), 12 of the Apennines; 9 taxa show Balkan or East Mediterranean affinities, 3 West Mediterranean affinities, while 7 show uncertain affinities. Three Sardo-Corsican endemics, three "occidental Alpine" elements (shared by the Italian and French sides of the Maritime and Cozian Alps and neighbour-



ing areas) and one “Julian-Dalmatian” element (occurring from Trieste to Istria) should be added to the strictly speaking Italian endemics. Of the remaining taxa, 40.8% show a Sibiro-European, 20.8% a S-European, 12% a Euro-Mediterranean and 13.4% a Mediterranean distribution; lastly, there are 6 Holarctic species, while 5 have resulted from more or less recent anthropogenic introduction. In further detail, among the taxa with an European distribution, 40 occur only in the Alps in Italy, while 29 also occur along the Apennines (9 are associated with relict montane *Abies alba* sites). It is noteworthy that while the S-European taxa are mainly of eastern distribution (44.1%), the Mediterranean ones are mostly circum-Mediterranean (65.8%) and West-Mediterranean (23.7%).

Alien species

Five recently introduced allochthonous Cerambycidae species are currently established in Italy. Besides the by now historical presence of *Neoclytus acuminatus*, a species native to the United States which was introduced at the beginning of the last century and occurs in central-northern Italy, four recently introduced species the establishment of which is almost certain must be added. These are: the Australian *Phoracantha semipunctata* and *P. recurva*, the former occurring in nearly all *Eucalyptus* plantations of central-southern Italy, the latter having been discovered only in 2003 in Apulia; *Callidiellum rufipenne*, native to the Far East, which in Italy appears to be restricted to the Romagna littoral near Ravenna where it was discovered and from where it seems not to have spread further; *Xylotrechus stebbingi*, introduced with timber from northern India, and first found in Venice at the end of the 1980s, is by now widespread in all central-northern regions and Sardinia. Another 3 species, which may also have become established in Italy, may soon be added to the Italian fauna: the first (*Anoplophora malasiaca* or *A. chinensis* var. *malasiaca*, according to the most recent systematic studies) occurs in Italy since 1998 near Parabiago in Lombardy, where it may have been introduced from China together with bonsais.

Relevant Literature

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Conservation

The reawakening of ecological awareness in recent years has brought to the issuing of laws and regulations for the protection of nature and the publication of Red Lists of endangered animals. An inconsistency of these tools is that they generally tend to protect large insects (e.g. *Cerambyx cerdo*) or conspicuous ones that are not in real danger (such as *Rosalia alpina*), while completely ignoring smaller insects with limited distributional areas which can be defended only through a more thorough environmental protection.

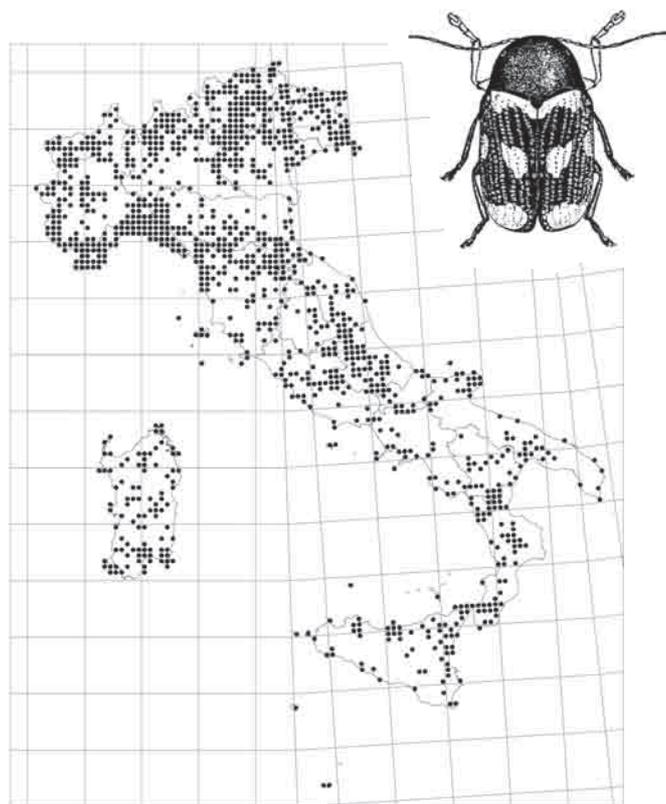
Due also to the continuous expansion of urban settlements, the purely economic exploitation of woods and forests (sometimes even inside nature reserves) and the considerable increase of forest fires in recent years, the future of many Italian Cerambycidae, mainly that of the endemics of course, is rather worrying. Nearly all the Sicilian endemics (*Schurmannia sicula*, *Clytus clavicornis*, *Grammoptera viridipennis*, *Neopicciella sicula*, *Ropalopus siculus*) live in extremely limited areas of the Nebrodi and Madonie, and the occurrence of a fire in one of these forests (by no means a remote possibility) would have devastating effects. The very interesting species *Rhamnusium graecum italicum* is also in great danger, on the brink of extinction, and survives in not at all protected habitats near expanding industrial areas. Other endemics, such as *Pedestredorcadion mediterraneum* and *Neodorcadion calabricum*, are probably already extinct due the destruction of their habitats; many others, endemic or not, like *Prinobius myardi*, *Necydalis ulmi*, *Rhamnusium bicolor*, *Acanthocinus xanthoneurus*, but also *Purpuricenus kaehleri* and *Aromia moschata* (this last species certainly at greater risk of extinction than *Rosalia alpina*) have disappeared from most of their distributional areas because of the cutting down of the old trees on which they developed. Fortunately, many of the most interesting Italian Cerambycidae occur within protected areas (nature reserves); to preserve and consolidate these areas, also by limiting their use by so-called “intelligent tourism”, would represent a better protection for the endangered species than their inclusion in a Red List.



Insecta Coleoptera Chrysomelidae

Cryptocephalinae

Davide Sassi



Cryptocephalinae form a vast and important subfamily of Chrysomelidae, widely represented in all continents. There are over 4,000 currently described species, around 1,800 of which belong to the extremely large genus *Cryptocephalus*, one of the richest in species of the whole animal kingdom. The systematics of Cryptocephalinae are at a standstill, being based on the traditional method of analysis of morphological features selected according to “empiric” criteria, no study of a phylogenetic type having yet been carried out, with the exception of extremely small groups of species.

Material and methods

The census of the species occurring throughout Italy was carried out using the works of Burlini (1956, 1968) as a starting point, supplemented by information taken from more recent faunistic papers. Of the approximately 7,400 used records, around 42% were unpublished or in any case obtained from the direct study of material kept in public and private collections. Among these, noteworthy are the collections of the Natural History Museums of Verona and Milan, which are particularly important for

the Chrysomelidae of the Italian fauna. Data taken from more ancient works were critically considered before eventually being added to the database.

Biodiversity

The species currently known for the Palearctic region are around 500, belonging to 6 separate genera. In Italy 149 taxa (including subspecies) occur, distributed within the 3 genera *Cryptocephalus*, *Pachybrachis* and *Stylosomus*. For at least two species (*Pachybrachis flexuosus* and *Cryptocephalus laevicollis*), records for Italy would need reconfirming by further data. The taxa occurring in peninsular Italy are 125, whereas they are 37 and 31 in Sicily and Sardinia, respectively. Italy is the region richest in species in Europe, and outnumbers both the Iberian (118) and Balkan (105) peninsulas and France, Corsica included (140); in central-northern Europe biodiversity for this group is much lower. Only within the genus *Pachybrachis* is the nevertheless remarkably rich Italian fauna (26) outnumbered by that of Spain (32), where climatic conditions are obviously more favourable to this genus, which shows marked heliophilous preferences.

Ecology

Adults are prevalently polyphagous, feeding on the leaves, petals and pollen of plants belonging to many different families. Some species have sometimes been reported as damaging both wild and cultivated species, such as *Cryptocephalus pini* on *Pinus nigra* in forest plantations. In reality, Cryptocephalinae do not seem to be of any agrarian interest, and never give rise to true infestations even when host plants are abundant. A characteristic habit of the adults is that of falling to the ground and playing dead (= thanatosis) for some time. Cryptocephalinae are mainly active in late spring and early summer, a period in which mating and oviposition occur, adults already becoming scarcer by the end of June. An exception to this consists of species occurring at high altitudes, such as for instance *C. pini*, *C. barii*, *C. violaceus*, *C. aureolus* and *P. danieli assiettae*, the phenology of which lasts until late August. Another exception is that of species of the subgenus *Burlinius*, which can be seen in large numbers on Mediterranean vegetation even in late September. The life habits of larvae are still poorly known. They generally develop within a theca made of faecal material, and live hidden amongst soil detritus or freely on foliage. Myrmecophily is uncommon but has been observed in some species.



Zoogeography

In Italy there are 44 taxa either endemic or showing a rather limited distributional area. The endemism rate is rather high, reaching 27% in *Cryptocephalus* and as much as 52% in *Pachybrachis*. The number of endemics occurring on island territories makes up for 34% of the total, but the assemblage of Apennine or Apennine-Dinaric species is also very rich (32%).

Moving from the peninsula to the large islands, one can observe, besides and obvious fall in the absolute number of taxa, also an interesting percent variation of the various genera and subgenera. *Pachybrachis* species range between 15% of all *Cryptocephalinae* on the peninsula and 27% in Sicily. The subgenus *Burlinius* increases from 23% on the peninsula to 45% in Sardinia. The species with a mainly Mediterranean distribution belonging to this last taxon seem particularly favoured by insular conditions. The frequency of *Burlinius* species compared to the total of *Cryptocephalinae* reaches 52% in Corsica and as much as 75% in the Balearic Islands. Many of these species are interesting endemics. For instance, half of the Sardo-Corsican endemics belong to this subgenus. On the other hand, the most specialized subgenera of *Cryptocephalus*, such as *Heterichnus* and *Protophysus*, are missing in Sicily and Sardinia like in all Mediterranean islands.

The Mediterranean area and especially its islands appear to be particularly favourable to speciation within the genus *Pachybrachis*. A demonstration of this is the high richness in endemics in islands of the East Mediterranean, the Iberian peninsula and peninsular Italy. A paradigmatic case is that of *P. scriptus* in Italy, which occurs in Sardinia and Tuscany and is phylogenetically closely related to *P. osellai* (endemic of the Egadi islands), *P. siculus* (endemic of Sicily) and *P. burlinii* (endemic of the Pontine islands).

Within some groups of *Cryptocephalus* of mainly Sibirop-European distribution, and therefore showing a more or less marked preference for relatively cool climates, speciation seems to have been favoured by Pleistocene climatic fluctuations. For example, the *C. hypochaeridis* group, which mainly consists of species characterized by very low morphological differentiation – which let suppose relatively recent speciation processes –, is probably of north Asian origin (central Siberia), having reached western Europe during one or more cold phases of the Pleistocene, through the corridor lying between two great central-European and Alpine glaciers (Leonardi and Sassi, 2001). During the warm phases (warmer than the current phase), in more southern areas, populations are thought to have found refuge (of an “interglacial” kind) on the higher mountainsides of the Caucasus and south-European mountain chains (Pyrenées, Alps, Apennines), thus splitting the distributional area of the species and giving rise to allopatric speciation phenomena. Nearly

all the endemic taxa of the southern Italian regions, belonging to the *C. hypochaeridis* group, and among these *C. falzonii* of the southern Apennines, are in fact more frequent at relatively high altitudes.

Alien species

No alien species are recorded.

Conservation

Cryptocephalinae do not include species at immediate risk of extinction, although the high number of endemic species occurring throughout Italy suggests that particular attention should be paid towards the management of territories where species with limited distributional areas occur. Many of the most significant taxa are associated with grassland and shrubby habitats of the montane belt. The abandoning of agricultural practices and pasturing, which has favoured the gradual spreading of woodland at the expense of meadows, could seriously threaten these species. Other species belong to the Mediterranean area, and are sometimes associated with small distributional areas and/or islands. Here also, negligence, fire and anthropogenic pressure could jeopardize the presence of these delicate species within a few years. Oligophagous or basically oligophagous species may be more sensitive than others to the rapid changes undergone by littoral zones. Among these species are *C. tetraspilus*, *C. infirmior*, *C. hirticollis*, the endemic *Pachybrachis* of the *P. scriptus* group discussed above, as well as all the *Cryptocephalus* species of the subgenus *Burlinius* that populate the arid Mediterranean belt, such as *C. pulchellus*, *C. blanduloides*, *C. equiseti*, *C. cognatus*, *C. politus*, *C. lostiai*, *C. alboscutellatus*, *C. ragusanus*, *C. plantaris*, *C. alnicola*. Many of these are also part of the precious assemblage of insular endemics.

It must be said that some endemics, frequently recorded throughout the country in the past, are poorly represented in recent collections. One of these is *Cryptocephalus stragula*, which according to old records was once distributed from Piedmont to Sicily, and is now clearly becoming rarefied. *P. testaceus* and *P. anoguttatus*, the biology and true abundance of which are poorly known and which have been recorded only from Sardinia in recent times, are particularly rare and localized.

Other species, rather common north of the Alps and often reported in the past also from Italy, are currently only sporadically collected. Among these are *C. populi*, *C. frontalis*, *C. querceti*, *C. frenatus* and *C. quinquepunctatus*, *C. octopunctatus*, *C. quadriguttatus*, *C. nitidulus*. The decline of these species, which do not appear to be particularly sensitive to ecological changes, at least in central Europe, could be due to casual fluctuations in the abundance of populations situated along the edge of their distributional areas. The same cannot be said of the decline (disappearance?) of *C. curvilinea*, *C. cicatricosus*



and *C. tristigma* in Sicily. The first, which is associated with humid environments, may be a victim of substantial alteration of ecological conditions, whereas the biology

of the other two, which are extremely rare, is completely unknown, and so are the reasons of their possible disappearance.

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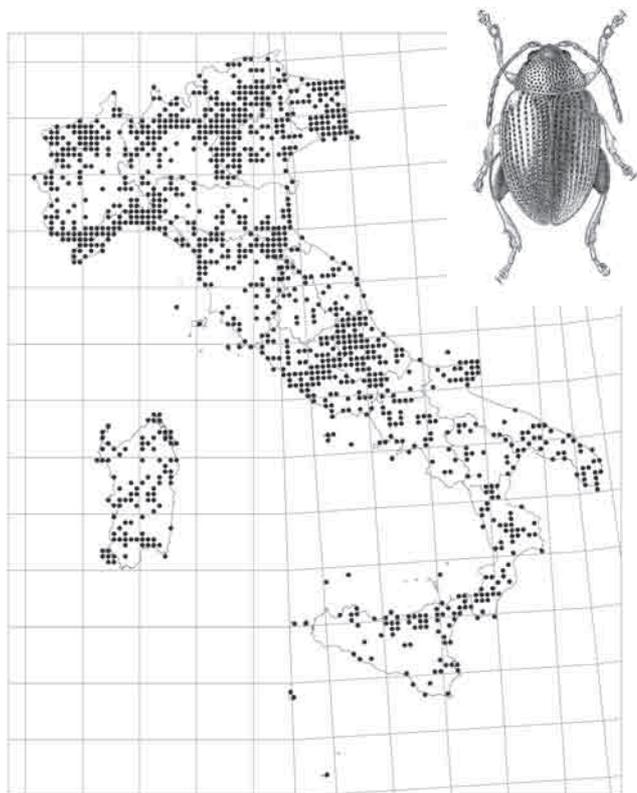
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Insecta Coleoptera Chrysomelidae

Alticinae

Maurizio Biondi



The Alticinae, with approximately 6,000 to 7,000 species representing just over 500 genera, form the largest subfamily of Chrysomelidae beetles. They occur in all zoogeographical regions and some genera, such as *Longitarsus*, *Chaetocnema* and *Phyllotreta*, are practically distributed all over the world. Morphologically they are mainly characterized by a metafemoral apodeme, which allows them to jump quite efficiently through the combined action of specific levers and muscles. Externally, the hind femora are greatly swollen compared to the anterior and middle ones. However, the jumping capacity and swelling of the hind femora are considerably reduced in some species, following adaptation to sublapidicolous habits. Moreover, the possession of a metafemoral apodeme is not in itself sufficient to establish with certainty whether a species belongs or not to this subfamily, since it is clearly a feature of adaptive value, which is not necessarily informative from a phylogenetic point of view. Also, recent biomolecular studies have highlighted the probable paraphyletic nature of this taxon.

Material and methods

The filing of species distribution data is based on litera-

ture starting from the second half of the nineteenth century, which was critically screened and supplemented by the examination of material preserved in the main Italian collections, as well as of the most recent international literature. Old citations of species belonging to recently revised groups were only considered when they could be confirmed by the examination of material. Unpublished data included in the database represent a large part of the total, and were mainly obtained from the study of material preserved in the main Italian Natural History Museums, as well as in various private collections including that of the author, which is kept at the Environmental Sciences Department of the University of L'Aquila.

Biodiversity

According to the present state of knowledge, the Italian Alticinae fauna consists of approximately 360 species belonging to 25 genera, four of which – *Aphthona*, *Longitarsus*, *Phyllotreta* and *Psylliodes* – comprise about 60% of all Italian species. However, despite the good overall taxonomical and chorological knowledge of this taxon, it is easy to foresee a considerable increase in the number of species occurring in Italy, also considering the slow but steady increase registered during the last thirty years. Currently, Italy is the European country richest in Alticinae, followed by France (about 330) and Spain (about 320). At a regional level, apart from a few obvious gaps in knowledge in Aosta Valley (23 species), Umbria (36), Molise (46) and the Marches (70), there is a high number of species (around 280) in the north, mainly in Friuli Venezia Giulia (177), Piedmont (153) and Trentino (145), while Lombardy (118) is certainly underestimated. As for the central regions, this subfamily is particularly well represented in Tuscany (152), Latium (153) and Abruzzo (153). There is an overall drop in species numbers in southern Italy, probably due to a “peninsula effect”, with an average of about 110 species per region. As for the major islands, there are currently 113 known species in Sicily and 89 in Sardinia, these numbers being probably not too far off from reality.

Ecology

Alticinae are, both as larvae and adults, largely associated with herbaceous plants, more rarely with trees. They are mainly monophagous (i.e. associated with one or more plant species of the same genus) or oligophagous (i.e. associated with one or more plant genera of



the same family); polyphagous forms, which go through their larval stages (larval polyphagy) or feed as adults (imaginal polyphagy) on several different plants belonging to systematically distant families, are less common. Several species can cause even serious damage to plants of economic interest. As for their life cycle, the Alticinae show one or more annual generations, with a winter diapause usually in the adult stage. The larvae are normally endophytic and bore into the rootlets of their host plants, usually eating their way up to the collar or the stalk, but cases of ectophytic larvae feeding on foliar parenchyma are not lacking. Pupation usually takes place in the ground. Such habits refer nearly exclusively to Palearctic and Nearctic species, since only very scarce information on the biology of species occurring in other zoogeographical regions, particularly in the Afrotropical, Neotropical and Australian ones, exists. Recently carried out research on the Mediterranean fauna have shown that the Alticinae play an important role in environmental characterization by providing guidelines for the evaluation of the state of conservation of both natural and variously anthropized habitats.

Zoogeography

The Italian Alticinae include around 5 to 6% of endemic species, particularly within the genera *Orestia* and *Psyllioides*, followed by *Aphthona*, *Longitarsus*, *Neocrepidodera*, *Minota* and *Dibolia*. Most endemics occur in the central and western Alps, the central Apennines, Sardinia and Sicily. They are mainly taxa associated with the montane woodland belt, whereas ealpine and Mediterranean elements are more rare. The origin of these taxa is most certainly related to the quaternary glaciations, when alternating climatic events enhanced differentiation phenomena. An interesting occurrence in Italy is that of *Arrhenocoela lineata*. This Mediterranean-distributed species belongs to a monotypic genus of probable tertiary origin, which shows direct oriental affinities and is systematically quite isolated from the rest of the West Palearctic fauna. *A. lineata* has a late-summer to autumn phenology, ectophytic larvae, and is associated with *Erica* shrubs; it mainly occurs in coastal and subcoastal habitats, and penetrates further inland only in areas characterized by strong Mediterranean features (Biondi and De Nardis, 2002).

As a whole, the Italian Alticinae assemblage can be divided into three groups (cf. Biondi, 1988): a) a first group, comprising the most northern regions of mainland Italy, characterized by a high percentage of species with a European s.l. distribution; b) a second, less homogeneous group, comprising the more strictly peninsular regions, characterized by a conspicuous number of S-European-distributed species in the inland mountainous areas and by a gradual increase of Mediterranean elements in a

north-south direction, particularly in regions with wide coastal zones; c) a third group, comprising the insular regions, largely differing from the previous two by its greater richness in Mediterranean elements, particularly ones with West Mediterranean and North African chorotypes, as well as by the strong reduction of species with a European s.l. distribution. The widely distributed component (Palearctic s.l.) is rather evenly represented throughout the country.

Alien species

Just one species has recently been accidentally introduced to Italy: *Epitrix hirtipennis*. This species is native to North America and is one of the main pests of tobacco plantations, especially high quality tobacco, a few holes on the leaf surface of which can prejudice its commercialisation. The first official record of *E. hirtipennis* for Italy and Europe dates back to April 1984, when a mass and unexpected invasion of this species occurred in various communes of the province of Benevento, causing damage to both nurseries and open-air tobacco plantations. Since then, despite ready and mass intervention with chemicals aimed at its limitation and successive eradication, *E. hirtipennis* has spread all over peninsular Italy, also at relatively high altitudes, using various Solanaceae, not only tobacco, as host plants.

Conservation

Although there are not many endemics within the subfamily, many species, often known in very few or even single populations, can be seriously threatened by wrong environmental management policies. Many human activities obviously cause a highly negative impact on phytophagous beetle assemblages, at least in terms of biodiversity. However, some specifications should be made concerning the Alticinae: a) the species associated with dune environments, such as *Psylliodes marcida*, *Psylliodes maroccana*, *P. pallidipennis*, are particularly vulnerable and can disappear very quickly (even when locally abundant) if the psammophilous vegetation is significantly altered; b) *Longitarsus laureolae* is an interesting southern Apennine endemic which inhabits *Daphne laureola* plants only when particular conditions of humidity of beech forests are fulfilled; these forests should therefore be very carefully managed, especially when coppiced; c) species associated with hygrophilous vegetation, such as *Longitarsus holsaticus*, *L. zangherii* and several *Chaetocnema* species, are also highly endangered given the fact these environments are often deeply modified or badly managed in terms of habitat conservation; d) medium and high altitude rupestral habitats should also be duly kept in mind by environmental planners, since they host interesting *Psylliodes* and *Phyllotreta* species.



Relevant Literature

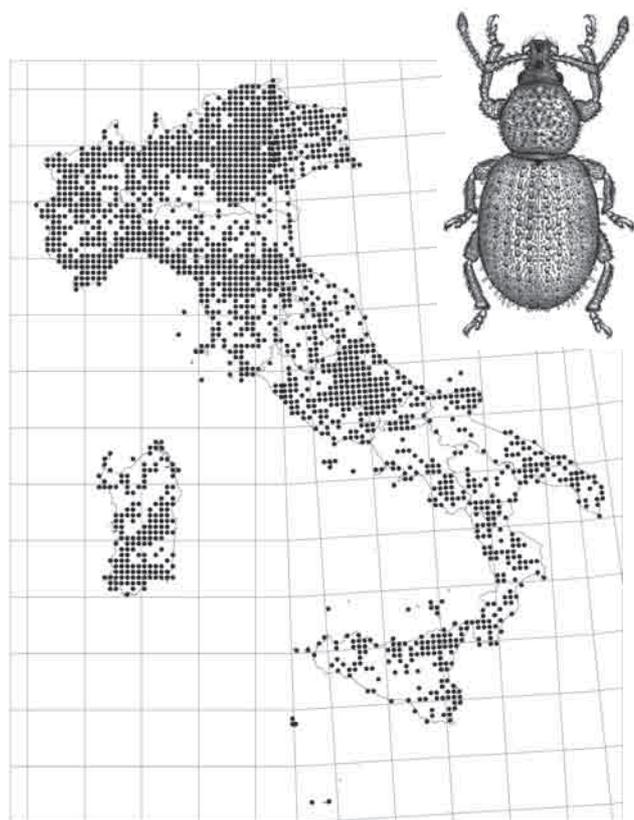
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Insecta Coleoptera Curculionoidea

Giuseppe Osella, Silvano Biondi, Carla Di Marco, Luigi Magnano, Anna Maria Zuppa



This superfamily of beetles is characterized by adults the head of which is produced into a rostrum (ranging from short and stout to long and thin) on which the antennae (straight or elbowed), of variable length, are inserted. They possess chewing mouthparts with either reduced or lacking palpi and robust mandibles; the larvae are cyrtosomatic, apodous, endophytic or subterranean. They are phytophagous insects, often oligophagous, amphigonic, rarely parthenogenetic. The superfamily, divided into 23 families (including the Scolytidae and Platypodidae) (Alonso Zarazaga and Lyal, 1999), numbers 6,000 genera and approximately 57,000 species. These values certainly only represent a fraction of the truly existing taxa (Thompson, 1992). The Curculionoidea are known since the Mesozoic.

Material and methods

The taxa analysed herein (769), although they represent only part of the total Italian fauna (34%), well summarize the naturalistic meaning of the Curculionoidea beetles. The present results were obtained from the analysis of the literature and material kept in Italian and foreign museums. Many data were taken from private collections.

However, the most important source of information was research work carried out by the authors.

Biodiversity

The Checklist of the Italian fauna (Abbazzi et al., 1994) reports, for the Curculionoidea, a total of 2,265 taxa (2,090 species and 175 subspecies) divided into 11 families and 505 genera. The numerical values having marked the increase of knowledge during the past 100 years are interesting. In 1899, Bertolini reported 1,779 species and 333 varieties altogether; Luigioni (1929) updated these values to 1,742 species and 509 varieties. Data of Abbazzi and Osella (1992) indicated the presence of 2,001 taxa (1,814 species and 187 subspecies) (Scolytidae and Platypodidae excluded). Such increases and changes are essentially due to research carried out during the last fifty years, but also to thorough classical taxonomic studies. On the other hand, the use of molecular biology techniques is still poor.

Many taxa need revision, particularly within the apterous and/or stenotopic groups, as well as among the strictly monophagous species. For these reasons, it is not easy to say where the limit to the Italian Curculionoidea assemblage really stands, since descriptions of new taxa and first records continually occur. By and large, the numbers reported above are thought to represent from 92 to 93% of the species actually occurring in Italy. Further field surveys are necessary to complete the picture. In fact, several areas of the north and south, the Apennines and the Alps, the Preapennines, Sardinia and the Po Plain would deserve further in-depth investigations. The most promising taxa in terms of the discovery of new species are the humicolous and forest ones (*Otiorhynchus* species of the subgenus *Lixorhynchus*, *Solariola*, Torneumatini, Raymondionymidae, etc.) and those colonizing xeric habitats (Peritelini, Mylacini, Trachifleini, Catormiocerini, etc.); lastly, worth pointing out among the colonizers of summit grasslands, the groups of species with a relict and punctual distribution (*Otiorhynchini* in particular) and the taxa monophagous on rare, relict or endemic plants.

Ecology

Curculionoidea beetles can be found in all inhabitable terrestrial environments. In Italy they can be found from sea shores to the highest altitudes. They can be divided as follows:

a) Hygrophilous elements. These are mainly related to



hygrophilous habitats and vegetation. Species with a northern distribution are dominant; endemics are rare. Because of reclamations and pollution they are strongly declining. They are excellent environmental indicators (e.g. part of the Ceutorhynchini, the Bagoini, the Tanyssyrini, etc.).

b) Xero-thermophilous elements. A large part of the Mediterranean s.l. elements are nearly exclusive to arid or xeric habitats. Their larvae are rhizophagous or associated with low vegetation, whereas the adults are nocturnal and apterous. They show a strong tendency towards endemism (Polydrosini, Trachifleini, Miniopini, Brachyceridae, etc.).

c) Forest elements. Mainly associated with broadleaved forests (litter layer, epigeal vegetation but also dead wood). They are extremely demanding in terms of humidity and temperature. The larvae are prevalently rhizophagous (except in the Cossonini), and adults are either flyers or non-flyers. They are excellent historical-ecological bioindicators (*Otiorhynchus* species of the subgenera *Troglorhynchus*, *Baldorhynchus*, *Lixorhynchus*, *Acallornewma*, Raymondionymidae, etc.). On the other hand, species associated with epigeal parts of the forest (Attelabidae, Rhynchaenini, Curculionini, Cossonini, etc.) are quite good flyers and therefore less significant as bioindicators.

d) Elements of open habitats. Most taxa with epigeal larvae and strong-flying adults (Attelabidae, Apionidae, Nemonychidae, Urodontidae, Ceutorhynchini, etc.) are part of this group. They are generally widespread and their importance as bioindicators is limited to the strictly monophagous species.

