

By Croatian legislation the introduction of a new species into open ecological systems is banned. Nevertheless, there are already about 15 species of acclimatized fish introduced during this century. They are: the rainbow trout, charr and brook charr, freshwater houting, pumpkin-seed sunfish, largemouth black bass, two kinds of dwarf catfish, gold fish, false rasbora, Mediterranean toothcarp, goldfish, and with less effect silver carp and grass carp.

Marine fish

In the Adriatic Sea about 410 fish species and subspecies have been recorded, which makes about 70% of about 579 known fish species and subspecies in the Mediterranean. 353 species and subspecies belong to the group of bony fish and 54 to the group of cartilaginous fish. By the number of fish species the Adriatic is numbered among richer seas, but by the density of their populations and possibilities of exploitation among those poorer.



Figure 87. White sea beam, a species in the east Adriatic seriously declined in number

(from the publication by Jardas I.: Adriatic Ichthyofauna, 1996., photo by V. Pfeifer)

There are only 7 endemic fish species in the Adriatic, chiefly of the families goby *Gobiidae*, pipefish *Syngnathidae* and sturgeon *Acipenseridae*. The Adriatic endemics among gobies are Kolombatović's goby, Liechtenstein's goby, andromeda goby, sand goby and grotte goby. The last one found recently (1976) in the shallow north Adriatic represents scientifically a new genus and species. Endemic species among pipefish are slenderbill pipefish and deep-snouted pipefish, and among sturgeons most likely the species of Adriatic sturgeon – for the time being proved with certainty only in the Adriatic.

Box 50. Threats to Adriatic fish

- excessive catch
- sea pollution
- eutrophication of the sea (north Adriatic, estuaries, municipal sewage) and
- disappearance of adequate habitats.

Box 51. Brown meagre (*Sciaena umbra*)

- Order: *Perciformes*
- Family: *Sciaenidae* (shadows)
- Croatian names: kavala, konj, krap
- Protection in Croatia: not protected

Black umber dwells in the coastal area of the sea, mostly close to the rocky and sandy seabeds covered with growth, as well as near the banks, sometimes entering the estuaries. It usually does not go deeper than 50 m and is more active during night. Since it swims slowly, it is easily caught. It spawns from May to July and the roe is pelagic. Sexual maturity is reached when 30 cm long. It can reach a length of 50 cm and a weight of 4 kg, but in most cases specimens between 25 and 35 cm of length are being caught. It feeds on small fish and crabs. It is spread along the East Atlantic coast, from the English Channel in the north to Senegal in the south, including the Canary Islands, as well as along the entire coast of the Mediterranean and the Black Sea and the Sea of Azov. In the Adriatic it can be found everywhere close to the mainland and island coast and banks. It does not have any particular importance for fishing industry and economy; the annual catch in the east Adriatic does not exceed 20 tons, with 1,000 tons caught in the entire Mediterranean. It is fished by means of various fishing tools, mostly by »net«, then by long static fishing nets, spear guns, small fishhook devices, fish spears under lamplight and fish traps.

In the east Adriatic it declined in number considerably, due to intensive catching in the coastal area, particularly by means of spearfishing guns. The Decree on Protection of Fish and Other Marine Organisms, based on the Marine Fishery Act, has protected this species by specifying the smallest size allowed to be fished (30 cm) and until recently it was also protected by the close season from 15 May to 30 June. The new Decree (Official Gazette No. 145/1998) abolished the close season for all fish species, including the brown meagre.

I. Jardas

Figure 88. Brown meagre

(from the publication by Jardas I.: Adriatic Ichthyofauna, 1996. photo by V. Pfeifer)



Threatened Adriatic fish number at least 64 (15.5%), of which nine are threatened on a global scale. The majority of threatened species in the eastern part of the Adriatic suffers from **overfishing**. This refers to all benthonic and benthopelagic species of cartilaginous fish (about 27 species), predominantly inhabitants of the continental bed or shelf. Some large pelagic species of sharks (about 9 species) are threatened in all seas throughout the world, but in the Adriatic they are chiefly rare or very rare. Among bony fishes **fishing** has harmful effect on e.g. hake, black-bellied angler, sea-horse, grouper, brown meagre, species of genus *Labrus* (cuckoo wrasse, brown wrasse, green wrasse), some species of genus *Diplodus* (white beam, two-banded bream, sheephead bream), black bream, moray, surmullet, weever, stonebass and some plaices – all predominantly benthonic or benthopelagic species. A great portion of the **hake** catch in the Adriatic are immature specimens one or two years old (up to 16 or 19 cm long). From the biological point of view this is not permissible and such fishing is unreasonable. The catch of another economically significant species in trawling areas of the Adriatic, i.e. **surmullet of mud**, has been reduced to about 50% of the former catch. Beside the species mentioned, nearly all species of cartilaginous fish have also drastically dropped in number in the same areas.

Some species are threatened by the **disappearing of habitats**, for example meadows of marine flowering plants, particularly eelgrass. This is particularly evident along the western coast of Istria and in some other shallow areas of the Adriatic Sea. Similar changes may be found in settlements of cystoseira alga which is posing a threat mainly to fish species of the family pipefish, but also to some others (for example, blenny, goby, *Serranidae*, etc.).

