

FRESHWATER FAUNA

STATE OF KNOWLEDGE

[Roberto Argano]

Though dealing with a very small portion, less than 0.01%, of the amount of water on Earth, freshwaters are the site of ecosystems of enormous importance, and among other factors, from their biological stability – in addition to physical and chemical – depends the quality of the invaluable resource that they represent.

An outline on the state of knowledge of animal diversity in the context of freshwater habitats cannot but be connected with a rapid analysis of the various situations in which these habitats find themselves in Italy. First of all, waters are conventionally defined as ‘fresh’, when present on the continental masses, with a salinity that does not reach a gram per litre, and where calcium salts predominate.

Surface freshwaters (which can be distinguished from the heterogeneous variety of underground waters, a precious resource which is highly at risk) flow along riverbeds (lotic waters) or are collected in basins (lentic waters) and are distributed into compartments which are generally isolated from each other. Each of these bodies of water have particular chemical-physical characteristics depending on rainfall and general climate of the area, on the particular land and rock formations, on plant cover and on the orographic characteristics.

Therefore, each river, stream, lake, and marsh constitutes an environment with its own morphological and structural (and therefore faunistic) individuality that is practically unique. Depending on the morphological and physical-chemical characteristics of each individual freshwater habitat, there are a certain number of plant and animal organisms which weave a very complex network of relationships (biocenoses). One need not think only of obvious differences, such as the one between an Alpine torrent and a southern river which runs practically dry in the drought season, nor the difference between a great terminal lake positioned in a valley ravine abandoned by a glacier and that of a small lake enclosed within an extinct volcano crater. In fact, two rivers that flow from the same mountain of the same region have a different biological dynamics, which can clearly be measured in limnology.

Since the beginning of last century, limnology has studied still or standing (lentic) water systems in particular, that is, lakes, ponds and temporary pools. Instead, run-

ning of flowing bodies of water, known as lotic (streams, torrents, rivers) were ‘discovered’ about fifty years later and only recently have they been the object of analytical and comparative studies.

A river is essentially a closed system and has its own typical ‘dynamics’. In fact, it originates from a spring, fuelled by subterranean waters, snowfields or a glacier, runs along a riverbed that is well defined by its banks, supplemented by the contribution of affluents and matures its own peculiar chemical structure along its route, eventually flowing into another river or into a lake of mixing with the marine waters at the mouth. From the point of view of its trophic-functional dynamics it is a substantially open system, in that it depends on the energetic contributions of nearby areas, which vary along its course and which the biocenoses that follow each other depend upon for their structuring.

The most significant physical characteristic of lotic waters is obviously the unidirectionality of the flow, which the biological component, that is, the multitude of organisms that live their entire life cycle in the river, have to come to terms with.

Therefore, in running waters plankton is practically absent, that is, all those organisms, or stages of organisms (larvae) which, though having a structure which allow them to actively move in a body of water, are unable to oppose themselves to the force of the current. At sea or in lakes, the movement of the water masses drags entire plankton communities from one point to another, but in rivers the only point of arrival would be the mouth. Therefore, only those organisms of marine origin that have lost or profoundly modified their planktonic larval stage have been able to settle in rivers. Obviously, some plankton components can settle into tracts of slow flowing waters in the plains, though these are situations which do not come within the general outline that we are attempting to outline.

The invertebrates that populate ‘reic’ habitats, more than 3,000 species in Italy, belong almost exclusively to *benthos*, that is, they live in contact with the bottom. Meteoric water is absorbed to a great extent into mountain systems, in various ways according to the geological structure, giving origin to vast aquatic subterranean habitats which in turn form headwater spring habitats (crenon) when rising to the surface.

Extremely specialised fauna of underground waters are often found in springs. In fact, among the moss and vegetation at the mouth of a spring, one can find series of elements (such as turbellarians and crustaceans of differ-

ent classes and orders), that have adapted themselves over an extremely long time to subterranean waters (stygobitic), that are pushed up to the surface where they no longer have the possibility of readapting themselves.

Apart from these elements, the fauna that populate the *crenon* are not generally relict/ancient fauna; in fact, often they are pioneer surface species which, at certain altitudes, return to the spring habitat practically each year, at the end of winter, moving up from areas that are down river.

However, there are many species (crenobionts) particularly suited to conditions of clear, highly oxygenated waters, characterised by stability in terms of temperature and chemical composition (the river has just begun its wading activity). Rich algal and moss vegetation are still missing at this point, and the primary food sources come from riparian vegetation.

Limnologists define the *rhithron* as the upper portion of a stream where currents are swift, water temperatures are low, and streambeds are composed of stones and gravel, which the current itself keeps clean from the sediment. The temperature of the well-oxygenated waters of the *rhithron* zone remain constant and are enriched with minerals from rocks and soil as well as with exogenous organic material from vegetation found along its banks. These factors together with the development of *periphyton*, epilithic vegetation on submerged stones and of moss along the banks determine the complex chemical and biological structure of these waters and the peculiarity of these aquatic habitats. Each river is different from any other, but even the same river is different with the changing of the seasons, every tract of the river is different from the one proceeding and following it and every point of the same tract is different from the others given that the speed of the current diminishes progressively from the centre towards the banks. The biocenoses model their complexity on this ever changing container.

And finally, through intermediate phases that vary according to the geography of the locations (which varies greatly in Italy), one reaches the 'mature' tract of the river: the *potamon*. The river flows along the plain, the water loses its tumultuous vivacity and solid particulate matter eroded up river slowly deposits, creating fine, and sandy riverbeds. The increased quantity of organic material transported by the water leads to an increase of filter-feeding organisms. The level of dissolved oxygen diminishes and the temperature is no longer constant and, in any case, increases with respect to the preceding tract of the river. Consequently, the fauna in this part of the river

are also completely different, the species are more adaptable, even if the zoological groups that we find here are essentially the same.

The effects of man's presence generally affects this tract of the river, often in a dramatic fashion. Apart from irrigation canals that create artificial habitats with characteristics of both running water habitats and those of standing water (therefore, plankton is found here, as in coves), intensive agriculture, urbanisation and industrialisation in the plains have taken the place of large forests, and not only in terms of landscape.

If one considers the most general biological aspects that are set off by the availability of nutrients capable of sustaining trophic networks, a distinction can be made between oligotrophic waters that are less productive, and eutrophic waters that are more productive. For example, in rivers from the *crenon* to the *rhithron* we find increased trophic levels, and the progressive variation in these levels determines the settlement of communities that are steadily richer in species, even if other factors, such as the environmental monotony of the beds, can interfere with this theoretical condition.

The best-known standing water habitats (also known as lentic) are lakes, characterised by open bodies of water that are generally large. However, lentic habitats also represent the successive stages of the progressive death of lakes; that is, ponds, marshes, and peat-bogs, which are formed when vegetation invades the basin until this are no longer open waters. Then there are also temporary pools, which at one time, covered vast areas and which dry up completely in summer, not to mention artificial habitats such as hydroelectric reservoirs, irrigation canals and rice paddies. Even fountains in public parks and squares are lentic habitats that host a rich fauna.

Essentially, running waters are characterised by a horizontal dynamism (the current), while in standing waters there is a less obvious dynamism in the vertical sense. Apart from the interaction of a complex series of factors which create conditions that are peculiar to each basin, one must keep in mind that under the influence of the seasons, there is a slow upward shift of the body of water. Therefore, as far as the physical-chemical parameters are concerned, there is a dynamic differentiation of the various layers, from the surface to the bottom, depending on the size of the basins, its depth and the general climatic situation. From the surface we only observe the wave motion, occasionally of certain intensity, the slow meanders of the currents, and the possible fluctuations of the bodies of water (seiches). The make up of

the animal community in lake habitats depends, in a generally direct manner, on the interaction of all these factors.

Finally, to conclude this brief description of the characteristics, and hence of the fauna of lentic waters, a very brief mention should be made of *plankton*, that group of organisms that has no contact with the bottom, and that are moved, passively by the currents. Apart from the large number of sarcodine, ciliate and flagellate protozoans, lake zooplankton hosts an impressive number of individuals of several species of rotifers and of copepod and cladoceran crustaceans.

A brief mention should also be made to temporary (astatic) waters. These ephemeral habitats, which at one time invaded the large coastal plain forests of the peninsula, which were successively reclaimed, now survive in localised pools and are very spare in number. These habitats, unknown to the general public, are disappearing. The numerous animals that populate these waters have developed certain survival mechanisms for dry periods, such as diapausing (or dormant) eggs of various crustacean species. One should keep in mind that even some small, high-altitude lakes which ice over in winter, apparently without life, are also considered temporary waters: *Chirocephalus marchesonii*, for example, lives in the Pilato Lake in the Sibillini Mountains, at about two thousand metres, with diapausing eggs during winter time.

Last of all, there are also artificial temporary lakes, such as rice paddies, where, for example, the extremely common Tadpole shrimp *Triops cancriformis* lives, or even less structured habitats, where the larvae of *Aedes albopictus*, the Asian tiger mosquito is capable of settling, a new and unwished for acquisition for our fauna.

Mention must also be made to the vast group of subterranean waters, made up of groundwater systems, cave waters and interstitial waters. The enormous work still to be done to reach a good level of knowledge of the specialised fauna that populate these habitats is easy to imagine given the obvious difficulty of gaining access to these habitats. This is not simply a purely academic need or a formal completeness of knowledge. The organisms that have adapted to subterranean habitats (stygobitic), mostly endemic (therefore, in a constant state of precariousness), are the living testimony of ancient geographic and environmental conditions (paleogeographic and paleoecological indicators) and, as they are highly adapted forms (stenoeious), they are extremely valid indicators of the quality of this irreplaceable water resource.

Moreover, it is important to keep in mind that both lentic and lotic habitats continue in subterranean systems through which the interface of surface/underground waters pass with complex interactions between the two types of habitats. In this context it must be mentioned that

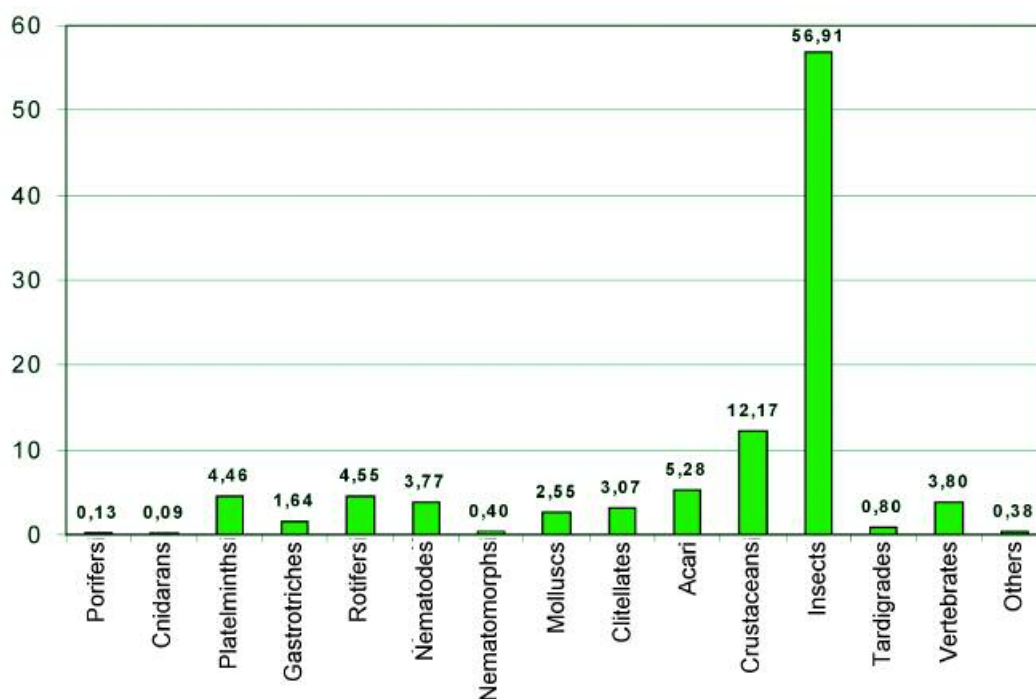


Fig. 5.15 - Megabiodiversity in Italian freshwater habitats.

these percolation waters host particularly specialized and diversified communities, in which a high number of endemic species is present.