Lots of Curculionoidea have been for various reasons cited by authors among the species causing economic damage. Some species with rhizophagous (*Otiorhynchus*, *Sitona*, etc.), anthophilous-carpophagous (*Anthonomus*, *Curculio*, *Tychius*), gall-forming larvae or larvae associated with stems (Ceutorhynchini, Mecinini) are particularly important in this respect. Currently, the most damaging pest species are those attacking vines, olive trees and ornamental field and greenhouse plants. They belong to *Otiorhynchus* and kin genera. In the past, Cleonini and Ceutorhynchini used to cause much damage to open field crops. Lastly, one must not forget that Curculionoidea are good controllers of infesting and anthropophilous weeds (e.g. the *Smicronyx* species associated with *Cuscuta*).

Zoogeography

The zoogeographical components of the Euro-Mediterranean Curculionoidea assemblage, from which the Italian assemblage originates, can be summed up as follows:

1 - Tethyan component. It occurs in the territories that used to surround this ancient ocean, from New Guinea to the Mediterranean area, the southern United States,

Mexico and Venezuela. It is exemplified by the Raymondionymidae.

2 - Gondwanian and Paleotropical component. It comprises many groups with an austral distribution (from Australia to South America), containing species having differentiated from the original one at the level of species, genus, subtribe and tribe in the Mediterranean area. This complex comprises the Anthribidae, Brachyceridae, Apionidae, Attelabidae and Curculionidae (Peritelini, Molytini, Tanyrhynchini, etc.). Since the West-Mediterranean Peritelini are vicariated in the southern United States, it can be supposed that the tribe was already present in the Tyrrhenian area before the Atlantic was formed.

3 - Paleomediterranean component. Restricted to the Euro-Mediterranean–Centralasiatic areas of the Miocene Tethys, it is mainly represented by elements colonizing xeric habitats (Orthochaetini, Torneumatini, etc.). Two Mediterranean genera also occur in the United States and Central America: *Mesites* and *Aphanommata*. Fossils of Mediterranean genera are known from Florissant (United States) (*Coniatus*).

4 - Pontic-Sarmatian component. It colonizes inland xeric habitats, even of medium altitudes. In the Apennines, where it is poorly represented, it mainly occurs in the central areas (*Bangasternus*, *Ceratapion*).

5 - Balkan component. Mainly distributed in the central-southern parts of the Adriatic side of the Apennines (*Dodecastichus*, *Otiorhynchus*, *Mylacus*, *Elytrodon*, etc.).

6 - Maghrebi component. Distributed on the islands of the Sicilian Channel and in Sicily; few species reach Calabria and further. It is not abundant, but is nevertheless important for the number of genera it includes.

7 - Alpine and Euro-montane component. Essentially pertaining to high altitudes, it colonizes summit grasslands, mesophilous woods and humid environments. It is numerous and faunistically important (*Otiorhynchus*, *Barynotus*, *Alophus*, *Plinthus*, *Tropiphorus*, *Leiosoma*, *Dichotrachelus*, etc.).

8 - Sibirop-European component. Of mainly quaternary origin, it is associated with boreal and mesophilous woods, summit grasslands and humid environments. It is exemplified in Italy by the Polydrosini, Bagoini, Erirhynini, etc. It usually becomes less abundant from the Alps to Calabria, occupying higher altitudes at the same time.

9 - Widely distributed Euro-Mediterranean component. It mainly consists of euryoecious and basically xerophilous species, normally influenced by anthropogenic activity. It forms an important part of the Italian assemblage, but is usually of low biogeographical significance.

Although it includes fragments of anciently emerged lands, the Italian peninsula is of recent origin; this explains why its fauna, as already mentioned above, has been influenced by those of surrounding territories. Therefore, the population phenomenon of "vicariance" (and subsequent in-place evolution) mainly involved the



above-cited groups 1 to 3 (Peritelini, Torneumatini, Raymondionymidae), which are particularly concentrated in the Tyrrhenian area and major islands. On the other hand, components 4 to 9 (late-tertiary, quaternary and holocenic) were mainly involved in the phenomenon of “dispersal”.

A very important feature of the Italian assemblage is the high number of endemics, which are 495 altogether (Scolytidae and Platypodidae excluded), i.e. approximately 25% of Italian Curculionoidea.

The faunistic characteristics of the Italian Curculionoidea assemblage can be summarized per section:

1) Alpine section (southern side). Despite the differences between the western and central-eastern parts, this assemblage is characterized by high numbers of Otiorynchini, Tropiphorini, Barynotini, Molytini, Dichotrachelini, etc. with a mainly European distribution, and by the abundance of species with a wide European and Palearctic distribution.

2) Apennine section. It is more complex than the Alpine one. The northern Apennines include a somewhat impoverished alpine assemblage, many Balkan elements (Adriatic side) and, above all, a significant Tyrrhenian component (Peritelini, Torneumatini, Raymondionymidae, etc.) on the hilly and coastal side. In the southern Apennines a decline of the northern and Tyrrhenian elements is counterbalanced by an increase of Ionic-Aegean species (*Otiorhynchus*, *Stomodes*, *Elytrodon*, *Auchmerestes*, *Metacinops*, etc.). Two genera of great biogeographical significance, *Ruffodytes* and *Solariola* (which is endemic), occur in this section. The Sicilian Apennines stand out for their species richness, but most of all for hosting genera and species with Maghrebi affinities or of Maghrebi origin: *Trachyphoeus*, *Choerocephalus*, *Cyrtolepus*, *Amonphus*, *Gonocleonus*, *Chiloneus*, *Geomecus*, *Chilonorhinus*, etc.

3) Sardo-Corsican section. The Sardinian assemblage is very particular, due to a) the presence of 5 monospecific endemic genera (*Neosimo*, *Poggionymus*, *Lostianus*, *Bohemanius*, *Pseudosimo*) and 2 Sardo-Corsican ones (*Lep tomeira* and *Neohexarthrum*), b) the incredible number of endemic Peritelini (48 of the 53 species occurring on

the island) and c) the absence (or very reduced presence) of most Apennine genera of Anthribidae, Apionidae, Atelabidae and Curculionidae.

4) Po section. Due to its environmental monotony and strong anthropization, the Po Plain is little significant from a faunistic point of view. However, in the past it must have hosted important hygrophilous and forest assemblages, and acted as a medium for faunistic exchange between the Alps and Apennines, western and eastern Europe, as demonstrated by the occurrence, in sites of the Prealpine and Preapennine belts, of various taxa showing a relict distribution in the Po Plain (*Anisorhynchus*, *Psolidium*, *Brachycerus*, *Minyops*, etc.).

Alien species

Many alien taxa have been found in the country, but few have actually become established. Four *Sitophilus* species, *Rhopalapion longirostre*, *Pantomorus cervinus* and *Gonipterus scutellatus* are among the most important ones from an economic point of view, while *Pentarthrum huttoni* and *Micromimus osellai* should be considered amidst those of uncertain acclimatization.

Conservation

There is no certain information on species having become extinct in Italy. The fact that many species have not been found again since their description (several species of *Dichotrachelus*, *Solariola*, *Torneuma*, *Elytrodon*, etc.) does not necessarily mean they have disappeared. Maybe the disappearance of *Otiorhynchus franciscoloi* (Bosco Tanassi, Guglionesi) should be considered as certain, due to the complete destruction of the only biotope from which it was known. On the other hand, the rarefaction or local extinction of stenotopic and stenoecious taxa are probably objective. Humicolous forest species are particularly sensitive as a rule, though to a different extent according to groups. For instance, *Otiorhynchus* species of the subgenera *Troglohyrchus* and *Lixorhynchus* are more sensitive than *Solariola* and *Torneuma* species to partial logging of forests. Briefly, it can be said that all the significant species “suffer” from the risk of local extinction (especially the hygrophilous ones).



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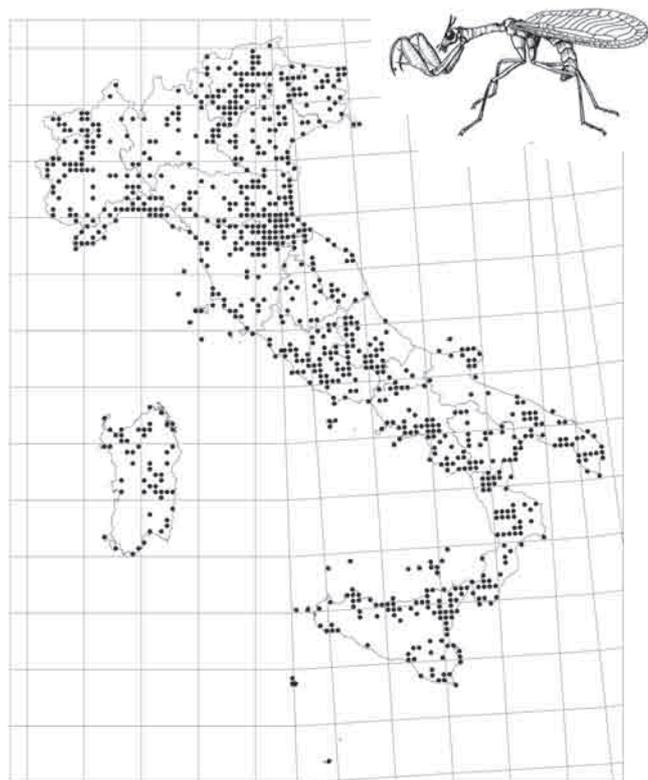
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Insecta Neuroptera, Megaloptera and Raphidioptera

Agostino Letardi



Neuroptera are holometabolous insects of small to medium size (in few cases large); there are over 6,500 estimated species worldwide, belonging to 3 orders (or sub-orders, according to the views of various authors): Megaloptera, Raphidioptera and Neuroptera sensu stricto. The Italian fauna is relatively well known thanks to works specifically aimed at this group, particularly following the revision of the European fauna that was published in 1980.

Material and methods

The filing of species distribution data was done by two authors (Pantaleoni did the Raphidioptera and the Chrysopidae and Myrmeleontidae among the Neuroptera; Letardi did the Megaloptera and the remaining Neuroptera), and only the part compiled by Letardi was updated to 2003. Most of the reported data were personally checked by one of the two authors: old citations, particularly those referring to the families Chrysopidae and Hemerobiidae, were carefully screened, their assignment to the species currently considered as valid being often difficult, if not impossible in some cases. Lots of the material preserved in the main public and private Italian

collections was included, thanks to study work carried out mainly during the past twenty years. The results of such studies had in most cases already been published, unpublished data therefore mainly accounting for only a small portion of total records.

Biodiversity

Approximately 190 species of Neuroptera s.l. are currently known for Italy, belonging to 14 families and seventy-odd genera (Bernardi Iori et al., 1995). After a rapid climb in the years following 1980, the number of species is still slowly but steadily increasing, and it is not impossible that the fauna of this group may exceed 200 species. Uncertainty concerning the exact number of species is also due to some “taxa complexes” the taxonomic rank of which is still under study, particularly within the Chrysopidae and Myrmeleontidae. A particularly complicated situation is that of *Chrysoperla* and *Dichochrysa*, though *Creoleon*, *Megalomus* and *Symphorobius* also need taxonomic revision. The European Neuroptera s.l. fauna shows (with the striking exception of the Sialidae) a clear increase in biodiversity along the north-south axis. The number of Italian species is comparable to that of the Iberian and Balkan peninsulas which include, however, a higher percentage of endemics, and are considered the centres of diffusion of the Dilaridae and Raphidiidae, respectively. The state of knowledge of Italian Neuroptera s.l. is widely inhomogeneous, both throughout the country and between families. From a territorial point of view, some areas and districts of the country are relatively well known (the Alpine area, Romagna, Sardinia, some parks of central and southern Italy), but vast areas have so far been only very poorly investigated. A big difference in state of knowledge exists between families of agrarian interest (i.e. Inocelliidae, Chrysopidae and Hemerobiidae, with the exception of the Coniopterygidae, which are badly known despite their key role as predators in various agro-ecosystems) or including conspicuous species (Myrmeleontidae and Ascalaphidae), all relatively well known throughout Italy, and the remaining families, which are very scarce in public and private entomological collections.

Ecology

The roughly 190 species of Neuroptera s.l. occurring in Italy occupy, from an ecological point of view, a variety of habitats. The most numerous assemblage – and also the most important one from a practical point of



view considering the possibility of using some species in biological control programmes – is that occupying, both in larval and adult stages, the foliage and trunks of trees, shrubs or herbaceous plants, and feeding on small arthropods, mainly aphids, scale insects and other phytophagous Homoptera. To this group of auxiliary insects – typically comprising the Coniopterygidae, Hemero-biidae and Chrysopidae – most Raphidioptera can be added, due to their importance in forests as predators of corticolous phytophages.

The feeding habits of adult Megaloptera are not known with certainty, while the larvae are predacious.

Raphidioptera larvae are normally corticolous or loosely terricolous and, like the adults, are ferocious predators.

All Neuroptera larvae are predacious, some groups having developed behaviours nearing parasitism, whereas the adults are either predators or glyciphages and paly-nophagous. Adults are mainly crepuscular or nocturnal. The larvae of Myrmeleontidae and Ascalaphidae are terricolous, and hunt their prey either in ambush or by building traps (funnels). Most species, with due exceptions, occur in arid and open habitats. Adult Ascalaphidae are the only fast- and steady-flying Neuroptera.

Zoogeography

Italian Neuroptera include a low percentage of endemics, nearly all of which are exclusive to the southern and insular regions (Aspöck et al., 2001). Letardi (1997) provided a general discussion on the zoogeography of these insects. Apart from a small assemblage of species of Afrotropical distribution, the remaining ones are subdivided into three comparable groups of Mediterranean, European (or South European) or wider (Holarctic, Palearctic, Sibiro-European and Euro-Mediterranean) distribution, respectively. Single families show less homogeneous chorological spectra: for instance, Hemero-biidae are mainly of European distribution, whereas Myrmeleontidae contain a majority of Mediterranean species, with the striking occurrence of species with Turano-Mediterranean chorotypes. The various Italian districts are quite similar from the point of view of species numbers, except Sicily and Sardinia, where numerically poorer but nonetheless interesting faunas occur.

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Alien species

No certain information concerning introduced species exists. There have been non-confirmed records of the presence of Afrotropical Palparini (Myrmeleontidae) species in areas along the Tuscan coast, having possibly been shipped together with timber. More plausible, though not yet confirmed, is the possible presence of Chrysopidae of the genera *Chrysoperla* and *Mallada*, having been used in field biological control tests. Some species of the *Chrysoperla carnea* group, which occur in all terrestrial biomes in several species, not all of which are well defined yet from a taxonomic point of view, are bred in large numbers and commercialized, generally as larvae, by European and American biofactories, as auxiliary insects to be used in the biological control of various crops, even in the open field. Moreover, a proved case exists of the use of non-European lacewings in southern Italian crops. However, until today, no evidence of any of these species having adapted to local conditions exists. This issue should be considered more carefully and surveyed, also considering the high capacity of dispersion of various *Chrysoperla* species.

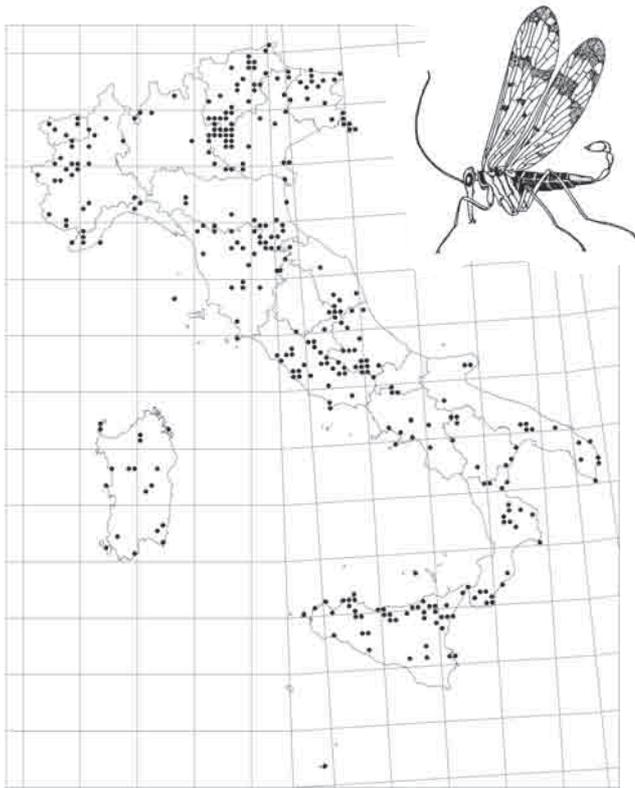
Conservation

Many of the species pointed out as rare could in fact be only poorly known, also because many Neuropterida mainly occur within the tree crown as adults, at heights that make them difficult to collect using standard insect nets. Apart from the case of *Isoscelipteron fulvum*, a species almost certainly extinct in Italy considering it was first and last collected around the middle of the nineteenth century, the few cases of risk of extinction refer to some members of the Raphidiidae and to the genera *Nevrorthus* and *Sisyra*. The preimaginal instars of the last two genera are, together with those of *Sialis*, associated with freshwater habitats. The combination of specific ecological needs and limited, if not punctual, distributions makes some of these species (namely *Tjederiraphidia santuzza*, *Subilla confinis*, *Raphidia ligurica*, *Nevrorthus fallax*, *N. iridipennis*, *Sisyra iridipennis*, *S. terminalis* and *Sialis morio*) vulnerable or threatened.



Insecta Mecoptera

Agostino Letardi



Mecoptera are a small order of medium-sized terrestrial insects, comprising some 500 species worldwide. Despite the low number of species occurring in Italy and the fact they are easy to collect and therefore common in museum collections, chorological data concerning these species are still incomplete. Recent morphological studies have solved many taxonomical problems, even though a complete revision of the W-Palaearctic fauna is lacking. Parallel to this, the want of an adequate morphological study of the Italian fauna sometimes causes problems in the identification of females of the genus *Panorpa*.

Material and methods

Due to the relatively recent taxonomical clarification of this order, much data from literature previous to 1980 were considered unusable without a verification of the cited material. The filing of species distribution data is based on the works of Willmann (1976) and Ward (1983), and was supplemented by the examination of material from the Natural History Museums of Verona

and Milan and from the Zoological Institute of Rome University "La Sapienza", as well as by the most recent literature. Because of difficulties in assigning many of the existing records from the literature, according to species between 25% and 50% of total records were unpublished.

Biodiversity

The Italian fauna only includes 10 species belonging to 3 genera. Until such a time as the taxonomical status of *Panorpa communis* is defined, this taxon being considered a single species by some specialists and a complex of twin species or morphologically very similar species by others, the Italian species assemblage is comparable to that of the rest of central-southern Europe, and should be considered as quite stable. Despite the diverse ecological preferences of the 3 genera occurring in Italy (two of these, *Boreus* and *Bittacus*, are mainly found in northern Italy; the third, *Panorpa*, is equally distributed throughout mainland Italy), species richness is practically the same all over the Italian peninsula, whereas in the major islands only species of the *Panorpa cognata* group are recorded. The recent finding of *Panorpa annexa* in Sardinia (Letardi, 2003), which also represented the first record of Mecoptera from this island, is one of the few expectable changes in the biodiversity of this order in Italy. Knowledge of this family is generally poor, particularly concerning *Bittacus*, which is little-studied also in the rest of Europe, and *Boreus*, which is on the contrary very well studied in the rest of the continent. Only a more careful study of the material preserved in public and private entomological collections would allow to better define at least the state of knowledge of *Panorpa*. It must be pointed out that the last certain record of a Bittacidae for Italy dates back to 1978, while the previous one is from as far back as 1951, so the possibility that *Bittacus* may have disappeared from Italy is plausible.

Ecology

Mecoptera are diurnal insects, living in shady and humid places. Their diet is rather varied, including both live and dead prey, and vegetal fluids (in some cases they can cause slight damage to crops). Males show interesting behaviour (similar to that of empidid flies) in offering a "food gift" to the female before mating occurs, a gift which varies according to species from a true prey to a small ball of saliva.



Zoogeography

The Italian Mecoptera are mainly of European, rarely Mediterranean, distribution and only one species is endemic (*Panorpa annexa*), with a Tyrrhenian distribution. *Boreus* seems to be confined to the mountain areas of the Italian peninsula. Very few records of *Bittacus* exist, nearly all from northern Italy. A larger amount of data exists for *Panorpa*, which includes prevalently northern species (*P. alpina*, *P. germanica*), mainly or exclusively southern species (*P. etrusca*, *P. annexa*) and species widespread in Italy (*P. communis*, *P. cognata*). Records of *P. annexa* exist for Sardinia and Sicily, but from single localities. A generic record of *P. cognata* also exists for Sicily.

Relevant Literature

BERNARDI IORI A., KATHIRITHAMBY J., LETARDI A., PANTALEONI R.A., PRINCIPI M.M., 1995. Neuropteroidea (Megaloptera, Raphidioptera, Planipennia), Mecoptera, Siphonaptera, Strepsiptera. In: Minelli A., Ruffo S. and La Posta S. (Editors). Checklist delle specie della fauna italiana, 62. Calderini, Bologna.

LETARDI A., 2003. Nuovi dati sulla distribuzione peninsulare ed insulare italiana di Mecotteri (Mecoptera). *Frustula Entomologica*, (2001), (n.s.), 24 (37): 99-102.

WARD P.H., 1983. Scorpion-flies of the *Panorpa cognata*-complex in the western palearctic region (Mecoptera). *Journal of Natural History*, 17: 627-645.

WILLMANN R., 1976. Zur Kenntnis der italienischen Mecoptera (Insecta). *Bollettino del Museo Civico di Storia Naturale di Verona*, 3: 157-177.

Alien species

No introduced species are recorded from Italy.

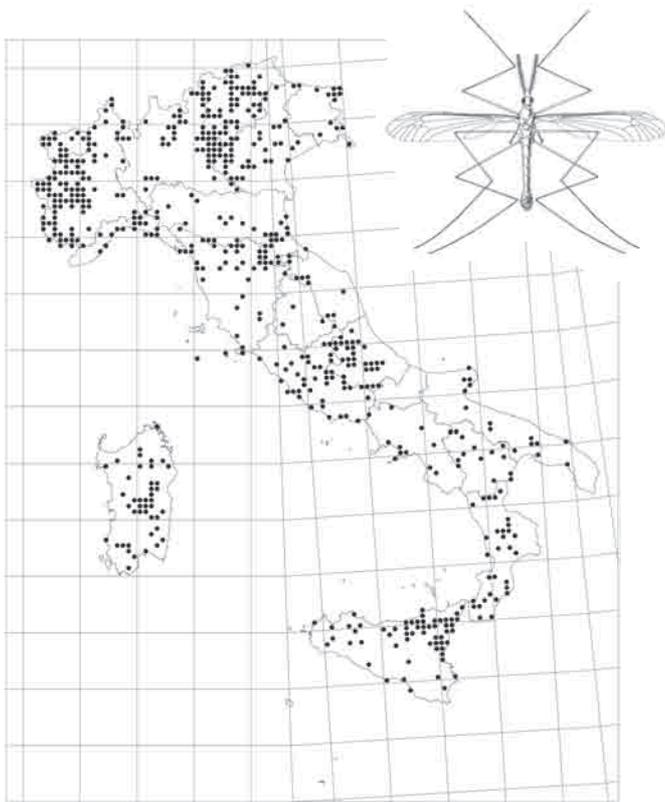
Conservation

The current state of knowledge does not allow for a reliable evaluation to be made in this regard. The only endemic species is at risk of local extinction in the two major islands, especially in Sardinia where suitable habitats for this species are very few. Legitimate doubts exist concerning the current occurrence in Italy of the only species considered as "threatened" (*Bittacus hageni*), but also that of *B. italicus*.



Insecta Diptera Tipulidae

Pjotr Oosterbroek



The family Tipulidae, together with the families Limoniidae, Pediciidae and Cylindrotomidae are included in the superfamily Tipuloidea, suborder Nematocera. Four thousand-two hundred species are known for the whole world, 600 of which are in Europe, 180 in Italy.

The Italian Tipulidae fauna is well known. The oldest citation referring to Italy is that of Fabricius (1782), who mentioned material belonging to Dr. Allioni, probably collected around Turin. The first faunistic data were published between 1892 and 1926 by the famous entomologist Mario Bezzi. In the second half of last century, some extensive revisions were published by Mannheims and Theowald (1959) and Theowald and Oosterbroek (1984). In the last 10 years knowledge on Italian fauna has been implemented in part thanks to collections in less studied areas (such as Liguria, Eastern Dolomites, Abruzzo, Gargano, Cilento, Pollino, Sicily), and by intense sampling in Piedmont by G.B. Delmastro from the Carmagnola Museum.

Material and methods

Data presented here include all the information on Italian Tipulidae known by the author at the end of 2001, and are based on the examination of material from sev-

eral museums (mainly from the Entomology section of the Zoological Museum of Amsterdam University, where the largest collection of Palearctic Tipulidae is deposited), private collections, and from the examination of about the 180 publications which contain all data on Italian fauna.

Biodiversity

The 180 species present in Italy can be divided into 3 groups: 78 species are distributed in Northern Italy (21 of which extend their distribution to the South to Emilia-Romagna and/or Tuscany), 48 in Central and Southern Italy, Sicily and Sardinia (15 of which extend their distribution to the North to Emilia-Romagna and /or Tuscany), and 54 are widely distributed in Italy. There are two reasons why Northern Italy has more species than Southern Italy (73% in the North and 57% in the South): Northern Italy has higher ecological diversity due to the Alps, and the European species with wide distribution are more abundant in Northern Italy (in fact, the percentage of endemic species is higher in Southern Italy). For both Northern and Southern Italy the amount of data studied is approximately the same, however, in the South some regions were studied more extensively than others. Therefore, the marked differences that can be noticed at regional scale are due to a stronger collecting effort. For instance, 83 species are known for Trentino-Alto Adige and 78 for Piedmont, whereas 20 are known for Liguria, 19 for Apulia, 17 for Campania, 14 for Molise.

Ecology

Tipulidae are generally associated with humid and temperate habitats, or with forested habitats, or with more open habitats such as bogs, marshes, gardens, prairies, and moors. Italian fauna is characterised by a high percentage of Alpine and subalpine species (subgenus *Pterelachisus*, *Savtshenkia* and *Vestiplex*), and by Mediterranean elements (represented mainly by the subgenus *Lunatipula*).

Adult Tipulidae (body length from 7 to 40 mm) have very reduced mouthparts and therefore do not feed: only rarely they have been observed sucking liquids from flowers. Larvae live mostly in the soil or in vegetal matter on the forest soil, under rotting wood, generally in humid or semi-aquatic habitats, in detritus near rivers, lakes and wetlands, in moss and liverworts, and sometimes they prefer dryer habitats (subgenus *Lunatipula*). In other cases larvae are aquatic, (subgenus *Emodotipula*) or live un-



der the bark or in the dead wood of broad-leaved forests (genera *Ctenophora*, *Dictenidia* and *Tanyptera*; subgenus *Dendrotipula*). Larvae feed on decomposing vegetal material: some damage pastures, cultivations and crops (genus *Nephrotoma*, subgenus *Tipula*), and can cause great economic damages. Life cycle consists in a short development inside the egg (1-2 weeks), followed by 4 larval stages and a short pupal stage (1-2 weeks) before emergence of the adult, which have a short life. Diapause can occur in summer or winter, at certain larval stages. Species from temperate habitats produce two generations per year, but according to the species and the kind of habitat, the entire life cycle can last from 10 weeks to 6 years.

Zoogeography

Tipulidae from Europe and Mediterranean Regions are relatively well known and, amongst them, Italy has the highest number of species (180). For instance, Spain and Portugal have 142 species, Switzerland 153, former-Yugoslavia 156, and Greece 164. Besides the high species richness, Italian fauna has a high number of relict species of ancient origin which are particularly interesting for their biogeography (Oosterbroek and Arntzen, 1992;

Oosterbroek, 1994). The number of endemic species is also high (32, representing 18% of the total). Most of the endemic species are located in Southern Italy (25 species, 3 of which are limited to Sardinia, 6 to Sicily and 2 are also present in Northern Italy).

It is interesting to underline that a certain number of species, even if not endemic for the actual political borders of Italy, has a restricted distribution: for instance, 8 species are present in Sardinia and Corsica, 26 more species are present in areas bordering Italy, but not elsewhere in Europe or in the Mediterranean area.

Alien species

On the basis of the present knowledge, Italian fauna does not have any introduced species.

Conservation

Knowledge on conservation status of the Italian Tipulidae are scarce. It is still unknown if some species are threatened or even extinct. The elevate percentage of endemic species can be important for some protected areas or regions.

Relevant Literature

MANNHEIMS B., THEOWALD B., 1959. Die Tipuliden Italiens (Dipt. Tipulidae). *Memorie della Società Entomologica Italiana*, 38: 15-54.

OOSTERBROEK P., 1994. Biodiversity of the Mediterranean Region. In: Forey P.L., Humphries C.J. and Vane-Wright R.I. (Editors). *Systematics and Conservation Evaluation (Syst. Ass. Spec. Vol. 50)*: 289-307.