Pollution by various organic-chemical compounds (phenols, petroleum, mineral oils, diverse detergents, etc.) is particularly harmfully affecting early development stages of fish (sexual products, larvae, post-larvae). Negative impacts of environmental pollution on fish and other marine organisms are proved, but their actual extent and mortality under natural conditions cannot be quantitatively evaluated.

As regards **economically significant species**, the major biomass in the Adriatic includes the species of small bluefish (**pilchard, sprat, anchovy**). Consequently, these several species have the greatest share in the commercial catch in the east Adriatic. Out of other fish species about a hundred have a certain smaller or greater economic significance, making them important not only from the ichthyofaunal viewpoint.

By **legal protection measures** related to fish and other marine organisms, as laid down by the Marine Fishing Act and by-laws, a great number of fish is protected in various ways. Among the fish threatened only 16 species are legally protected and regulations have specified the smallest sizes of specimens below which they are not allowed to be fished and marketed.

Habitats in which **fishing is restricted or banned** are mostly parts of the coastal marine belt that provide

favourable conditions for reproduction and breeding of fish (bays, coves, river mouths, etc.).

Amphibians and reptiles

In European proportions Croatia's fauna of amphibians and reptiles may be considered rich, because with the total number of 56 species that belong to these two groups this country is ranking very high (more species are found only in Italy – 62, Spain – 66, Greece – 68 and Yugoslavia – 70), particularly if we do not take into account countries that geographically belong to Europe only partly (Russia, Turkey) and, to the most part, to southern latitudes much richer in amphibian and reptile species. This country is inhabited by a great number of subspecies, which is the result of the indented coastline and the presence of a great number of bigger and smaller islands and cliffs.



Figure 89. Grass frog can endure lower temperatures and therefore appears in higher mountainous regions too

(photo by M. Mrakovčić)

Amphibians

Of a total of 20 amphibian species 6 are threatened on a global and 4 on a national scale. It is likely that some more species could be found, such as the frog *Rana gracea* and *R. shqipERICA* and perhaps some new, so far undescribed species of edible frog.

All species are **legally protected**, including the possibility of limited gathering of all three green frog species: *Rana esculenta*, *R. ridibunda*, and *R. lessonae*, in the areas of farming fishponds. Edible frogs are gathered for food and mostly exported into other European countries. Their gathering is regulated by special gathering permits

Table 13. Diversity of amphibians

Order	Family	Species total	Species assumed	Threatened Croatia	Threatened Europe	Endemic total	Threatened endemic (sp./ssp.)	Leg. protec.
Caudata	Proteidae	1	1	1	1	1	1	1
	Salamandridae	6	6	2	2	0/3	(1)	6
Anura	Pelobatidae	1	1	0	0			1
	Discoglossidae	2	2	0	2	0/1		2
	Bufoidea	2	2	0	0			2
	Hylidae	1	1	0	0			1
	Ranidae	7	9	1	1	1	1	7
Total	7	20	22	4	6	2/4	2+(1)	20

Box 52. Threats to amphibians

- disappearance and fragmentation of wetland habitats
- agricultural measures (use of various pesticides and fertilizers)
- barriers created by road construction
- introduction of new fish species into waters
- killed on roads during migrations and
- gathering to commercial purposes.

Box 53. Olm (*Proteus anguinus*)

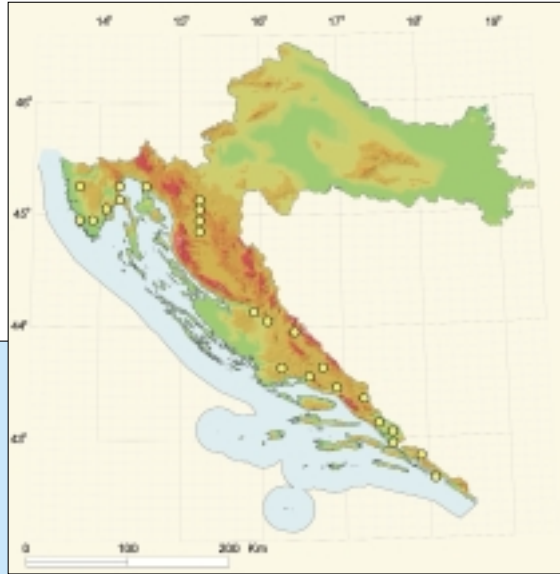
- Order: *Caudata* (tailed amphibians)
- Family: *Proteidae* (olm)
- Croatian name: čovječja ribica
- IUCN: vulnerable (VU)
- Protection in Croatia: protected since 1964 by the Nature Protection Act



Figure 90. Olm
(photo by A. Novosel)

a species is considered threatened only by chemical and biological pollution of underground waters, with local populations potentially threatened by water management undertakings by which underground watercourses are given other directions and the level of underground waters changed.