Last of all, the extremely delicate group of anchialine habitats should be mentioned. Anchialine habitats are flooded inland marine caves and ground waters that lack any direct surface connection with the open sea. A good example is the Zinzulusa Cave that is included in the *top ten list* of the *World Endangered Karst Ecosystems*. In this cave, apart from the 60 species discovered (most of which are endemic stygobitic species), there are species of exceptional interest such as the decapod *Typhlocaris salentina* and the stygobitic sponge *Higginsia ciccaresei*.

Freshwater animals make up an important fauna component in relation to the number of species (Figure 5.15). Almost all the systematic groups currently living on land

are also present in freshwater habitats, as well as, with the given adaptations, groups of phyla that are characteristic of marine habitats such as Porifers, Cnidarans, Nemerteans, and Bryozoans.

On the basis of the latest census of European Limnofauna, the recognised freshwater animal species in Europe are about 15,000. In Italy, the species of the entire limnic sector (excluding Protozoans) are about 5,500, that is, 10% of the entire Italian fauna.

Briefly described below are the principal zoological groups (excluding the protozoan and the aquatic stages of parasite organisms) present in Italian freshwater habitats, along with a brief mention on the state of knowledge and of the degree of precariousness of some species (where possible, the flagship species of each group are considered).

**PORIFERS, CNIDARANS, TURBELLARIANS, NEMATODES,
TARDIGRADES, GASTROTRICHES, ROTIFERS,
HIRUDINEANS, OLIGOCHAETES**

[Romolo Fochetti]

Porifers

Porifers, or sponges, are a phylum of typical marine animals, though they are also present in freshwater habitats with three families. The Spongillid family is present only in Italian freshwaters. Freshwater sponges take on cushion-like or digitate forms in lentic waters, while they have an encrusting development in running waters. Of the 479 species recognised for Italian fauna (out of the 6,000 known species) only six species are present in inland waters, belonging to four genera. *Spongilla lacustris* and *Ephydatia fluviatilis* (Linnaeus) are the most well known.

The distribution and ecology as well as conservation status of freshwater sponges is poorly known in Italy. *Trochospongilla horrida*, *Heteromeyenia stepanowii*, *Spongilla alba* and *S. fragilis* are only present in northern Italy. Mention of the stygobitic sponge *Higginsia ciccaresei* was made in the previous section.

Cnidarians

Cnidarians are also a prevalently marine group and their presence in freshwaters is both limited and marginal. In fact, there are only five species that belong to Italian freshwater fauna, from two genera, out of the 463 known species in Italy and out of approximately 15,000 recognised species. The two genera, both of the class Hydrozoa, are of the polypoidal type (*Hydra*) or are dimorphic, alternating between both a polyp and medusa morph (*Craspedacusta*). *Hydra viridissima* prefers stagnant bodies of water, while *H. oligactis* and *H. vulgaris* prefer inhabiting running waters. *Craspedacusta sowerbyi* (about whose status of introduced species, from Brasil or China, speculation is relentless), considered a threatened species, has been reported in very few sites of the Italy mainland and in Sardegna and is considered (Pavan, 1992) at risk in our country.

Turbellarians

Among the Turbellarians, flat worms of the phylum Platyhelminths, the only information regarding threatened species concerns the order of Tricladids also known as Planarians. This group includes many freshwater forms. The body is flattened and it has a compact structure. Planarians have a blind alimentary sac and are hermaphroditic,

with direct development in freshwaters. Many species reproduce through fragmentation, while in sexual reproduction the eggs are deposited in cocoons fixed to the substrate. They are predators though occasionally they feed on dead invertebrates, and they live in both running as well as stagnant waters. Of the 501 known species for Italian fauna, 181 occur in inland waters.

While the systematics of the group is fairly well known in Italy, little is known of their conservation status. Among the troglobian species, the *Dendrocoelum collini*, *D. italicum*, *D. benazzii*, *Atrioplanaria morisii* and *Polycelis benazzii* are considered extremely rare.

Nematodes

The freshwater species of the phylum Nematodes live in sediment are all extremely small in size, from less than 1 millimetre to a few millimetres. They have microphagous feeding habitats and feed include bacteria, algae, and fungi. They are usually observed as separate sexes, though hermaphroditism as well as parthenogenesis is also common. There are knowledge gaps as regards the systematics of the group. Due to its small size, and the scarce systematic and taxonomical knowledge, the biology and ecology of the group is poorly known.

As regards the conservation status of the 207 Italian freshwater species (out of the 1,357 known in Italy), seven species are considered extremely rare: *Trobilus longicaudatus*, *Eudorylaimus rhopalocercus*, *Oxydirus oxycephaloides*, *Thornia steatopyga*, *Plectus acuminatus*, *P. armatus*, *P. elongatus*. Another six are considered rare, including *Myelonchulus cavensis* and *Odontolaimus aquaticus*.

Tardigrades

Tardigrades are a phylum of small organisms that populate marine, freshwater, and limnic environments of moss cushions, thalli of lichens, and leaf litter. Rarely larger than a millimetre, they are of separate sexes even if hermaphroditism is present and parthenogenesis is common. They feed mainly on unicellular green algae. The freshwater species, 44 out of the 244 that make up Italian fauna, live on the bottom of lakes or watercourses; they often live among submerged mosses, algae or phanerogam, and in any case, covered by a film of water.

Given their size, it is difficult to precisely establish the habitats of single species. Hence, little is known about their conservation status. *Isohypsibius baldii* is considered extremely rare, while *Pseudobiotus matici* and *Carphania fluviatilis*, are threatened endemic species of

Sicilia. Last of all, *Macrobiotus nocentiniae* and *Isohypsiobius marii* are considered rare.

Gastrotriches

The phylum includes 90 freshwater species (out of 232 that make up Italian fauna), that come within the order Chaetonotida. Knowledge regarding this group is still incomplete, notwithstanding a great improvement in the last decades: the systematics is still poorly defined and there are still numerous knowledge gaps on the detailed distribution of the species. Five species of the genus *Chaetonotus* (*C. pentacanthus*, *C. brachyurus*, *C. lunatospinosus*, *C. minimus*, *C. mutinensis*) are rare as well as endemic, along with *Heterolepidoderma multiseriatum* and *H. pineisquamatum*.

Rotifers

The phylum is made up of aquatic, semi-aquatic, endoparasite and ectoparasite micro-organisms. Knowledge concerning the systematics and geographical distribution are still incomplete: from this a lack of knowledge about the conservation status of the group ensues. Out of the 257 species that make up the Italian fauna, 250 belong to the freshwaters. In any case, recognition of the various species is made difficult by the generally obligatory parthenogenesis in their life cycles.

PAVAN (1992) indicates 25 rare Rotifer species, 7 of these species belong to the genus *Lecane*. Moreover, many species are considered rare and have a distribution limited to small geographical areas in Italy. Among these *Brachionus dimidiatus*, *Cephalodella delicata*, *Ploesoma truncatum*.

Hirudineans

Hirudineans, more commonly known as leeches, are segmented hermaphroditic worms easily recognisable by the conspicuous external metameria and by the presence of two suckers, an anterior and a caudal one. Some species are ectoparasites of invertebrates or vertebrates, others are predators that feed on insect larvae or other invertebrates. Freshwater leeches live either in flowing or stagnant waters. Among the Hirudineans, *Batrachobdella al-gira*, *Placobdella costata* and *Cystobranchus respirans* are considered rare.

Hirudo medicinalis is present as a low risk species (LR) on the Red List of Threatened European Species (1989), in the Appendix of the Bern Convention (Council of Europe, 1992) and in Annex II of the Habitats Directive. This is due to the disappearance of marshy habitats and to the substantial decline of anuran populations that it attaches itself to for nourishment, and to the indiscriminate gathering for medical purposes.

Oligochaetes

Oligochaetes are cylindrical, metameric, hermaphroditic worms that colonise practically all freshwater habitats, even though various families have particular adaptations to different habitat types (soft-bottom, submerged vegetation, hard bottom). The taxonomical status of Oligochaetes is poorly known in Italy as their determination is never easy, often making identification even above the rank of species difficult.

Little is known of their conservation status. Oligochaetes and Hirudineans (Clitellates) make up a total of 161 freshwater species out of the 338 known ones in Italy.

MOLLUSCS

[Folco Giusti, Marco Bodon, Giuseppe Manganelli]

Conservation status

Italian freshwater Molluscs comprise around 170 species, for the most part belonging to Gastropods, and only a small part to Bivalves.

Gastropods

Gastropods include about 140 species allocated to 14 families: *Neritidae*, *Viviparidae*, *Thiaridae*, *Melanopsidae*, *Bithyniidae*, *Hydrobiidae* s.l., *Pyrgulidae*, *Emmericiidae* (Prosobranchia), *Valvatidae* (Hetrobranchia, Heterostrophic), *Physidae*, *Lymnaeidae*, *Planorbidae*, *Acroloxidae* and *Ancylidae* (Heterobranchia Basommatophora). The level of taxonomic knowledge is good only in a few cases, remaining scarce in many others. In particular, in the *Hydrobiidae* s.l., the above-species rankings, as well as the validity of many taxa described in the past need careful reconsideration. Moreover, many gastropods, above all, those small in size and confined to subterranean waters, are still being studied and described (Figure 5.16).

Therefore, the number of Italian species is approximate and is likely to increase. Among other aspects, recent genetic studies have produced data which call for great consideration of the speciological characteristics of a number of taxa. Even in the case of the two most important families of Basommatophors, *Lymnaeidae* and *Planorbidae*, the current faunistic data must be reconsidered in the light of some recent publications which could significantly alter the picture of species regarded as valid up to now.



Fig. 5.16 - Many species of small size freshwater gastropods living in spring or subterranean waters and belonging to the *Hydrobiidae* s.l. have been described in the last twenty years, such as *Sardopaladilithia plagigeyerica*, *'Alzoniella' lunensis*, *'Alzoniella' macrostoma*, *'Alzoniella' manganellii*, *Sardohoratia sulcata* and *Sardohoratia islamioides* (from left to right) (Photo by S. Cianfanelli).

Bivalves

Freshwater bivalves only include about thirty species assigned to five families (*Margaritiferidae*, *Unionidae*, *Dreissenidae*, *Sphaeriidae* and *Corbiculidae*), with one or few species, with the exception of the *Sphaeriidae* (17 species, 15 of which are assigned to the genus *Pisidium*). The level of taxonomic knowledge is generally considered good, except for the *Anodonta*, *Unio* and *Sphaerium*.

Conservation status

Many species that occur in surface water exhibit a wide ecological valence, are widespread and well represented in vast areas. However, there are several more stenoeccious groups that live in lentic habitats that are at risk due to habitat alteration or destruction. Some species have had their range drastically reduced following extensive land reclamation projects carried out in the 19th and 20th centuries, involved vast areas of the Italian peninsula. Faunistic data, in fact, highlights a drastic decline and a considerable reduction of the distribution in Italy of common and widespread species, such as *Lymnaea stagnalis* and *Planorbarius corneus*, as well as species now considered rare, such as *Aplexa hypnorum*, *Physa fontinalis*, *Anisus vorticulus* and *Segmentina nitida*.

Numerous endemic species, generally those of *Hydrobiidae* s.l., which inhabit spring habitats and/or subterranean waters are particularly endangered (Table 5.35). The exploitation of spring waters is considered a high risk factor for freshwater prosobranchia, such as *Pseudamnicola lucensis*, *Orientalina callosa* and *Melanopsis etrusca*.