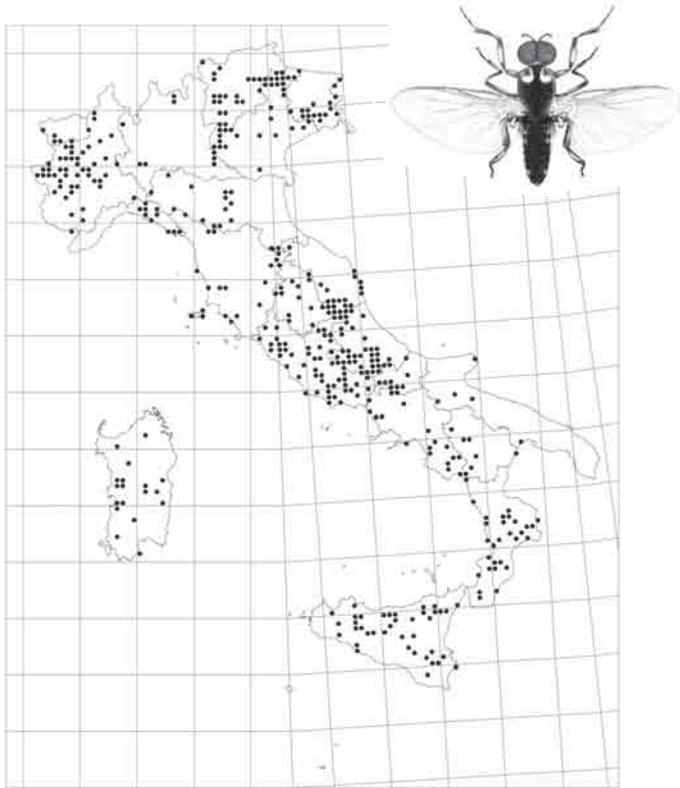
OOSTERBROEK P., ARNTZEN J.W., 1992. Area-cladograms of Circum-Mediterranean taxa in relation to Mediterranean palaeogeography. *Journal of Biogeography*, 19: 3-20.

THEOWALD B., OOSTERBROEK P., 1984. Zur Zoogeographie der westpalaearktischen Tipulidae, 5. Die Italienischen Tipuliden (Diptera, Nematocera). *Fragmenta Entomologica*, 17: 245-291.



Insecta Diptera Simuliidae

Laura Mancini, Leo Rivosecchi



Simuliidae is a family of Diptera Nematocera with pre-imaginal stages developing exclusively in running waters. Adult females are usually hematophagous on mammals and birds. Taxonomy above species level is quite controversial. Rubzov and Yankowsky (1988) distinguish 33 genera among the Palearctic Simuliinae, whereas Crosskey (1990) includes all of them in the genus *Simulium* with 14 subgenera.

Material and methods

Until 1960 the only data on Italian fauna were those by Corti (1914-1916), referring to a few species, collected at the adult stage, mostly in Pavia Province. From 1960 on, Rivosecchi collected larvae and nymphs and reared them until they reached the adult stage. He applied this method first on specimens collected in Latina Province (Rivosecchi, 1960), and then he extended it to all Italy, increasing the number of Italian species to values similar to the rest of Europe. Larvae, nymphs, male and female adults, obtained with this methodology, are deposited at the Civic Museum of Natural History of Verona and were used as a basis to compile the volume of the Italian Fauna on Simuliidae (Rivosecchi, 1978).

Biodiversity

Five genera, 12 subgenera, and 70 species are presently recorded for the Italian Simuliidae. Obviously, those Italian regions where collections were more accurate have higher numbers of species recorded. However, even in those areas, biodiversity is probably underestimated. For instance, in Piedmont, where Rubzov had numerous collecting stations, two more species which had not been detected in the previous research have been discovered later on: *Twinnia hydroides* and *Simulium* (*N.*) *oligotubercolatum*.

Ecology

There are two groups of species: one is univoltine, stenotherm typical of cold waters, and the other one is polyvoltine and euritherm. The latter ones move along the rivers from the plains towards the mountains when the temperature increases. Thus, each species has a characteristic altitudinal and seasonal distribution, which in our country has been studied in details only for the mountains of Central Italy. The frequency of association among species is another important species attribute, it defines which species can coexist in the same habitat when they have different trophic niches. This phenomenon was studied in the hydrographic basin of the Mignone River and in the Sila plateau in Calabria. Simuliidae take advantage of all smooth surfaces, on which they can adhere because of the viscous material they secrete from the salivary glands. They can therefore avoid competition from other filter-feeders which have to use the substratum roughness to survive the action of the current. The distribution of Simuliidae along rivers and streams can be used to define the zonation from the spring to the rivermouth. Different groups of species are differently adapted to hypoxia and thus can be used as bioindicators of eutrophy and oligotrophy.

Adults are very vagile, females search not the host but the vegetation (pastures, woods, bushes, reeds, etc.) where they have the highest chance of finding a host, which they locate by the CO₂ emission. It is therefore understandable why the population dynamics of Simuliidae in a stream or river does not depend exclusively on the water quality, but on the surrounding vegetation as well (Rivosecchi e Mancini, 1998).

Zoogeography

Seventy species are recorded for Italy, they can be divided on the basis of their geographical distribution as follows:



2 Holarctic, 6 Euro-Asiatic, 5 Euro-Mediterranean, 31 Euro-Boreoalpine, 4 Mediterranean, 2 Balkanic, 20 endemic. The lack of certain species such as *Wilhemia sergenti* and *Simulium ruficorne* (common in North Africa and the Iberic peninsula), from Sicily and Sardinia is odd. The lack of the Moroccan species *Simulium xanthinum* (common in Spain and Southern France almost to the Italian border) from Italy is equally odd.

Alien species

On the basis of actual knowledge, there are no exotic species in the Italian fauna.

Conservation

As a consequence of human activities the populations of Simuliidae either totally disappear or their biodiversity is reduced and one species is involuntarily favoured. The subsequent demographic explosion of this species can cause massive attacks to domestic animals (cattle Simuliidae-induced toxycosis in Adige Valley) or to man.

Attacks to man by *Wilhemia paraequina* and *Simulium intermedium* have been reported in Friuli, Marche and Sardinia, whereas those in the Adige Valley where mostly due to species of the group *reptans*.

Byssodon maculatum, a specie typical of large rivers, at the time of Corti's research was a nuisance species attacking the cattle along the Po River, can be considered extinct.

Relevant Literature

CROSSKEY R.W., 1990. The natural history of black flies. John Wiley & Sons: 711 pp.

RIVOCCHI L., 1960. Un contributo alla conoscenza dei simuliidi italiani: stazioni di raccolta di larve e pupe in prov. di Latina. *Rendiconti dell'Istituto Superiore del Sannio*, 23; 1300-1357.

RIVOCCHI L., 1978. Simuliidae (Diptera Nematocera). Fauna d'Italia, XIII. Calderini, Bologna: 553 pp.

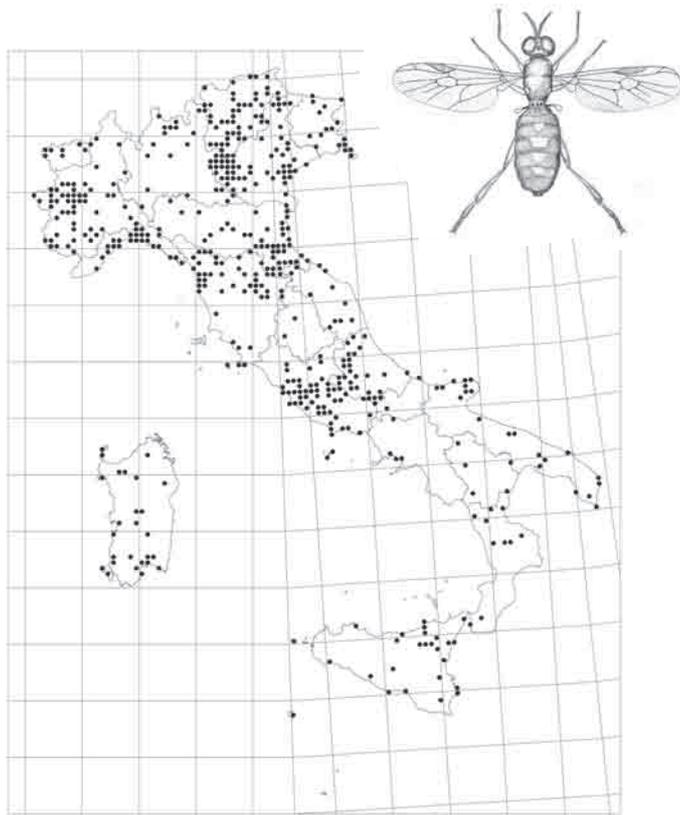
RIVOCCHI L., MANCINI L., 1998. Trasformazione del paesaggio agrario e attacco all'uomo di simuliidi del gruppo *ornatum*. *Parassitologia*, 40 (1): 151.

RUBZOV J.A., YANKOVSKY A.V., 1988. Family Simuliidae. In: Soos & Papp (Editors). Catalogue of Palearctic Diptera, 3. Akademiai Kiadó. Budapest- Amsterdam: 124-186.



Insecta Diptera Stratiomyidae

Franco Mason



Stratiomyidae are an averagely large family of Brachycera Diptera, called “Soldierflies” (Mouches armées, Waffenfliegen) for the variable number of spines inserted on the scutellum and in some cases on the sides of the thorax. The body length varies between 2 and 20 mm. Because of the large dimensions and the vivid metallic colors, Stratiomyidae are considered the most attractive Diptera of the Italian fauna, together with Syrphidae. In the past, because of the high variability of colours and dimensions, several species were described; the revision by Rozkošný (1982, 1983), based on the genital morphology, synonymised 40 of them. At the worldwide level, Stratiomyidae include 2,651 species, belonging to 12 subfamilies and 375 genera; 426 of these species have a Palearctic distribution (Woodley, 2001).

The references for European fauna are the monograph by Rozkošný (1982, 1983) and the manual on Palearctic Diptera (Rozkošný, 2001). New data for the European fauna were recently summarized by Mason and Rozkošný (2003). Finally, the volume by Stubbs and Drake (2001) on British Stratiomyidae gives information on the biology of several species common for the Italian fauna. The most important contributions on the

Italian fauna are those by Rossi at the end of 1700, and subsequently those by Rondani and Bezzi between the end of 1800 and the first decades of 1900.

Material and methods

The list of 1,440 records is compiled from the literature and from 31 private and public collections. An entire collecting day can end with few to no specimens, for this reason Stratiomyidae are poorly represented in collections. In the last decades however, the use of the Malaise trap increased the capture probability, particularly for those groups which swarm only in restricted times of the year (Beridinae).

The most productive capturing technique is still the entomological net, especially if used scything on isolated bushes (for instance, on *Corylus avellana*) or broad-leaved trees in ecotones where the adults rest to find refuge or to warm up at the sun.

Biodiversity

Italy is the European country with the highest number of Stratiomyidae (89 species and 21 genera). The present checklist adds 13 species to those presented in the 1995 Italian checklist. The average number of species per region is 22 – the maximum number is recorded in Latium (42), the minimum in Molise (2) – and is related to the research developed. The highest number is in fact recorded in those regions where research was more intense, such as Latium (42), Veneto (32), Liguria (30) and Piedmont (39). On the contrary, the almost total lack of data for Molise (2), Campania (4), Umbria (8) and Basilicata (8) is clear; these regions will have to be the first to be studied in the future. Sicily (27) and Sardinia (19) have obvious gaps too, at least twice as many species could probably be present in these regions.

Ecology

The adult Stratiomyidae live in the immediate vicinity of their larval habitats. They feed on nectar, pollen and honey. Larvae can be terrestrial or aquatic, the terrestrial ones live in rotting vegetation or in humus (Beridinae, *Chloromyia*, *Microchrysa*), in horse or cow manure (Sargini). *Clitellaria ephippium* lives in the nests of saproxylic ants of the genus *Lasius*, other species live under the rotting bark or in cavities of old trees (*Pachygaster*, *Eupachygaster*, *Praomyia*). The aquatic larvae have anal setae which hold air for respiration: they can be found in running waters and in the hygropetric hab-



itat (*Oxycera*), in ponds and lakes (*Stratiomys*, *Odonatomyia*, *Oplodontha*). *Nemotelus* larvae are adapted to coastal waters with salinity higher than 104 g/l. In these biotopes, adults can be easily collected scything the base of *Salicornia europaea* plants (Mason, pers. obs.). Stratiomyidae are good indicators of environmental quality, being exceptionally sensitive. Thus, they are good tools for conservations studies (Stubbs and Chandler, 2001).

Zoogeography

Stratiomyidae are usually associated with specific habitats; nevertheless, the attribution of a chorotype for most of the species is problematic due to the scarcity of data on their distribution. The range of chorotypes for the Italian fauna shows a strong prevalence of Mediterranean species (80%), whereas 18% are Central-European. Three species are endemic for Italy. Only one species, *Hermetia illucens*, is Holarctic.

Conservation

Relevant Literature

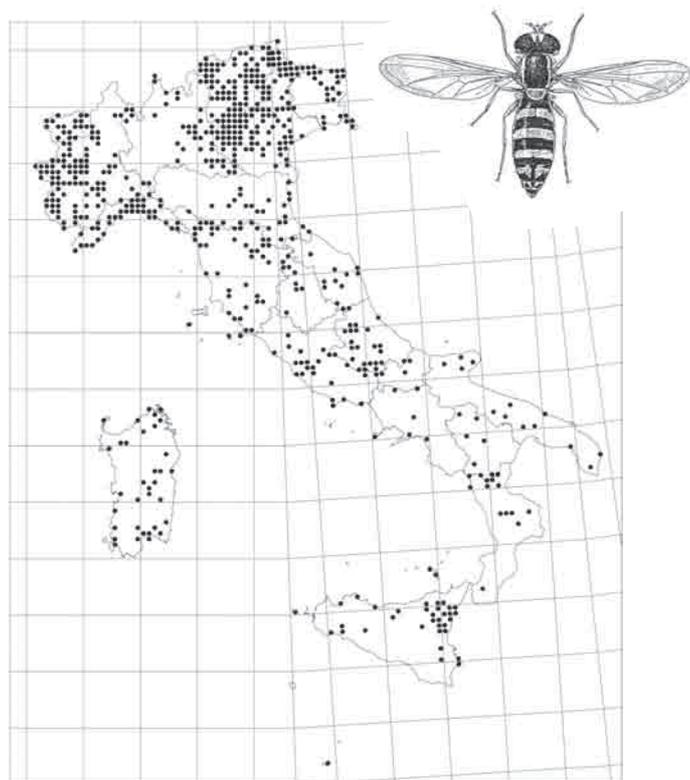
- MASON F., ROZKOŠNÝ R., 2003. Interesting records of European Stratiomyidi including description of the female of *Nemotelus danielssoni* (Diptera Stratiomyidae). *Bollettino della Società Entomologica Italiana.*, 134(3): 253-264.
- ROZKOŠNÝ R., 1982, 1983. A Biosystematic study of the European Stratiomyidae (Diptera). Vol. 1 and 2. Dr. W. Junk B.V., The Hague-Boston-London: 401+431 pp.
- ROZKOŠNÝ R., 1997. Family Stratiomyidae. In: Papp L. and Darvas B. (Editors). Contributions to a Manual of Palearctic Diptera. Science Herald, Budapest: 387-411.
- STUBBS A., DRAKE M., 2001. British Soldierflies and their allies. British Entomological and Natural History Society: 512 pp.
- WOODLEY N.E., 2001. A World Catalog of the Stratiomyidae (Insecta: Diptera). Mya Vol. 11. Backhuys Publishers, Leiden: 484 pp.

Stratiomyidae must be considered "rare" on the basis of their abundance and distribution, such as, for instance, *Clitellaria ephippium* and *Exodontha dubia*. *Stratiomys rubricornis* in the Abruzzo Apennines is among the most interesting endemic species of the Italian fauna, together with *Nemotelus crenatus*, which is limited to brackish coastal wetlands in Veneto and Friuli Venezia Giulia. Most of the Stratiomyidae are endangered by the progressive erosion and alteration of their habitat. The most sensitive species are those with larvae living in springs in the Padana Plain (*Oxycera nigricornis*), the saproxylic species living on dead wood and in old hollow trees (*Eupachygaster*) and those in the brackish coastal wetlands (*Nemotelus*). *Alliocera graeca* and *Lasiopa krkenis* are endangered because they are rare and at the outer limit of their distribution range. Very worrisome is the rarefaction of the populations of *Nemotelus crenatus* on the coastal areas of Veneto and Ferrara, due to *Bacillus thuringiensis*, which is used for mosquito control.



Insecta Diptera Syrphidae (Syrphinae, Syrphini)

Daniele Sommaggio



Syrphidae is a family of Diptera Aschiza with more than 6000 described species. Syrphidae, with their worldwide distribution, Antarctica excluded, are among the best known dipterans, probably due to their striking appearance. Syrphidae are divided into three subfamilies: Milesinae, Syrphinae and Microdontinae (some authors consider the latter a separate family). Syrphinae are divided in several tribes, the most abundant being the Syrphini, which will be discussed here. Some fundamental studies developed at the end of the 60's (Dusek and Laska, 1967; Hippa, 1968; Vockeroth, 1969) clarified the division into genera, mostly on the basis of male genitalia. Recent revision clarified the taxonomy of some genera, such as for instance *Syrphus* and *Epistrophe*. Other genera have not been revised recently, and the positions of several species are not defined. Identification keys at species level are lacking for some genera, such as *Sphaerophoria* and *Parasyrphus*. In the present work, the genus *Chrysotoxum* is placed in the tribe Syrphini, as suggested by recent morphological studies, in particular regarding larvae, and by some molecular biology data.

Material and methods

Several sources have been used to compile the present map:

- literature: only for papers published after 1970. Previous data were used for those species which taxonomic position has not changed or when the records were confirmed by the study of the reference collections.
- collections: private and public collections have been checked.

Biodiversity

Italian fauna of Syrphini includes 105 species belonging to 19 genera. Ninety-nine of those species are reported from Northern Italy, 51 for central and Southern Italy, and only 21 and 13 for Sicily and Sardinia, respectively. Although some species have a prevailing Alpine distribution (for instance *Sphaerophoria*), the smaller number of species reported for Central and Southern Italy, and for the islands is related to the very reduced number of studies carried out in those areas. This fact appears evident from the distribution map of *Episyrphus balteatus*, an ubiquitous species, surely present everywhere in Italy: its distribution can be considered an indicator of the status of the faunistic knowledge in Italy.

Ecology

The adult Syrphidae feed mostly on flowers and pollen; larvae have a wide variety of trophic strategies and live in different habitats. Syrphini larvae are all predators. Most of them prey on aphids and thus they are an important control factor for the populations of those pests. Few exceptions are represented for the Italian fauna, by *Parasyrphus nigritarsis*, which preys on Crysomelidae Coleoptera larvae, and by *Dasysyrphus tricinctus*, which preys on Lepidoptera and Hymenoptera larvae. Some species, such as *Episyrphus balteatus* or *Syrphus ribesii*, can feed on aphid of different taxa. There are no sure cases of monophagous species. However, it must be underlined how most of the Syrphidae developed capture techniques, and/or predator-defence strategies which limit their presence to well defined conditions. For instance, larvae of the genus *Epistrophe* are found only on broad-leaved trees, whereas those of the genus *Sphaerophoria* prey on aphids on the grass: these species are thus linked to meadow habitats. Larvae of the genera *Xanthogramma* and *Chrysotoxum* prey on aphids living in the roots associated with ants nests. The strict ecological requirements, together with a rela-



tively good knowledge of this group at the taxonomic level, makes Syrphidae good bioindicators. An environmental evaluation system based on Syrphidae was developed and standardised recently; this system is valid for Atlantic Europe and is known as “Syrph the Net” (Speight et al., 1998).

Zoogeography

Because of the high mobility, some species migrate; endemisms are quite rare, and in Italy there are no endemic Syrphini.

The highest number of species is recorded from the Alps. Species of the genus *Sphaerophoria* are common in pastures and above the tree-line. Several species of the genera *Dasysyrphus*, *Parasyrphus* and *Eriozona* are present in conifers woods; species belonging to *Epistrophe* and *Doros* live in deciduous woods.

The Apennines has the same genera, even if usually with less species, due partly to the lack of Sibiric-European species whose distribution is limited to the Alps. Xerothermic habitats of the Apennines can host Mediterranean taxa, which are lacking or rare in the North, such as *Chrysotoxum cisalpinum*.

The Padania Plain has a reduced Syrphidae fauna because of the high anthropization level. Tolerant species are abundant, such as *Episyrphus balteatus*, *Sphaerophoria scripta* and *Eupeodes corollae*. The few non- or little degraded habitats can nonetheless host a well diverse and specific fauna, such as *Epistrophella euchroma*, living in the few remains of planitial woods, or *Sphaerophoria loewi*, a very rare species, present only in well-preserved wetlands.

Relevant Literature

DUSEK J., LASKA P., 1967. Versuch zum Aufbau eines Natürlichen Systems mitteleuropäischer Arten der Unterfamilie Syrphinae (Diptera). *Acta Scientiarum Naturalium Academiae Scientiarum Bohemoslovacae-Brno*, 1: 349-390.

HIPPA H., 1968. A generic revision of the genus *Syrphus* and allied genera (Diptera Syrphidae) in the Palearctic region, with descriptions of the male genitalia. *Acta Entomologica Fennica*, 25: 1-94.

SPEIGHT M.C.D., CASTELLA E., 2001. An approach to interpretation of lists of insects using digitised biological information about the species. *Journal of Insect Conservation*, 5: 131-139.

VOCKEROTH J.R., 1969. A revision of the genera of the Syrphini (Diptera Syrphidae). *Memoirs of the Entomological Society of Canada*, 62: 1-176.

There are little data on species composition in the Mediterranean chaparral. However, *Chrysotoxum parmense* and *Scaeva mecogramma* among Syrphini are species linked to this habitat.

Alien species

There are no data regarding introduced species for the Italian fauna.

Conservation

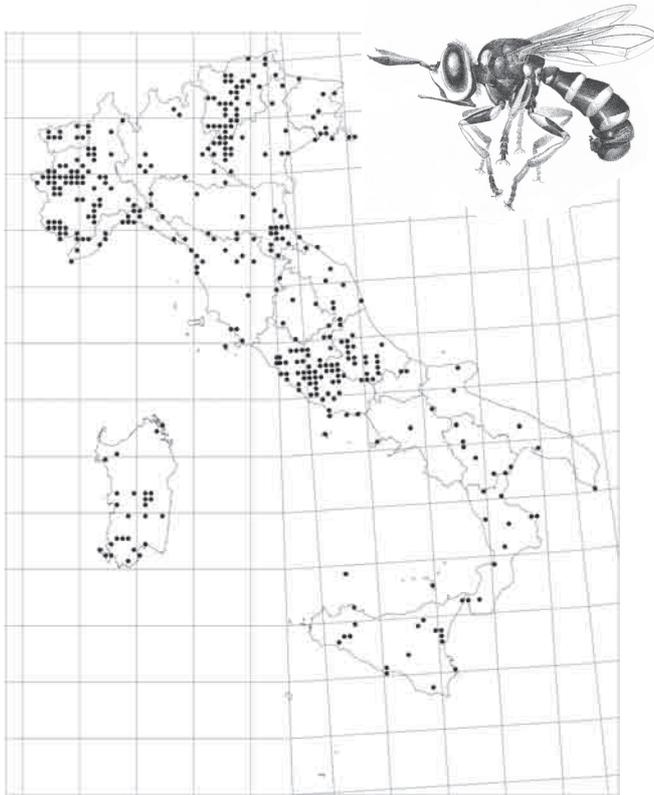
The strict environmental requirements of many Syrphidae species poses serious conservation concerns. This is particularly evident for several sapro-xilophagous species of Milesinae. Even among Syrphini there are species which are endangered by human activity. Some cases need to be mentioned. *Sphaerophoria loewi* lives only in wetlands with reeds, where human activity is absent. Its presence in all Europe is very limited, and in Italy, this species is known only from one location in the North. This can be considered as a highly endangered species which risks extinction on our territory, as do other species of Milesinae with saprophagous larvae, for instance *Anasimyia contracta*.

Several species are associated with very old and well-preserved forested areas, such as the Syrphini *Doros destillatorius*, *Melangyna barbifrons*, *Eriozona syrphoides*. These species often have a puntiform distribution due to the strict environmental requirements and can be considered, together with several sapro-xilophagous species of Milesinae, good indicators of well-preserved forests.



Insecta Diptera Conopidae

Maurizio Mei, Leo Rivosecchi, Pier Luigi Scaramozzino



Conopidae is a small family of parasitoid Diptera, including approximately 60 genera and 900 described species. The family is distributed in all zoogeographic regions except the polar ones and most of the Pacific Islands (Smith e Petersen, 1987).

Taxonomy of Italian and European Conopidae are well known, except for the genus *Physocephala*, several taxa of which are still not clear. The faunistic knowledge of Italian Conopidae however, have several gaps. Literature reveals how most of research on the Italian Diptera, and on Italian Conopidae in particular, dates from the second half of 1800 to the beginning of 1900, continuing sporadically, and ending around the 1950s. Recent new faunistic data on this family were published by Rivosecchi and Scaramozzino (1995) with the Italian checklist, and by Mei (2000). In fact, most of the literature data used in the database are "historic", and they should be used with caution, because they could refer to biotopes nowadays disappeared or deeply altered.

Material and methods

Data on species distribution come from the authors' collections, from other entomologists' private collections

and from collections deposited in several Museums and research Institutes. In addition, literature was critically and exhaustively examined. Unpublished data in the database represent more than 50% of the total. Numerous old citations, which could not be related with certainty to valid species, were not taken into consideration. Data from old literature that are important for our fauna, such as those published by Rondani (1857), are listed in the database even if the author gave generic information.

Biodiversity

The family is represented in Italy by 11 genera belonging to the subfamilies Conopinae, Myopinae, and Dalmaniinae. Sixty-three species are recorded, 34 of which (54%) are grouped in the genera *Conops*, *Physocephala*, and *Myopa*. The taxonomic status of three further species, described by Rondani on type material from Italy, still has to be defined.

Italian Conopinae include 78% of the 80 species known for Europe and it is therefore one of the richest faunas among European countries. For instance, 24 species are known for Great Britain and Denmark, 44 for Sweden, approximately 50 for Spain, Poland and former Czechoslovakia, and around 60 for France.

The number of known species reported for Italy approximates well the real number of species; the finding of more species is obviously possible, particularly in the Northern regions and in the main islands, but it is unlikely that the total number of species could increase of several units. The best-studied regions are Piedmont, Latium and Trentino-Alto Adige (53.3% of all available data refers to these three regions only). For all the other regions, knowledge is scarce and fragmented and in the case of Marche, Umbria, Molise, Apulia, Campania, and Calabria, almost non-existing. Data related to these 6 regions represent all together 4.7% of the total available data. Less than 10 species have a uniform distribution in Italy and are known from several, or almost all, the regions. The actual distribution of all the other species still has to be defined and 15 species (24% of the total) are known from 1 or 2 regions only, and with only one or very few records.

In our opinion, this situation is due mainly to the lack of research, and only for a small part, and only for a few species, to the rarity of these Diptera.

Ecology

Most of the species of Conopidae have little known ecology.



Adults are associated with flowers. Larvae of the 3 subfamilies living in Italy are endoparasite of Aculeate Hymenoptera, but this assumption is based on occasional data, and refers to few species. Larvae and the hosts of most of the Italian Conopidae are in fact still unknown. They are polyphagous to a certain degree, but some species, and at least one genus, seem to have strong preferences for the host. In particular, species of *Leopoldius* seem to be associated with several species of *Vespa*, whereas species of the genus *Sicus* (*S. ferrugineus* in particular) and *Physocephala rufipes* are parasites of *Bombus* spp.

Zoogeography

All Italian Conopidae are widely or very widely distributed, and there are no endemisms. Most of the species (55, representing 87% of the total) are more or less widely

distributed in the Palearctic Region, of the remaining 8 species, 1 (*Myopa vicaria*) is Holarctic, 6 (4 of the genus *Leopoldius* and 2 *Conops*) are apparently limited to Europe and the last one, *Conops elegans*, has a Afrotropical-Mediterranean chorotype.

Alien species

On the basis of actual knowledge, all species present in Italy are autochthonous.

Conservation

Due to the scarcity of ecological and faunistic data, it is quite difficult to evaluate the conservation status of Italian Conopidae. However, the rarefaction of the population over the last 30-40 years is apparent. This is caused by the rampant anthropization of the Italian territory and in particular of the plain areas.