N. Tvrković



Map 15. Distribution of olm

(according to data by N. Tvrković)

The olm is spread from the north-westernmost area of Italy, through Slovenia to border areas of Croatia and Bosnia and Herzegovina towards Montenegro (Yugoslavia) (Map 14). It is an endemic of the Dinaric karst where it lives in underground waters or rather, more precisely, in underground lakes and stiller parts of watercourses. It feeds on various tiny underground aquatic animals. Four isolated populations are likely to live in Croatia, but their taxonomic status has not been clarified yet. So far neither the size of individual populations nor their threats have been assessed. Olms over the age of 14 spawn 70 eggs each year, but the phenomena of live births are also likely. The embryonic development lasts about 130 days. Larvae have gills that they keep as adult specimens after transformation (neoteny). Sexually mature specimens are probably long-lived, because natural enemies of adult olms in the underground are unknown. They mostly get killed when thrown out of their natural habitat by the streams of swollen waters. The olm as

issued by the Ministry of Environmental Protection and Physical Planning.

The only exclusively Croatian endemic is a subspecies of a smooth newt *Triturus vulgaris* subsp. *schreiberi* with a very limited distribution round Zadar. Other endemics of a wider regional importance are: olm, smooth newt (subspecies of *Triturus vulgaris* subsp. *meridionalis* and *T. vulgaris* subsp. *dalmaticus*), yellow-bellied toad (subspecies *Bombina variegata* subsp. *kolombatovici*) and the Italian agile frog. Among them the smooth newt *T. vulgaris* subsp. *schreiberi*, olm and the Italian agile frog are threatened.

Reptiles

Of Croatia's 38 species of reptiles, or rather 36 that are reproduced in Croatia, 10 are threatened on a global scale. All species with the exception of nose-horned adder and common adder are legally protected. A particular curiosity and value are 49 subspecies of Croatia's so-called endemics. These are endemic subspecies of Dalmatian and Italian wall lizard of Adriatic islands whose accurate taxonomic status is still under examination. The majority of them dwell on

Box 54. Threats to reptiles

- disappearing of adequate habitats and reproduction areas
- activities of gathering and intended devastation
- threat to marine turtles due to disappearance of coastal habitats and
- disturbance and incidental catch when fishing.

smaller uninhabited islands. A necessary prerequisite for their survival is legal protection of such islands with the highest possible restriction of tourist-related and other economic activities so as to prevent the possibility of an intended or unintended introduction of other species that could pose a potential threat to the indigenous populations.

The endemic taxa of the wider region are the Dalmatian algyroides, the Horvath's rock lizard, the Mosor rock lizard, sharp-snouted rock lizard, Dalmatian wall lizard and Balkan whip snake.

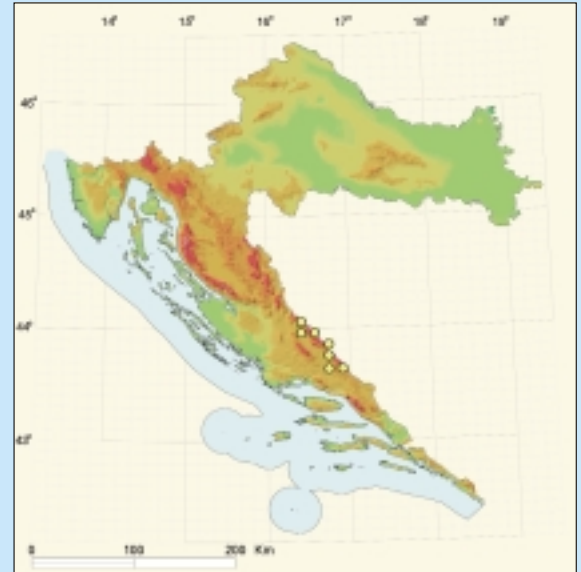
Box 55. Orsini's viper (*Vipera ursinii*)

- Order: reptiles, *Squamata*
- Family: vipers, *Viperidae*
- Croatian name: stepska ridovka
- IUCN: endangered (EN)
- Protection in Croatia: protected since 1965 by the Nature Protection Act

Orsini's viper is the smallest and at the same time the most threatened European viper. Until recently it was considered to be distribution, except in Europe, throughout Asia too, but its Asian taxa are very likely to belong to separate species. Its spread in Europe is mosaic-like and in recent molecular-genetic researches the isolated subspecies showed a high genetic isolation. In Croatia it is found on Dinaric mountain and its foot (the Balkan mountain taxon of *V. macrops*), with documented findings from Istria and the island of Krk (probably the Apennine taxon of *V. ursinii*) originating from the beginning of the 20th century. The habitats of this species are lowland and highland meadows of the steppe or semi-steppe type. The females give live births and have up to 10 young once a year. Orsini's viper

Figure 91. Orsini's viper

(photo by G. Agačević)



Map 16. Distribution of Orsini's viper

(according to data by N. Tvrtković)

feeds mostly on grasshoppers, lizards and tiny mammals. Due to its mosaic-like distribution, small local populations and threatened habitats it is classified as the most threatened species in Europe. Beside fragmentation and degradation of its natural habitats in Croatia it is also threatened by construction of asphalt roads through spatially limited finding places and by succession of meadows as a result of abandoning traditional cattle breeding. There is also a danger of depleting the stocks of isolated populations due to excessive catch for the needs of illegal markets of terrarium animals. There are no recent data from Istria and the island of Krk available, and the accurate distribution and size of populations in the Dinaric area are also unknown. Because of the threat posed to this species it should be given priority in research works in order to identify its real threats and elaborate the protection.