Some large, freshwater bivalves, indicated in the annexes of the Habitats Directive (Annexes II, IV, V), are particularly threatened. Because of their complex life cycle, these organisms are also vulnerable because of their strict dependence on fish, on which their larvae (glochidia) carry out a parasitic stage. However, the greatest risk factor for these bivalves probably lies in the bad management of Italian fish populations that has led to the frequent introduction of fish species from other Italian and European basins. In fact, fish can carry the glochids of different bivalve species and/or diverse populations of the same species, thus setting off the respective processes of intraspecific competition or introgression, thus threatening the genetic originality of populations.

Worthy of mention is the *Margaritifera auricularia*, the only Italian Mollusc species whose extinction is practically certain (Figure 5.17). This bivalve, one of the largest among European freshwater species, lives imbed-

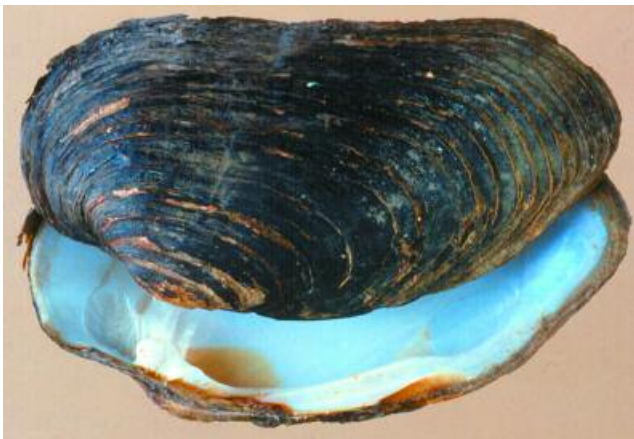
Species	Distribution
<i>Alzoniella cornucopia</i>	Phreatic waters of the Torrente Arbia (Toscana)
<i>Alzoniella feneriensis</i>	Karst subterranean waters of Monte Fenera (Piemonte)
<i>Alzoniella lunensis</i>	Phreatic waters of the River Magra basin (Toscana-Liguria)
<i>Alzoniella macrostoma</i>	Phreatic waters of the River Magra basin (Toscana -Liguria)
<i>Alzoniella microstoma</i>	Phreatic waters of the River Magra basin (Toscana -Liguria)
<i>Alzoniella sigestra</i>	Subterranean waters west of Genova (Liguria)
<i>Belgrandia bonelliana</i>	Thermal waters near Sarteano (Toscana)
<i>Bythiospeum vallei</i>	Karst subterranean waters near Bergamo (Lombardia)
<i>Heleobia aponensis</i>	Thermal waters of the Berici and Euganei Hills (Veneto)
<i>Iglica giustii</i>	Subterranean waters along the River Isonzo (Friuli-Venezia Giulia)
<i>Iglica pezzoli</i>	Karst subterranean waters of the Monte Fenera (Piemonte)
<i>Islamia cianensis</i>	Spring waters near Siracusa (Sicilia)
<i>Islamia gaiteri</i>	Subterranean waters of the Island of Elba (Toscana)
<i>Orientalina callosa</i>	Spring waters in the Province of Pescara and L'Aquila (Abruzzo)
<i>Pezzolia radapalladis</i>	Subterranean waters near Recco and Rapallo (Liguria)
<i>Pseudamnicola lucensis</i>	Thermal waters of Bagni di Lucca (Toscana)
<i>Plagigygeria stochi</i>	Karst subterranean waters of the River Timavo (Friuli-Venezia Giulia)
<i>Sardohoratia islamioides</i>	Subterranean waters near Dorgali (Sardegna)
<i>Sardohoratia sulcata</i>	Subterranean waters near Dorgali (Sardegna)
<i>Sardopaladilbia plagigygerica</i>	Karst subterranean waters near Dorgali (Sardegna)

Table 5.35 - Endemic *Hydrobiidae* s.l. with a greatly reduced distribution.

ded in sandy-pebble sediment, preferably in shallow tracts of fast-flowing waters, and at times even in deep waters of large river systems, though currently it has disappeared almost everywhere. Recent reporting have only been made for the Ebro basin in Spain and that of Loira in France, though living specimens have only been found in Spain. Reports in Lombardia and in Veneto date back to last century, and regard sightings in rivers and canals of the Chiese and Mincio basins and in the Padua canals. As the causes for their decline can be more than one (search for pearls and mother-of-pearl, water pollution, changes to river beds and original range), the dramatic disappearance in almost all its original range could also be due to the parallel decline of the European sea sturgeon (*Acipenser*

sturio) which is the likely host fish of their larvae. Another serious threat for Italian malacofauna comes from the introduction of allochthonous species. Both fish repopulation and aquarium trades have contributed, through the intentional or occasional release of exotic species, to the faunistic pollution of our freshwater environments. Thus, in the last few years, Italy, as other European countries, has borne witness not only to the diffusion of various nonnative species in natural environments, both gastropods (*Potamopyrgus antipodarum*, *Physa acuta*, *Helisoma duryi*, etc.), and bivalves (*Anodonta woodiana*, *Dreissena polymorpha*, etc.), but also to the transfaunation of a few autochthonous species (*Viviparus ater*, *Emmericia patula*, etc.) from one geographic district to the next.

Fig. 5.17 - *Margaritifera auricularia*, one of the largest European freshwater bivalves, is the only Italian Mollusc species whose extinction is practically certain. In the past, *Margaritifera auricularia* was widespread in numerous western European watercourses, but currently it is only present in the Ebro basin in Spain and in the Loira basin in France (Photo by S. Bambi)



OTHER GROUPS

[Romolo Fochetti]

Some groups are only marginally present in freshwater habitats with a reduced or greatly reduced number of species. This is the case of *Araneidi*, that have only one species, *Argyroneta aquatica* that populates above all ponds and slow flowing canals, where it breathes the atmospheric oxygen stored in air bubbles underwater. In Italy, it only occurs in the north and due to its particular biology this species should be protected. Even *Nemertini*, typically ma-

rine vermiform animals, have only one freshwater species in Italy, *Prostoma graecense* which, though not seemingly threatened and cosmopolitan, is considered a species with a narrow ecological valence and should be safeguarded because of its particular biology. Only two species are also reported for *Polychetes*, a greatly diversified group in marine habitats, *Marifugia cavatica*, a troglobian species which only occurs in the north of Italy (only in Venezia Giulia), with a restricted ecological valence like all the stygobitic species, and *Troglochaetus bernecki*, an Archianellid stygobitic species recently reported in Trentino and Veneto.

CRUSTACEANS

[Roberto Argano]

Crustaceans are a well represented (about 700 known species) and diversified group in Italian freshwater habitats. They populate practically all habitats, from subterranean waters to temporary pools, from watercourses to stagnant waters. They are an important element in the trophic chain in lentic habitats, contributing in large part to the plankton biomass along with Cladocerans and Copepods. Specific cases regarding flowing water decapods, *Austropotamobius pallipes*, *Astacus astacus* (prawn), mentioned respectively in the Annexes B and E of the Habitats Directive, and *Potamon fluviatile* (crab) are emblematic of the changes caused by anthropic impact in 'reic' habitats which has led to the consequent rarefaction the Italian populations of these species.

The list of greatly endangered stygobitic crustaceans (Decapods, Mysidaceans, Thermosbaenaceans, Isopods, Amphipods, Ostracism, Copepods, Mystacocarids) would be too long to list, though example can be found in the Zinzulusa Cave, and in any case in the subterranean waters of Salento, where there is a rich taxocenosis made up of endemic stygobitic paleomediterranean species (*Spelaeomysis bottazzii*, *Typhlocaris salentina*, *Hadzia minuta*, *Monodella stygicola*, *Mixtacandona stammeri*, *Nitocrella stammeri*, *Esola spelaea*, *Psyllocamptus monacus*,

Metacyclops subdolus, *Metacyclops stammeli*, *Microcharon arganoi*). The same situation is also found in other Italian regions. To mention some emblematic cases, there is the decapod *Troglocaris anophthalmus* of the subterranean karst systems, thermosbaenacea such as *Tethysbaena argentarii* (Grotta degli Stretti) and *T. siracusae* in Sicilia, and the stenassellid isopods of Toscana and Sardegna (Figure 5.18).

Pavan (1992) listed more than thirty Cladoceran species, including *Sida cristallina* considered threatened, 38 Ostracod species, 15 Copepods species, 10 Isopods (including species of *Proasellus*, *Monolistra*, *Typhlocirolana*, *Microcerberus*) and 38 Amphipod species, which includes many endemic species of genera such as *Niphargus*, *Bogidiella*, *Ilvanelia*, *Metaingolfiella* and others.

This brief description would be incomplete unless the endemic and threatened Crustacean species belonging to astatic waters were not mentioned, some of which have truly become the emblem of the status of precariousness. Among the Anostracans, there is *Chirocephalus marchesonii* and *C. sibillae*, both endemic to the high-altitude lakes of Monti Sibillini, *C. ruffoi* to the Calabrian Apennines, *Tanymastix stellae*, endemic to Sardegna.

Last of all, mention should be to the introduction of several alien species such as the decapods *Procambarus clarkii* and *Orconectes limosus* that have greatly affected the biocoenoses in which they presently inhabit.



Fig. 5.18 - A stygobitic isopod (*Stenassellus*) of the subterranean waters of Sardegna and Toscana which is of great paleobiogeographic interest.

INSECTS

[Romolo Foschetti]

Ephemeropterans

Ephemeropterans are an order of hemimetabolic insects, with subaerial adults and aquatic larvae. The larvae colonise all freshwater habitats, both stagnant and flowing waters, where they represent an important component of biocoenosis because of the number of species, individuals and for biomass. Several Ephemeropteran species are considered indicators of good water quality (several Heptagenids) together while others species have a wide ecological valence (species of the genera *Baetis* and *Ephemerella*) (Figures 5.19 and 5.20).

The taxonomy of the group is well known in Italy (94 species reported) while their detailed distribution is poorly known in some areas of the peninsula. Rare species (about ten) include: *Potamanthus luteus* reported in few sites in the Ligurian Apennines, *Brachycercus harrisella* so far only captured in the River Po near Piacenza, *Ephemerella ikononovi* and *E. mucronata*, the first limited to southern Italy, while the second occurs in Friuli-Venezia Giulia. Even the *Torleya major* is considered rare, reported in a few localities in central-northern Italy, and *Thraululus bellus*, has only been reported in the Ligurian Apennines. All the species mentioned above must be considered endangered given the increasingly compromised state of inland waters. According to PAVAN (1992) *Ephoron virgo* is critically endangered.

Odonates

Odonates include dragon-flies and damselflies and are heterometabolic insects that is, the pupal stage in their life cycle is omitted and thus no metamorphosis. Odonate larvae are aquatic (amphibiotic) and breathe through gills. Instead, the adults are strong fliers and have bright colouring. The larvae are active predators of other aquatic invertebrates and populate all inland waters, from lakes to ponds, canals to temporary pools, drinking troughs to flowing waters. Some species also colonise in brackish habitats. The group is well known from a systematic and biogeographical point of view. Of the 88 species known in Italy, only one is endemic (*Cordulegaster trinacriae*): this is understandable given their great capability for flight and dispersion.

About half the species and subspecies are considered either threatened or vulnerable to various degrees. For example, *Nehalennia speciosa* has only been reported at two piedmont sites in Lombardia and Friuli, while *Ischnura fountainei* has only been sighted on the island of Pantel-



Fig. 5.19 – *Baetis* males are easily distinguished by their large ‘stalk’ type eyes. In Italy, there are about fifteen species belonging to this genus.



Fig. 5.20 - An Ephemeropteran nymph of the genus *Epeorus*. The larvae of *Epeorus* species inhabit cold waters in the upper tracts of unpolluted watercourses.

leria. *Lyndenia tetraphylla* is considered very rare in Italy with few sightings along the Tyrrhenian coast and Sardegna where it lives in coastal lakes. Even for *Epitheca bimaculata* there are only two very old reported sightings for Veneto and Trentino, while *Brachytemis leucosticta* occurs in a few sites in southern Sicilia. From literature, Odonates are certainly considered one of the groups most threatened by pollution and changes to freshwater habitats. *Coenagrion ornatum* and *Epitheca bimaculata* are probably extinct in the Italian territory.