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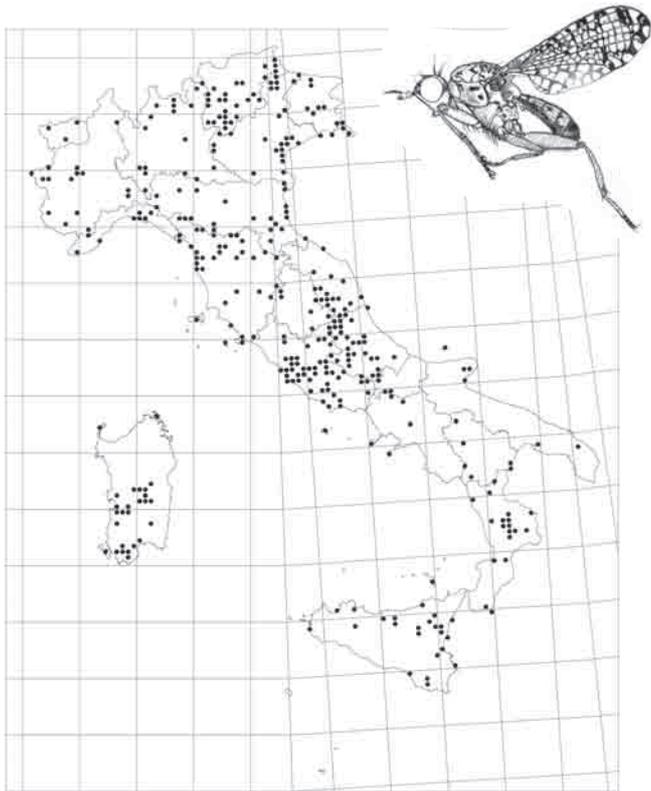
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Insecta Diptera Sciomyzidae

Laura Mancini, Leo Rivosecchi



Sciomyzidae is a family of Diptera Acalyptera which at the larval stage are parasite of aquatic or terrestrial molluscs. The exception is *Pelidnoptera nigripennis*, subfamily Phaeomyiinae, which is a parasite of Diplopoda of the genus *Ommatoiulus*. Adults feed on sugars. Three subfamilies can be distinguished: Salticellinae, Phaeomyiinae and Sciomyzinae. The latter is divided in two tribes: Sciomyzini and Tetanocerini.

The specific diagnosis is based on the morphology of male genitalia (Rozkosny, 1987).

Material and methods

All the main Italian collections of Diptera were reviewed (Rondani, Bezzi, Bellardi, Venturi, Corti, Costa, Rivosecchi, Contini), and male ipopigi were dissected and prepared. The drawings from these specimens are all original (except those of *Pherbellia rozkosnyi*) and are presented in a volume of the Italian Fauna (Rivosecchi, 1992). The revision of the Rondani collection gives this author the

priority in the description of three species of the genus *Pherbellia* (*P. albicarpa*, *P. pallidicarpa* e *P. majuscula*).

Biodiversity

Italian fauna includes 21 genera, 2 subgenera and 81 species. Thanks to the contribution of Lorenzo Munari from Veneto, diversity is similar to that of other European countries. There are less species in peninsular and insular Italy than in continental Italy, however, two new species of *Pherbellia* (*P. silana* and *P. garganica*) were recently discovered in the peninsula, and another species of the same genus (*P. dentata*) was collected in Garfagnana. The presence of *Ectinocera borealis* in the Stelvio pass suggests that alpine bogs might host species not yet recorded for Italy.

Ecology

The biology of almost all genera or species-groups which are specialised on molluscs are known (Knutson, 1973): Tetanocerini prey on aquatic molluscs (Lymneidae, Planorbidae and Physidae), species of the genus *Renocera* prey on Bivalvia (Spheridae), all Sciomyzini and species of *Euthycera* and *Coremacera* prey on terrestrial molluscs (Helicidae), *Tetanocera elata* preys on Limacidae and species of *Antichaeta* prey on egg-clumps.

Zoogeography

Italian species can be divided on the basis of their distribution as follows: 15 Holo-Palearctic, 2 East-Palearctic, 22 Euro-Asiatic, 20 Central and North-European, 10 Sout-European, 10 West-Mediterranean, 1 East-Mediterranean, 1 endemic. Thus, distribution areas are very wide and Euro-Mediterranean and Euro-Asiatic elements are predominant.

Alien species

Exotic species were never introduced into Italy.

Conservation

The "total reclamation" of wetlands for malaria control, greatly reduced the possibility of collecting Sciomyzidae in natural humid habitats. For these organisms usually there are no conservation laws. In the former Pontine wetlands, Sciomyzidae can be found in the banks of a few canals without concrete levees.



Laura Mancini, Leo Rivosecchi

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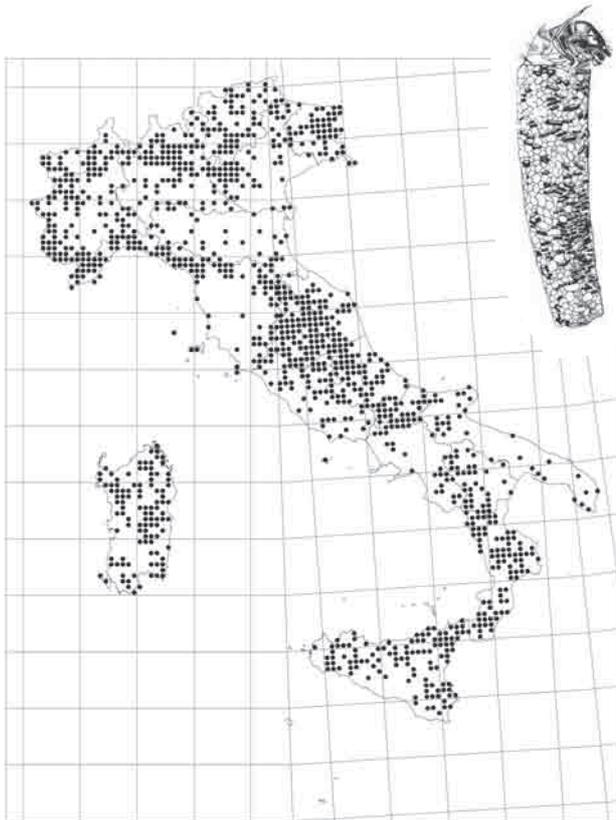
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Insecta Trichoptera

Fernanda Cianficconi



Trichoptera are holometabolous, amphibiotic insects, with larvae and pupae living in running and standing waters, whereas adults are subaerial. They are commonly known as caddisflies because most of the larvae build a transportable protective case of various shape, structure, and dimension. The cases can be cylindrical, quadrangular, conic, shield-like, and even helicoidal. They are built with the silk produced by the larvae, or with silk and sand, parts of leaves, twigs, algae, seeds, and other animal material, such as small molluscs and freshwater sponges, held together by silk secretions. They range from a few mm (*Microptila minutissima*) to 7-8 cm in length (*Agrypnia varia*, *Grammotaulius nigropunctatus*). Few larvae are free-living (Rhyacophilidae), or build silk nets among the rocks on the bottom (Hydropsychidae). Larvae can be vegetarian, omnivorous, detritivorous, even predator. They absorb dissolved oxygen by tracheal gills. When ready to reach the nymphal stage, larvae close the ends of their cases with an opened silk layer and attach the case to the substrate, often forming high density populations (*Micrasema*, *Potamophylax*). Free-living larvae build with sand a pupal case securely attached to the substratum; subsequently they build an elliptical cocoon inside the case. Upon reaching the adult stage, the insects reach

the surface swimming, leave the exuvia, and emerge to the surface. Emergence occurs mostly in spring, summer or fall, but there are genera which emerge in winter (*Drusus* in the Apennines). Adults have four membranous wings covered with hairs. Wings are not coloured; they tend to be amber-brown, brown, black, sometimes with metallic shine (*Mystacides azurea*). There are brachypterous species in winter (*Leptodrusus butzi* from Sardinia) or at high elevation (*Acrophylax zerberus* from the Alps), apterous species (females of the genus *Enoicyla*) and species with scaly wings (*Monocentra lepidoptera*). During the day the adults mostly hide among the riparian vegetation, folding their wings roof-like over the abdomen. They fly primarily at sunset, and several species are attracted by artificial lights. Nowadays the use of light traps allows good capture, mostly in the lower courses of rivers and in wetlands. Sexes are separated; eggs are deposited in gelatinous masses. The adults life is short and limited to the reproductive period.

The larval stages of several species described on the basis of the genital armature of the male, are unknown. For this reason there are still several gaps in the classification of aquatic stages. The Italian representatives are well known for their systematic, distribution, morphology, and biology.

Material and methods

Most of the data on species distribution is based on Giampaolo Moretti and his group's work. Moretti supervised the study of Trichoptera from 1932 to 1997, cooperating with collectors and entomologists, and revising the collections of Universities (Bologna, L'Aquila) and Museums (Verona, Trento, Firenze, Udine, Genova, Bergamo). The distributional catalogues for the Alps, the Apennines, Sardinia, Sicily, Elba and Capraia Islands were compiled with data from studies conducted with his students on Italian continental waters. Trichoptera specimens are located partly in the private Calco collection (temporarily at the Museo Civico di Scienze Naturali "E. Caffi" in Bergamo for restoration and revision), partly in the Moretti collection at the Department of Animal Biology and Ecology at the University of Perugia. The Calco collection represents a historic document. It includes material collected in Northern Italy from the end of the 19th century to 1956; the material was often identified by Navas and Mosely, who were Moretti's mentors at the beginning of his studies.

Biodiversity

Trichoptera fauna of Italy includes 93 genera belonging to 20 families. Three families (Rhyacophilidae, Hydrop-



tilidae, Limnephilidae) include about 50% of the Italian species. Among the 23 European families, those missing in Italy are Arctopsychidae, Molannidae, Calamoceratidae, and the best represented are Beraeidae (74% of the European species), Philopotamidae (61%), and Goeridae (56%). The 416 species and 32 subspecies recorded for Italy represent about 35% of the European species. Only the Balkan and Iberic peninsulas have a fauna as diverse as the Italian one. The biodiversity pattern shown in this list reveals a higher species richness of Rhyacophilidae, Phryganeidae and Limnephilidae in the Northern regions (particularly in Piedmont), of Hydroptilidae in Central Italy (particularly in Tuscany), of Hydropsychidae and Lepidostomatidae in Southern Italy (particularly Calabria). Basilicata and Sicily have the highest number of families (18).

Ecology

Trichoptera are well represented in all aquatic habitats, both lotic and lentic, and in hypogean habitats, at all latitudes and altitudes. The majority of species live only in lotic waters. In the watercourses, longitudinal zonation can be observed. Some species live only in hygropetric habitats, (*Stactobia caspersi*, *Tinodes maclachlani*), others live only in the krenal (*Drusus improvisus*, *Crunoecia irrorata*) or in the epi-hypokrenal (*Catagapetus nigrans*, *Silo nigricornis*). Several rheobiont or rheophylous species find a favorable habitat in the epi-hyporhithral. A few euribiont species (*Rhyacophila dorsalis acutidens*, *Hydroptila angulata*, *Hydropsyche pellucidula*, *H. modesta*, *Cheumatopsyche lepida*, *Psychomyia pusilla*) inhabit the potamal. Trichoptera are rarely found in phreatic, brackish or sulphurous waters. Only one genus (*Enoicyla*) can be considered terrestrial because both larvae and pupae live on riparian vegetation.

Species living in lentic waters are less abundant. Trichoptera have been collected in high altitude lakes in the Alps and Apennines, in the insubric, volcanic, and tectonic lakes. Wetlands, temporary waters and alpine pools host *Agrypnia varia*, *Grammotaulius nigropunctatus*, *G. submaculatus*, *Limnephilus bipunctatus*, *L. flavicornis*, *L. sparsus*, *L. vittatus*.

Even artificial water habitats (dam-generated lakes, agricultural lakes, ditches, fountains, rice fields, drinking troughs, etc.) are populated by these insects.

The winged Limnephilidae Stenophylacinae are troglodylous, and find in the hypogean karstic systems favorable conditions for mating.

Trichoptera have a wide ecological specialization and are highly sensitive to pollution (only the euryecious species *Hydropsyche pellucidula*, *H. modesta*, and *Ecnomus tenellus* can live in polluted waters), therefore they are indicators for good water quality.

Aquatic and subaerial stages are food for several fishes, mainly salmonids, and they are commonly used as bait

for fly-fishing. The flying stages are also prey for birds and bats; the Stenophylacinae living in caves are food for *Dolichopoda* and for spiders.

Larvae can cut fishing nets, dig holes in submerged poles supporting bridges, and damage the rice plants in rice fields. Larvae of *Plectrocnemia* can destroy fish eggs.

Zoogeography

The geographical distribution of Italian Trichoptera is characterised by a majority of Northern elements. A low percentage is represented by Holarctic (*Limnephilus rhombicus*, *Holocentropus picicornis*) and Palearctic (*Grammotaulius nigropunctatus*, *Limnephilus flavicornis*, *Mystacides azurea*) species, mainly in standing water habitats. European species are dominant. Among the central European genera, 12 (*Neureclipsis*, *Oligostomis*, *Cryptothrix*, *Metanoea*, *Anabolia*, *Phacopteryx*, *Rhadicoleptus*, *Acrophylax*, *Parachiona*, *Consorophylox*, *Pseudopsilopteryx*, *Lithax*) do not trespass the southern side of the Alps, others (*Drusus*) are distributed in the Apennines with endemic species in this Province. Some Alpine species are vicariated in the Apennines by very close endemic species and subspecies (*Rhyacophila vulgaris* vicariated by *R. foliacea* in the Central Apennines, and by *R. hartigi* in the Southern Apennines). Western faunal elements are present in Italy, such as several tyrrhenic taxa (for instance *Hydroptila giudicellorum* present in Sicily, Capraia Island, Sardinia, Provence, Iberic peninsula; *Tinodes maroccanus* in Sicily, Maghreb, Iberic peninsula; *Leptodrusus budtzi* in Sardinia, Corsica, Balearic Islands), and 12 Sardinian-Corsican species, included *Beraeodina palpalis*, which belongs to a monotypic genus. Several Eastern faunal elements are also present in Italy, these are some trans-Adriatic (for instance *Micropterna wagneri*, present in the Central and Western Apennines, Balkans, and *Enoicyla costae*, in the Southern Apennines, Sicily, Balkans), and some trans-Ionic species (such as *Micropterna malaspina* present in Apulia, Anatolia, Greece, Crete, and *Triaenodes ochreellus lefkas* in Apulia, Lefkas, Kefalonia, Corfu).

Endemic fauna (22%) is represented by the genus *Mono-centra* (*M. lepidoptera* - Pennine, Maritime, and Apuanian Alps, and Ligurian Apennines), by 72 species belonging mostly to the families Philopotamidae, Sericostomatiidae, Beraeidae, Polycentropodidae and by 23 subspecies, 6 of which belonging to the genus *Wormaldia*.

The percentage of endemic species is low in the Alps, with the exception of the Maritime Alps, (4), increasing along the Apennines from North to South, and reaching high values in the islands (Sardinia 16, Sicily, 11, Elba Island 3). Some peninsular endemics have reduced distributional range, such as *Tinodes apuanorum* (Apuanian Alps), *Apatania volscorum* (Latium, Posta Fibreno lake), *T. bruttius*, *Chaetopteryx vulture*, *Beraea crichtoni*, *Plectrocnemia geniculata calabrica* (Calabria). Calabria and



North-eastern Sicily have endemic species in common. It must be underlined that the Italian endemic taxa live mostly in running waters, particularly in springs and small spring-fed creeks.

Alien species

To this date, there is no information concerning exotic species among Italian Trichoptera.

Conservation

Because Italian Trichopteran fauna is rich in endemic species, and in stenocious differently specialised species, it represents a natural treasure of high biogeographical value. Only the proper management of the water bodies and of the hypogean areas where these organisms live can preserve its integrity. The frequent and repeated episodes of pollution, canalisation, and river regulation are the main causes of the rarefaction and extinction of

these insects from wide areas of the Italian peninsula. Several species have now disappeared from stations where they had been previously collected (for instance, *Chimarra marginata* in the Toffo area, where it had been recorded by Moretti in 1937), or their populations are reduced in number (for instance, the population of *Grammotaulius nigropunctatus* in the Colfiorito marshes appeared seriously reduced in '88-'89, 50 years after Moretti's studies). The crenophylous populations from small natural springs in hills and mountains are particularly endangered. The lowering of the aquifers, spring captation, and proliferation of constructions which alter the natural hydrological features have a deadly effect especially on the crenophylous Apenninic endemics (*Drusus improvisus*, *D. camerinus*, *D. aprutiensis*, *Helicopsyche crispata*). Fens, which are characterised by high diversity as well, are rare biotopes with high naturalistic value that need to be maintained and protected.

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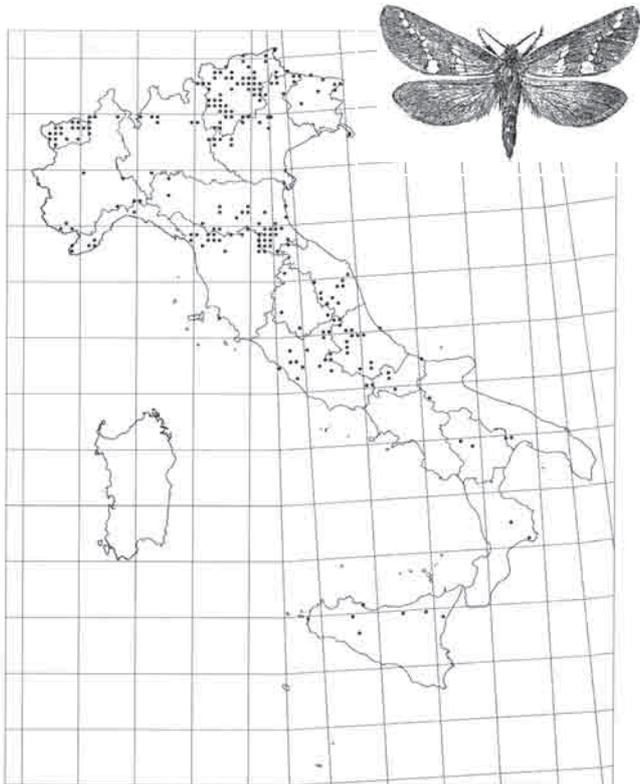
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Insecta Lepidoptera Hepialidae

Alberto Zilli



Hepialidae is a small family of Lepidoptera, with about 500 species known for the whole world, and with great phylogenetic importance (Nielsen et al., 2000). In fact, this is a very primitive group, as shown by the homoneuran venation of the wings (similar between the two pairs) and by the exoporian genital system (with copulatory orifice separated from the ovipore, and without communication between the two sections, as it happens in the higher Lepidoptera). Even if this family is systematically close to several “microlepidoptera”, which have been traditionally studied by a few specialists, it contains species of medium and large dimensions. For this reason, several faunistic data are available in literature, representing the basis for ecological and zoogeographical studies.

Material and methods

The species distributions were deduced by the available literature (the recent synthesis by Bertaccini et al. (1997) must be remembered here) after an appropriate screening, and by the study of some collections. Some records were not used because they referred to wide

geographical areas which could not be used as a distribution reference.

Biodiversity

Italian fauna is represented by 10 species of Hepialidae, belonging to 6 genera. The highest species concentration is in Northern Italy, primarily in the Alps. Only 3 species extend their distribution to the Italian peninsula; the low number might seem an underestimation, but in fact Hepialidae are typical of temperate-cold climates. The decrease in number recorded from North to South is evident in Sicily, with one species present. There are no species of this family in Sardinia.

Faunistic knowledge on Hepialidae is satisfactory, however some groups (*Pharmacis*) tend to be isolated and thus to speciate in some confined areas of the Alps. The exploration of the high altitude habitats could lead to the discovery of new species. It is also likely that some species known from outside the Italian borders might one day be collected in Italy.

Ecology

Hepialidae larvae live digging galleries in the soil and feed on roots, or they are endophytic inside stems and roots. Several species are associated with ferns (and, likely, with mushrooms) and therefore are present in humid habitats. Because the proboscis is non-functional, adults do not feed, and typically fly in the late afternoon or at sunset, rarely at night, and are often most active before sunrise.

Males of some species (*Hepialus humuli*) aggregate in “leks” to attract females. Sexual dimorphism is often strong, in colour patterns (*H. humuli*), or body shape (the high altitude females of *Pharmacis* are brachypterous). All Italian species are univoltine or with a biannual cycle. They prefer humid meadows, generally in the mountains, and clearings in forests. One Italian species is euryecious and is not linked to a specific habitat (*Triodia sylvina*); all the other species have preferences for specific habitats with a high naturalness level.

Zoogeography

Three species of the genus *Pharmacis* are endemic for Italy, therefore 30% of the Italian fauna is endemic. *Pharmacis anselminae* and *P. claudiae* are limited to North-Western Alps, whereas *P. aemiliana* is present almost in all of the Apennines. Other species of the family have Euro-Siberian or Central-Asiatic-European distributions.



Alberto Zilli

Alien species

There are no introduced species.

Conservation

Two of the three Italian endemic species are known exclusively from very confined Alpine areas, where every reduction of the appropriate habitat (due to tourism, con-

structions of ski-lifts, exc.) or environmental alteration could determine the extinction of the local populations. Other montane species could be locally affected by the same reasons but, because they have a wider distribution and have probably still undiscovered populations, do not appear to be endangered.

Relevant Literature

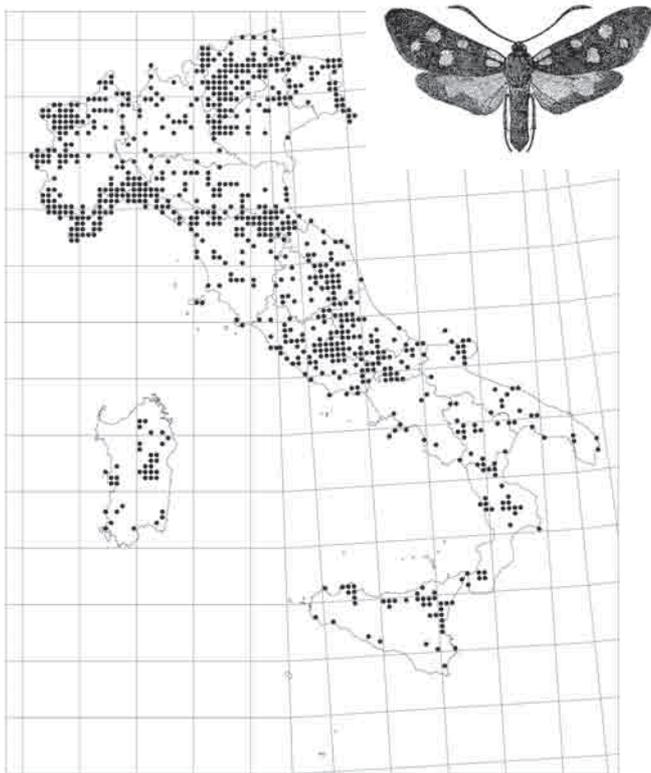
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Insecta Lepidoptera Zygaenoidea

Emilio Balletto, Simona Bonelli, Luigi Cassulo



Zygaenoidea is a Lepidoptera superfamily widely distributed in all the terrestrial habitats. Its chorology and taxonomy is usually well known. The distribution of Procridinae is not well known because they can be identified only after dissection. The use of molecular techniques has not been relevant for the identification of phyletic lineages, and for the determination of the rank of some taxa.

Materials and methods

The filing of distribution data was based on recent literature (see Tremewan, 1988), in particular on works by Reiss and Tremewan (1967), Hofmann and Tremewan (1996), Naumann et al. (1999), Efetov and Tarmann (1999). Literature data were critically evaluated and integrated with material from the main Museums and private collections.

Biodiversity

Italian fauna includes 6 genera and 2 families. Two genera – *Adscita* e *Zygaena* – make up for more than 88% of the Italian species. The average species number is 7.3 but there are wide differences among genera. Forty-

three species are known for Italy. The biodiversity pattern shown by this work reveals higher species richness in the Northern regions, mostly in the Alpine and Prealpine regions, with 37 species total. In Central and Southern Italy there are 27 species, 11 in Sicily and only 2 in Sardinia.

Ecology

Italian Zygaenoidea are mostly xerothermophilous, widespread in the Mediterranean horizon and more abundant in the lower mountain region. Few species, usually mesophilous, reach the upper mountain horizon, and one (*Zygaena exulans*) is present above the tree line. Among the Mediterranean species, *Zygaena orana* is limited to the herbaceous areas near the sea, both in the chaparral and, more frequently, in the littoral dunes. *Z. lavandulae*, *Z. sarpedon*, *Z. rhadamanthus* and *Z. occitanica* are instead, at least in Italy, restricted to the chaparral. *Z. ephialtes* (nemorale), *Z. lonicerae*, *Z. filipendulae* and *Z. osterodensis* are mesophilous mountain species. One species, *Theresimima ampellophaga*, which larvae develop on grapes, is anthropophilous and associated primarily to Apenninic and Alpine xerothermic formations, which are now very rare.

Zoogeography

Italian Zygaenoidea have a percentage of endemics similar to that of diurnal butterflies (9,5%), but much lower than that typical of other Mediterranean regions such as Morocco (15 endemics over 31 species: 48% of the total), Algeria (3 over 22: 14%), Anatolia (6 over 52; 11.5%) and Spain (4 over 40: 10%). The percentage of global endemics of the Euro-Mediterranean region is 27.1% (36 endemics over 133 species). The four Italian endemic species (*Heterogynis eremita*, *Adscita tenuicornis*, *Zygaena oxytropis*, *Z. rubicunda*) are all peninsular, although one of them (*Zygaena oxytropis*) extends its distribution North-West to the Ligurian Alps and another one (*Adscita tenuicornis*) is also present in Sicily. Among other species, *Zygaena vesuviana* has a very narrow distribution, on the Italian and French sides of the Ligurian Alps, whereas *Adscita alpina* can be considered endemic to Italy, even if its distribution range extends beyond the Alps, in Austria, Switzerland, and France. Only one species is a Sardinian-Corsica endemism (*Z. corsica*), whereas the Sicilian populations of *Z. trifolii*, are so allopatric with the other populations that they should be studied at the molecular level. Besides, perhaps, *Z. vesubiana*, there are no other endemics in the Alps, a



very unusual situation. The non-endemic Italian species have predominantly Mediterranean (16 species: 37.2%) and Central-Asiatic-European (13 species: 30.2%) chorologies. Among the latter group one species (*Z. exulans*) has a fragmented boreo-Alpine distribution. All other species have SW (and S) European chorologies.

Alien species

The presence of allochthonous species of Italian Zygaenoidea has not been demonstrated. Some doubts arose regarding *Zygaena orana*, a species from Maghreb absent from Corsica but present in Sardinia on the Western and South-western coasts, where it was discovered in 1892 and where it is characterised by a well distinct morphology. Whatever their origin, those populations do not seem to interact with the indigenous species. *Theremima ampellophaga*, originally described in 1808 from specimens collected in Pavia province, between Broni and Casteggio, might not be autochthonous, because its distribution changed following the grape cultivations.

Conservation

Because of their ecology, Zygaenoidea extended their distribution following the cyclic extension and retrac-

tion of agriculture in the Mediterranean and mountain areas. Species of *Zygaena* are characterised by very fast morphological evolution. Changes in their distribution therefore favoured the evolution of several populations morphologically distinguishable, several of which today are endangered or extinct. The most extreme case is that of the grape “zygaena”, very unpopular among vine growers, which at present is the most endangered species of the entire superfamily, and it may be extinct in North Africa, Spain and Hungary. Although extinctions are not known for Italy, some species of *Zygaena* disappeared from certain European countries (*Z. cynarae*: Germany; *Z. osterodensis*: Denmark, Finland; *Z. trifolii*: Austria). Therefore, other extinctions could easily occur in the next decades.

Zygaenoidea have not attracted the attention of the international organizations in charge of biodiversity conservation, so that there are no Zygaenoidea species investigated by IUSC, neither are they in any appendix of the Bern Convention (the most attentive to these kind of problems), or of the European Union Habitat Directive. The vivid, aposematic colours of several species might make these butterflies particularly interesting for the international public (flag ship species).

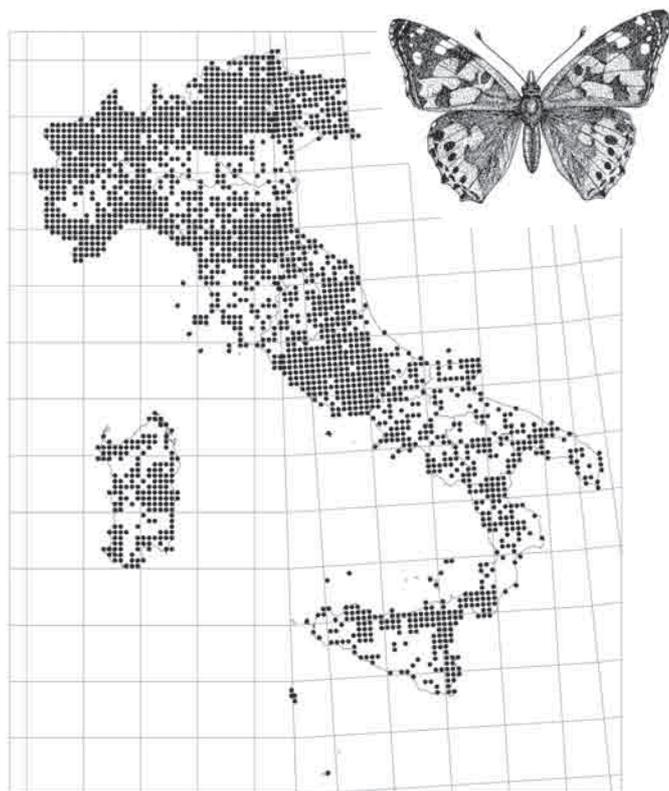
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Insecta Lepidoptera Papilionoidea (Rhopalocera)

Emilio Balletto, Simona Bonelli, Luigi Cassulo



each genus is 3.13. Several genera, represented in the Palearctic Region by numerous species, reach Italy with only one or a few species. This happens, for instance, with the genera *Aporia* (1 species over 35 known, mostly Chinese), *Oeneis* (1 over 35 Siberian, Central-Asiatic or North-American), and *Neptis* (2 over 53, mostly Oriental). Genera of the Rhopalocera Lepidoptera often include a lower number of species than, for instance, Curculionoidea Coleoptera. The richest genera are *Pyrgus* (17 species: 6.1% of our fauna), *Polyommatus* (18 species: 6.5%) and *Erebia* (32 species: 11.5%). Italian fauna represents 37% of the Euro-Mediterranean fauna and is much richer than that of other European countries, Russia (to the Urals) included. Those countries with a similar number of species are France (258 species), and Greece (240 species). Among Mediterranean countries, only Turkey with 357 species of diurnal butterflies has higher species richness than Italy. The trend of Italian biodiversity reveals a higher species richness in the Northern regions, mainly the Alpine and Pre-Alpine ones. This is a consequence of the “peninsula affect” (Tontini et al., 2003), only partly balanced by the endemism in Southern and insular Italy. For diurnal Euro-Mediterranean butterflies, most of the biodiversity is recorded in the Alpine region (Balletto, 1996).