N. Tvrtković

Table 14. Diversity of reptiles

Order/suborder	Family	Spec. total	Repr. in Cr.	Assum. no. of species	Thr. in Cr.	Thr. in Eur.	Endem. total (sp./ssp.)	Endem. threat. (sp./ssp.)	Leg. prot.
Testudines	<i>Cheloniidae</i>	1	0	2	1	1			2
	<i>Dermochelyidae</i>	1	0	1	1	1			1
	<i>Testudinidae</i>	1	1	1	1	1			1
	<i>Emyidae</i>	2	2	2	1	2			2
Squamata	<i>Gekkonidae</i>	2	2	2	0	0			2
	(<i>Sauria</i>) <i>Anguidae</i>	2	2	2	0	0			2
(<i>Sauria</i>)	<i>Lacertidae</i>	12	12	13	1	0	5/49	1	12
(<i>Sauria</i>)	<i>Scincidae</i>	1	1	1	1	0			1
(<i>Serpentes</i>)	<i>Colubridae</i>	12	12	12	1	3	1	0	12
(<i>Serpentes</i>)	<i>Viperidae</i>	4	14	5	2	2	0/2	0/2	1
Total	10	38	36?	41	9	10	6/51	1	36

Birds

Croatia's ornithofauna consists of a total of 371 bird species, of which 226 species are considered breeding birds. In European proportions both figures are comparatively high, suggesting a very rich ornithofauna. Croatia numbers among the European countries with the richest and the most diverse ornithofauna and, considering the protection of birds, among those most important, particularly viewing its relatively small

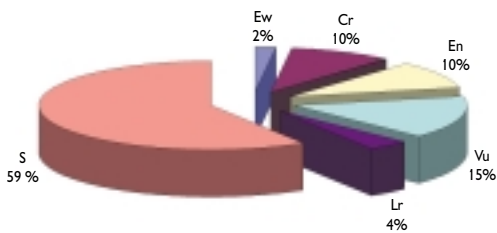
surface area. Nearly all small and medium-sized European countries have less breeding birds. Comparing the countries by the number of breeding birds of the species threatened in European proportions we come to the actual value of Croatia's ornithofauna. In Croatia as many as 78 species threatened in Europe are breeding, which is more than in all small and medium-sized European countries together (with the exception of Albania) and more than in the majority of

big European states. By the number of breeding birds of the species threatened in Europe Croatia is ranking fourteen in Europe, with far bigger countries such as Russia (the European part), Spain, Turkey (including the entire Asian portion), Ukraine and France in the leading positions.

There are **no endemic species** of birds connected with Croatia. **Economically significant** are species considered game according to the Act on Hunting (26 species). Beside pheasants there are ducks, quails, partridges, etc. that are also hunted. The bird game is particularly interesting for the Italians who, by their methods of hunting and their non-observance of regulations, pose threat to the entire protected ornithofauna in the hunting grounds.

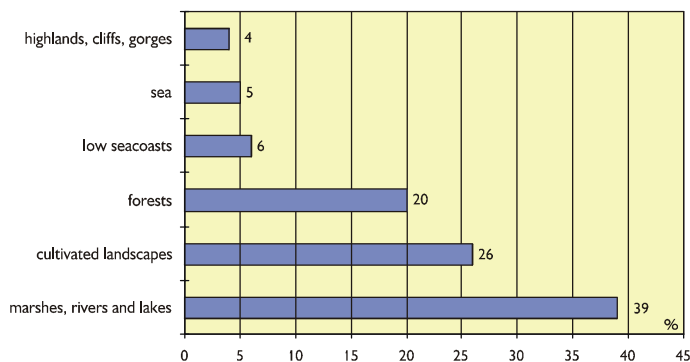
Croatia's ornithofauna may be said in general to be highly **threatened**. Some species are already extinct; some others have several times declined in number. The high percentage of threatened species is partly a result of Croatia's being a small land, but to the most part it is a consequence of threat posed to the majority of habitats and of the higher or lower anthropogenic pressure in nearly all habitats in Croatia.

In the course of the NSAP development the threats to Croatia's ornithofauna have been analysed and the species threatened classified according to the IUCN categories (IUCN Red List Categories) (Graph 8).



Graph 8. Share of individual categories of threat (152 species) within the total number of species of Croatia's ornithofauna (371 species): EW – extinct in the wild (7); CR – critically endangered (36); EN – endangered (38); VU – vulnerable (57); LR – lower risk (14); S – safe (219).