Plecopterans

Plecopterans are an order of heterometabolic insects with aquatic larvae and terrestrial or subaerial adults. The larvae need cold and well-oxygenated waters: they live on the bottom of watercourses and have various feeding habits,

from predatory to detritivorous. Their particular ecology makes them one of the main groups of bioindicators of good environmental quality (Figure 5.21).

Their case is emblematic of the conservation status of flowing waters. Last century, at least four species became extinct in Italy (*Isogenus nubecola*, *Brachyptera rifasciata*, *Isoperla obscura*, *Taeniopteryx nebulos*) and more than twenty are seriously threatened with extinction, in that they are currently reduced to very few puntiform populations. Among these, the situation is particularly serious for *Pera bipunctata*, *P. burmeisteriana*, *Xanthoperla apicalis*, as well as for all the threatened endemic species. It is interesting to note that at the end of the 19th century, *Brachyptera rifasciata*, given the enormous number of individuals, was considered harmful to hedges and road illumination because it obscured the light from lamp posts. Of the 144 species reported for Italian fauna (out of the 426 that constitute European fauna), almost all the fluvial species have disappeared because of water pollution that seriously affects the terminal tract of watercourses. If one considers that 44 out of the 144 known species are endemic to small areas of Italy, the state of health of this group is distressingly clear, as it is also clear that entire taxocenoses and other entities are in danger of extinction in nature.

Heteropterans

Heteropterans are an order of heterometabolic insects, known with the common name of varied-wing bugs. Most of these freshwater species are predators and feed on invertebrates but also tadpoles or small fish. Heteropterans occur in all freshwater habitats, even though ponds and marshes are their elective habitats. Of the 1,405 species reported for Italian fauna, less than one hundred (88 to be precise) are confined to inland waters. The systematic knowledge is satisfactory only for Corixids and Gerromorphs.

As assessment cannot be made as to the vulnerability of the species because there are still knowledge gaps regarding their ecology. Many species reported in Italy are endemic to limited areas. For example, *Sigara servadei*, *Nepa sardiniensis* and *Velia sarda* are Sardinian or Sardinian-Corsican endemic species. Among the most important freshwater Heteropterans there is the *Aphelocheirus aestivalis* which prefers potamal zones of watercourses. Because of its peculiar respiration, it needs water large amounts of dissolved oxygen. As the potamal tracts of watercourses are most affected by pollution, *A. aestivalis* is at great risk in Italy. It has been reported in only a few sites of the Italian peninsula.



Fig. 5.21 - Plecopterans are among the most effective bioindicators of the quality of flowing waters. (in the photograph a nemuroidae).

Coleopterans

Coleopterans are also an extremely diversified group in freshwater habitats, that they colonise with a large number of families. They are holometabolic insects, thus with a cycle that includes the pupa phase in which the complete metamorphosis takes place; they all share a characteristic construction of their wings: the first pair is strongly chitinased, transformed into covers while the second pair is membrane-like. Second only to Dipterans (see above) in freshwater habitats with 580 species out of the almost 12,000 that make up Italian fauna; even their trophic spectra is diversified, being predators as well as detritivores. They inhabit all lotic and lentic habitats, from the plains to the mountains.

This is probably the best known group from a systematics point of view, though their conservation status is not so well known. Among Haliplids, *Haliplus* (*Liaphlus*) *rubidus* is considered extremely rare and threatened; among Hydraenids, *Ochtebius gestori* is very rare and *Hydraena bonionensis* is rare; among Dryopids, *Dryops italicus* is very rare, *D. striatellus* rare; among Helminths, *Elmis oscura*, *Oulimnius troglodytes*, *Potamophilus acuminatus*, *Riolus apfelbecki* and *Stenelmis consobrina* are considered rare. Some of the best known aquatic Coleopterans are Dytiscids: *Dytiscus lapponicus* is vulnerable while *Coelambus pallidulus*, *Dytiscus latissimus*, *Graphoderus bilineatus*, *Herophydrus guineensis* and *Metronectes aubei*, *Cybister vulneratus* are threatened species. The situation is more serious for *Dytiscus latissimus*: this species is included in the IUCN Red List (1990) and in ESC Red List (Economic and Social Council of Europe, 1989). Moreover, it is present in Appendix II of the Bern Convention (1992) and in Annexes II and IV of the Habitats Directive along with the above-mentioned *Graphoderus bilineatus*.

Megalopterans

Megalopterans are a small order of holometabolic insects with aquatic larvae. These last mentioned generally inhabit flowing or stagnant waters, where they live in fine, grainy substrates. Moreover, they pass from microphage feeding habits to that of a carnivore. In Italy (and in Europe), Megalopterans are only present with the genus *Sialis*, which includes four species. *Sialis fuliginosa* and *S. nigripes* are considered rare, and only few reports exist for the Italian region.

Planipennes

Planipennes are a small order, previously included in the Neuropterans. The genera *Osmylus*, *Neurorthus* and *Sisyra*, inhabit freshwater habitats in the larval stages.

The larvae of *Sisyra* have a particularly interesting biology: they are sponge or bryozoan parasites. Little is known of their ecology, and little is known of the biology of an interesting species endemic to Sardegna, *Neurorthus fallax*.

Dipterans

Dipterans are a group of holometabolic insects. The common feature of dipterans is the absence of the second pair of wings which have been reduced to the so-called halteres. The larvae are worm-like and occur in all habitats in aquatic species. Present in lakes, watercourses, they are madicolous and psammophile. In general, the move to terrestrial habitats comes about before the pupal stage. The high number of species that colonise inland waters makes it difficult to summarise the characteristics of Dipterans as a group, with 1,750 species (out of the 6,615 known in Italy), which make up the most numerous group in freshwater habitats. Dipterans are a poorly known group from a systematic point of view: they represent perhaps the order for which human resources and skills are less capable of coping with the kind of study that is at stake.

Knowledge regarding their conservation status is also scarce. About twenty species have been indicated in literature as threatened, including the Simuliid species: *Cneta minuta*, *Obuchovia continii*, *Simulium paramorsitans*, *S. rivoecchii*, *Tetisimulium graium*, *Wilhemia mediterranea* (subspecies *fluminicola* and *sulfuricola*) and *Zavrelimyia hirtimana*, the Atericid species: *Ibisia marginata*, *Atherix ibis* and *Athricops crassipes* and at least five Chironomid species. These indications are incomplete as many other families comprising more demanding taxa, such as Blepharicerids, have definitely witnessed a considerable reduction in the number of species and a loss of taxocenosis.

Trichopterans

Trichopterans are a group of well known holometabolic insects. Systematics and ecological studies have been conducted on this group since the end of the 19th century. The larvae and pupa live in aquatic habitats (either lentic or lotic) while the adults are subaerial (Figure 5.22). The larvae build the tube-like cocoon with different materials such as: pieces of reed, living and dead fragments of leaves of water plants, seeds, crustacean shells, sand and little stones. The cocoons are used as shelters that are either mobile or fixed to the substrate. Few larvae live freely (Figure 5.23). Trichopterans have a varied diet: some species



Fig. 5.22 - *Hydropsyche pellucidula* is a widespread Trichopteran in Italy. Its larvae tolerate alterations to water quality well, and thus are considered indicators of organic pollution.

are predators, some are lithophagous, while others are either detritivores or omnivores. The Checklist of Italian Fauna Species reports 367 species: 123 taxa are present in a single region.

The Council of Europe reports 24 Trichopteran species that are considered at risk in Italy and Europe because of man-made changes to aquatic habitats, where the larvae live. According to PAVAN (1992) *Chaetopteryx euganea* and *Beraea ilvae* Moretti are considered extremely rare. Another 45 species are considered rare. This picture is clear if one considers that 66 species (and 24 subspecies) are endemic to the Italian territory. For example, *Tinodes apuanorum* only occurs in the Apuan Alps, the range of *Apatania volscorum* is limited to the Posta Fibreno Lake, *Drusus camerinus* is only present in spring habitats of the Umbrian-Marchigian Apennines, *Potamophylax inermis* has only been reported in the Velino and Nera Rivers, *Melampophylax vestinorum* Moretti only occurs in the River Tavo (Abruzzi), and *Beraea ilvae* is endemic to Elba Island.



Fig. 5.23 - Trichopteran larvae construct their peculiar cocoons with all kinds of material found in watercourses.

Hymenopterans

Hymenopterans are a group of typically holometabolic terrestrial species. Only one species (out of 7,526 that make up Italian fauna) occurs in flowing waters. The species in question, *Agriotypus armatus*, parasitises trichopteran larvae: it is possible to observe the respiratory apparatus of these hymenopteran larvae come out from the larvae or pupal cocoons of parasitized trichopterans. Only some trichopteran genera are chosen: owing to this extraordinary example of co-evolution this species should be protected. Unfortunately little is known regarding its detailed distribution and only occasional sightings have been made.

Lepidopterans

Among Lepidopterans, the well-known terrestrial butterflies, only 5 species colonise inland waters mainly in the larval stage, inhabiting environments where host plants are present, with a preference for stagnant waters. They belong to the family of Piralids (in Europe) and are divided into four genera in Italy. The female adult of *Acen-tria ephemerella* lives in water and has the characteristic rudimentary wings. Considering the exiguity of this taxocenosis and its speciation, attention must be paid to safeguarding this Lepidopteran freshwater species.

In figure 5.24 the percentage consistencies of the various orders of insects present in Italian freshwaters are presented concisely.

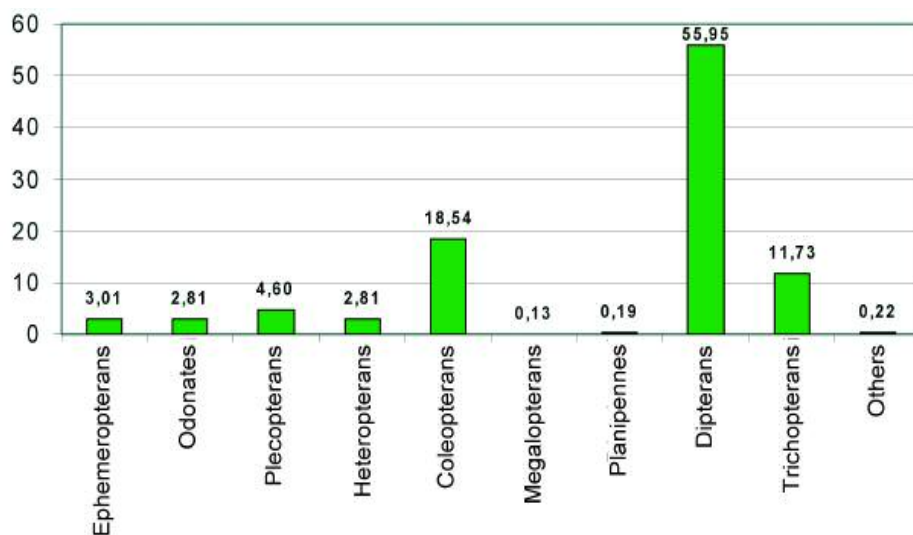


Fig. 5.24 - The insect orders present in Italian freshwater habitats.

FISHES

[Gilberto Gandolfi]

State of knowledge

Italian inland waters have a particularly rich fish fauna which are distributed throughout the territory depending on their capacity to adapt to different environmental conditions. There are fishes suited to cold waters, such as the Trout (*Salmo* spp.), the Arctic char (*Salvelinus alpinus*), the Bullhead (*Cottus gobio*) (Figure 5.25), the Minnow (*Phoxinus phoxinus*), which are all typical of moun-



Fig. 5.25 - the Bullhead, *Cottus gobio*, is a typical species found in the cold waters of mountain torrents and the spring waters of the high plains. Widely distributed in central and northern Europe, in Italy it occurs along the entire Alpine Arc and in the Prealpine belt of the Padano-Veneta Plain. Several isolated populations are present on two slopes of the northern Apennines.

tain regions and occur in high-altitude plain areas where there are springs, and those species that inhabit warmer waters, such as the European grayling (*Thymallus thymallus*), the Barb (*Barbus* spp.), the Dace (*Leuciscus souffia*), and then those of warm waters, such as the Rudd (*Scardinius erythrophthalmus*), the European roach (*Rutilus erythrophthalmus*), the Roach (*Rutilus rubilio*), the Bleak (*Alburnus* spp.), the Italian nase (*Chondrostoma soetta*) and the European perch (*Perca fluviatilis*).