The taxonomy, chorology, biology and ecology of diurnal butterflies are usually well known. Molecular techniques, together with morphological studies, clarified the taxonomy of several genera, mainly Satiridae (*Erebia*, *Hipparchia* and *Melanargia*) and Lycaenidae (some *Polyommatus*). Other groups still have to be revised, and the main problem is the rank attributed to taxa, more than their identification. The phylogenetic position of our fauna in the wider Palearctic scenario is still not clear, and will be the subject of further studies.

Material and methods

Distribution data filing is based on existing literature, critically evaluated and integrated with data from museums and private collections, and observations of the authors. Old citations were not always useful, because they are incomplete, and not reliable. New unpublished record form more than 50% of the total data listed in the database.

Biodiversity

Italian fauna includes 279 species belonging to 79 genera and 9 family. The average number of species for

Ecology

Diurnal butterflies live in the entire range of terrestrial habitats, from the sea level to the maximum altitudes, even if in Italy only a few of them can reproduce above 2,500 m. The diversity of the different vegetation horizons differs greatly: starting from the highest altitudes, 47 species are widespread only, or mainly, above the trees line and therefore must be considered true alpine; 90 more species are associated with the mountain horizon, around half of them live primarily in the upper region (beech or spruce horizon, more rarely extending their distribution to the European turkey oak horizon), the remaining ones in the lower region (oak horizon, or hills). A few species, such as *Colias hyale*, *Maculinea alcon*, *M. teleius*, *Euphydryas aurinia*, *Coenonympha oedippus*, are true planitial and inhabit exclusively the Padana Plain, whereas *Heteropterus morpheus* and *Lycaena dispar*, also planitial, live in the Apennines as well. The Mediterranean species, exclusive to the littoral areas, are not abundant, approximately one dozen. Several other species have wide vertical distribution and can extend to two or more vegetation horizons.



Regarding vegetation preferences, Italian diurnal butterflies are largely associated to non-climax habitat. However, this rule has exceptions: for instance, true Alpine species are largely associated with alpine pastures, with a few transitions to the shrubs of lower altitude. These elements are both hygrophilous (*Parnassius phoebus*, *Colias palaeno*, *Boloria napaea*) and, more often, xerophilous (*Colias phicomone*, *Albulina orbitulus*, *Boloria pales*, *Euchloe simplonia*, etc.). Several more, strictly from climax habitats, are mesophilous, such as *Agriades glandon*, *Melitaea asteria*, *Erebia nivalis*, *E. christi*, *E. pandrose*, etc. Shrubs hosting the hygrophilous formations, represent typically the exclusive habitat of species such as *Colias palaeno*, *Albulina optilete*, *Aricia nicias* etc. Species typical of transition habitats, predominantly of gravel-beds, are also present above the tree-line, such as *Pyrgus andromedae*, *Erebia gorge* and *E. pluto* (Balletto and Kudrna 1985). Some of this kind of species, such as *Oeneis glacialis*, are adapted to extreme habitats because adults emerge two years after eggs are laid, allowing the larvae to grow for two short summers.

Below the tree-line, butterflies are associated predominantly with ecotones, such as clearings, gravel-beds, and unconsolidated slopes. The vegetation present in Italy before the last ice age is still unknown. In the last 10,000 years, in some orographic situations, such as those provided by plains or not-too steep hills, mountain and plain butterflies, were probably living in the same habitat of large herbivores such as the aurox. Later on these species were favoured by certain human activities, and they colonised the pastures or certain cultivations. For these species, the highest diffusion periods occurred between the abandonment of agriculture and the expansion of forests, which caused local extinctions. Some endemic species of the pre-Alpine and inter-Alpine area (*Polyommatus humedasaе*, *P. exuberans*, *Plebejus trappi*) represent a typical case: these species survived until today in xerothermic refuges, represented by those cultivated areas on terraced steep hillsides exposed to the sun which were cyclically abandoned and then used again. The final abandonment of these cultivations (mostly vineyards, but in past times oat fields, exc.) nowadays not economically productive, caused a succession of xerophilous grasses. These are followed first by xerophilous, and then by mesophilous, forests, which are not compatible with the survival of those butterflies. Similar conditions led to the extinction of *Parnassius apollo* in several areas of Europe. In Italy this species finds the right habitats in the screes "macereti" on the Alps, whereas several Apenninic populations are endangered and some of them are extinct.

Even if ecotonal diurnal butterflies are dominant in hill habitats, species typical of mature forests are also present there. Species as *Carterocephalus palaemon*, *Favonius quercus*, *Satyrium acaciae*, *S. ilicis*, *Thecla betulae*, *Argynnis pandora*, *Limenitis populi*, *Apatura iris*, *Araschnia le-*

vana, *Neptis rivularis*, *N. sappho*, *Erebia aethiops*, *E. ligea*, *Hipparchia fagi*, *Lasiommata achine* and a few more, and in Sardinia *Maniola nurag*, prefer forests, even if they can also live in the clearings, mostly to feed on flower nectar. Among the Sardinian-Corsican species, *Argynnis elisa* together with the Sardinian-Corsican-Elban *Lycaeides corsicus*, live in the tall heather shrubs, which represented the dominant vegetation at the end of the Würm glaciation. In the last few years, because of the reduced use of the forests and the abandonment of several cultivations, some nemoral taxa such as *Carterocephalus palaemon*, *Apatura iris*, *Limenitis populi*, or *Erebia medusa*, began to extend their distribution towards the North-Western Apennines. Planitial habitats have a few diurnal butterflies. Besides the above-mentioned species, which are ecological "specialists", the remaining ones are widely diffused, and can live in the Apenninic and pre-Alpine hills, or in the Mediterranean chaparral. True planitial species are usually hygrophyle, and live in habitats that flood cyclically, at least in spring. The Padana Plain shares with the lowlands of continental Europe a similar tree-cover, represented by oaks which grow roots only in the first meter of soil (*Quercus robur*), and species of *Carpinus*. Diurnal butterflies strictly typical of forests are rare in these woods: only *Limenitis camilla* is present. *Apatura ilia* lives in willow and alder riparian trees which grow along rivers and streams. Large grassy plains have more species: *Heteropterus morpheus*, *Colias hyale*, *Maculinea alcon*, *M. teleius*, *Lycaena dispar* (mainly in *Magnocaricion* beds), *Euphydryas aurinia*, or *Coenonympha oedippus* are typical of these habitats.

Notwithstanding the large extension of the Italian coasts, the Mediterranean habitats in Italy hosts only a dozen of these exclusive species, most of which are limited to small areas. Some are Sardinian-Corsican endemics, such as *Spialia therapne*, *Papilio hospiton*, *Pseudophilotes barbagiae*, *Hipparchia neomiris*, or *Coenonympha corinna*. *Coenonympha elbana* vicariates *C. corinna* in the Tuscany arcipelago, "fossil" islands included. Other species, such as *Satyrium esculi* and *Zizeeria knysna*, enter Italy only in Western Liguria, or in Lampedusa. The most widely distributed species is *Charaxes jasius*, although its distribution on the Adriatic side is restricted to a few stations in Apulia, and it is not established if a stable population lives in Conero. The most peculiar "negative" feature of the Mediterranean habitats in Italy is the lack of those species exclusive to the thermophilous *Oleo-Ceratonion* vegetation (a similar situation does not occur, for instance, in Spain), maybe due to the limited extension of these vegetation formations.

Zoogeography

Diurnal butterflies fly quite well and thus do not have high endemism rates. Eighteen species (7.5% of the total) are exclusive of Italy. Some species, such as *Pyrg-*



gus centralitaliae, *P. piceus*, *Lycaena italica*, *Polyommatus virgilius*, *Hipparchia neapolitana*, *H. blachieri*, *Coenonympha elbana* (but probably not *Polyommatus gennargenti*) can be considered “subspecies” of taxa with wider distribution further decreasing the endemism rate to 3.9%. This does not mean that Italian Rhopalocera are particularly mobile: more than 35% of them does not move more than a few dozen meters and only 7% of them migrate extensively. The highest concentration of endemics is in the Apennines (10 species) followed by Sardinia and Sicily, each with 3 species, and by xerothermic areas of the Western Alps (2 species). This distribution is mostly a “geographic artefact”: some alpine endemics live also on the non-Italian side of the Alps, and thus they can not be considered strictly endemic for Italy. The distributions of species such *Erebia scipio*, *E. aethiopella*, *E. flavofasciata*, *E. christi*, *Melitaea asteria*, etc. are more reduced than those of several Apenninic endemics. The same situation applies to several Sardinian-Corsican elements.

The Alps are characterised by several species of *Erebia*. Thirty-five Palearctic species (and 4 Nearctic ones) belong to this genus, 35 of which live in the Alps, with 13 endemic species. All of these species, except *E. claudina*, are present in Italy. As a comparison, the second worldwide endemic area is the Pyrenées-Cantabria Region (6 endemic species), the third is Tien Shan (4 species). The Alpine endemics are divided geographically in three areas: 2 (*E. aethiopella* and *E. scipio*) limited to small areas of the Western Alps, 3 (*E. christi*, *E. flavofasciata* ed *E. tyndarus*) to the Central Alps, and 4 (*E. claudina*, *E. stiria*, *E. nivalis* and *E. calcaria*) to the Eastern Alps.

Several more species, even if non-endemic, live in the Western and Eastern Alps with distinct “subspecies (*E. manto*, *E. pluto*, *E. euryale*), with rarely investigated transaction and maybe hybridisation areas, in the Central Alps. In the Alpine Province, above the tree-line, endemisms are present (for instance, *Oeneis glacialis*) and some Sibiric-European species which often have a Boreo-Alpine chorology in Europe (*Pyrgus andromedae*, *P. cacaliae*, *Parnassius phoebus Agriades glandon*, *Aricia nicias*, *Albulina optilete*, *Colias palaeno*, *Pieris callidice*). Several Euro-Sibiric taxa (*Limenitis populi*, *Euphydryas intermedia*, *Melitaea diamina*, *Lasiommata achine*, *L. petropolitana*, *Aphantopus hyperanthus*, *Neptis sappho*), or Asiatic-European taxa (*Apatura iris*, *L. camilla*, *Neptis rivularis*), live at lower elevations in this province in nemoral or subnemoral habitats. The Western and sub-Western borders of the Alps host xerothermophilous species which probably had wider distributions before the Würm glacial period, and which at present have reached various speciation stages. Small, morphologically distinguished, isolated populations of *Papilio alexanor*, live in the Ligurian Alps; this species is widely distributed from Tien Shan to the Balkans. A

distinguished peripheral isolated population of *Boloria graeca* is present between the Maritime and the Cozian Alps; this species is widely distributed from the Balkans to Greece. *Polyommatus exuberans* is an Italian endemism, limited to the low Susa Valley (Cozian Alps); it belongs to the subgenus *Agrodiaetus* and its (possible) sibling-species has not reached Italy. In the same subgenus, *Polyommatus humedasmae* is an endemic restricted to the Aosta Valley, morphologically very similar to *P. aroaniensis* from Peloponnesus. The Eastern border of the Alps does not have Italian endemics and is characterised by Sibiric-European (*Lycaena hippothoe*), Asiatic-European (*Pyrgua malvae*, *Pseudophylotes vicrama*), Eastern Alpine (*Erebia calcaria*, *E. stiria*, *Melitaea asteria*) or European (*E. oeme*) species.

The Padana Plain is eco-geographically a cisalpine extension of the Amur large mesophyle plains which are located North of the Central Asiatic-Hungarian steppe, and extend from Southern Siberia to Germany and France. The hygrophylous planitial formations of the Padana Plain represent the exclusive habitats for several Sibiric-European species, such as *Euphydryas aurinia*, *Coenonympha oedippus*, *Maculinea alcon* and *Maculinea teleius*, all living in relict stations near the hills area. Among the other species present in the Padana plain, *Minois dryas* and *Lycaena dispar* are more abundant species, and share a wider Asiatic-European distribution. *Colias hyale* is a planitial species in Europe, and seems to have a Central Asiatic-European distribution.

The Apenninic endemic species are sometimes considered subspecies of species more widely distributed. *Pyrgus centralitaliae* and *Lycaena italica* are peripheral isolated taxa of the Euro-Sibiric *P. alveus* and *L. hippothoe*, which extend their distribution to the Amur. *Pyrgus centralitaliae* is close to *P. foulquieri*, a species ranging from Central France to the Western Alps. *Polyommatus virgilius* belongs to a group of allopatric taxa, which includes *P. fulgens* (North-Eastern Spain), *P. dolusvittatus* (Central France), *P. dolus* (Ligurian and French Alps) and *P. menalcas* (Anatolia). The biogeographical connection with the Eastern Mediterranean basin are represented by *Hipparchia neapolitana* and *H. blachieri* (the latter from Sicily), which are part of the species-complex of the Anatolian *H. senthes* (Cesaroni et al., 1985, etc.). *Polyommatus galloi* is endemic for Pollino and Orsomarso, and is perhaps related to *P. demavendi* from Anatolia. The most famous Apenninic endemic is *Melanargia arge*, molecularly very distinct from other species (Mensi et al., 1990), which is a sibling-species of the species-complex *M. occitanica*. Only 8 of the 47 species present in the Alps above the tree-line is present in the Apennines. One of these species (*Erebia pandrose*) is Sibiric-European, all the remaining are European (*Erebia epiphron*, *E. euryale*, *E. gorge*), or Alpine-Apenninic (*E. carmentis*, *E. pluto*, *Boloria pales*, *Melitaea varia*).



Even the small Thyrrenic islands have endemic taxa: *Coenonympha elbana*, sibling-species of the Sardinian-Corsican *C. corinna*, is also present in peninsular Italy, primarily on fossil islands. Some researchers consider the population of *Lycaeides corsicus* from the Elba Island a separate taxon. Finally, *Hipparchia sbordonii*, limited to Ponza Island, belongs to the *H. semele* group, and *H. leighebi*, endemic of the Eolian Islands, belongs to the *H. aristaeus* group.

Sardinian fauna includes 51 autochthonous species of diurnal butterflies, 12 of which are endemic to Sardinian, Sardinian-Corsican, and Sardinian-Corsica-Elba (23,5%) areas. Three species are endemic only to Sardinia (5,9% *Pseudophilotes barbaggiae*, *Polyommatus genargentii* and *Maniola nurag*). The most interesting among the non-endemic taxa is *Aricia cramera*, with West-Mediterranean distribution (Maghreb, Iberic peninsula). The remaining Sardinian taxa are 33% Asiatic, 16% European, and only 10% strictly Mediterranean; 17% are widely distributed species. As a consequence, Sardinian fauna is composed by endemics, and by species with medium-high vagility, including several anthropophilous species of recent introduction. This partly explains the lack from Sardinia of species of *Melitaea* (widespread elsewhere), *Erebia*, *Chazara*, *Hesperia*, *Ochlodes*, *Zerynthia*, *Satyrrium*, etc. However, the lack of taxa such as *Aporia crataegi* or *Pieris napi* is still unexplained.

One hundred-two species of diurnal butterflies are reported for Sicily, three of which are endemic (2,9% *Hipparchia blachieri*, *H. leighebi* and *Melanargia pherusa*). Among these, *Hipparchia blachieri* is at times considered the same species as with *H. senthes* of Anatolia, whereas *H. leighebi* is limited to the Eolian Archipelago. *Melanargia pherusa* and the West-Mediterranean *M. ines*, belong to the circum-Thyrrenic allopatric complex of *M. occitanica* (Mensi et al., 1990). *Melanargia pherusa*, the W-Mediterranean *M. ines*, *Melitaea aetherie* and *Zizeeria knysna* (in Lampedusa) are African species.

Alien species

Two species of diurnal butterflies were recently introduced in Italy: *Danaus chrysippus* and *Cacyreus marshalli*. The former is widely diffused in the Palaetropical region, and was first reported in Italy by Ochsenheimer at Torre del Greco (Naples) in 1806-1807. The species was subsequently extinct, and reappeared in Italy from 1983 on (W. Cameron-Curry). The reappearance of this species is natural, probably due to global warming, and occurs in the Western Mediterranean basin. Thus, this species can not be considered allochthonous. A different situation pertains to *Cacyreus marshalli*, originally from Southern Africa, whose larvae feed on cultivated geranium (*Pelargonium*). The

presence of this species in Europe was observed for the first time in Mallorca in 1990: later on it spread first to continental Spain, than to France and several other locations in Europe. In Italy this species was observed for the first time in Rome, in the EUR area, in 1997. It quickly expanded its range in the peninsula: it was recorded in Sanremo in 2001, and in Milan in 2003. In 2003, favoured by a very hot and humid summer, it was the most common butterfly in Genoa and Turin. The unstoppable expansion of *Cacyreus marshalli* is only limited by cold winters. This species is anthropophilous and is a pest for geranium, but does not seem to interact with autochthonous species.

Conservation

Conservation of diurnal butterflies is a very debated subject in Europe, and in the last 20 years numerous international conferences and symposia have been dedicated to this subject. The appendixes 2 and 4 of the European Union Habitat Directive list 8 species of diurnal butterflies present in Italy as endangered for the whole European territory, and 2 more may be added to the list with the next revision (*Polyommatus galloi* and *P. humedasa*, already classified by IUCN as, respectively, "endangered" and "critically endangered"). We estimate that 21 species are at risk of extinction in Italy. Generally speaking, endemic diurnal butterflies usually are not the most endangered species, and the contrary is often true: the most endangered Italian species are the planitial ones, distributed only in the Padana Plain (*Lycaena dispar*, *Maculinea alcon*, *M. teleius*, *Euphydryas aurinia*, *Coenonympha oedippus*) and associated with those meso-hygrophilic habitats which are often listed in the Habitat Directive as endangered (*Molinia* and *Magnocaricion* moors). At least one species, *Lycaena helle*, is extinct in Italy, whereas *Melitaea britomartis*, hygrophilous in Italy, is extinct in Piedmont (Ivrea) and along the Ticino River, and survives only in the Friuli plain. Species of the genus *Maculinea*, given their peculiar larval biology, require good environmental conditions to sustain adults, larvae, the plants on which they feed, and also the ants which host them during winter. The group of xerothermophilous species, whose ecological problems were discussed above, is also among the Italian endangered species.

In conclusion, diurnal butterflies live very often in ecotones and are rarely associated with climax habitats. Those species living in the Alps and in forests are, with few exceptions (for instance *Lasiommata achine*), among the less endangered. It is obvious that in order to ensure their conservation (mainly inside small protected areas, such as the Biotopes of European Interest), cyclic management interventions, even if costly, must be planned as unavoidable.



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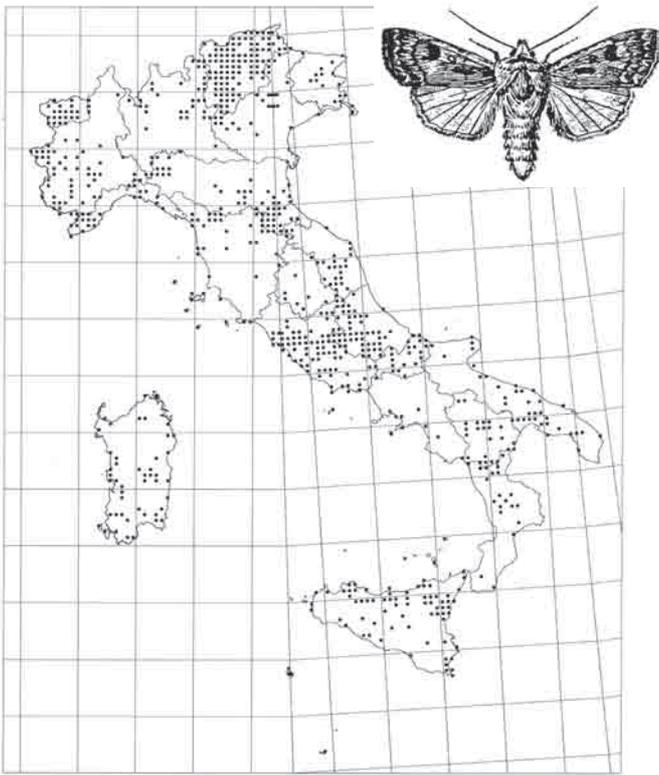
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Insecta Lepidoptera Noctuidae (Plusiinae, Noctuinae)

Alberto Zilli



Noctuidae is the largest family of Lepidoptera, with about 35,000 described species for the whole world; more than 800 species are present in Italy. The complexity and evolutive diversification of Noctuidae are so remarkable that experts opinions differ on many aspect of their systematics. The most debatable subject the monophyly of the group (Weller et al., 1994; Speidel et al., 1996). Results obtained with different sets of data, such as the morphology of adults and pre-imaginal stages, or molecular data, are not very comparable. In addition, there are no specialists who can manage such a wide and diversified group and, with few exceptions, specialists are familiar only with taxonomy of the Holarctic fauna, which include a small number of species and phyletic lineages compared with the Tropical ones. The latest tendencies, however, are to separate Nolidae from Noctuidae: that family includes the typical Nolidae and also some subfamilies traditionally included in the Noctuidae (for instance Sarrothripinae, Cloephorinae, Westermanniinae), and in the Pantheidae, but there are wide disagreements on whether the remaining lineages can be considered a monophylum or not (Holloway, 1998; Kitching & Rawlins, 1999; Yela & Kitching, 1999). Some groups inside

the “family” are well defined and represent valid reference taxa for ecological and biogeographical analyses. Among those represented in the Italian fauna, the subfamilies Plusiinae and Noctuinae have wide range of distribution patterns and ecological valences, and thus have been chosen as a model for the present project.

Material and methods

Distribution data were obtained from available literature, which was critically evaluated, and by the examination of various public and private collections. Because of the high amount of unpublished material deposited in several Italian and foreign museums, and the dispersion of faunistic data in numerous publications, filing must be considered preliminary. However, the typologies of the ecological distributions are well defined for each of the species studied. For this purpose, it must be remembered that the value of mapped data decreases with the increasing diffusion and ecological valence of the species, to the point that the distributions of some euryecious, highly vagile, abundant and polyphagous taxa are largely underestimated. For species such as *Chrysodeixis chalcites*, *Trichoplusia ni*, *Autographa gamma*, *Peridroma saucia*, *Noctua pronuba*, *Paranoctua comes*, *Megasema c-nigrum*, *Agrotis exclamationis*, *Agrotis ipsilon* and *Agrotis segetum*, authors rarely recorded the puntiform distribution in their faunistic reports, only mentioning the taxon as “a common element, widely diffused in the areas under consideration”. The reader can consider those species as everywhere widespread in Italy. Another limitation, relative to the oldest literature, is represented by numerous faunistic records with no geographical validity because they refer to wide areas or even to entire geographical districts (for instance Rome countryside, Susa valley, Maritime Alps, Sardinia). Some of those records have been used in the database when they were the only records for a wide geographical area.

Two species of *Abrostola* were excluded from the files: *A. tripartita* (Hufnagel, 1766) (= *triplesia* auct. nec L.) and *A. triplesia* (Linnaeus, 1758) (= *trigemina* Wernerburg, 1864), because endless misidentifications of the types and uncertainties on the species names used in literature would have made the determination of the records too subjective. In other similar cases (for instance *Euxoa nigrofusca*/*E. eruta* and *Agrotis puta*/*A. syricola*) there were enough reasonable preliminary data, which have therefore been used, although the resulting distributions have to be considered as still



in progress. Records of *Anomogyna speciosa* and *A. viridescens* have been merged because there are still doubts whether these are two distinct species (see Mikkola et al., 1994; Beck, 1999-2000). Other taxa with a doubtful systematic status, or with distribution that could not be used as a reference, or not surely confirmed for Italian fauna, have been excluded as well: *Euchalcia siderifera* (Eversmann, 1846), *Euschesis tertia* (von Mentzer, Moberg e Fibiger, 1991), *Violaphotia molothina* (Esper, [1789]), *Chersotis cyrnea* (Spuler, 1908), *Anomogyna sincera* (Herrich-Schäffer, 1851), *Pachnobia lorezi* (Staudinger, 1891), *Xestia trifida* (Fischer von Waldheim, 1820), *Parexarnis fugax* (Treitschke, 1825), *Euxoa (Euxoa) tritici* (Linné, 1761 *nec sensu auct.*) and *Agrotis turatii* Standfuss, 1888.

Biodiversity

Thirty-five species of Plusiinae, belonging to 18 genera, and 127 species of Noctuidae, belonging to 38 genera, were used for this project, but it must be remembered how there are continuous changes in the taxonomic status of those taxa (Beck, 1999-2000).

The biodiversity pattern of Italian Plusiinae mirrors the climatic characteristics of Italy, and the interactions of the temperate and Mediterranean ecosystems with the different ecological requirements of the species. In fact, the penetration of Alpine and orophylous taxa towards the South is limited by the presence of mountains, (*Tetrargentia*, *Syngrapha*, *Euchalcia*, *Autographa* [partim], *Standfussiana*), whereas steno-Mediterranean taxa can extend their distribution towards the North along the coasts, or in areas characterised by Mediterranean vegetation (*Daubeplusia*, *Ctenoplusia*).

This is probably a trend in the eco-geographic distribution of all the Italian Lepidoptera and it is apparent also for Noctuidae, if we examine large groups and genera, or if we compare pairs of close species (such as *Lampra fimbriata* and *L. tirrenica*, respectively with a Northern and Southern distribution). An intermediate situation is represented by numerous mesophylous taxa.

The present knowledge on distribution of Italian Plusiinae and Noctuidae is satisfactory, with the only exception of Noctuidae in the littoral sandy areas of Sicily (for this subfamily, comparable areas of the Mediterranean host a group of psammophylous or sub-eremic species which, quite strangely, are absent in Italy). The only uncertainties pertain to some populations of *Autographa* collected in the Eastern Alps which might relate to *A. excelsa* (Kretschmar, 1862) and *A. buratetica* (Staudinger, 1892), two species collected elsewhere in Europe. A detailed faunistic knowledge of other groups is not good because some species complexes are still not well known (for instance *Diachrysia* gr. *chrysitis*, *Euschesis* gr. *janthina*, *Anomogyna* gr. *speciosa*, *Euxoa* gr. *nigrofusca*, *Agrotis* gr. *puta*).

Ecology

Plusiinae and Noctuidae larvae are phytophagous and feed principally on herbs and grasses. Noctuidae include some of the better known “cutworms”, those caterpillars which at night cut the leaves from the petiole, and eat the leaves while they are sheltered on the ground. Adults are usually good flyers, they are nocturnal and feed on nectar, but some species can fly or feed during the day (*Autographa gamma*), primarily in mountain areas (*Syngrapha*, *Dichagyris*, *Chersotis*). The two subfamilies also include “wanderfalter”, i.e. extraordinarily vagile species which can move at several thousand kilometres distances (Eitschberger et al., 1991), probably using an astronomic orientation system during their movements (Sothibandhu, Baker, 1999).

Environmental preferences vary with the species, as does the phenology and the number of generations per year, mirroring the evolutive differentiation of this family. Typical species, at times exclusive, of numerous terrestrial habitat (moors, bogs, sandy dunes, marshes, tundra, forests, etc.), are included in Italian fauna. The only exception is represented by halophytic habitats, where other Noctuidae are dominant (Hadeninae). In general, Plusiinae are predominantly hygrophylous or mesohygrophylous (for instance *Plusia*, *Diachrysia*, *Lamprotes*), whereas Noctuidae are typical of high altitude prairies (for instance *Epipsilia*, *Rhyacia*, *Chersotis*, *Standfussiana*, *Ledereragrotis*, *Euxoa* [partim], *Agrotis* [partim]).

Numerous species live in highly natural biotopes and are strongly linked to their habitats, thus becoming important bioindicators. Among these are *Protolampra sobrina*, *Paradiarsia punicea* and *Diarsia dahlii* for bogs, *Plusia festucae*, *P. putnami* and *Naenia typica* for all kinds of wetlands, *Lycophotia porphyrea* and *Xestia agathina* for moors, *Agrotis endogaea* for littoral dunes, species of *Anomogyna* for conifer woods with *Rhododendron* and *Vaccinium* understory, and numerous species of various genera (*Syngrapha*, *Standfussiana*, *Chersotis*, *Pachnobia*, *Ledereragrotis*, *Yigoga*, *Euxoa*, *Agrotis*) for prairies or rocky areas at high altitude. Generally, environmental alteration can be detected when the Lepidoptera community is represented only by those euryoecious and vagile taxa previously discussed.