So far 7 species have completely died out in Croatia, including 6 species of the breeding population that disappeared. The number of the threatened and extinct species in Croatia is 152, making 41% of the total Croatia's ornithofauna. Among them waterbirds account for even 39%, showing clearly that wetland habitats are the most threatened habitats in Croatia. They are followed by birds inhabiting the cultivated landscapes (26%) and forest birds (20%). These three groups include about 85% of all threatened birds. Birds inhabiting the low (sandshores and mudflats) seacoasts of Croatia are practically all threatened



Graph 9. Distribution of threatened species of Croatia's ornithofauna by habitats

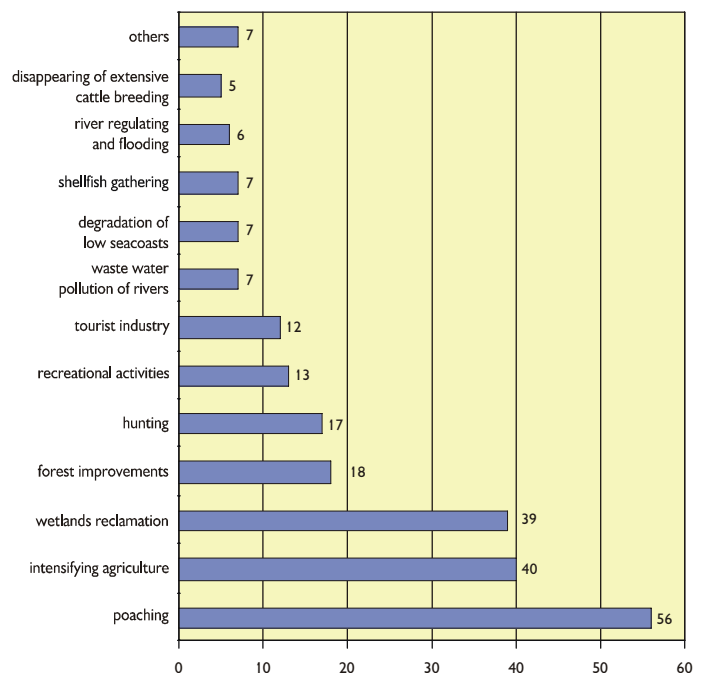


Figure 92. Common kingfisher, a skillful fisher nesting in river bank holes (photo by M. Mrakovčić)

and represent 6% of all threatened species. Sea birds account for 5% of the total number of threatened birds, which is also very much, because this group is not numerous in Croatia. The least threatened are birds living in highlands, cliffs, gorges and rocky areas (4% of threatened birds) (Graph 9).

Analysing the threats to birds by the number of species affected it becomes evident that the majority of bird species in Croatia is threatened by **poaching**. Despite strict regulations the state is serious and the law poorly observed and enforced in practice. The situation is particularly serious in the coastal areas, in Dalmatia above all, and the worst of all in the region of Neretva in south Dalmatia (Graph 10).

Birds are a group of animals **legally protected** in the most comprehensive manner. This protection covers all breeding birds and all other European species, with the exception of game according to the Act on Hunting (26 species) and the great cormorant on farming fishponds and the starling in agricultural areas.



Graph 10. Threats to Croatia's ornithofauna showed by the percentage of threatened species in relation to the total no. of threatened species (152) affected

Map 17.
*Distribution of
ferruginous duck in
Croatia*

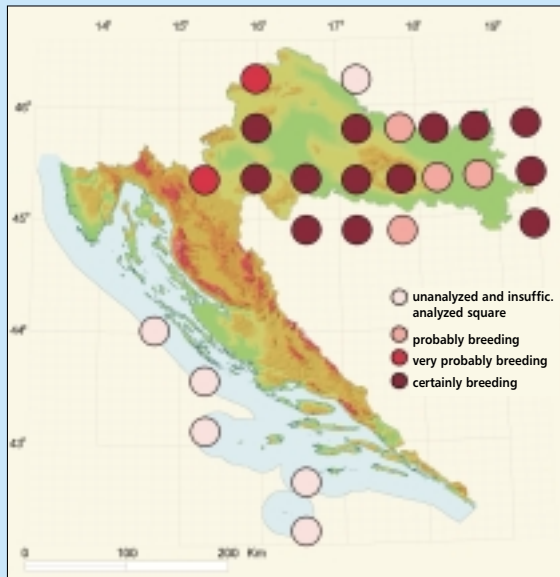
(according to data by D. Radović)

Figure 93.
Ferruginous duck

(photo by M. Schneider-Jacoby)



Box 56. Ferruginous duck (*Aythya nyroca*)



- Order: *Anseriformes*
- Family: *Anatidae*
- Croatian name: patka njorka
- IUCN: vulnerable (V)
- Protection in Croatia: protected by the Nature Protection Act

Ferruginous duck is a nesting bird of the steppe, desert and southern forest zone of Europe and western Asia. Its optimal habitats are shallow marshes rich in floating and underwater vegetation interspersed with patches of reeds and sedges. As a migratory bird it winters mainly in coastal wetlands of the Mediterranean and the Black Sea, the Sea of Azov and the Caspian Sea, and a considerable part of the population in tropical Africa too. Ferruginous duck is an omnivore, but its diet consists mostly of seeds and other parts of wetland plants (*Potamogeton*, *Ceratophyllum*, *Hydrocharis*, *Carex*, *Polygonum*, *Nymphaea*, *Lemna*). To a smaller extent it feeds on aquatic invertebrates (molluscs, annelids, crabs, insects) and small fish and frogs up to 3 cm long. It gathers food from the water surface, dips its head under the surface or dives to the bottom. The nesting season lasts from May to August. The females make the nests themselves and lie on eggs. The ducklings are precocials, they feed themselves and during night they are safeguarded and warmed by females.