Generally speaking, a fair amount of knowledge is available on the presence of fishes in part of the Italian territory. However, there are still large areas for which knowledge is somewhat vague or insufficiently updated.

Ichthyogeographic districts

In the most recent zoogeographical studies, particularly in consideration of the distribution of endemic species, two ichthyogeographic districts have been identified in Italy with populations that have been affected by events starting from the Messinian, about 5 million years ago, and which have continued up to recently.

The Padana-Veneto district includes the tributary basins in the northern Adriatic zone. The formation of this hydrographical network and the presence of fish fauna made up of numerous species that are mostly endemic, essentially refer back to recent phenomena, in particular, the last glaciation which led to the expansion of the Po river basin up to the Meso Adriatic Depression. Cold water species such as the Arctic char, the Bullhead and the Minnow, in common the Danube area, seem to be of transalpine origin. For some endemic species, such as the Po brook lamprey (*Lethenteron zanandreai*) and the Adriatic sturgeon (*Acipenser naccarii*), one theory indicates that their ancient origins that go back to events of the Middle Miocene that created a connection between the Adriatic and the Pannonic regions. Instead, two endemic salmonids, the Large carp (*Salmo carpio*) and the Marble trout (*Salmo marmoratus*), seem to have a recent Pleistocene origin. The species suited to temperate waters of the valley floors and plains include many endemic taxa that could have Messinian origins, apart from those present in the Danube areas which seem to have Russian origins, even though some ichthyologists say they could be species introduced during the Roman era or the Middle Ages.

The Toscana-Lazio district, made up from basins on the Tyrrhenian side from the Serchio River to the Tiber River, is populated by a dozen indigenous taxa, some of which are endemic. The species that are in common with the Padana-Veneto district, such as the Bullhead, the Dace, the European chub (*Leuciscus cephalus*), and the Italian barbel (*Barbus plebejus*) probably all have transapennine origins, while endemic species, such as the Arno goby (*Padogobius nigricans*), the Roach and the Brook chub (*Leuciscus lucumonis*) could be species of Messinian or of more recent Balkan origin.

As far as the other areas of Italy are concerned, the scarceness of indigenous species stops us from defining these areas as districts. Only one endemic species is present in southern Italy, the Italian bleak (*Alburnus vulturius*), apart from several possibly indigenous forms which should be considered of trans-Balkan origin.

River typologies

For Italy, it is not easy to refer to generalised conditions that describe how fish species are distributed along a river. In fact, various river typologies must be considered, often very different from each other. A general typology, valid at least for most Italian rivers, can be outlined in as follows:

the Trout Zone, with clear and well-oxygenated waters, very fast currents, beds composed of boulders, pebbles or coarse gravel, scarce or moderate presence of macrophyte, water temperature up to 13-14 °C; typical species are the Brown trout and the Marble trout.

the Spawning Zone for Lithophilous Cyprinids, with clear waters subjected to brief tracts of turbidity, fast currents alternating with areas where the water slows down and there is greater depth, riverbed covered in fine gravel and sand, moderate presence of macrophyte and temperature rarely more than 18-19 °C; typical species are those of the genus *Barbus*.

the Spawning Zone for Phytophilous Cyprinids, with slow flowing waters that are often turbid, muddy riverbed with abundant macrophyte, temperature up to 25 °C; typical species are the Tench (*Tinca tinca*) and the Rudd.

the Brackish Water Zone, in correspondence to the end tract of rivers where or salt and fresh water mix; typical species are those of the genus *Pomatoschistus*.

The typical species indicated above in the different zones have a limited capacity of adaptation to other en-

vironmental conditions, above all, in the reproductive period; other species, with a wider ecological valence, are capable of occupying several areas even in the reproductive period.

The rivers with the greatest volume of water descend from the Alpine and Prealpine Arc. In the highest parts of these basins one can find the Trout, *Salmo trutta*, which are currently represented by populations that refer to the morpho (or semispecies according to some authors) *fario*. They are mainly specimens of Atlantic stock introduced more than a hundred years ago that have probably forced populations of the Marble trout further downriver. The status of this trout is controversial: some consider it a species (*S. marmoratus*), others a semispecies, or even a subspecies. It is possible that the Marble trout, still present in the valley floors and in large rivers of high-altitude plains does not swim up river as far as the introduced Brown trout. Gradually, the Bullhead and two small-sized cyprinids, the Minnow and the Dace are found along with the Trout. These species are also present in streams and in cold spring waters wells in high-altitude plains all along the Prealpine slopes.

Further down valley, where the riverbeds are covered in pebbles, one can find the European grayling, the Mediterranean barbel (*Barbus meridionalis*) and successively, the southern European nase (*Chondrostoma genei*), the Italian barbel (*Barbus plebejus*) and the Gudgeon (*Gobio gobio*) (Figure 5.26). In areas with moderate current, the Freshwater goby (*Padogobius martensi*) dwells under



Fig. 5.26 - The Gudgeon, *Gobio gobio*, is a cyprinid that occurs in temperate waters of central and eastern Europe. In Italy, it colonises in watercourses of the Padana-Veneto basins in moderately flowing waters over gravel beds.

cobble stones, and in marginal sandy-bottom tracts of river courses one can find the Spined loach (*Cobitis taenia*) (Figure 5.27). The reproductive sites of several anadrome species can be found on gravel beds of large rivers: the enormous sturgeons that are now practically extinct, such as the Great sturgeon (*Huso huso*) and the Atlantic sturgeon (*Acipenser sturio*), and the smaller-sized and endemic Sturgeon of the Padano-Veneto district, which still survives though with great difficulty in the River Po and in some large rivers in Veneto and Friuli. Even the very rare Sea lamprey (*Petromyzon marinus*) and the Twaite shad (*Alosa fallax*) reach piedmont areas to reproduce by swimming upriver, often hindered by numerous barriers. The Eel (*Anguilla anguilla*), which swims upriver to carry out its trophic phase, is capable of going further up to the zones colonised by the trout.

Many of the species mentioned can be found in tracts of rivers along the plains as well as other species that gradually substitute them. Firstly, there is the European Chub and then, in deeper and slower flowing waters the Redfin perch, the Bleak (*Alburnus alburnus alborella*), the Danube Roach (*Rutilus pigus*) (Figure 5.28), the Italian Nase, the Rudd, the European roach and, in calmer waters rich in submerged vegetation, one can find the Northern pike (*Esox lucius*), the Tench and the Carp (*Cyprinus carpio*) which was introduced into Italy about two thousand years ago. The tracts of the river in the plains are also utilised in summer by various eurialine species such as the Mullet. For example, the Thin-lipped grey mullet (*Liza ramada*) swims upriver for more than 200 km in the River Po.

In the Apennine affluents of the River Po, there is a



Fig. 5.27 - The Spined loach, *Cobitis taenia*, is a fish that is widespread in Europe, is present over sandy beds of moderately flowing watercourses and lakes. Often used by fishermen as live bait, it was accidentally introduced to habitats outside its original range.

scarce volume of water in winter and summer, alternating with maximum volume in spring and autumn. In these watercourses, the number of species slowly decreases from west towards east. The Bullhead has small isolated populations; the Minnow occurs here and there in springs, the European grayling is absent, apart from in the Trebbia basin where it was introduced. Equally absent are the Sturgeons, the Redfin perch, the Danube roach and the Italian nase. Immediately preceding the mouth of the River Po, the river tract in the plain is short and practically inexistent in rivers that flow into the sea. Consequently, there are either no or greatly reduced populations that characterise this part of the river.

In the rivers of the Ligurian slopes, the Apuan Alps and Sardegna, the greatest volume of water is in winter and spring; in the northern Tyrrhenian from the basins of the River Arno to that of the Tiber, the greatest volume of water is at the end of winter and in November, while in summer there is very little. There are fewer indigenous species of fish fauna here. Species that have recently adapted to freshwaters, such as the Trout, the Three-spined stickleback (*Gasterosteus aculeatus*) the Freshwater blenny (*Salaria fluviatilis*), and the Eel, make up the inland waters populations in Liguria and Sardegna together with other species introduced in recent times. Eurialine species of the family *Mugilidae* that are characteristic species of estuary waters also in other parts of Italy enter the mouths of rivers, swimming up tracts that vary from a few dozen metres to a few kilometres.

In Toscana and in Lazio, migratory populations of the River lamprey (*Lampetra fluviatilis*) can be found, while



Fig. 5.28 - The Danube Roach, *Rutilus pigus*, has a limited distribution in the mid Danube basin and in the Padana-Veneto plain, in waters rich in vegetation. The specimen photographed is a male with nuptial tubercles that are bony protuberances that develop on the head and on the anterior part of the spine during the reproductive periods.

the Brook lamprey (*Lampetra planeri*) which is non-migratory is found at great distances from the sea. The European chub, the Dace, and some endemic species such as the Brook Chub, the Roach and the Arno goby also occur in these two regions. Recently, a proposal was made to consider an Italian barbel (*Barbus tyberinus*) and a Rudd (*Scardinius scardafra*) as species in their own right. They had been described in the 19th century and were then considered synonyms of the Mediterranean barbel and the common Rudd. Other cyprinids present in the Toscana-Lazio district, such as the Southern European nase, the Italian barble, the Bleak, and the Spined loach, widespread today in this range, are the result of introductions carried out by man in recent times.

In southern Italy and in Sicilia, the hydrological conditions of basins vary greatly. In the central and southern Apennines, the permeability of the soils lead to dry summer periods and scarce variations in flow for the remaining part of the year. Instead, along the Ionian side of Basilicata, watercourses are in full spate in spring followed by prolonged low water levels for the rest of the year. A similar condition can be found in Calabria and in Sicilia. There are very few indigenous species as the situation is similar to the one for Liguria. Only one endemic species is found on the Ionian side: the Italian bleak. In the waters of eastern Sicily and Sardinia, the Mediterranean toothcarp (*Aphanius fasciatus*), confined to brackish waters elsewhere, occurs even long distances from the sea. Along the entire western side of the Italian peninsular and in the islands, the trout is represented by several residual populations of the Mediterranean form known as *macrostigma*. There is also a controversy concerning this trout as to whether it should be considered as a species, semi-species or subspecies. In a large part of this range, the *Macrostigma* trout has been substituted or has cross-bred with the Brown trout that has been introduced throughout the country for several decades.

Lake habitats

Lake populations of fish species are worthy of mention on their own. In the largest and deepest lakes, several different components of fish population can be considered, each one linked to a particular type of habitat. Many species, typical of coastal habitats that are rich in aquatic vegetation, correspond to those that are found in rivers in the spawning zones for phytophilous cyprinids.

In the lakes of the Padano-Veneto district, the Rudd, the European roach, Tench and the Carp are principally

concentrated along the muddy beds near cane thickets along the edges, associated with predators such as the Northern pike and the European perch. Today, many other introduced species are found along side these species such as the Goldfish (*Carassius auratus*), the Black bullhead (*Ictalurus melas*), the Pumpkinseed sunfish (*Lepomis gibbosus*), the Largemouth bass (*Micropterus salmoides*) and, in some Brianza lakes, even the Zander or Pike-perch (*Stizostedion lucioperca*), that has inhabited these areas for many decades, even in river habitats. The Bleak, the European Chub and the Dace are the most widespread cyprinids that are found at lake edges over gravel beds, and are associated with the Common goby while, in some lakes, with the Freshwater blenny (*Salaria fluviatilis*).