Zoogeography

If we consider the Italian political borders, endemic species are not numerous: they are represented by *Euchalcia italica* in the Central Apennines for the Plusiinae, and by *Agrotis predotai* in Sardinia for the Noctuidae. However, several species are endemic of natural geographic districts: for instance *Euchalcia bellieri* in Western Alps, *Standfussiana insulicola*, *Coenophila jordani* and *Agrotis schawerdai* in the Sardinia-Corsica regions (the latter species reaching the Balearic Islands).

The peculiar geographic position of Italy produced a



very heterogeneous fauna, as shown by the biogeography of several taxa: *Pachnobia alpicola* is Sibiric-European, *Dichagyris constanti*, is W-Mediterranean, *Agrotis herzogi* is Saharan-Sydic and *Xestia cohaesa* is Turanic-Mediterranean.

Some areal disjunctions which occur in Italy are quite peculiar: *Cladocerotis optabilis* is present in the French Alps and in Sicily, due to the post-glacial re-extension towards the North and the South of populations which had found a refuge in the Atlantic-Mediterranean area (Racheli, Zilli, 1988). The distributions of *Yigoga signifera* common in the Alps and Sila, and of *Chersotis fimbriola*, common in the Western Alps and abundant in Sicily, can be interpreted only on the basis of their ecology, because the distribution of these species extends to Central Asia. The lack in Italy of several species present in Iberic and Balkanic peninsulas, which therefore have a typical es-cato-Mediterranean distribution, is similarly unusual and related not only to the species ecology (Zilli, 2000).

Alien species

Exotic species have not been recorded. However, it is likely that, due to global warming, some Southern species such as *Chrysodeixis acuta* (Walker, 1858) might extend their distribution to Italy, as it has already happened for some Noctuidae of other subfamilies.

Conservation

The species strictly linked to habitats which are rare in Italy and subject to high anthropic pressure (such as some planitial, coastal or valley bottom areas) are the most endangered. For instance *Diachrysia zosimi*, exclusive of peat prairies of the Padana Plain and Veneto with *Sanguisorba officinalis* as the dominant vegetation, and *Euxoa segnilis*, exclusive of humid coastal meadows, are the two most endangered species. *Plusidia cheiranthi*

was collected in three stations in Italy, with abundant populations only in one of them (Pescara "pinewood"): this species has not been recorded in the last 50 years in the site.

The use of generic pesticides and of so-called "selective bio-pesticides" kill all the caterpillars feeding on leaves (for instance *Bacillus thuringiensis* var. *kurstaki*) which is an obvious threat for those populations living near the cultivations. Among these are the relict colonies of xerothermophilous elements such as *Euxoa distinguenda*, *Agrotis vestigialis* and *Dichagyris vallesiaca*, living at the base of the mountains in alpine valleys. The use of metamorphosis inhibitors to protect cultivations from phytophagous organisms and the reduced air exchange occurring in those valley causes toxic substances to remain in the valley bottoms and on the adjacent mountain slopes, affecting all the species present below that altitude.

Global warming is another factor that may threaten populations living at the highest altitudes (which until now had not been impacted much by anthropic activities, given their isolation). In fact, rising of temperature will eventually kill those species, which can not find a refugium at higher elevations, given that they already live on the mountain tops. For instance, the only Italian population of *Agrotis fatidica* not living in the Alps is confined to an elevation of about 2,100 m on the Gran Sasso d'Italia (Central Italy): this population would obviously go extinct after reaching the mountain top (2,914 m), even if the geomorphology of the higher sections of the massif (very steep and rocky) might prevent the species survival already at 2,400 m.

Another "global" factor causing a progressive faunistic impoverishment is light pollution, which was not considered a relevant ecological factor, but which in fact strongly impacts the phototrophic nocturnal Lepidoptera.



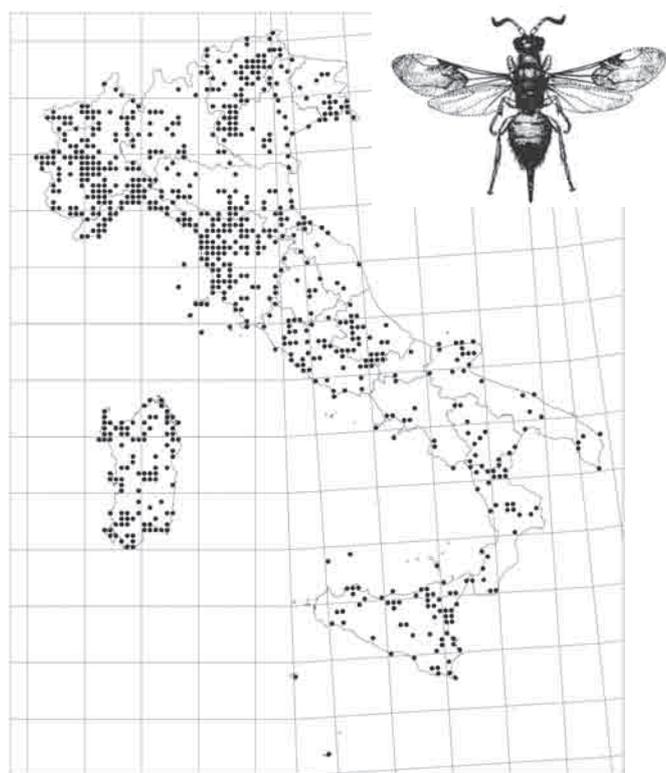
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Insecta Hymenoptera Chrysididae

Franco Strumia



The Hymenoptera family Chrysididae belongs to the series Aculeata and, with about 242 species known for Italy, it represents one of the most abundant monophyletic groups. Higher numbers of species are recorded only for the paraphyletic Apoidea (about 950 species, usually divided in 7 families) and Sphecidae (about 380 species, divided in 3 families). It can be estimated that in Italy the known species represent 90%, and maybe 95%, of those actually present. The high biodiversity, however, does not correspond to a proportional richness in individuals, probably as a consequence of the high trophic level of Chrysididae in the biocoenosis. Therefore, these Hymenoptera are proportionally rare in the main museum collections, except for local collections.

Material and methods

The taxonomy of Chrysididae was remarkably changed and improved by Linsenmaier (1959) and Kimsey and Bohart (1990), which began to use the male genitalia to establish the taxonomic status at genus, subgenus, and species level. As a consequence, prior data available in literature, should be cautiously evaluated, and often rejected (for instance *H. gloriosa* is a taxon recently

abolished by ICZN; numerous records of this species were totally incorrect, because they referred to a group of sibling-species). This situation appeared evident upon examination of the main museums collections, where specimens described in the '800s and in the first half of '900 are deposited.

For this revision, only those literature data which were considered reasonably correct were used, and museum specimens (particularly those from Turin and Genoa museums) were personally checked when possible. Literature data were omitted when the original material was available for re-study (for instance, Chrysididae collected by Doria on Giglio Island, published by Mantero, and deposited in the Civic Museum of Natural History of Genoa). Unpublished data were obtained by the abundant material collected with Malaise traps by the Museum of Natural History of Pisa (Tuscany represents the Italian region with more collection stations), and were added to the list.

Biogeography and ecology

In Europe, Chrysididae larvae are, without exceptions, parasitoid on other Hymenoptera, whereas the adults feed on nectar from flowers of various families (but they prefer Euphorbiaceae, Umbrelliferae, and some Compositae), and from exudations produced by plants attacked by fungi, insects, etc. Adults of the subfamily Chrysidinae lay their eggs in the nests of other Aculeata (Sphecidae, Eumenidae and Apoidea) and one parasitoid develops in each cell. As far as we know, each species uses as host one or more species, even from different families. As a consequence, up to 100% of the adult can have different sizes. Adults of the subfamily Cleptinae are parasitoid of Hymenoptera Tenthredinidae (Symphita) and generally show a smaller variability in body size of adults.

Chrysididae do not seem to have habitat preferences, even if they can be collected more frequently where their hosts nest, and in open areas rich with their preferred flowers. Because of this uniform behaviour, we did not fill up the columns in the Species Table in the same repetitive way.

The direct collection of Chrysididae gives good results only sporadically, and only recently the use of Malaise traps improved the collecting efficiency and confirmed, for instance, the presence of two little-known species (*Chrysidea asensioi* and *Cleptes triestensis*) in the "Maremma" Regional Park.



The geographic distribution of Chrysididae is still insufficiently known and the species distribution ranges are continuously updated and widened. Chorology data must therefore be considered cautiously. Moreover, the Apennines do not separate chorotypes 3.02 and 3.03 but, on the contrary, those two chorotypes overlap almost for all of Italy. In the Holarctic Region there are some high diversity areas, which are considered points of origin and diversifications. The areas relevant for Italian fauna are: the Iberic peninsula, the Middle East and Peloponnesus. Few North-European species have Siberic-European origin.

Alien species

No species introduced by man are known so far.

Conservation

The conservation status of Chrysididae is hard to evaluate, also because data on the biology and chorology of the hosts of several species are few or lacking. With the only exception of some doubtful and probably wrong records, all the species collected in Italy in the '800s have been recently re-collected, even if presently the populations are predominantly confined to the less-anthropized habitats. Extinction of taxa can therefore be excluded for Italy (maybe the only exception is represented by *Euchroeus purpuratus* F. 1787). One case of spontaneous introduction is *Chrysis marginata* from the Balkans, probably around 1950-60. However, several species are rare and/or localised, and were labelled as rare (R) in the station list, even if some of them are common and even dominant in other areas (as it is the frequent case for several species of chorotype 3.02).

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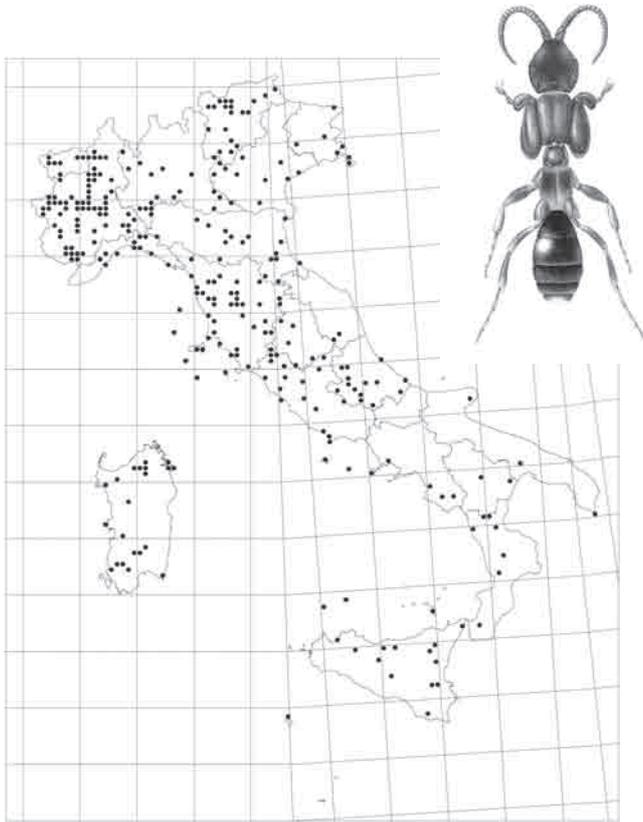
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Insecta Hymenoptera Dryinidae Embolemidae Sclerogibbidae

Massimo Olmi



Dryinidae, Embolemidae and Sclerogibbidae are Hymenoptera Apocrita belonging to the superfamily Chrysoidea. The first two families include species parasitoid on Homoptera Auchenorrhyncha, and Sclerogibbidae parasitize Embioptera. Females of almost all Dryinidae can be easily recognised because their anterior legs are represented by strong chelae, which they use to capture the host. Italian Dryinidae have been investigated quite well, whereas chorological and biological data on Embolemidae and Sclerogibbidae are still incomplete.

Material and methods

Filing of the distribution data is based on material personally collected by the author (about 90% of all data) or deposited in the main collections. All data reported refer to specimens personally examined by the author. All data from literature were checked. The resulting picture is quite incomplete, and there are large gaps in data from Southern Italy.

Biodiversity

Italian Dryinidae includes 10 genera from 5 subfamilies. Sixty-seven species are known for Italy which represents

the European country with the richest fauna, together with Spain. Of the 123 species reported for Europe, 33 are known for Great Britain, 36 for Germany and 60 for France, to mention the countries where this family is better studied. Central and Northern Italy have the highest species richness, although Southern Italy is insufficiently investigated.

European Embolemidae are represented by 3 species, and 1 species, belonging to the genus *Embolemus*, is present in Italy. Sclerogibbidae are represented in Europe and Italy by 4 species belonging to the genera *Sclerogibba* and *Poggiana*. This family has low number of taxa at worldwide level, but there are wide gaps in the relative knowledge.

Ecology

Dryinidae and Embolemidae, being parasitoid of Cynipidae, live wherever their hosts are present. Italian Dryinidae live on epigeal parts of grass, shrubs and trees, where they actively seek their hosts. The hosts of the only Italian species of Embolemidae are unknown, although they are likely to be young Cixiidae living on roots. Sclerogibbidae are parasitoid on Embioptera. They live in the silk galleries spun by their hosts under the rocks, in the soil, or under the tree bark.

Zoogeography

Only 4 of the 67 species of Italian Dryinidae are exclusive of our country. They are non-endemic, because they are parasitoid of a wide range of hosts that often migrate from one region to the other. Often the presence of a species exclusively to one country is apparent and due to the lack of research. Italian species of Embolemidae and Sclerogibbidae have a wide geonomy. Also the distribution of *Sclerogibba dissimilis* and *Poggiana pilosella*, which appears to be limited to Sardinia, is probably due to the lack of research as well.

Alien species

The only exotic species in Italy is the Nearctic Dryinidae *Neodryinus typhlocybae*, introduced from 1994 for biological control of the North-American Cynipidae *Metcalfa pruinosa*. The introduction was successful.

Conservation

Dryinidae and Sclerogibbidae are not associated with one host, but to groups of species, at times belonging to different genera. This plasticity allows them to survive



Massimo Olmi

in a variety of habitats, and there is no risk of extinction due to the loss of habitats and of the hosts living there.

The Italian species of Embolemidae is scarcely known to define its conservation status.

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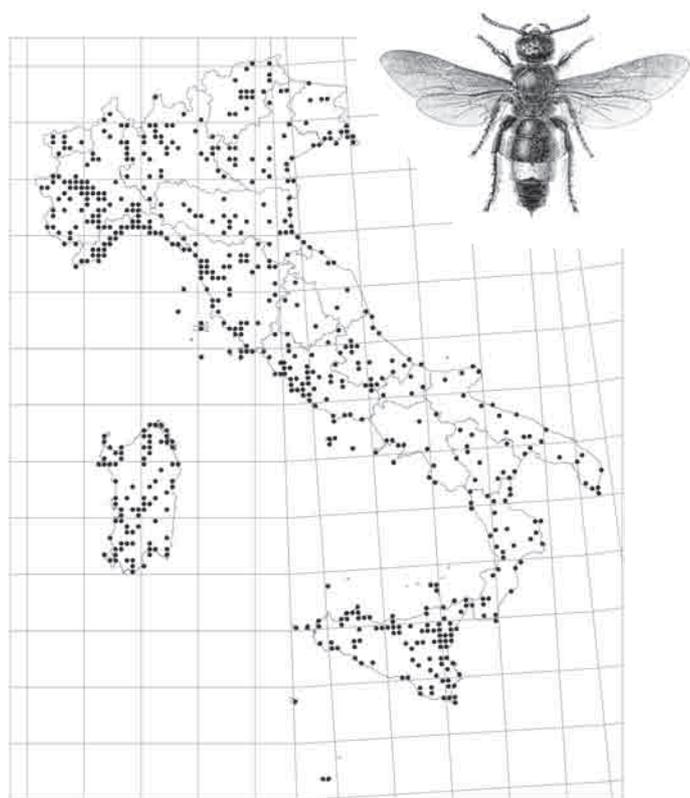
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Hymenoptera Scolioidea (Tiphidae excluded)

Guido Pagliano, Maura Generani, Pier Luigi Scaramozzino



Scolioidea is a superfamily of Hymenoptera Aculeata widespread in warm regions. The taxonomy and chorology of these insects are not well known. Six families are present in Italy: Bradynobenidae, Sapygidae, Tiphidae, Methochidae, Scoliididae and Mutillidae (Myrmosidae included). Tiphidae will not be discussed here.

Material and methods

The species distribution was prepared using the authors' collections, and several public collections.

Data were integrated with those obtained from literature. For the systematic of Mutillidae we followed Lelej (2002) who ranks the Myrmosidae as a subfamily of Mutillidae. For Scoliididae we followed Osten (2000), and for Sapygidae Gusenleitner and Gusenleitner (1994).

Biodiversity

Italian Scolioidea include 116 species and subspecies, grouped in 6 families: Methochidae with 2 species, Sapygidae with 5 species and 4 genera, Scoliididae with 13 species and 3 subspecies, 5 genera, Tiphidae with 15 species, 1 subspecies and 4 genera, Bradynobenidae,

with 1 species, and Mutillidae (Myrmosidae included) with 66 species, 10 subspecies, 19 genera.

Ecology

Scolioidea are ectophagous entomo-parasitoids; their biology and ecology are not well known. Sapygidae are clepto-parasites on other Hymenoptera (Apoidea) which nest inside the dry wood of trees trunks and limbs. Scoliididae are robust insects which parasitize larvae of Scarabeoidea Coleoptera of the families Cetoniidae and Dynastidae, which live in soil or in rotting wood. Also the weaker Tiphidae have similar behaviour but parasitize larvae of Scarabeoidea Melolonthidae. The adults of these two families are good flyers and live near the flowers of several Umbelliferae (wild carrot, fennel, eringium, exc.) and other plants on which they feed. They are thermophilous organisms, particularly abundant along the Mediterranean coasts where they can find the plants they seek: behind the dunes, in the Mediterranean chaparral, in weeds along roads, on riverbanks.

The apteran females of Methochidae (which are considered by some to be specialised Tiphidae), attack *Cicindela* larvae inside the holes they dig in the compact soil. The rare females can be found on the bare ground where the hosts are available, the winged males at times can be collected with Malaise traps.

Mutillidae have a strong sexual dimorphism: females are always apteran, males are winged and good flyers, rarely micropteran or apteran. Mutillidae attack the nest of several Apoidea species and parasitize their larvae. Females can be found on the ground near the colonies of Hymenoptera hosts. Mutillidae can be frequently found near the nesting areas of the hosts, such as open areas, in loose, bare soil (escarpments on the roadsides, river and stream banks, exposed soil banks, exc.). Males fly near the ground looking for females and are collected in great number by Malaise traps.

Zoogeography

Data on the distribution of these insects are incomplete and do not provide a final biogeographical characterisation. We tried to assign a chorotype to each species and subspecies, even if the picture presented here will need to be continuously readjusted.

Thirty-five percent of the species is exclusively Mediterranean; 14% of the species are endemic with 8 species and subspecies from Sardinia-Corsica (1 Methochidae and 7 Mutillidae), 2 Sicilian (one of which is present also in Lampedusa) and 4 Apenninic (three of which are



subspecies of doubtful systematic value) Mutillidae. The remaining species are widely distributed in the Palearctic Region. No chorotype could be attributed to 18 % of the species.

Alien species

There are no species introduced by man.

Conservation

Today these Hymenoptera are not endangered, the only risks being the loss of those habitats where they live together with their hosts, particular the littoral habitats (shores of various typology where a great number of species of this groups and their hosts live) which are at risk because of the intensive development of tourism.

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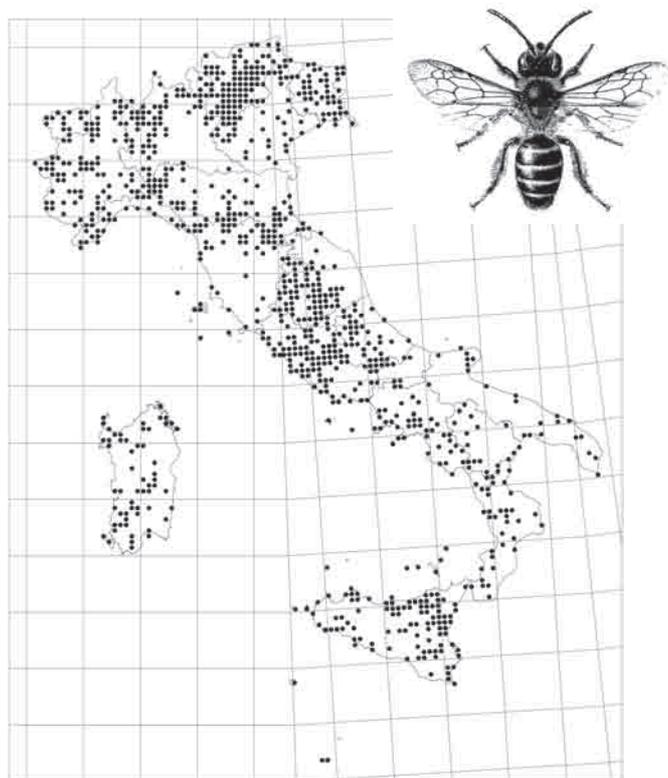
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Insecta Hymenoptera Aculeata

Apoidea (partim)

Livio Comba, Mario Comba



The bees, Apoidea, are insects common in various habitats from the coast to the vegetation limit on the Alps and the Apennines. In large cities, green areas (gardens, yards, flower beds) sometimes host several species. The honeybee, *Apis mellifera*, and all wild bees in general have a great ecological value because, feeding on nectar and pollen, they act as pollinators. Adequate pollination is required for long-term conservation of wild plants and to improve qualitatively and quantitatively several crops (Corbet et al., 1991). Apoidea systematics is well defined (Michener, 2000), but some subgenera, genera, and families were, and still have been split and merged again. This is the case, for example, for the genera *Bombus* and *Psithyrus*, recently combined by some authors into the one genus *Bombus*, or for the Antophoridae, sometimes included within the Apidae.

Material and methods

Italian Apoidea, in particular the genus *Bombus*, are well known. Literature is abundant, and research on the various taxa of this group characterised the species distribution in Italian regions with peculiar geography, climate, and vegetation (e.g. Trentino, Emilia-Romagna,

Lazio, Tuscany islands, Umbria, Marche, Sicily, Sardinia, some sections of the Alps). The literature examined ranges from the species lists related to the first Italian hymenopterological research projects at the end of the 1800s to the systematic revisions and checklists of recent years. Private and public collections were also examined, among which the most important were those of the Museum of Rome University "La Sapienza", the Zoology Civic Museum of Rome, the Agrarian Entomological Institute of Portici (46 genera, 352 Italian species), and the Comba collection. The numerous unpublished records obtained from the latter, which was started in the 1940s and is almost exclusively dedicated to Italian Apoidea (about 20,000 specimens and more than 600 Italian bee species), were added to records published in the course of the last 120 years. The limitations imposed by the size of this work required a partial treatment of Apoidea, which are thus represented here by 11 genera and about 200 species, equivalent to about 20% of the total number of Italian bee species. Genera were chosen to represent the biology, ecology, and distribution of each family and of the superfamily as a whole. Some genera were too abundant to be included here (e.g. *Andrena*, with 170 species). Among the 62 genera which are known for Italy, the following were selected: *Colletes* (Colletidae); *Panurgus* and *Panurginus* (Andrenidae); *Halictus* (Halictidae); *Melitta* (Melittidae); *Megachile*, *Osmia* and *Anthidium* (Megachilidae); *Anthophora* and *Xylocopa* (Antophoridae); and *Bombus* (Apidae). When required by the discussion, some taxa which are not listed here will also be mentioned.

Biodiversity

The distinctive geographic position, together with the geomorphological, climatic and vegetational complexity of Italy explain its high species richness. Pagliano (1995) lists 944 species (62 genera), but new recent records have not been added yet. The genera *Andrena* (170 species), *Nomada* (108) and *Lasioglossum* (96) together represent more than 1/3 of the Italian species, and 11 genera (*Panurginus*, *Rhophitoides*, *Systropha*, *Exanthidium*, *Trianthidium*, *Ammobatoides*, *Epeoloides*, *Pasites*, *Tarsalia*, *Triepeolus* and *Apis*) are present in Italy with one species each. The highest bee diversity in Europe occurs in the Iberian Peninsula (1,043 species) (1956). Great Britain has 255 species (1978); Gaul (France, the Walloon area of Belgium, Luxembourg and



Switzerland) 913 (1995); Germany, Austria and Switzerland together 728 (1996); Poland 454 (1991); and Finland 230 (1968). Because this work encompasses only a part of the Italian Apoidea, it was not possible to describe exhaustively species diversity for the different areas of the country. The general picture, combined with data available in the literature, shows how some areas and provinces, and at times entire regions, have a low number of records (e.g. Molise, Liguria and Basilicata). These differences are partly due to more or less intense research activities which over the years have been developed systematically only in a few regions (Latium, Piedmont, Sicily, Sardinia). The most accurate estimates report 450 species for Latium (1991) and 553 for Piedmont (2004). Also, in Piedmont 231 species belonging to 36 genera and 6 families have been captured in a small alpine area (about 300 km² located between 500 and 2,800 m a.s.l.) in Turin province. For Sicily, 473 bee species have been reported (1995), and 256 are known for Sardinia (1995).

Ecology

The soil and its exposure, and the availability of sites and materials to build the nest, are some of the factors which, together with the required food resource, determine the presence of a certain species in a given area. Apoidea feed on nectar and pollen, and a varying degree of species specificity associates each bee species with her host plants regarding pollen (poly- or oligolectic species), nectar, or nectar and pollen (poly- or oligotrophic species). Most of the solitary species show strict responses to diurnal and seasonal changes in temperature, whereas social species of the genus *Bombus* have an effective thermoregulatory system that extends their activity at temperatures lower than 10 °C. At the same temperature, *Apis mellifera* workers cease any activity outside the beehive. Dispersal is limited by altitude, and many species live below 1,000 m a.s.l., with the exception of species of the genus *Bombus* and their parasites of the genus *Psithyrus*. The genus *Bombus* is dominant in terms of number of individuals almost everywhere, and especially above 1,000-1,400 m, where it also shows its highest diversity. The feeding habits and characteristics related to nest-building of some bee species have made it possible to develop rearing techniques for their use in agriculture. Besides *Apis mellifera*, *Bombus terrestris*, *Osmia rufa*, *Osmia cornuta* and *Megachile rotundata* are also reared in Italy and used to pollinate several crops in open and confined environments. *Bombus* colonies are reared and sold in several countries. With regards to environmental quality monitoring, *Apis mellifera* and honey are used as indicators of the presence and levels of pesticides, heavy metals, and plant pathogens.

Zoogeography

In the Alpine areas, Palearctic taxa with an European distribution extending to Central-Asia and Siberia prevail, but Southern-European and Mediterranean species have been captured as well. Sicily hosts a South-European and Mediterranean bee fauna, with some elements which are more or less restricted to small areas of the Mediterranean basin, or extended to Mahgreb and, towards the East, to Iran, Anatolia, or Central-Asia. There are a few endemic species known for Italy, if compared with the total number of species (2-3% of the total), and they are exclusive to Sicily and Calabria, or Sardinia.

Alien species

The accidental introduction of exotic species from areas adjacent to Italy has not been documented. Also, rearing and pollination practices have not caused the introduction of new taxa, in contrast to what happened in some other countries. A special case is represented by colonies of *Apis mellifera* which are moved for crop pollination and/or honey production. Mouth-parts morphology, partly-shared floral preferences, and patterns of activity make the honeybee a potential competitor for the resource normally available to wild species only. The use of large numbers of beehives and the consequent spatial concentration of thousands of *Apis* foragers in habitats which are already fragmented and impoverished by agricultural practices can cause competition for pollen and nectar, affecting resident wild species which are less efficient, less numerous, and dependent for forage on a limited number of plant species.

Conservation

It is difficult to assess whether or not a rare taxon is actually at risk. Nevertheless, it has been shown that more and less common *Bombus* species are endangered almost all over Europe. In those areas of Italy where environmental conditions have been strongly modified (such as, for instance, Rome province), several social and solitary species which were collected quite frequently until the '60s, are today less common. The conservation of Apoidea is not only important for their intrinsic naturalistic value, but is essential to maintain wild plants populations and natural habitats (Corbet et al., 1991). Several plants species are pollinated exclusively by Apoidea. For all species, habitat fragmentation, contraction of plant populations and a decline in diversity caused by urban growth and agriculture are a threat at the local and national scale. Species living in mixed habitats may forage on wild plants and on crops offering accessible nectar and/or pollen. In large agricultural areas, a lack of proper, diverse and accessible forage can put at risk populations at the local scale and cause subsequently a (local) reduction of species richness.