Ferruginous duck is a globally threatened species, with its number declining constantly in almost all countries – in some of them even drastically. The major threat to this species is the disappearing of suitable marshes. In Croatia it found a compensation habitat in large carp fishponds of central Croatia and Slavonia. For that reason its population in Croatia belongs to a small number of stable ones, making even 13% of the total European population, and is of global importance for the survival of this species. The future stability of this population in Croatia depends on the survival of carp fishponds with the semi-intensive method of agriculture as used to date. At the moment its greatest threat is hunting, although it is protected and its hunting illegal.

D. Radović

Mammals

The list of Croatia's mammals without domesticated species contains a total of **101 species**. Permanent members of Croatia's fauna (those constantly breeding here at the moment) presently number a total of **86 known species**. Apart from species coming to Croatia's area periodically (whales and dolphins) for the following 8 species there are no data on their breeding in Croatia: Mediterranean monk seal, common dolphin, Mehely's horseshoe bat, Blasius' horseshoe bat, northern bat, greater noctule, parti-coloured bat, and raccoon dog. Until recently the first two of these species have been common indigenous species. For two species (ground squirrel and Palestine mole mouse) there are no data on whether they have still been members of Croatia's fauna over the last 30 years (no research). The bats mentioned probably come to Croatia constantly or periodically for wintering. In winter the island population of bats migrate to wintering grounds on the continent and some Central-European species come also to winter at the coast. Bats are at the same time the least known species of mammals.



Figure 94. Bank vole, the commonest forest vole of the mainland part of Croatia

(photo by M. Mrakovčić)

Box 57. Long-fingered bat (*Myotis capaccinii*)

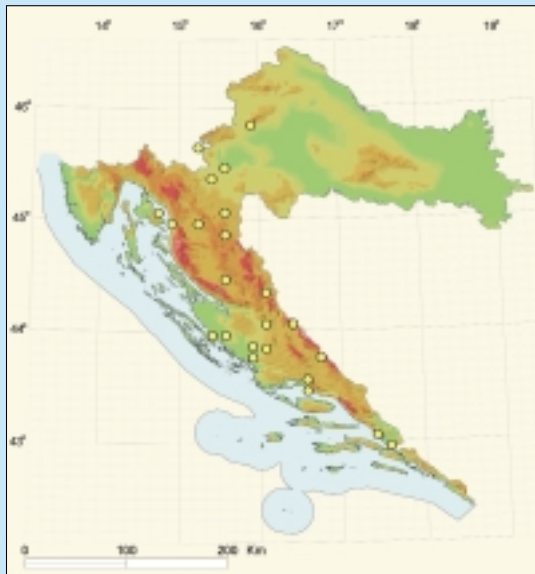
- Order: *Chiroptera* (bats)
- Family: *Vespertilionidae* (mouse-like bats)
- Croatian name: dugonogi šišmiš
- IUCN: vulnerable (VU)
- Protection in Croatia: protected since 1978 by the Nature Protection Act

The long-fingered bat is one of the rare bat species associated exclusively with the karst area; it is spread over the wider Mediterranean area of Europe and Asia. The daily roosting places and summer colonies with the young may be found only in caves and pits with a temperature between 10 and 17°C, at the same time close to karst flowing waters and lakes. It feeds on insects living above inland waters. Its prey are adult flying forms of the species whose larvae live in the water and which it catches flying immediately above the water surface. The long-fingered bats have only one young yearly in the period between May and July. In the middle of November the colonies migrate for wintering in colder caves and return to their summer dwelling places during March. According to the research to date the long-fingered bat is almost nowhere particularly numerous, the colonies known number mostly between 30 and 120 specimen. One of the greatest two summer colonies in Europe consisting of some 3,000 to 4,000 specimens lives in the cave of Miljacka II in the Krka National Park. All populations in Croatia are temporarily estimated to about 7,000 specimens. So far the disappearance of two and a considerable reduction of three more out of 10 known separate colonies has been recorded. The causes are filling the cave entrances by wastes, mounting of iron doors of inadequate structure, killing wantonly (vandalism) and out of ignorance, as well as frequent disturbance of colonies with youngs. These causes are probably to be supplemented with changes in natural populations of insects connected with karst flowing waters that took place after river regulations or their flooding due to construction of storage lakes for hydropower purposes. This species is also threatened by possible tourist-related arrangement of caves that are its thousand-year-old sanctuaries. For an efficient protection it is necessary to become more familiar with its distribution, number and ecology of species, and also to monitor changes in the number of individual colonies on a regular basis.

N. Tvrčković



Figure 95.
Long-fingered bat
(photo by D. Pelić)



Map 18. Distribution of the long-fingered bat in Croatia
(according to data by N. Tvrčković)

By the number of species in proportion to the surface area Croatia belongs to the top of European countries with great biological diversity of mammals.

The subendemic taxa of mammals are Martino's snow vole, alpine pine vole and Palestine mole mouse and two subspecies of Dalmatian garden dormouse and Kolombatović grey long-eared bat. This number of species is a result of the biogeographical position of Croatia, the history of settling and the fact that during the ice ages there existed at least two sanctuaries along the Adriatic coast. All five taxa (one species, two semispecies and two subspecies) belong to the category of subendema, which means that they are not limited only to the area of today's Croatia.