At present in central Italy, the lake populations often correspond to the one outlined above, even though they were originally much poorer in number of species, in that there were only cyprinids typical of the Toscana-Lazio district (the European chub, the Roach, the Dace). Even in this part of the country, the quantity of introduced species that has colonised the coastal zone is considerable: the Zander or Pike-perch, for example, is abundant in the natural and artificial lakes of the Arno and Tiber River basins. All the species native to North America are present here, as well as in the Padano-Veneto district.

Other species are typical of the limnetic zone. In this case, these species are either not present or sporadic in flowing waters. In Garda Lake there is the Large carp, an endemic plankton-feeding salmonid. In the lakes of northern Italy, two naturalised species of the Whitefish are found: the Common whitefish (*Coregonus lavaretus*) introduced in the 19th century and the River spawning whitefish (*C. oxyrinchus*) of more recent introduction. In the large Prealpine lakes, even the Twaite shad is present, that is, populations of the species *Alosa fallax* which no longer carry out trophic migration in the sea. The Pejerrey (*Odonthestes bonariensis*), a planctophagous species native of the Rio della Plata estuary in South America has been introduced into Nemi Lake.

Several benthic species can be found in deep lakes. The Eel was once very common in all lakes throughout the Italian territory. Today, it is in decline due to the difficulty that juvenile forms have in surpassing man-made barriers. The Burbot (*Lota lota*) and the Large trout (*Salmo trutta*) of the *morpha lacustris* that is characterised by its particular silver colouring and considerable size are present in the Prealpine lakes. The Brown trout is present in all lakes where the water temperature is sufficiently cold. As far as salmonids are concerned, peculiar situations are found in

Posta Fibreno Lake and in the Liri-Garigliano basin, where two trout populations cohabitate: one refers to *Macrostigma* trout, the other to an endemic species *Salmo fibreni*, found in the deepest area, small in size with a different reproductive period from the precedent species. A sizeable population of the Stickleback is also present in this lake.

There are populations of the Artic char in the high-altitude lakes of the Alps, often associated with the Bullhead and the Minnow. Even the Brook trout (*Salvelinus fontinalis*) and the Rainbow trout (*Onchorynchus mykiss*), introduced from North America, are fairly common in Alpine and Prealpine lakes and their effluents.

In all perennial stagnant water habitats, one can find species mentioned previously for the spawning zone of phytophilous cyprinids. The Rudd, the Tinca, the Carp and *Rutilus aula* are the most common species, at times associated with the Bleak. The role of predator is carried out by the Northern pike in this bioceonosis. In many ponds and marshes, as well as in oxbow lakes with similar characteristics, native North American species such as the Largemouth bass (*Micropterus salmoides*), the Pumpkinseed sunfish (*Lepomis gibbosus*) and the Black bullhead (*Ictalurus melas*), which have a diet mainly based on bottom-living invertebrates, have colonised for decades. The Mosquito fish (*Gambusia holbrooki*) has been introduced into many stagnant water. Because of the possible, constant or temporary connections during flood periods, the pond and marsh population can vary as species that are typical of watercourses can be found.

In high-altitude pools and marshes in the Alpine Arc, the Minnow and the Dace can be found when moderate eutrophic conditions exist, while only the second species is found in the Apennines. Other fish species that could possibly be present in hill and mountain stagnant waters due to past introductions are the Tench, the Carp, the Rudd, the Loach and the Goby.

Drinking troughs and artificial canals that utilise spring waters for irrigation purposes are also of considerable naturalistic interest. Troughs, at one time, were found throughout the Padana-Veneto plain, and are still commonly found today north of the River Po, while in the plains at

the foot of the Apennines there are now very few because the water table has been drastically lowered. As the water temperature in these artificial habitats is quite low throughout the year, one can find very particular stenoeccious fauna and flora elements. Small-sized fishes rarely found in other types of habitats are found in drinking troughs: the Canestrini's goby (*Knipowitschia punctatissima*), a small endemic goby that occurs from Lombardy to Friuli; the Italian loach (*Sabanejewia larvata*), with an original distribution similar to that of the previous species; and the Stone roach (*Orthrias barbatula*), present only in the eastern part of the Padana-Veneto district. Even the Po brook lamprey and other species typical of warm waters, such as the Minnow, the Bullhead, and occasionally the Threespined stickleback are also found in drinking troughs. The Northern pike utilises springs when swimming upriver in winter up to reproduce.

Conservation status

Conditions of involution have been documented with population changes caused by the introduction of an increasing number of exotic fauna or by the translocation of indigenous species outside their original range, which can also be considered as 'introductions' to all extents and purposes.

The urgent measures needed to safeguard biodiversity in this faunistic sector could be outlined as follows:

- reconstruct an outline of the distribution of species throughout the national hydrographical network, with particular attention given to endangered species;

- set up a network that continually monitors the qualitative state and abundance of fish communities;

- create topic maps that are made available to local authorities responsible for fish management;

- organise a national database that gathers and updates information on fish fauna that can be consulted by all the interested parties;

- encourage taxonomic research aimed at genetically characterising populations that can be used in repopulation projects.

AMPHIBIANS

[Giuseppe M. Carpaneto]

State of knowledge

Urodeles

There are some urodele and anuran species whose active life cycle is carried out for most of the year in water. Tritons are urodeles of the Salamandrid family and live in numerous freshwater habitats that are either permanent or temporary, such as pools, marshes, and bogs, also adapting to artificial basins. The most Italian common species are the Italian crested newt (*Triturus carnifex*), the Common newt (*T. vulgaris meridionalis*) and the Italian newt (*T. italicus*). The first is a species that occurs principally in Italy, even though it is not endemic, the second is a subspecies that is common in northern and central Italy, while the third is an endemic species to southern Italy. The Italian crested newt is becoming quite rare in several regions due to the disappearance of pools and marshes in plains and hills, while because of their smaller size, the other two species can also survive in small bodies of water, such as ditches and temporary pools. The typical Alpine newt (*T. alpestris alpestris*) lives in small lakes and pools in the Alpine Arc, even at high altitudes. Moreover, two endemic Italian subspecies are present: *T. a. apuanus*, from the Ligurian Alps to the Tuscan Apennines, with relict populations in the central Apennines (Monti della Laga) and *T. a. inexpectatus*, localised along the Calabrian coastal belt. These two endemic subspecies require careful monitoring as they have localised populations which can easily become extinct following possible intervention by man of their habitats.

In Sardegna, the genus *Triturus* is absent and is substituted by the genus *Euproctus*, an interesting example of Sardinian-Corsican-Pyrenean fauna. In fact, this genus only has three species distributed respectively in Sardegna, Corsica and in the Pyrenees. The Sardinian brook newt (*Euproctus platycephalus*) has three population found in the mountain ranges of Limbara, Gennargentu and the Sette Fratelli. The populations of this interesting Sardinian endemic species should be carefully monitored and its sites protected.

Proteids are represented in Italy by a single species, the Proteus or Olm (*Proteus anguinus*), that lives in underground waters in the karst systems of Venezia Giulia, Slovenia, Croatia, Bosnia and Montenegro (it was introduced into a cave in Veneto in 1850). It has an unusual appearance in that its skin lacks pigment, on each side of the head

there are gill tufts that are used in respiration, and it possesses short and feeble limbs. As this species is the only European troglitic vertebrate (depigmented and almost blind) it should be protected through careful monitoring of water pollution and of the sport activities of speleologic sort taking place in the caves where it is present.

Other amphibian species generally associated to freshwater habitats, at least in the larval stage, are the Fire salamander, Spectacled salamander and all the anurans. Among the last mentioned, there are species that are more associated to freshwaters during the adult stage, such as discoglossids and the group of 'green frogs'.

Anurans

The following two genera belong to the Discoglossid family: *Discoglossus* and *Bombina*. The first includes two species present in Italy: the Painted frog (*Discoglossus pictus*), which occurs in Sicilia, North Africa, Spain and southern France, and the Tyrrhenian painted frog (*D. sardus*), an endemic Sardinian-Corsican species, also present in the Tuscan archipelago (Giglio and Montecristo) and on Mount Argentario. This species completely substituted the green frogs in Sardegna before they were introduced onto the island from the continent. The endemic status of the Tyrrhenian painted frog makes this species worthy of great attention along with the Sicilian populations of the Painted Frog that need to be monitored, considering the water shortage on the island in recent years, and habitat change caused by illegal activity.

The Fire bellied toad (*Bombina*) is generally associated to small-sized ponds, even with muddy and turbid waters. In Italy, there are two creatures that many authors consider distinct only at the subspecies level: the Yellow-bellied toad (*Bombina variegata*) and the Apennine yellow-bellied toad (*B. pachypus*) (Figure 5.29), occurring respectively in northern Italy (the Alps and north-eastern Pre-Alps) and on the peninsular (from eastern Liguria to Aspromonte). The rarefaction or local extinction of these species has been reported in several regions. In any case, a census on a national scale needs to be made and their sites need suitable protection.

'Green frogs', belonging to the Ranid family, are the most common and widespread anurans in Italy. They are found in a great variety of freshwater habitats, both natural and artificial. They spend most of their time lying in ambush on the water surface or on the banks. In the non-reproductive period, they also exploit temporary basins for food sources. 'Green' frogs include the so called 'synklepton', that is, hybridogenetic complexes formed

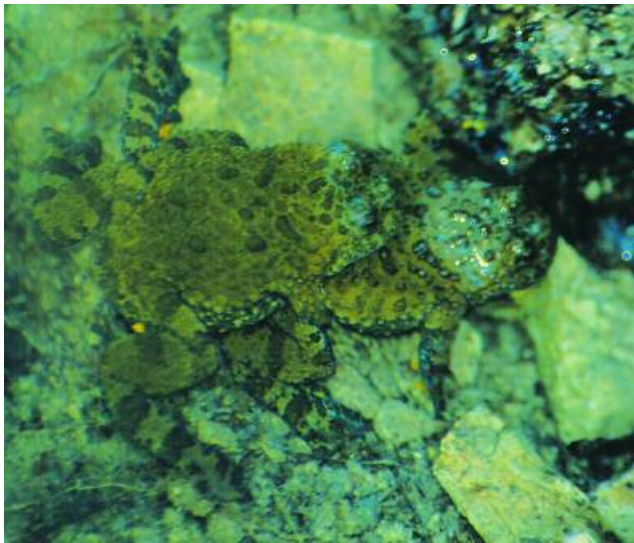


Fig. 5.29 - The Apennine yellow-bellied toad (*Bombina pachypus*). It is present in hill and mountain woodland areas where suitable climatic and edaphic conditions exist (Photo by M. Bologna).

by a hybrid that regularly cohabitates with only one of the two parental species. Scientific interest in hybridogenesis and the biogeographic uniqueness of the peninsular synklepton (see Table 5.36) make Italian green frog populations quite important, and hence they should be carefully monitored even though they are not currently endangered. Last of all, two introduced species are worthy of mention: the Balkan frog (*R. kurtmuelleri*), a species of the ‘green frogs’ group introduced from Albania, which is found in Liguria and south-eastern Piemonte; and the Bullfrog (*Rana catesbeiana*), introduced as a food source from North America, and which is found, above all, in the north (Piemonte, Lombardia, Emilia and Veneto) and in central Italy (Toscana and Lazio). The populations of this last mentioned tend to be locally extinct in the countryside of Rome and in Friuli-Venezia Giulia.

Conservation Status

According to the *World Conservation Union* (IUCN), 25% of the 5,100 known amphibian species come with-

in one of the three categories *vulnerable*, *endangered*, *extinct*. Anurans are particularly endangered because they are generally more closely associated to water habits than urodeles, and because most of these species need suitable environmental conditions during the larval stage (aquatic and often phytophagous larvae) as well as during the adult stage (prevalently insectivores and those associated to the surrounding terrestrial habitats). Factors that disturb either stage, or which effect the food sources of larvae and adults can endanger these species. In essence, the existence of anurans can be threatened by the transformation of terrestrial ecosystems, such as deforestation or terrestrial population, as well as by alterations to aquatic habitats through land reclamation, pollution, water works, etc. Moreover, amphibian eggs are particularly vulnerable to environmental factors in that they do not have a protective covering and their skin is thin and without the effective protection from unforeseeable mechanical or chemical agents.