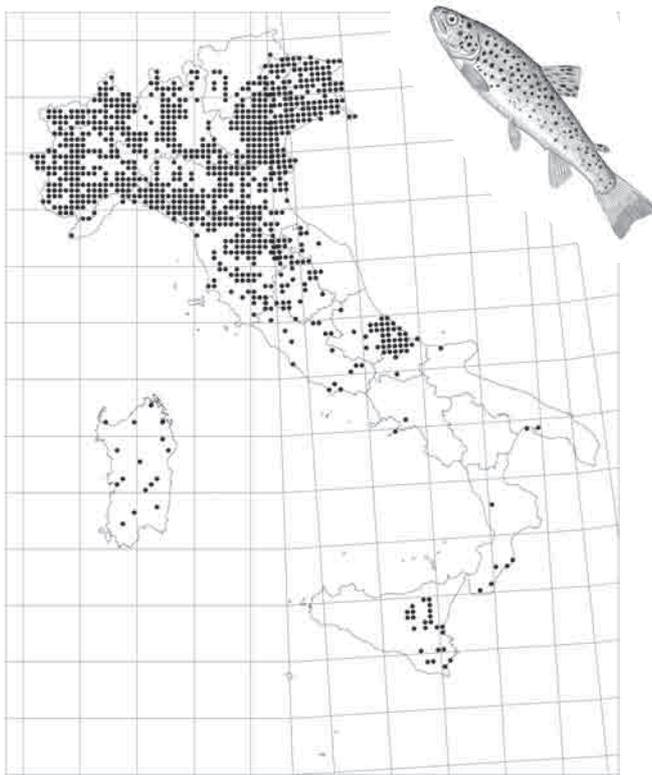
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Agnatha Osteichthyes

Laura Bobbio, Luigi Sala



Agnatha is a class of Vertebrates similar to fishes, characterised by jawless mouth. Four species are represented in Italian waters, one of which is endemic.

Osteichthyes, or bony fish, are Gnathostome Vertebrates, i.e. characterised by a mouth with jaws. About 70 species are present in Italian freshwaters, including the numerous allochthonous species now totally acclimated to our rivers and streams. The systematic of some Osteichthyes is still problematic, due to the limited knowledge and also to the confusion caused by the hybridisation of autochthonous taxa with allochthonous ones.

Material and methods

Following the criteria used by Gandolfi et al. (1991), we took into consideration all those species which live permanently in fresh or brackish waters and those which spend there one phase (trophic or reproductive) of their biological cycle (gars, shads, eels). We excluded all those species that live in brackish waters and lagoons, and breed in the sea or in high salinity waters. Only the truly acclimated exotic species were taken into account.

We used data from published literature or, in some rare cases, from unpublished reports. In order to present a correct and updated description of the species distribu-

tion, we examined only recent literature. The oldest citation dates to 1967, whereas most of the literature (96%) dates after 1980. Older citations are, in fact, meaningless because the taxonomy of several taxa was reviewed and, most important, because almost all Italian rivers and streams have extensively changed, together with their fish communities.

The most relevant contribution given by literature comes from the "Carte Ittiche" ("Fish maps"), which group and summarize large amounts of data on the characteristics of rivers and on the distribution and biology of fishes living there. The "Carte Ittiche" are used to plan correct management of the rivers and streams and of fish on a regional, provincial, or single river scale. Although the "Carte Ittiche" are not homogeneous as analysis methods and thus, as quality and quantity of data they record, they provide a large amount of updated and precise information regarding fish. Data are collected directly on the field, with samples from several locations properly distributed along rivers and stream, or over entire hydrographic basins.

Available information on freshwater fish of Italy have two setbacks: research concentrated only on those species with commercial value, and they were mostly developed in Northern Italy.

One hundred-forty publications were examined, including the "Carte Ittiche" and other references, leading to 16,000 records, all entered in the database

Biodiversity

Freshwater of Italy hosts 4 species of Agnatha belonging to 3 genera of the family Petromyzontidae. One species, *Lethenteron zanandreae*, is endemic to the Padano-Venetian area.

The class Osteichthyes is represented by 49 genera and 23 families. The total number of species is 71, 19 of which are endemic, whereas the number of exotic species now acclimated in Italian waters is higher (27). Cyprinidae is the most abundant with 27 species, followed by Salmonidae with 11 species.

The taxonomy of some taxa, mostly among Cyprinidae, is still uncertain. Systematic of the genus *Barbus* is very controversial. We followed the classification proposed by Gandolfi et al. (1991) who recognise two autochthonous species *B. plebejus* and *B. meridionalis*. Records attributed by other authors to other taxa with uncertain taxonomy were inserted in the database as *Barbus* sp. In a similar way, it is still not clear if populations of *Scardin-*



ius erithrophthalmus from Central Italy should be considered a distinct taxon.

The biodiversity pattern shows a higher poverty of species in Central and Southern regions and in the islands, as explained in details below.

Ecology

Among the 4 Italian species of Agnatha, *Lampetra planeri* and *Lethenteron zanandreaei* are non-migratory species, which prefer clear and cold waters of small rivers. The remaining two species (*Petromyzon marinus* and *Lampetra fluviatilis*), are anadromous and move upstream to the main Italian rivers to reproduce. All 4 species are very sensitive to water quality.

Freshwater fishes have a typical zonation from spring to rivermouth, according to the physico-chemical characteristics of the rivers. Each zone is characterised by a typical association of species and is named after the dominant species. For rivers of the Padania Plain-Veneto basin, five zones can be identified: 1) "Trout" zone, corresponding to the higher part of the river, where *Salmo (trutta) trutta*, *Cottus gobio* and *Phoxinus phoxinus* can be found; 2) "Thymallus" zone, where the current is still high but there are some pools, and deposits of gravel and rocks; this zone is inhabited by *Thymallus thymallus*, by the endemic *Salmo (trutta) mormoratus* and by *Leuciscus souffia*; 3) "Barbus" zone (or reophilic Ciprinidae zone), with slow current and wider riverbeds, with sandy areas; the typical species of this zone are *Barbus meridionalis*, *B. plebeius*, a *Chondrostoma genei* and other benthic fishes such as *Padogobius martensii* and *Cobitis taenia*; 4) "Tinca" zone (or limnophilic Ciprinidae zone), the section of the river flowing in the plain, characterised by *Tinca tinca*, by numerous Ciprinidae such as *Scardinus erithrophthalmus*, *Rutilus erithrophthalmus*, *Leuciscus cephalus*, *Cyprinus carpio*; 5) "Plaice" zone, at the rivermouth, with brackish waters, characterised by small Gobiidae such as *Knipowitschia panizzae* and *Pomatoschistus canestrini*, *Aphanius fasciatus* and the Atherinidae *Atherina boyeri*.

In Central Italy the zonation is less marked because rivers running from the Apennines to the sea are shorter and faster. Four zones can be recognised, because the "Trout" zone includes the first two on the previous list. *Salmo (trutta) macrostigma*, and the endemic *Padogobius nigricans* (which vicariates *P. martensii*) and *Rutilus rubilio* (which vicariates *R. erythrophthalmus* and *R. pigus*) are typical of the Tyrrhenic side of the Apennines.

The species living in springs and "fontanili" (resurgences) in the plains are characterised by *Knipowitschia punctatissima*, a small Gobiidae endemic for the Padano-Venetian area. Other species that prefer cold, well-oxygenated and vegetation-rich waters can be found there as well, such as *Esox lucius*, *Gasterosteus aculeatus*, *Phoxinus phoxinus* and *Leuciscus souffia*.

Fishes living in the largest and deepest lakes are distributed following the habitat preferences described above. Most of the species are those of the limnophyle Cyprinidae. Two endemic Salmonidae are each present in a different lake: *Salmo carpio* in Garda Lake and *Salmo fibreni* in Posta Fibreno Lake (Frosinone).

Fish are very important at various levels of the food-web: they are predators (*Esox lucius* and *Micropterus salmoides*), omnivorous (several Cyprinidae), herbivorous (grass carp), and planktivorous (whitefish introduced in several lakes in the Pre-Alps and Latium).

Zoogeography

Two Agnatha species do not migrate from the sea into freshwater: one of them, *Lethenteron zanandreaei*, is endemic to the Padano-Venetian area, the other one, *Lampetra planeri*, is distributed in rivers and streams of the Tyrrhenic side. *Petromyzon marinus* moves upstream to the main Italian rivers to reproduce, whereas *Lampetra fluviatilis* migrates only into rivers and streams of the Tyrrhenic sides.

The zoogeographical analysis of Italian ichthyofauna by Bianco (1987) defined two main ichthyogeographic districts on the basis of different paleogeographic histories: the Tuscany-Latium district, and the Padano-Venetian district (which includes the Adriatic side of the Apennines to the Vomano river in Abruzzo). The compared analysis of the fauna from the two districts shows how the latter has a higher number of species and of endemics than the former. Taking into account only the autochthonous species in their original distribution area, about 20 species are exclusive to the Padano-Venetian district, 4 are shared with the Tuscany-Latium district, and around 10 are distributed in the entire peninsular Italy. Only 6 species are exclusive to Central or Southern Italy. There are 11 taxa endemic to the Padano-Venetian district, only 5 in the rest of Italy, and none in the islands. However, rivers and streams of Northern Italy, and in particular those in the Padano-Veneto district, are the most investigated, whereas knowledge on Central Italy ichthyofauna are scarce, and almost non-existent for some Southern regions and the islands. It is not unusual that the distribution of some species in Northern and Central Italy is well known, whereas their southern distribution is totally unknown due to the lack of data.

As underlined by Zerunian (2002), the distribution of Italian fish fauna has been greatly altered by introduction of exotic species and by the transportation of species by man. In fact, in the last three decades a high number of fish have been moved, accidentally or not, from one hydrological basin where they were autochthonous to a different one, where they were not present before. Most of the cases refers to the movement of species from Northern Italy to the rest of the country: several of the small Cyprinidae of the Padano-Venetian dis-



trict are presently found frequently living in rivers and lakes of Tuscany, Liguria, or Latium, where they compete with the local species. Some movements in the opposite direction are known as well, such as *Rutilus rubilio* now present in some streams and rivers of the Northern side of the Apennines. Two Gobiidae, *P. martensii* and *P. nigricans*, which are endemic respectively for the Padano-Venetian region and for the Tuscany-Latium region, are both present in the Florence province on the Adriatic and Tyrrhenic side of the Apennines.

The consequences of these transfaunations are particularly negative in the Central and Southern regions of Italy where knowledge on fish fauna is scarce, and thus it is very difficult to understand which were the original native taxa before the introduction of allochthonous species and their hybridisation with the indigenous ones. It is therefore unclear if the presence of *Leuciscus cephalus* in rivers of Southern Italy is a natural phenomenon or if this species was introduced here. In Southern Italy, *Leuciscus cephalus* seems to be a threat for the small endemic Cyprinidae *Alburnus albidus*, because the two species easily produce hybrids.

Alien species

Italian ichthyofauna includes at least 27 exotic species. Some of them were introduced and acclimated several years, and at times centuries, ago; these species are now part of the local sociological-cultural knowledge. This is the case of *Ictalurus melas*, *Cyprinus carpio*, *Micropterus salmoides*, *Lepomis gibbosus*. Very peculiar, and far in the past, is the introduction of *Gambusia holbrooki* at the beginning of 1900 for mosquito control. At least 13 species were introduced recently, i.e. in the last 30 years. The introduction was sometimes involuntary, through non-controlled restocking, or voluntary, mainly for species used for sport-fishing. *Silurus glanis* is one of the most worrisome species: it greatly expanded in the Padana Plain basin, and it thrives exploiting the autochthonous species.

The introduction of species which are autochthonous, but with individuals coming from other countries, is another common phenomenon. A typical example is represented by the continuous restocking of *Salmo (trutta) trutta* with material coming primarily from Northern Europe. The main negative consequence is the hybridisation of these organisms with the Mediterranean *Salmo (trutta) marmorata*. In several rivers in Piedmont, the higher course hosts only hybrids, in the lower course

stretches *Salmo (trutta) marmorata* is decreasing in numbers, and it is found together with hybrids.

A high number of allochthonous species is not acclimated in Italy, however they are continuously released, as is the case of *Ctenopharyngodon idellus*.

Conservation

Italian ichthyofauna is extremely important not only for its biodiversity, with a high number of endemic species and for biological balance, but also for the economy: several species are relevant for sport fishing and fish farming.

The wide sampling efforts needed to compile the "Carte Ittiche" highlighted severe alterations of the original fish communities which occurred in the last decades. These are due to the presence of exotic species, of species coming from other parts of Italy, and of allochthonous populations of indigenous species, as it is the case for *Salmo (trutta) trutta* and *Thymallus thymallus*. To stop this situation, restocking should be reduced to the minimum necessary, and the origin, homogeneity, and health of the material used should be controlled with strict regulations.

Data on the conservation status of the various species are quite alarming. All four species of Agnatha are strongly endangered by the degradation of their habitats and, for the migratory species, by the presence of barriers, such as dams and watergates that hinder the adults ready for reproduction to move upstream.

The impact of barriers not provided with corridors extends to all species of migratory fishes such as gar and eel which, for instance, can not reach waters above Piacenza due to the dams at Casale Monferrato first, and next at Isola Serafini on the Po River. The case of gars and eels is macroscopic, because it affected a wide geographic area, and because these fishes have great economic relevance. However, even those species which move towards the upper course to reach the spawning areas (such as several Cyprinidae), are negatively affected by any kind of barriers used to rule the river flow.

Five of the 19 endemic species are endangered, 10 more are vulnerable. The strong urbanization of the plains, industrial activities, habitat alteration due to river regulation, professional fishing and, even more, sport fishing, and finally the lack of environmental respect, are the main causes of this situation. In addition, exotic species introduced by man negatively affect the biocoenosis, with effects ranging from hybridisation to the total extinction of local populations.



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Amphibia and Reptilia

Emilio Balletto



Amphibia and Reptilia are two vertebrate orders widespread in all terrestrial habitats of Italy, and are all well known. The publication of the European Atlas (Gasc 1997) started a reorganisation of the taxonomy and chorology of these two groups which will be concluded in this decade. For Italy, several local atlases are available, mainly at regional level, and more are in preparation. The use of molecular biology techniques, together with morphological studies, clarified the taxonomy of numerous Amphibia, demonstrating how Italian species are very often taxonomically distinct from those of the rest of Europe.

Material and methods

Filing of the distribution data was based on the observation carried out by members of the Societas Herpetologica Italica, which started in the '90s (1st Conference SHI 1996), and on recent literature. Old citations were not always usable, because they were incomplete or not reliable; however, they could be related to the present taxonomy and chorology, even if some populations are now extinct. In the case of herpetofauna, the database was reduced to one point citation for each UTM square of 10x10 Km. New unpublished data entered in the da-

tabase represent 50% of all the records.

Biodiversity

The herpetological fauna of Italy includes 38 genera belonging to 18 families (8 of Amphibia, and 10 of Reptilia). The 83 Italian species represent 36% of the entire European fauna (up to the Ural and Caucasus) which includes 233 species, and 20% of the entire Euro-Mediterranean area, which includes 423 species (nearly the same number recorded for North America). Italy has a higher number of species than other European country. The closest numbers are those of Spain (79 species) and Greece (69 species). Taking into account the entire Euro-Mediterranean area, the countries with richer fauna are Turkey (123 species), Morocco (101), Israel (Palestine included: 100 species) and Algeria (89). The case of Israel is remarkable: notwithstanding the small area, this country hosts a great number of eremic species, primarily with Turanic-East Mediterranean distribution, mainly in the Negev.

As happens for several other groups, the biodiversity pattern emerging from this work reveals higher species richness in the Northern regions, with 57 species, whereas 42 are present in the Apennines. As a consequence of the "peninsula effect", relatively few species reach Calabria (28), Sicily (27), and Sardinia (23). However, considering that Aosta Valley with 18 species is the Italian region with the poorest herpetological fauna (but it is also the smallest region), that Trentino-Alto Adige has 26 species, Emilia-Romagna, Tuscany and Piedmont have 36 species, this North-South trend is less strong than it seems. Opposite of what happens for other groups, the Alps represent a barrier which herpetofauna can pass only at the Eastern and Western margins. The two regions with highest species richness are therefore Liguria and Friuli Venezia Giulia, with respectively 38 and 37 species.

Ecology

Reptilia and Amphibia are poikilothermous. More than other vertebrates, their life cycles are strongly influenced by annual variations in temperature and rainfall; all Italian species interrupt their activity at least once per year. In most of Italy, this interruption occurs in winter but, moving towards the South, some species (for example, *Testudo hermanni*) estivate, mainly in August. In Calabria the interruption of the activity takes place in summer and the species of the genus *Triturus* start their courtship



in December-February (depending on the years and the elevation, even until May). Most of the amphibians try to maximize the survival of their larvae from changes in temperature, rainfall, and drying of their habitats. Species which colonize the driest habitats are often opportunistic (for instance, *Bufo viridis*), and can reproduce at different times of the year, as soon as it start to rain (March-June). Those which live at high altitude have to deal with short summers, during which the larvae have to reach metamorphosis and the adults have to accumulate enough trophic resources to survive the long winter, and to reproduce the following spring. Eggs are laid as soon as the environmental conditions allow it, often (*Rana temporaria*, *Triturus alpestris*) before the snow melts. Night frosting often kills hundreds of individuals. At intermediate altitudes, where water is relatively abundant and temperature is less extreme, eggs are laid in spring, in different times according to the species. In Northern Italy *Bufo bufo* is the first to lay its eggs (February), followed by newts and *Rana dalmatina*. The last species to lay their eggs (May) are usually green frogs and tree frogs. Few species live in the littoral, and among them only *Bufo viridis* can tolerate low brackish waters.

The areas where amphibians reproduce are very different as well. Toads, especially *B. viridis*, but also *Bufo bufo*, need wide and shallow waters, well warmed by the sun and never shaded, which allows for a good view of the sky. Green frogs prefer large ponds with aquatic vegetation. Red frogs, especially *R. italica* and *R. latastei* but also species of *Salamandra* and *Salamandrina terdigitata* are associated with small streams in wooded areas. With the exception of those species strictly associated with water (for instance, green frogs), adult amphibians are nemoral and are difficult to see after reproduction. Species of the genus *Speleomantes*, all endemic to Italy, live in small cavities. They are found in palaeo-landslides, rock cracks, but they are easier seen in caves. Their biologic cycle is still imperfectly known. The case of *Proteus anguinus*, is also strange: this animal lives in subterranean waters of the Karst in Trieste and Gorizia province, only rarely it can be seen, and only in those caves which reach groundwaters.

Almost all Italian reptiles are thermophyle and some xero-thermophyle. Mesophyle species are not abundant, even if at times they are relevant as biomass, such as *Natrix natrix*. Some taxa which are mesophyle in Northern Europe and typical of planitial areas, occupy instead the higher horizon of the mountains in Italy, at times above the tree-line. This happens, as already stated, also for *Rana temporaria*, but mostly for *Lacerta agilis*, *Zootoca vivipara* and *Vipera berus*. The progressive movements of mesophyle species towards higher elevations moving N-S is well known for several other animals.

We conclude this short chapter noting that, for reptiles, the structure of the vegetation is often more important

than the vegetation itself. Few reptiles, in fact, are actually nemoral or typical of open areas, the remaining live in ecotones between the wooded areas (or scrubs) and meadows. In a very simplified manner, it can be stated that the narrow home-range of each individual must contain appropriate areas for thermal regulation (for the animals to warm up in the morning and to cool down in the afternoon), areas to lay eggs (i.e. sandy or fractured areas), and areas sheltered from the weather and from predators to spend the hibernation or the aestivation periods. The mesophylic or thermophylic preferences, together with different trophic needs, determine the presence and distribution of the different species on a microgeographic scale.

Zoogeography

Italian herpetofauna includes a high percentage of endemic species (15, representing 19.3% of the total). This datum does not encompass species such as *Salamandra lanzai* and *Speleomantes ambrosi*, which extend their distribution for a few kilometers into France and *Podarcis filfolensis* (present in Linosa and Lampione, in the Pelagie Islands, and in Malta), or *Discoglossus sardus* and *Hyla sarda*, both Sardinian-Corsican endemics. The status of *Natrix [natrix] cettii* is not yet clear but it is almost certain that it will be considered a distinct species. The same might apply to *Pelobates [fuscus] insubricus*. As stated elsewhere, the taxonomy of the Italian *Bufo viridis* populations will have to be evaluated with more attention. For the other European countries the global endemism rate is 21.8% (51 species). Only Spain has a higher endemism rate than Italy (22.8%), primarily due to the high number of endemic species in the Canary Islands (genera *Tarentola*, *Gallotia* and *Chalcides*). Greece is third, with 10 endemics (14.5%). The Euro-Mediterranean area as a whole has an endemism rate (calculated on the basis of the most recent political borders) of 21.3% (90 species), the highest endemic rates are recorded in the Southern countries. Besides Spain, Morocco represents the species richness hotspot, with 21 endemic species (20.8% of the total). Turkey, in spite of its wide extension and the numerous species (125), is placed after Greece, with 8 endemics (11.6%).

For Italy, the high endemisms rate is primarily due to amphibians, 42% of which are endemic, and it is related to the remarkable number of species belonging to the genus *Speleomantes*. Opposite of what happens in several other groups, the Alpine and pre-Alpine provinces do not have any endemic species. At European level, there are only two Alpine endemics: *Salamandra atra* (which reaches the Balkans) and *S. lanzai* (restricted to the South-Western Alps). The highest number of endemics is recorded for the Apennine area (9 species, 7 of which exclusive) in Sardinia (5) and in Sicily (2 species, with only one truly Sicilian species, *Podarcis wagleriana*,



whereas the other one, *P. raffonei*, is limited to the Eolian Islands). *Hyla intermedia* and the non-hybrid green frog of the Apennines and Sicily *Rana bergeri*, are endemic to Italy as well. The Apennine endemics are widespread: some in the entire Italian territory, from the Padana Plain to Sicily (such as *Hyla intermedia*), others from Liguria to Aspromonte (*Salamandrina terdigitata*, *Bombina pachypus*, *Rana italica*, *Chalcides chalcides*), or more rarely from the Central Apennines to Aspromonte (such as *Triturus italicus* and perhaps *Rana bergeri*, whose northern limit has not yet been defined). Italian herpetofauna does not include punctual endemics, such as it happens for instance with several invertebrates. The Sardinian endemics of the genus *Speleomantes* have the narrower distribution: the extreme case is *S. flavus* which is limited to the Albo Mountain massif, between the town of Posada and the Siniscola Stream.

The biogeographic meaning of the endemism pattern of Italian herpetofauna is quite evident. Chromosomic, electrophoretic and biomolecular studies developed since 1980, showed that, at least for Amphibians, divergence time from their European vicariants occurred probably some millions of years ago. The exception is represented by the green frogs of the *Rana esculenta* complex, that are characterised by well-known processes of hybridisation and hybridogenesis, and that probably had shorter divergence times. The origin of most of the endemic Italian herpetofauna dates back to the cycles of glaciations and glacial regressions that occurred from the end of the Tertiary to the beginning of Pleistocene. During this last period, after the last glacial regression, the Alps ceased to represent a barrier, and areals could expand again: widespread European species expanded to the Padana Plain eliminating, at least for some cases, the species already living there, or colonising habitats which had few reptiles and even fewer amphibians. *Rana latastei* is the only endemic species of the Padana Plain; this species reaches the southern tip of Switzerland following the Ticino River to the North, and Slovenia and Croatia to the East.

Rana latastei represents the only recognizable remain of how the ancient Padana herpetofauna before the reopening of a corridor in the Alps. *Pelobates [fuscus] insubricus* shares with the previous species the same distribution to the East, but almost certainly this latter species originated more recently, whichever might be its real taxonomic status. As a consequence of the Pleistocene opening, or re-opening of a passage through the Alps, Italian fauna was enriched with species that were exotic before. This happened, with the same amount of species, at the two extremities of the Alps. From the East several species entered in Venezia Giulia (*Bombina variegata*, *Hyla arborea*, *Coluber gemonensis*, *Algyroides nigropunctatus*, *Archaeolacerta horvathi*, *Podarcis melisellensis*, *Telescopus fallax*, *Vipera ammodytes* and *Lacerta viridis*, which

has at least one population in Friuli. From the West, other species entered in Liguria (*Hyla meridionalis*, *Pelodytes punctatus*, *Timon lepidus*, *Chalcides striatus*, *Malpolon monspessulanum* and *Elaphe scalaris*). Some of those species changed or expanded their distribution Westward to Trentino (2), Veneto (2) and Lombardy (1), and Eastward to Piedmont.

A peculiar and not yet well-investigated case is represented by the *Rana ridibunda* species-complex. This species was introduced in various parts of Italy (similar to the introduction in Liguria of the balkanic species *R. kurtmuelleri*, but it must be ascertained if this is the case for Venezia Giulia and Trentino, where *Rana ridibunda* might have originated from the North. There are populations of this same group in Liguria and Piedmont which might belong to *Rana perezi* (W-Mediterranean) but have not been studied yet. Such a marginal penetration of species occurred, in a way still not well understood, for the Pelagic Islands, which host the Italian populations of *Psammodromus algirus*, *Podarcis filfolensis* and of the Maghrebin "subspecies" of *Malpolon monspessulanum*. The remains of older faunas can still be found in the Sicilian lizards of the genus *Podarcis* (*P. wagneriana* from Sicily; *P. filfolensis*, from Linosa and Lampione, in the Pelagic Archipelago, and Malta; *P. raffonei*, in the Eolian Islands). The first two species are very close sibling-species, therefore it is possible that *P. filfolensis* originated from ancestors coming from Sicily. *Podarcis raffonei* is sibling-species of the Sardinian-Corsican species *P. tiliguerta*, therefore it belongs to an oldest thyrrenian species complex which might have originated in the Miocene (Oliverio et al., 2000). A similar situation is represented by species with high divergence belonging to the genus *Euproctus* (*E. asper* in the Pyrenées, *E. montanus* in Corsica, *E. platycephalus* in Sardinia), which might represent a paleothyrrenic complex (Caccione et al., 1997). It must be remembered that the Pletodontidae of the European genus *Speleomantes* were included until recently in the genus *Hydromantes* together with three species from California (*H. brunus*, *H. shastae*, *H. platycephalus*). The separation between the American Pletodontidae, which include 26 genera, and the European ones, can be dated back to the Jurassic. A similar dating was hypothesised for the Urodela of the genus *Proteus* (1 or 2 European species), which family (Proteidae) would be sister to the American Sirenidae (2 genera, *Pseudobranchius* and *Siren*, with 4 species).

Alien species

The introduction of allochthonous species is a very important problem, recognised at international level. Just for Florida the exotic herpetofauna increased from 3 species in 1958, to 23 species in 1991, represented primarily by Sauria, but a small crocodile (*Caiman crocodilus*) and a blind snake (*Ramphotyphlops braminus*) were recorded



as well. The situation is slightly better in Europe, with 4 (at least for now) non-European species (*Bufo mauritanicus*, *Rana catesbiana*, *Trachemys picta*, *Teira perspicillata*). The continuous import of tropical species as pets will certainly increase the number of allochthonous species in Italy as well (Lanza & Corti, 1993). Several other species were introduced in Italy from other European countries. In Italy, there are 7 established exotic species (*Rana kurtmulleri*, *Rana catesbiana*, *Trachemys picta*, *Mauromys caspica*, *M. leprosa*, *Testudo graeca*, *Chamaeleo chamaeleon*), whereas the situation of *Rana ridibunda*, as stated before, is less clear. Other problems are reported for tortoises of the genus *Testudo*, including *T. hermanni*, which is typical of Italian fauna, but allochthonous to several Italian regions. There are also doubts on the presence of *T. marginata* in Sardinia, where it is considered introduced, although it is morphologically different from all the other known populations. A similar case is probably represented by *Podarcis [sicula] cettii* from Sardinia, for long time considered to be introduced, but recently hypothesised to be a distinct species (Oliverio et al., 2000). Among lizards, *Podarcis sicula* expanded its distribution, damaging the endemic species of Sardinia (*P. tiliguerta*) and Sicily (*P. wagleriana*). Nesting of *Trachemys scripta* was recorded several times in Italy, and this species could compete with *Emys orbicularis*, a species threatened to extinction, at least in Northern Italy.

Conservation

Herpetofauna represents a well-known case among European conservationists, which was discussed in nu-

merous meetings, including the "Standing Committee" of the Bern Convention. The first attempt to focus the attention of European herpetologists on the problems linked to conservation of reptiles and amphibians was represented by the constitution of Societas Europaea Herpetologica (SEH) and, during its first Conference, the establishment of the Conservation Committee (1981). The "Experts Group on Amphibians and Reptiles" of the European Council originated from that. The Habitat Directive of the European Union lists 22 species of amphibians and reptiles, including the 3 Italian vertebrates whose conservation is considered a priority by the EU (*Salamandra atra aurorae*, *Pelobates [fuscus] insubricus* and *Caretta caretta*) in appendix 2. It was known from the 1980s that amphibians are among the groups at highest extinction risk and that entire populations and even species can disappear in a short time, at times without apparent cause. With the exception of marine turtles, which are similar to amphibians in their ecological requirements (nesting on the land and adult life in aquatic habitats), for reptiles the cause of extinction is related with habitat loss. For amphibians, instead, there are more connected causes. Because their life cycle includes aquatic and terrestrial habitats, they are subject to the negative impact affecting both habitats. In recent years it was demonstrated that they are affected by the use of herbicides and fertilizers, the attack of certain viruses, the increase in UV radiation, etc. In several other cases, a limiting factor is represented by the introduction of fishes, mostly salmonids, for fishing purposes. There is still a lot to study and discover.