At the European level 15 species, or rather 8 subspecies of mammals are threatened. The elk, the European bison and the wild ox disappeared from Croatia in historic times and the beaver, the chamois and the lynx late in the 19th and early in the 20th century. The last three species that had disappeared were reintroduced into Croatia or adjacent areas, thus becoming again members of the country's fauna. Five

species are presently considered critically endangered: the Mediterranean monk seal, the common dolphin, the ground squirrel, Palestine mole mouse and the beaver of which only the beaver is surely reproduced in Croatia. For the Mediterranean monk seal it is necessary to develop an action plan of reintroduction, but it should be well elaborated, because the success of the resettlement is very questionable and, besides, one should be prepared to pay compensation to fishermen. One should investigate the possibility of its survival in the marine reserves foreseen. The possible success of retaining the common dolphin is also

Box 58. Threats to mammals

- habitat disappearance and degradation
- hunting and poaching, and
- use of pesticides

Table 15. Diversity of mammals.

A – number of species recorded in Croatia to date;

B – assumed number of species in Croatia;

C – number of threatened species at the level of Croatia (own estimates, the number in brackets showing threatened subspecies or isolated populations!);

D – number of threatened species at the European level (acc. to the European Red List, UN 1991, column A groups);

E – number of endemic species/subspecies;

F – percentage of endemic species/taxa;

G – number of threatened endemic taxa;

H – number of protected species (and parts of population) in Croatia.

Taxa (families and orders)	A	B	C	D	E	F	G	H	red list
Erinaceidae	1	1	0(1)	0	0	0	0	0(1)	yes
Soricidae	8	8	0	2	0	0	0	8	no
Talpidae	1	2	0(1)	1	0	0	0	0(1)	yes
INSECTIVORA	10	11	0(2)	3	0	0	0	8(2)	
Rhinolophidae	5	5	2	2	0	0	0	5	yes
Vespertilionidae	23	24	2	9	0/1	0/4.31	0	21	yes/no
Molossidae	1	1	0	1	0	0	0	1	yes
CHIROPTERA	29	30	4	12	0/1	0/3.4	0	27	
Canidae	4	4	1	1	0	0	0	4	yes
Felidae	2	2	0	3	0	0	0	1(1)	yes/no
Herpestidae	1	1	0	0	0	0	0	1	no
Mustelidae	7	7	1	4	0	0	0	7	yes/no
Phocidae	1	1	1	3	0	0	0	1	yes
Ursidae	1	1	1	2	0	0	0	1	yes
CARNIVORA	16	16	4	13	0	0	0	15(1)	
Balaenopteridae	1	1	1	3	0	0	0	1	no
Delphinidae	6	6	2	1	0	0	0	6	no
Physeteridae	1	1	0	0	0	0	0	1	no
Ziphiidae	0	1	0	0	0	0	0	0	no
CETACEA	8	9	3	4	0	0	0	8	
Suidae	1	1	0	0	0	0	0	1	no
Cervidae	4	4	0	1	0	0	0	5	no
Bovidae	2	2	0	6	0	0	0	3	yes/no
ARTIODACTILA	7	7	0	7	0	0	0	9	
Sciuridae	2	2	1	1	0	0	0	2	yes/no
Castoridae	1	1	1	0	0	0	0	1	yes
Muridae	21	23	1(4)	8	3	2	1	4(3)	yes/no
Myoxidae	4	4	0(2)	3	0/1	0	0	4	no/yes
Myocastoridae	1	1	0	0	0	0	0	0	no
RODENTIA	29	31	3(6)	12	3/1	2	1	11(3)	
Leporidae									
LAGOMORPHA	2	2	1	1	0	0	0	2	no
MAMMALIA	101	106	15(8)	52	3/2	3	1	80(6)	complete
Total									

questionable, because in the north Adriatic this species is practically extinct and the situation in the southern part of the Adriatic is unknown. For two **steppe species** (ground squirrel and Palestine mole mouse) it is necessary to carry out the field research as soon as possible. If they are found to be still members of the country's fauna, a special protected area is to be established, because these species number among the most threatened in Europe. Should the

reintroduction of **the beaver** prove to be successful, it is likely to pass over into the lower categories of **threat**. The **wolf** and the **lynx** are considered **threatened**. Although a national standing committee has been established to identify their number and damage they cause, no comprehensive study of the possibility of their survival in Croatia is available, because the required preliminary investigations and monitoring are lacking. For the time being, the presence of

Group	A	B	C	D	E	F	G	H**	I
Sea fish	410	415	64	9	7		16-MR	no	no
Freshwater fish	113 (145)	157	52	110	33		SR	no	yes
Amphibians	20	22	5	6	2	1	20	no	complete
Reptiles	36 (38)	41	9	10	6	44?	36	no	complete
Birds	226 (371)	380	152	78	0		*	yes	complete
Mammals	86 (101)	106	15	52	3	2	80-ZZP, ZL	no	complete
Total	891 (1,085)	1,121	297	265	51				

Table 16. Diversity of vertebrates. A – total number of species; B – assumed number of species; C – number of species threatened in Croatia; D – number of species threatened in Europe; E – number of endemic species; F – number of endemic subspecies; G – number of legally protected species (MR – according to the Marine Fisheries Act; SR – according to the Freshwater Fisheries Act; ZZP – according to the Nature Protection Act; ZL – according to the Law on Hunting); H – list of species in a group; I – red list of the group; () – number of species recorded in Croatia's area no matter whether reproduced here or not; * – according to the Nature Protection Act all European species are protected, except 26 game species (closed season according to the Law on Hunting) and the great cormorant at fishponds and the starling in agricultural areas; ** – during the NSAP development the preliminary lists were made, representing the in-house material of the Ministry of Environmental Protection and Physical Planning.

large carnivores is incurring high expenses for settling the damages and is affecting adversely the possible actions for the protection of other species.