According to several specialists, the causes leading to the present decline of amphibians could be: (1) prolonged dry spells associated with global warming; (2) introduction of allochthonous amphibian and fish species that compete with the autochthonous ones and prey on them directly; (3) the consequences of water, land and air pollution; (4) accumulation of toxic substances such as pesticides, transferred by insects to amphibians that prey on them; (5) increased pH that affect species in freshwater habitats because of acid rain; (6) increasing ultraviolet radiation on epidermis and eggs, following changes in the ozone layer; (7) habitats loss due to agricultural development and land reclamation of wetland areas.

The decline of amphibians troubles the specialists for three reasons: (1) it could be a symptom of serious environmental deterioration; (2) it could lead to the extinction of numerous fish, reptile, bird and mammal species as amphibians represent an important food source for these species; (3) pharmaceutical exploitation of chemical substances secreted from the epidermis of amphibians because of their antibacterial, antiviral, anaesthetic, anti-inflammatory character, etc.

Klepton	Parental species present	Parental species absent	Distribution in Italy	Zoogeographic status
<i>Rana hispanica</i>	<i>Rana bergeri</i>	<i>Rana ridibunda</i>	Peninsula, Elba, Sicilia	Endemic Autochthonous
<i>Rana esculenta</i>	<i>Rana lessonae</i>	<i>Rana ridibunda</i>	Padana Plain	Autochthonous
(none)	<i>Rana ridibunda</i>		Venezia Giulia	Autochthonous
(none)	<i>Rana kurtmuelleri</i>		Liguria, Piemonte	Autochthonous

Table 5.36 - Italian green frogs currently include 6 species, including the two klepton species *R. hispanica* and *R. esculenta*.

REPTILES

[Giuseppe M. Carpaneto]

Lakes, slow flowing rivers, marshes and ponds in Italy are often inhabited by the European pond turtle (*Emys orbicularis*), the only indigenous representative of the Emydid family. This species is in great decline due to alteration of watercourses. Moreover, they could also be affected by competition from exotic species, in particular, the Red-eared slider (*Trachemys scripta*), introduced from North America and increasingly common. Even though this last mentioned species reproduces with discontinuity in Italy, the number of specimens that are continually freed into the wild is extremely high and thus increases the acclimatised populations of this long-lived and low mortality rate species (generally adult specimens are freed). Conservation measures for the European pond turtle must

include satellitar localizing and protection of sites where eggs are deposited, in addition to the elimination of all exotic turtles introduced by man in Europe.

The Water snake is commonly found in aquatic habitats and displays different degrees of adaptation depending on its role of predator in the water or along the banks. It feeds primarily on amphibians and fish. The species most associated to aquatic habitats is the Dice snake (*Natrix tessellata*), present in almost all Italian regions, though the most common and widespread species is the Grass snake or Ringed snake (*N. natrix*), that can be found from coastal zones to mountain torrents. The Sardinian population, reported as an endemic subspecies (*N. n. cettii*) (Figure 5.30), is poorly known and very rare. Hence, both monitoring and protection measures are necessary. A third species, the Viperine snake (*N. maura*), lives in north-western Italy and in Sardegna.



Fig. 5.30 - The Sardinian grass snake (*Natrix natrix cettii*). It is considered a taxon worthy of the rank of species by several authors (Photo by G. Carpaneto).

AQUATIC BIRDS

[Francesco Pinchera]

State of knowledge and conservation status

One of the principal factors that lie behind the decline of many aquatic species is the extensive land reclamation of wetlands conducted throughout the national territory in the 20th century. This activity is now slowly diminishing, while the protection status of aquatic habitats is currently considered the most effective among those organised in Italy. Particularly vulnerable habitats are the extensive rice paddies in the north-east, where economic and agronomic reasons govern the destiny of these important areas for avifauna.

Podicipediforms

This group, made up of small to medium-sized aquatic species, has a cosmopolitan distribution and is morphologically homogeneous. The family Podicipedidae includes all the species in the order (about 20), 5 of which



Fig. 5.31 - *Phalacrocorax aristotelis* (Photo by M.Iacobini)

are present in Italy: *Tachybaptus ruficollis*, *Podiceps auritus*, *P. cristatus*, *P. grisegna* and *P. nigricollis*. Two species have large contingents that nest in the national territory: the Little Grebe (*T. ruficollis*), a polytypical species with a Palearctic-Paleotropical-Australasian distribution is present in Italy with 1,000-2,000 pairs, that covers several valley and coastal areas, while the Great crested grebe (*P. cristatus*), a polytypical species with a Palearctic-Afrotropical-Australasian distribution is present in Italy with more than 1,500 nesting pairs. This species passed through a period of expansion in terms of numbers and range, above all, in the 1980s and 1990s.

Pelicaniforms

Medium to large-sized order of aquatic birds, made up of 6 families found in the western Palaearctic Region, of which three are present in the Italian territory with various phenologies. The nesting species in Italy belongs to the family of *Phalacrocoracidae*: *Phalacrocorax aristotelis*, *P. carbo* and *P. pygmaeus*. The last two species utilise freshwater habitats. The cormorant, *P. carbo*, a polytypical species with a subcosmopolitan distribution, is present with the subspecies *sinensis* in central and southern Europe. Since the 1970s, the subpopulations of northern and central Europe have increased rapidly, reaching more 200,000 nesting pairs on the Continent. In turn, the wintering contingents in Italy have shown a great increase. The Pygmy Cormorant (*P. pygmaeus*) is a monotypic species with a Euroturanic distribution that has recently settled in Italy (Table 5.37).

Ardeids

These birds of prey are associated to shallow aquatic habitats and constitute a numerous and morphologically homogeneous group, made up of medium to large-sized taxa with a cosmopolitan distribution. Nine species are regularly present in Italy: the Great bittern (*Botaurus stellaris*); the Little bittern (*Ixobrychus minutus*); the Black-crowned night-heron (*Nycticorax nycticorax*); the Squacco heron (*Ardeola ralloides*); the Cattle egret (*Bulbuc ibis*); the Great white egret (*Egretta alba*); the Little egret (*E. garzetta*); the Grey heron (*Ardea cinerea*); and the Purple heron (*A. purpurea*).

Habitat transformation, in particular the reduction of *Phragmites* habitats, has led to a reduction of the nesting contingent of the Bittern, *B. stellaris*, in difficulty in its European range; the nesting contingent in Italy declined slightly in the period 1970 - 1990 and is estimated at 20-30 pairs. A decline has also been reported for the Lit-

Species	Period and origin	Location	pairs (2000)	
Pygmy cormorant	<i>Phalacrocorax pygmeus</i>	'80 - immigration	Punte Alberete (RA)	approx. 40.
Cattle egret	<i>Bulbucus ibis</i>	'80 - immigration	Province of Cagliari	approx. 400
Great egret	<i>Casmerodius albus</i>	'90 - immigration	Po Delta	approx. 40
Black stork	<i>Ciconia nigra</i>	'90 - immigration	Province of Novara	approx. 5
White stork	<i>Ciconia ciconia</i>	'60 - immigration	Province of Vercelli	approx. 30
Eurasian spoonbill	<i>Platalea leucorodia</i>	'80 - immigration	Comacchio Valleys	approx. 50
Greater flamingo	<i>Phoenicopterus roseus</i>	'90 - immigration	Stagno Molentargius (CA)	1,000-1,200 fluctuating
Mute swan	<i>Cygnus olor</i>	'60 - immigration	Lombardia-Canton Ticino	500
Gadwall	<i>Anas strepera</i>	'70 - immigration	Comacchio Valleys	20-50
Northern shoveler	<i>Anas clypeata</i>	'70 - immigration	Comacchio Valleys	100-200
Pochard	<i>Aythya ferina</i>	'50 - immigration	Po Delta (Veneto)	250-400
Tufted duck	<i>Aythya fuligula</i>	'70 - immigration	Massaciuccoli Lake	approx. 10
Common eider	<i>Somateria mollissima</i>	'90 - immigration	Province of Gorizia	1
Common merganser	<i>Mergus merganser</i>	'90 - immigration	Province of Belluno	2-4
Black-tailed godwit	<i>Limosa limosa</i>	70- immigration	Province of Vercelli	approx. 10
Eurasian curlew	<i>Numenius arquata</i>	'90 - immigration	Province of Vercelli	2-3
Mediterranean gull	<i>Larus melanocephalus</i>	'70 - immigration	Comacchio Valleys	approx. 2,500
Black-headed gull	<i>Larus ridibundus</i>	'60 - immigration	Comacchio Valleys	500-1,000
Slender-billed gull	<i>Larus genei</i>	'70 - immigration	Province of Cagliari	approx. 3,400
Gull-billed tern	<i>Gelochelidon nilotica</i>	'50 - immigration	Comacchio Valleys	approx. 230
Lesser crested tern	<i>Sterna bengalensis</i>	'80 - immigration	Comacchio Valleys	1
Sandwich tern	<i>Sterna sandwicensis</i>	'70 - immigration	Comacchio Valleys	approx. 700
White-winged tern	<i>Chlidonias leucopterus</i>	'70 - immigration	Province of Vercelli	approx. 10

Table 5.37 - New nesting species in Italy (specie associated to freshwater and wetland habitats, that immigrated or were introduced in the second half of the 20th century).

tle bittern (*I. minutus*), also considered in difficulty in its European range. The Italian contingent is estimated at 1,000-2,000 pairs.

Italy hosts a considerable share of the European contingents of the Black-crowned night-heron (*N. nycticorax*) and the Little egret (*E. garzetta*). The first nests in Italy with about 20,000 pairs (approximately a third of the European contingent), the second with 6,000-15,000 pairs (more than one fifth of the European contingent), mainly concentrated in rice paddies of the northern Padana Plain. Management programmes should prevent further habitat change in common nesting sites, and organise the recovery of the most compromised habitats. The Purple heron (*A. purpurea*) has an unfavourable status in Europe; a third of the European contingent is concentrated in Italy, 350-500 pairs many localised in the Padana Plain. The Cattle egret (*B. ibis*) (sub-cosmopolitan), and the Great white egret (*E. alba*) are cosmopolitan species that have recently settled in Italy (Table 5.37).

Ciconids (Storks)

This group of large-sized birds with a cosmopolitan distribution is made up of 6 genera and 17 species, two of which are present as recently settled nesting species in Italy: *Ciconia ciconia* and *Ciconia nigra* (Table 5.37).

Threskiornithids

These cosmopolitan birds, medium-large in size, occur in tropical, sub-tropical and hot temperate areas. The family consist of about 14 ibis genera and 1 spoonbill genus. There are two nesting species in Italy, though with relatively small contingents: *Plegadis falcinellus* and *Platalea leucorodia* (a recently settled species – Table 5.37). The Glossy ibis (*P. falcinellus*) is a polytypical species with a subcosmopolitan distribution. In southern Europe, it has a fragmented distribution influenced by great numeric variations; in the last fifty years the number of pairs has fluctuated from zero to a dozen in Italy.

Phenicopteriforms (Flamingos)

This order is made up of only one family: Phoenicopteridae, which includes 5 species. In the western Palaearctic Region it is present with only one nesting species: *Phoenicopterus ruber* that has recently settled in Italy (in the early 1990s in Sardegna). The flamingo, a polytypical species with a subcosmopolitan distribution, has a fragmented reproductive range and noticeable numeric fluctuations in the nesting sites. The nesting contingents in Spain, and above all, in Italy (generally 1,000-1,200 pairs) have particularly marked fluctuations. The nesting sites in southern France, which host a number of

pairs that generally vary from 12,000 to more than 20,000, have also witnessed great fluctuations. The species seems to have maintained a favourable trend. The role of Sardegna is important as a wintering area.