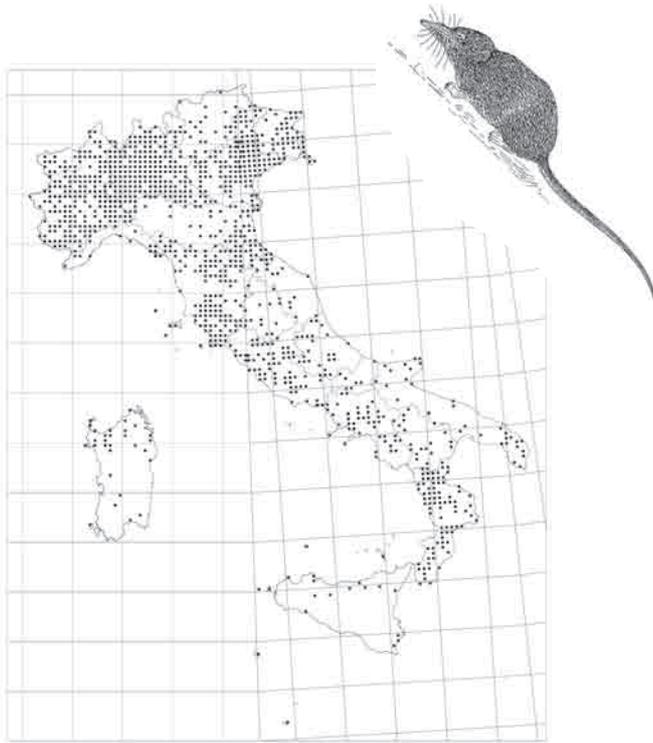
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Mammalia Insectivora

Giovanni Amori, Gaetano Aloise



Insectivora are small mammals, present on all the Italian territory, small and large islands included. The taxonomy of some taxa of this order are still under study (Amori et al., 1999), and as a consequence their chorologies are not certain as well. Recent biomolecular studies helped to define the taxonomic position of some species, particularly in the genera *Sorex* and *Crocidura*, although some other species are still problematic.

Material and methods

The species distributions were obtained using all data available from literature and from the revision of material stored in Museum and collections, with the addition of some new unpublished data. For some geographical areas (in particular Southern regions such as Campania, Molise and Basilicata), distribution data are not complete because of the scarcity of data and research.

Biodiversity

Italian Insectivora are represented by 3 families, 6 genera, and 17 species including *Sorex arunchi*, a species recently described for North-Eastern Italy, whose status as a new species needs to be confirmed by karyological studies. An 18th species might be added to the list,

Sorex araneus, but its presence in Italy is still doubtful. Molecular and cariological studies published recently (Brünner et al., 2002) showed that the chromosomic race Valais, which belongs to the “*araneus*” group, represents a new species, *Sorex antinorii*. This species originated in allopatry in the Italian peninsula during the last ice ages and lately colonized the Alpine valleys, included those in Southern Switzerland and the extreme South-Eastern valleys of France. *Sorex antinorii* is currently known in the Alps, the Padana Plain, and in the Apennines extending South to Calabria. In Abruzzo and Calabria *S. antinorii* was sympatric with *Sorex samniticus* (even if this latter species was present at lower altitudes). Therefore, in Italy there are three species (*S. antinorii*, *S. samniticus* and *S. arunchi*) with very similar dimensions and colours, and which differ only in their karyotype. *Sorex araneus* may possibly be present in Italy in areas adjacent to France (North-Western Italy) and Slovenia (North-Eastern Italy). A recent phylogeographical study, based on mitochondrial DNA of *Crocidura russula* (Lo Brutto et al., 2004) showed that Sardinian populations of *Crocidura russula* (a species present in Northern Europe, Spain, Morocco, and Western Algeria) should be attributed to a new species, *Crocidura pachyura*. This species would include those populations from Eastern Algeria, Tunisia, Ibiza, Pantelleria and Sardinia, now belonging to *Crocidura cossyrensis* (Contoli and Aloise, 2001). Therefore, after the revision, the *russula* taxon will not be part of the Italian fauna.

Our peninsula hosts the highest number of Insectivora species than all the other European countries, including the Iberic and Balkanic peninsulas (Gippoliti e Amori, 2002).

Ecology

Insectivora occupy a wide variety of habitats. Some species are terrestrial (*Erinaceus*), some other are semi-fossorial or fossorial (*Sorex*, *Crocidura*, *Suncus*, *Talpa*) or semi-aquatic (*Neomys*). All Erinaceidae and species of the subfamily Soricinae prefer areas with vegetation cover. Species of the Crocidurinae can live in scarcely vegetated areas and near rural and urban built-up areas in peninsular and insular Italy. Species of *Talpa* can live in all those habitats (meadows, pastures, cultivations, gardens, woods) with a good layer of soil, and do not flood.

Insectivora feed on insects and other small invertebrates as miriapods, anellids, etc., and some species are carnivore. They are predators, and they in turn represent an important role as prey of other animals such as nocturnal raptors, snakes, and small carnivores. They are good en-



vironmental indicators, and being high-level consumers, they are often used in ecotoxicology because, among all the small terrestrial mammals, they accumulate more of the environmental contaminants (pesticides, organic contaminants, industrial inorganic contaminants, heavy metals, etc.).

Zoogeography

Insectivora have the highest endemism rate (5 species over 18, about 30%) of all the Italian orders of mammals. The results of a comparison of Italian and European populations of *Sorex minutus* based on molecular analysis (which might be confirmed by data still in study on the morphology and cariology of the same populations), indicates that the Italian populations represent a different, endemic species. The high endemisms rate, recognizable as well in the haplotypes (for instance in *E. europaeus* in Sicily), confirms that the populations in the Italian peninsula are highly diverse (as are those of the Iberic and Balkanic peninsulas): the Italian peninsula probably had several refuges during the last ice ages, and thus represented a starting place not only for re-colonisation of continental Europe, but also for speciation (Bilton et al., 1988).

Sorex alpinus is characteristic to the Alpine Province; this species is also present on the Balkanic and Carpathian mountains. *Sorex arunchi* is endemic to the Padana Province, and *Sorex samniticus*, missing from the Alpine Province, characterizes the Apenninic Province, together with *Talpa romana*. Apulian Province is not characterized by endemisms, but by the lack of species of the subfamily *Soricinae*, the only exception being represented by *S. samniticus* in Gargano (Umbra Forest). Sicily, Sardinia, and all the small islands, host only Soricidae of the subfamily *Crocidurinae*. In Sicily and circum-Sicilian is-

lands there is one important endemic species, *Crocidura sicula*, whereas *C. pachyura* lives in Sardinia and Pantelleria. This species has an Eastern-Maghrebic distribution and represents the only species of this order with African origin, instead of European.

Alien species

Exotic species have not yet been reported. Besides *C. sicula*, insular populations were all introduced in proto-historic times.

Conservation

The high number of endemic species makes Italian Insectivora very important for their biogeography, and thus they are on top of the conservation priorities. *C. sicula* needs particular attention: this species is not at risk of extinction (with the exception of a melanic population from Ustica), but it represents, together with *Crocidura zimmermanni* of Crete, the only remains of the Pleistocene mammalofauna living in the Mediterranean basin islands.

We do not have quantitative demographic data for most of the species of Insectivora, however they seem to be widespread in all their areals and therefore not at immediate risk. However, all those species need protection, because they are affected by environmental pollution (pesticides, fertilizer, etc.) that accumulates along the food chain, where Insectivora occupy a high level. Moreover, Insectivora are highly sensitive to habitat alteration and fragmentation and (particularly for those species linked to water such as *Neomys*) to vegetation cover and to riverbanks morphology.

Another limiting factor, especially for species of the genus *Erinaceus*, is represented by the high mortality rate caused by cars.



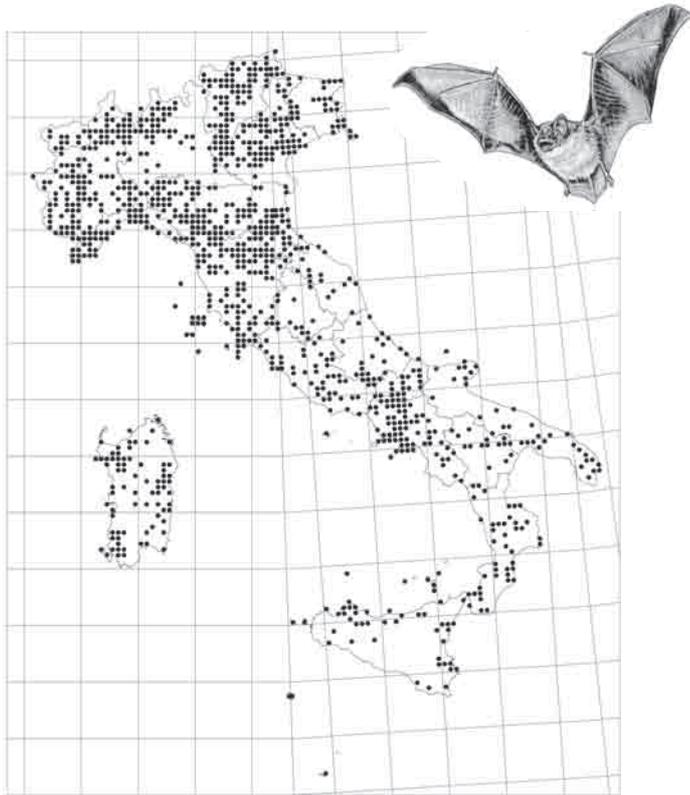
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Mammalia Chiroptera

Paolo Agnelli



The order Chiroptera includes mammals present in Europe with the only suborder Microchiroptera. They are nocturnal animals, and they are strongly specialized: they can fly, use ultrasounds to locate the prey and hunt it in the dark, and hibernate to survive those unfavorable periods when prey is scarce. Molecular biology techniques were applied to study some sibling-species of the genera *Myotis*, *Pipistrellus* and *Plecotus*, as a result the number of taxa recorded for Italy increased to a total of 34 species.

Material and methods

The distribution data were collected in cooperation with the Italian Research Group on Chiropterans (Gruppo Italiano Ricerca Chiroteri): as a result, a detailed examination of the local literature and of the specimens deposited in small local museums was developed. Moreover, members of the group provided several unpublished records regarding field research by the members themselves. The collection of the Museum of Natural History of Florence (Zoology section "La Specola") is the most complete for Italy, but 21 Italian, and 2 foreign, private and public collections, were used as well. While analyzing the published data only those data which were to-

tally sure were taken into consideration: therefore, most of the data provided by the bat detector" were not used. The use of ultrasound detectors is a technique that distinguishes a certain number of species on the basis of the reception, recording, and analysis of the ultrasounds emitted, typically during feeding flights. Unfortunately, there are no standard operating procedures to make the analysis of the signals recorded with the "bat detector" an objective datum, and in some cases the inexperience of the person in charge of recording, or the use of improper techniques, can compromise the significance of the results. The few records considered valid are those related to species easy to recognize, and only if they were recorded and analyzed with advanced techniques such as the temporal expansion and the bioacoustic analysis, validated by the application of quantitative criteria. Unfortunately, technical details are not included in several publications, or it is impossible to distinguish those data obtained with the "bat-detector" from those obtained by capture.

Biodiversity

The order Chiroptera is represented in Italy by 4 families, 11 genera, 34 species. There are numerous sibling species that are newly-described, or not clearly attributable to a taxon.

- *Myotis myotis* / *M. blythii* / *M. punicus*: the first two species are present in all the regions excluded Sardinia, and were distinguished only from middle nineties. In compiling the database, we used only data referring to recent captures, specimens from Museums (if possible to check them) and literature data if they contained information useful for correct identification. *M. punicus*, once considered a subspecies of *M. blythii*, was given the species rank on the basis of recent genetic studies. *M. punicus* lives in Northern Africa, Corsica and it is the only large *Myotis* living in Sardinia. All the specimens previously recorded in Sardinia as *M. myotis* or *M. blythii* belong to this new species.

- *Myotis mystacinus* / *M. brandtii*: females of these two species are still difficult to distinguish. The rare available specimens of *M. brandtii* were examined (Agnelli and Lanza) and in some cases re-determined as *M. mystacinus*.

- *Myotis auraszensis*: it was described by Kujakin in 1935 as subspecies of *M. mystacinus*, and given the species status in 2000. In Italy this species is reported for one locality: Monte Altissimo di Nago, Monte Baldo (TN). Recent analysis indicates that *M. auraszensis* is not diver-



gent enough from the group *mystacinus* from a genetical point of view. For this reason it is more prudent to consider those records as *M. mystacinus*.

- *Pipistrellus pipistrellus* / *P. pygmaeus*: these two sibling-species were distinguished in 1999 and the new species *P. pygmaeus* was recorded in Italy too. Numerous records of *P. pipistrellus* pre-dating 1999 could be attributed to either of the two species. In any case, we consider it useful to keep those records, reporting them as *P. pipistrellus vel pygmaeus*.

- *Plecotus* spp.: knowledge on the genus *Plecotus* are presently evolving quickly, and the distinction of the two species is not always easy. Until 2001 *P. auritus* and *P. austriacus* were recognized as sibling-species, and were distinguished for certain just recently. To compile the database we used data referring to recent captures, to specimens deposited in Museums when it was possible to check them, and literature data if they included information useful for correct identification. Two more species of *Plecotus* were recently added to the Italian fauna, making the identification of records doubtful again, at least for certain regions: *Plecotus macrobullaris* was collected in the Alpine region and was initially described almost at the same time by two groups of specialists, and as a consequence two different names were attributed to this species: *Plecotus alpinus* Kiefer and Veith, 2002 and *Plecotus microdontus* Spitzenberger, 2002. Later on, the comparison of the publication date established that the legitimate name is *P. alpinus*. More recently, the name *Plecotus macrobullaris* was proposed for this new species, because it corresponded to a subspecies of *P. auritus* already described by Kuzjakin in 1965, and known for the Alps between Liguria and Slovenia up to now. In regards to exactness of the reports of *P. auritus*, those dating prior to 2001 in the Alpine region must be considered as *P. auritus/macrobullaris*.

- *Plecotus sardus*, represents the only endemic species for Italy, reported for Sardinia. Other species present in Sardinia are *P. auritus* and *P. austriacus*.

Ecology

The biological cycle of Chiroptera follows the alternation of the seasons and the subsequent changes of the weather affecting their choice of refuges, and the degree of activity. They have winter refuges, where the animals spend the unfavorable season in hibernation, and summer refuges, which are represented by diurnal refuges (which are temporary), by areas used as nurseries, and by areas used for coupling. There are three kinds of refuges: tree-hollows, buildings, hypogean areas (caves, galleries, quarries, etc.) Foraging areas differ among species and are represented by forested woods, meadows, ponds, urban areas, or the aerial space above all those habitats. This association with the various habitats is very strict, and the animals each day cover the distance (which can

reach several Km) between the feeding area and the refuge area. Preys are represented by several invertebrate (mainly insects) and in rare cases by small fishes and birds. Males usually adapt to simple diurnal refuges, where they spend the day in torpor, whereas sexually mature females gather in larger refuges, where they form reproductive colonies of about ten to thousands of individuals. In those refuges they usually give birth to one individual; the offspring is fed until the time it is able to fly. At the approach of winter, bats abandon the summer refuges, and they move to other locations where they mate. With the progressive lowering of the air temperature, and the decrease in available prey, they change again their refuges to find those with a microclimate (temperatures low and constant, and high humidity) that allows them to spend the winter in hibernation. Summer and winter refuges can be close to each other, but they are generally from a few dozens to hundreds of kilometers apart. Sometimes may occur seasonal migrations of thousands of Km (for more details on the biology of the single species, see Schober and Grimmberger, 1997; Lanza and Agnelli, 1999; Agnelli et al., 2004).

Because of the peculiar biology of Chiroptera, distribution data have to be used cautiously to define the environmental preference of the species and the habitat suitability. In fact, the record of the animals in an area might be due, for instance, to the presence of a good winter refuge (such as a cave or an artificial gallery) in an area totally unfavorable to the same animal during the good season. The year when the animal is recorded must be taken into consideration as well because, unfortunately, several large colonies existing until half of the XX century have now all but disappeared.

In the species card, the field "adult habitat" indicate the most common kind of refuge for the reproductive colonies and then, separated by a line, the characteristic habitats of the main feeding areas. In the field "bioindicator" we reported only those species strictly associated to a particular feeding habitat, so that those species might be used to identify the habitats that need to be protected.

Zoogeography

Chiroptera have high mobility, and therefore they have a wide distribution areas. However, *Plecotus sardus* is endemic to Sardinia. For some other species, distribution areas include Italy only marginally. This is the case of Northern and Eastern species (Asiatic-European or Central-European distributions) which have been recorded in small areas of central or Northern Italy (*Myotis brandtii*, *Myotis dasycneme*, *Eptesicus nilssonii*, *Vespertilio murinus*, and the new species *Plecotus macrobullaris*, whose real distribution is not yet known). The presence of *Rhinolophus blasii* in Italy is not too clear: the distribution of this species is Afro-tropical, but in Italy was signaled only in Trieste Province, until 1927. *Myotis dasycneme*



is known for Italy with one record as well, from Trento in 1881. These two latter species are often considered not to be part of the Italian fauna anymore, because more recent and other records do not exist.

Species with European distribution are few or even lacking in some Italian Southern regions, due not necessarily to a real faunistic poverty, but more likely to the scarcity or lack of research in those regions.

Alien species

Exotic species are not present.

Conservation

The definition of the *status* of a species must be based on the objective knowledge of its distribution, population abundances, and the trends in abundance changes. I.U.C.N. compiles and updates the conservation *status* of the species referring to their entire areal and on the basis of standardized criteria. The so-defined *status* is listed at www.iucn.org. For the Italian population the present state of knowledge is still too poor to define the conser-

vation status of bat populations; as a consequence the “conservation status” reported in the database is based on simplified categories instead of the I.U.C.N. ones, and it must be considered presumptive.

Several European countries recorded a decrease in bat populations: this is unfortunately true for Italy as well. Because the primary needs of bats are represented by good quality feeding areas and by several good refuges, any factor compromising these resources affects greatly the bats survival (for instance: use of monocultures; reduction of insects biodiversity; incorrect use of pesticides; rarefaction and logging of old trees; collapse, restructuring and reuse of old building, particularly monumental ones; disturbance to cave refuges due to sport activities or to the opening to the public; premeditate destruction of colonies due to fear, superstition, and ignorance). It's important underline that the habit of grouping in large colonies (in winter or for reproduction) and the low reproductive rate expose bats to the risk of sudden reduction in abundance of their population.

Relevant literature

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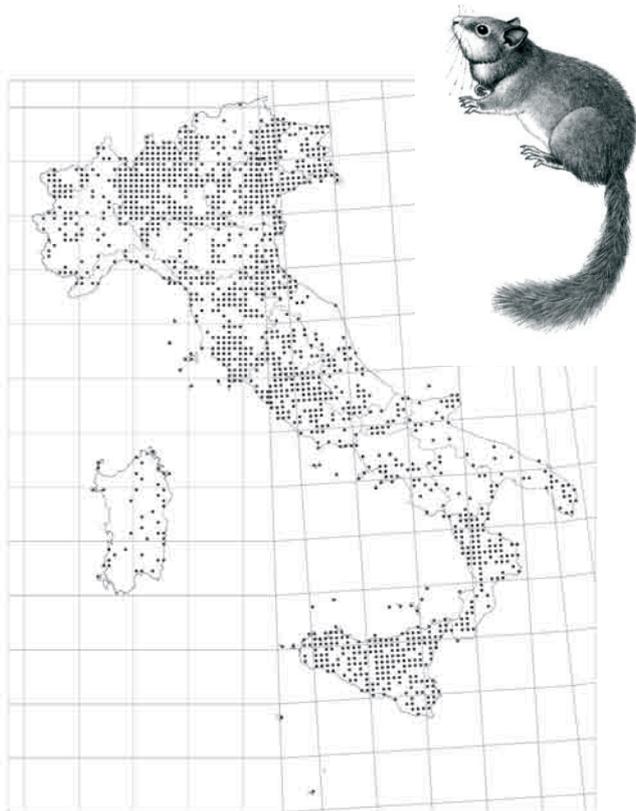
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Mammalia Rodentia

Giovanni Amori, Gaetano Aloise



Rodentia is an order of mammals widespread in our territory. Their taxonomy is well known, although some taxa needs further studies. The chorology is well known, with the exception of some regions (such as Apulia, Sardinia and Basilicata) and some species (such as *Sciurus vulgaris*, *Rattus norvegicus*) which still have gaps in those studies, and for different reasons. The distribution of the species of the genus *Microtus* is still problematic because these animals have strong morphological convergence, and precise diagnostic characters are still lacking, thus the specific status of some specimens is difficult to ascertain. It would be necessary to investigate further the presence of *Micromys minutus* in Central Italy, and of *Chionomys nivalis* along the Central and Southern Apennines.

Material and methods

Distribution data of each species were obtained by literature and by material stored in Museums and from private collections, integrated with original data.

Biodiversity

Rodentia is the most numerous mammal order in the world, and in Italy, with 30 species, it follows only Chi-

roptera. Italian species belong to 19 genera and 6 families (Amori et al., 1999), or 5 families (if Microtidae are included in Muridae, as is the case for the last checklist of world mammals). The 30 Italian species include *Microtus liechtensteini* and *Microtus brachycerchus*, whose status as species were recently re-evaluated. The status of *Microtus liechtensteini* was discussed and interpreted differently numerous times. On the basis of morphological or kariological studies, authors considered it to be either a distinct species, or a subspecies of *Microtus multiplex*. A recent molecular genetic study (Haring et al., 2000) recognised differences between *M. liechtensteini* and *M. multiplex*; the two taxa are still difficult to recognise only on morphological basis. Therefore the distribution of *M. liechtensteini* is at present based on individuals identified for their karyotype, and it is waiting for an accurate revision of the specimens based on clear and precise morphological characters.

Microtus brachycerchus, previously a subspecies of *M. savii*, has been given specific rank on the basis of kariological studies (peculiarity of the sexual chromosomes in males) (Galleni et al., 1994). The authors analysed only two populations (Fiumefreddo Bruzio and Rosarno, Calabria). To be able to define the distribution of this species, the kariological analysis needs to be extended to higher numbers of populations, and the status of this species needs to be confirmed by enzymatic, molecular, and morphological studies. At present, the distribution of this species is not completely identifiable, except for very general geographic areas.

Apodemus alpicola, displays diagnostic morphological characters, but specimens from the Alps have not been entirely reviewed, therefore the distribution is known only for those few areas where the specimens were analysed genetically.

Ecology

Rodentia are adapted to live in almost all habitats, from sea level to the mountaintops. They adapted to terrestrial, subterranean, arboreal, and semi-aquatic habitats. Most of Italian species are nocturnal-crepuscular, and others are diurnal (*Sciurus vulgaris*, *Chionomys nivalis*, *Arvicola terrestris*, *Marmota marmota*). Some Italian rodents (for instance, Gliridae) hibernate, whereas at lower latitudes, they can be active the entire year or even estivate. All species are primary consumers: they feed mainly on vegetation and seeds, and they can integrate their diet with insects and other invertebrates. Many



small rodents are characterized by a high reproductive rate (r-selected species) and, when food and refuges are available, populations greatly increase in number, sometimes damaging cultivations, wooded forests, and foodstuff. Moreover, they can be vectors for several diseases. Notwithstanding these economically negative aspects, Rodentia play an important role in the ecosystems, because they are food for several predators (mammals, birds, reptiles) and contribute to renew the forests by dispersing the seeds. These ecological features make rodents good environmental indicators, and they have been widely used in ecotoxicology studies to monitor environmental contaminations, and to forecast the effects of contaminants.

Zoogeography

Two species of this order are endemic to Italy (4%); their percentage is low when compared with Insectivora (about 30%). However, genetic studies confirmed the status of several subspecies. *Apodemus flavicollis geminae*, *Eliomys quercinus pallidus* were confirmed by karyological and gene-enzyme studies, whereas *Arvicola terrestris italicus* by molecular studies. Other species have distinct haplotypes, such as populations of *Clethrionomys glareolus* in the North-Western Alps and Central Italy, of *Apodemus sylvaticus* in Sicily, and of *Microtus arvalis*. Further genetic-molecular studies might confirm and discover new endemic taxa.

The mountain massifs of the Alpine Province are characterized by *Marmota marmota*. This species occupied this mountain region, together with the Carpathian and the Tatra Mountains, after the last Würm ice age. Recent introductions occurred in the Ligurian and Tuscany-Emilian Apennines.

Apodemus agrarius is known solely for the Padana region, which was colonized by this species in recent times (Pleistocenic fossil records are lacking). This species lives in several habitats, such as non-intensively cultivated areas and woods, from the sea level to hills and foot of the mountains.

Hystrix cristata is characteristic of the Apenninic region, this specie originated from Africa, and it is now present in Italy with populations ranging from Southern Lombardy to the South of the peninsula, and Sicily. It was for a long time considered a species introduced by ancient Romans, whereas it is probably a geographical relict (as proved by several fossil and sub-fossil records).

There are no species typical of Apulia and Sicily. It is interesting to note that Sicily lacks some species widely distributed in the peninsula, the most important being *Sciurus vulgaris*. The lack of *Arvicola terrestris* is due to extinction occurring probably in historic times, because this species was certainly present in Sicily in 3,000-4,000 B.C.

All Rodentia fauna of Sardinia is of antropochorus origin.

It is possible to recognise *Glis glis melonii* and *Eliomys quercinus sardus* on the basis of their morphology and, for the latter, on the basis of its karyotype.

Alien species

Rodentia has the highest number (5 species) of recently introduced species among all the mammals (Gippoliti e Amori, 2002). If we take into consideration the palaeo-introductions of the commensal species (*Mus domesticus* and *Rattus rattus*) and *Rattus norvegicus*, occurred around the XVI-XVIII century, the total number is 8 species.

Sciurus carolinensis, from North America, was introduced in Italy after World War II. Today, this species lives in an area of some hundred km² near Turin, with a population of several thousands of individuals. The original population was represented by a few individuals, released in a very restricted area (Stupinigi Park). Two more populations are present in Italy, one in Liguria and one at the border between Piedmont and Lombardia. *S. carolinensis* is considered as pest because it damages fruit trees and forested woods, it is a good predator on eggs and nestlings, and it is an aggressive competitor of *Sciurus vulgaris*, which as a consequence is excluded in the areas colonized by *S. carolinensis*. If the progressive expansion of *S. carolinensis* will not be controlled, it might reach the Alps in the near future (it is already present in prealpine areas) and perhaps even the Apennines. Another squirrel posing serious conservation problems is *Callosciurus finlaysonii*, from the South East Asia, living in Italy with a small population localised in one urban woods in Acqui Terme (Piedmont), and with a larger population recently discovered in Lucania. In this area *C. finlaysonii* has seriously damaged the vegetation by removing the bark of the trees. The impact of this species on the local fauna, especially on *S. vulgaris* or birds, has not been evaluated yet. A third squirrel introduced to Italy, *Tamias sibiricus*, is Oriental-Palaearctic. It is used as a pet and therefore it is easily and intentionally released, as shown by the small populations localized in urban parks or in areas adjacent to towns in Piedmont, Liguria, Friuli Venezia Giulia, Trentino and Latium. An abundant population lives along the Piave River, near Belluno. *Tamias sibiricus* is terricolous, diurnal and granivorous, it does not seem to compete with any autochthonous species. *Myocastor coypus*, originally from South America, is now present in nearly all the Italian regions, Sicily and Sardinia included; it lives in freshwater and brackish water habitats. This species was imported and bred for industrial-amatorial practices, and it quickly expanded its distribution when it was released after these practices were abandoned. *Myocastor coypus* damages the structures used for water regulations, and cultivations. A population of the North American *Ondatra zibethicus* arrived in some areas of Friuli Venezia Giulia from Slovenia, where it was introduced (as it



was in most of continental Europe), for industrial purposes. This species does not seem to create nuisance probably because the populations are small, but it could potentially be a danger for the aquatic phytocoenosis and for the stability of the riversides, and it can compete with the autochthonous species *Arvicola terrestris*.

Conservation

Although some species of Rodentia have a bad reputation due to the damages they make, or the diseases they can transmit, these animals have an important role in most terrestrial ecosystems. Many species are highly specialized, and adapted to living in restricted habitats which can become fragmented, reduced or altered (wrong forest management, use of pesticides, etc.) with subsequent

reductions to the populations abundances, sometimes to the point of local extinctions. The species most sensitive to environmental alteration are those associated with forested areas, such as *Sciurus vulgaris* and all the species of the family Gliridae (*Glis glis*, *Muscardinus avellanarius*, *Eliomys quercinus*, *Dryomys nitedula*). Some rodent species are threatened by the introduction of exotic predators. This is the case, for instance, of *Mustela vison* which strongly impacts populations of *Arvicola terrestris*.

An effort should be made to collect as many information as possible on the biology of the various species. Often there are no data on the status of populations with narrow areals, such as *D. nitedula* in Calabria and Basilicata, *G. glis melonii* in Sardinia, and some insular populations of *E. quercinus*.

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