Anseriforms

Italy carries out an important role in the wintering of several geese species of the genus *Anser*. The wintering areas in the central and northern Italy has been subjected to considerable environmental change, above all, in the 1960s. The numerous contingents of the Bean goose (*A. fabalis*) and of the White-fronted goose (*A. albifrons*) declined rapidly in those years, particularly in the marshes and countryside of the coastal zones of Manfredonia (Foggia). The wintering areas in north-eastern Italy are becoming more important. The customary wintering of the Greylag Goose (*A. anser*) is relatively recent, probably encouraged by the legal protection of the species (late 1970s); the areas of presence are also distributed over relatively limited marshland habitats.

As for the genus *Anas*, Italy has a certain importance as a wintering area and part of the migratory route, while its contributes in a limited manner to the world-wide population as the nesting contingents in the country are limited (several species have settled recently – Table 5.37). The Gadwall (*A. strepera*) and the Northern shoveler (*A. clipeata*) settled in Italy as nesting species in the early 1970s and have populations respectively of a few dozen and a few hundred pairs. The Wigeon (*A. Penelope*), the Gadwall (*A. strepera*), the Pintail (*A. acuta*) and, above all, the Common teal (*A. crecca*) have considerably conspicuous wintering contingents in Italy compared to the estimated total for the Black Sea-Mediterranean area (around 5% of the total). Among those species whose European range has decreased, there is the Garganey (*A. querquedula*) with a particularly significant reduction in the nesting areas of eastern Europe, where the most numerous contingents are present. The nesting contingent in Italy is of limited strategic importance, and is estimated in several hundred pairs with either declining or stable contingents depending on the location. An increase of nesting and wintering contingents has been impeded by hunting activities.

The Red-crested pochard (*Netta rufina*) has a European

population concentrated in the west (Iberian Peninsula) where great expansion is underway and in the east (Russia – Romania), where the nesting contingents are apparently in decline. The number of nesting contingents in other European countries is limited; in Italy it is restricted to a few pairs, above all, in the Oristano area; similar data for the wintering pairs. For the genus *Aythya*, Italy hosts limited nesting contingents of the Pochard (*A. ferina*), the Ferruginous duck (*A. nyroca*) and the Tufted duck (*A. fuligula*) (Table 5.37). The wintering contingent of the Pochard is greater in Italy than that of the Ferruginous duck. The genus *Mergus* has recently settled with a few pairs of the species *M. merganser* (Table 5.37). The White-headed duck (*Oxyura leucocephala*), the only representative of the nesting genus in Italy became extinct in the 1970s (Table 5.38).

Rallidae

These small to medium-sized birds are associated to wetland and aquatic habitats with dense vegetation cover. Generally selective in choosing their habitats, several species of the family have an unfavourable status. The Water rail (*Rallus aquaticus*), the Spotted crake, (*Porzana porzana*) and the Little crake (*P. parva*), small-sized species linked to typical vegetation of wetland habitats, are in decline in most European countries, including Italy. The Corncrake (*Crex crex*), in decline in most European countries and on the IUCN Red List as an endangered species (category ‘vulnerable’), maintains a very limited and apparently irregular presence in Italy, confirming the tendency of regression throughout Mediterranean and central Europe. The Purple swamphen, *P. porphyrio*, has a tropical and subtropical distribution, while its presence in the western Mediterranean area is limited to restricted zones in Sardegna, the Iberian Peninsula and Magreb. The Sardinian population is estimated at 240-300 pairs and on the increase. In eastern Sicilia, a reintroduction project based on the introduction of specimens of Iberian origin is underway.

Charadriiforms

A large and heterogeneous group of small to large-sized birds that include dotterels, gulls and terns is made up of different taxa linked to freshwater habitats. They are di-

Species		Period	Last site of presence	Notes
White-headed duck	<i>Oxyura leucocephala</i>	1970s	Sardegna	Reintroduction project in Puglia
Osprey	<i>Pandion haliaetus</i>	1960s	Sicilia and Sardegna	-
Aquatic warbler	<i>Acrocephalus paludicola</i>	1950s	-	-

Table 5.38 – Extinct aquatic species in Italy in the second half of 20th century.

vided into *Recurvirostridae*, *Charadriidae* and *Laridae*.

Recurvirostridae are made up of three genera, two of which nest in Italy: the Black-winged stilt, *Himantopus himantopus* (cosmopolitan) and the Avocet, *Recurvirostra avosetta* (Palearctic-Afrotropical). In Italy, both species have nesting contingents estimated at about a thousand pairs; the Avocet is considered on the increase.

Charadriidae are present with the genera *Charadrius* and *Vanellus* that include nesting taxa in Italy: the Snowy plover (*C. alexandrinus*), the Little ringed plover (*C. dubius*), the Common winged plover (*C. hiaticula*), the Dotterel (*C. morinellus*) and the Lapwing (*V. vanellus*). Italy hosts large migratory and wintering contingents for the genera mentioned above, as well as for the genus *Pluvialis*: the Golden plover (*P. apricaria*) and the Grey plover (*P. squatarola*). The Snowy plover, a sub-cosmopolitan species, shows evident signs of decline in Europe. In Italy, there are an estimated 1,500 pairs.

About 16 genera of the numerous family *Scolopacidae*, whose diversity is centered toward the northern latitudes of the northern hemisphere, occur in Italy. Among the species in decline in Europe, there is the Dunlin (*Calidris alpina*), the Ruff (*Philomachus pugnax*), the Common snipe (*Gallinago gallinago*), the Great snipe (*G. media*), the Black-tailed godwit (*Limosa limosa*), the Curlew (*Numenius arquata*) and the Common redshank (*Tringa totanus*). The causes for this decline can be traced back to the intensification and increase of agricultural practices and the drainage of wetland areas in nesting areas in Europe. The Black-tailed godwit and Curlew have recently settled in Italy (Table 5.37).

The *Laridae* are present in Italy with several species, though the genus *Larus* has the largest contingents. Larids are undergoing a period of expansion in Italy, both in terms of numbers and range (three species associated to freshwater habitats have started to reproduce in Italy recently – Table 5.37). The *Sternidae*, a cosmopolitan chorol-

ogy group with greater diversity in tropical regions, are present in Italy with three genera: *Gelochelidon*, *Sterna* and *Chlidonias*. Evidence of great changes in range of the Stern can be seen in 4 out of the 8 nesting species that settled in Italy in the second half of last century (Table 5.37). Italy hosts one of the most important nesting contingents of the Little tern (*S. albifrons*), in Europe, an estimated 5,000-6,000 pairs (probably still inferior to the Russian one, which is in evident decline).

Passeriforms

Cinclidae and *Sylviidae* belong to this group.

Cinclidae are a small family made up of a single genus *Cinclus* that includes highly aquatic species. In Italy and Europe, it is present with the Scandinavian black-bellied race (*C. cinclus*). This species associated to torrents in considered stable in central-northern Europe and on the decrease in Mediterranean countries. One possible cause for the decline could be the reduced flow of water in the upper tracts of watercourses, caused by the increased use made of spring waters.

Sylviidae include genera that are particularly associated to wetland areas: *Locustella* and *Acrocephalus*. Some species have seen their areas of presence drastically reduced by land reclamation, and consequently, their numbers have dropped. The Aquatic warbler (*A. paludicola*), a European chorology species, is now extinct as a nesting species in Italy (Table 5.37). The Sedge warbler (*A. schoenobaenus*), a species with a Eurasian distribution, has a limited Italian contingent of less than 100 pairs that is in further decline.

The Penduline tit (*Remiz pendulinus*) (*Remizidae*), a species associated to hypertrophic wetland habitats, has undergone a rapid expansion of the south-western part of its range since the early 1950s in eastern Europe. The species is still considered in rapid expansion (particularly in Spain), while Italy hosts the most numerous European contingent, an estimated 25,000 nesting pairs.

MAMMALS

[Roberto Argano]

Of the five mammal species linked to freshwater habitats in Italy, two are allochthonous rodents: the Common muskrat, *Ondatra zibethicus*, a North American species, and the South American Coypu or Nutria (*Myocastor corpus*), which became part of Italian fauna last century (respectively in the 1950s and in 1928). The autochthonous species (two insectivores: the Miller's water shrew *Neomys anomalus* and *N. fodiens*; a carnivore, and the European otter, *Lutra lutra*) are obviously affected by the deterioration of the Italian fluvial systems. The otter, in particular, is confined to the restricted Campano-Lucana area.

Freshwater fauna conservation issues

Indications on the state of knowledge, causes for decline and on the necessary measures to recover biocoenosis have been provided for each single taxonomic group. In the following paragraphs, some aspects of the same issues that refer to freshwater Italian fauna in its entirety are mentioned.

Present knowledge regarding the abiotic compartment of freshwater habitats is, apart from several taxonomic groups, decidedly scarce. Flowing water habitats have felt the effects of this knowledge gap even more than stagnant waters, in that the study of these habitats is far more recent, especially as far as the more typical ecological aspects are concerned. Therefore, among the priority interventions, there is the need to create schools of taxonomy that produce specialists capable of conducting research on new groups (for example, Dipterans which include more than 1,700 species) to guarantee a certain continuity in competence where present, and to allow diversified methodologies to be used in disciplines that are often feel the burden of out-dated approaches. In fact, little is known of aspects regarding the functioning of freshwater systems, such as trophic-functional articulation and the trophic chains, productivity assessment (above all, for flowing waters), the theorization of structural models. And finally, little or nothing is known about the life cycle of most organisms that populate these habitats, as well as the relationship with other species and with the physical environment itself. In general, one can state that our knowledge is principally focused on vertebrates, while the real knowledge gap regards the rest of the fauna which is decidedly much more diversified.

Freshwaters are the most threatened ecosystems on Earth. The nutritional substances that support the abiotic communities of a watercourse, for example, are mostly of allochthonous origin and come from the complex action of its hydrographic basin. Therefore, lotic and lentic habitats are open ecosystems that are greatly affected by the surrounding territory, which is also the cause of their vulnerability.

Deforestation and alterations to basins, dams and barrages, pollution, tapping of the water tables or springs, deviations of watercourses, cementing or excavation of the bottoms and banks are a partial list of elements that threaten the biological health of flowing and stagnant waters. All these types of interventions, carried out without considering the biological structure of habitats, has led to the deterioration of all the sections of watercourses in reic systems: the springs (*crenon*) and their high level of endemism, the mid-section (*rhithron*) with its high level of diversity, the plain section (*potion*) where most of man's activity takes place.

One aspect of vital importance for freshwater habitat conservation, and for rivers in particular, is the integrity of the riparian ecotone which, either directly or indirectly affects the water quality. It carries out a primary role in maintaining the auto-purification capacity of water bodies acting as a 'buffer strip' by retaining nutrients and polluting substances from the surrounding territory, and the percolating substances moving from the soil in the direction of the water.

According to a report by the Ministry of the Environment (1986-1996) on the State of the Environment in Italy, only 19% of watercourses were found to be unpolluted.

The quality of the waters of lakes and artificial bodies of water is decidedly poor from a trophic point of view. For example, in Sardegna, 40% of these bodies of water have algal bloom, in Sicilia, 50% of the waters are either mesotrophic or eutrophic, while in the North, there has been a great increase in acidification of the waters and in the quantity of phosphorous (as in the Lakes of Como and Iseo).

Subterranean water systems are worthy of particular attention, as can be seen from the analysis made beforehand. Apart from the precious and exclusive fauna found in underground habitats, even the stigobionts that live at a great depth in subterranean networks, are subjected to the threat of pollution of Karst aquifers, which in some areas, and has already provoked the extinction of important faunistic groups. Unfortunately, the increasing water needs of our society are

increasingly satisfied by recurring to spring water tapping, and the exploitation of the water tables have had a considerable impact on aquatic ecosystems, often guiltily overlooked. Even phreatobic species, that live in particular habitats along watercourses, can negatively be affected by intervention to the riverbeds such as excavations and gravel extraction which, in certain cases, can drastically reduce

these habitats as they lower the level of the water table.

Last of all, mention should be made of the harm done, as was expounded over again in the fauna analysis, by either the deliberate or accidental introduction of alien species that has often had serious repercussions on the biocenotic structure of habitats to which they belong by now.