Among nine **vulnerable** species four refer to **bats** (chiefly cave species) which require immediate start of the monitoring of great summer and winter colonies known.

The assessment of distribution of the beaver, the bottlenose dolphin and the brown bear has given good initial results, while for the bottlenose dolphin and brown bear some even more complex ecological research was carried out, unfortunately covering only a limited area of Croatia.

In general, **the introduction of herbivores and predators to islands should be promptly banned** and the introduction of foreign populations restricted, based on the preliminary opinion obtained from a special commission. The species with isolated "island" populations threatened are to be taken into consideration when developing physical plans.

For a comparatively great number of mammals, among which bats are the most numerous, the existing criteria did not allow to identify the category of threat, although the majority is suspected to be threatened. This accounts for a

comparatively small official number of threatened species in Croatia that does not reflect the actual state. Such species with the unknown status of threat are to be given priority in the research planned.

Nevertheless, the majority of mammals are not **threatened**, but only certain groups of large carnivores, marine mammals, mammals using aquatic habitats, mammals that used to live in semi-steppes and, finally, a group of bats. A part of the species is threatened mostly by hunting and poaching (large carnivores, marine mammals), another indirectly through their prey due to insecticides (bats) and a part as a result of the habitat disappearance (semi-steppe habitats and follow land, aquatic and wet habitats, the ground squirrel, Palestine mole mouse, the common otter, the beaver).

Legal regulations have **protected** 58 species and 6 parts of populations. 22 species are partly or temporarily protected. **Economically significant** species are the game hunted for pelts, trophies or meat. Among them some threatened taxa may be found, such as the brown bear, the pine marten, the hare and the beaver which is still not hunted because of the recent reintroduction.

INVERTEBRATES

Terrestrial and inland waters invertebrates

Among the groups of terrestrial and inland waters invertebrates of Croatia a **total of 17,575 species** have been recorded. Viewing the fact that this overview has not included numerous groups of aquatic and inland invertebrates for which either data or scientists to deal with them are not available, it can be assumed with certainty that the **actual number is by far greater and that it exceeds 55,000**.

On the basis of the data collected, in Croatia's **inland waters** the presence of 2,001 taxa of invertebrates was identified. This number includes larvae of insects whose mature forms inhabit the inland. However, to this number a certain number of species are to be added that, according to data obtained from the adjacent countries, are likely to live in the area of Croatia too, but the data are insufficient. These species total 1,526 which means that inland waters of the Croatia's region are probably inhabited by 3,527 species. Moreover, it should be emphasized that the species considered have been examined to a comparatively small extent. Therefore the presence of a considerable number of species may be expected with great certainty, which is to be confirmed by further research. In the expert opinion about 1,090 more species may be expected. Consequently, the inland waters of Croatia are probably inhabited by about 4,618 species of invertebrates. If we compare this number with the total of 14,065 species of invertebrates present in inland waters of the European area, it is evident that the area of Croatia is inhabited or presumably inhabited by an extremely great number of species.

Invertebrates as a whole are poorly explored. For numerous groups there are no inventories of species whatsoever. The basic inventories of species have been made for the following groups: earthworms, diplopods, sawflies, crane flies, horseflies, hover-flies, *Milesiidae*, *Merodontidae*. The basic problem is **the lack of experts to deal with systematization and taxonomy of invertebrates**. Data on numerous groups are few. The existing data on individual groups have been obtained mostly from the work of foreign researchers.

Among invertebrates a total of 730 **endemics** have been identified, which is 4.15% of 17,575 species recorded. The groups of snails and crabs include generally the highest

Box 59. Basic threats to invertebrates

- habitat destruction and change
- pollution and pesticides
- introduction of foreign species and
- excessive exploitation and gathering for food or collections.

percentage of endemics. So there are 40% endemics among snails living in surface waters, among those living in underground habitats even 82% of the groups identified are endemic, while the share of endemics among terrestrial species amounts to 30%. In the group of ten-legged crabs, numbering only 8 species, 3 of them are endemic. As many as 57% of the total identified species of crustaceans are endemic, mostly species inhabiting the underground waters. The same applies to the group of isopods with even 62% of the aquatic forms being endemic, while the share of endemics among the terrestrial forms amounts to 50% relating chiefly to species inhabiting the underground habitats.

Among terrestrial species a considerable share of endemics may be found in groups of diplopods – 43%, harvestmans – 41%, earthworms – 27% and ground beetles –

Figure 96. Dragonfly Leucorrhinia caudalis is a species facing extinction; it needs clear water to survive and lives exclusively on floating plant leaves in old backwaters; found in Croatia in only a few of sites

(photo by M. Schneider-Jacoby)



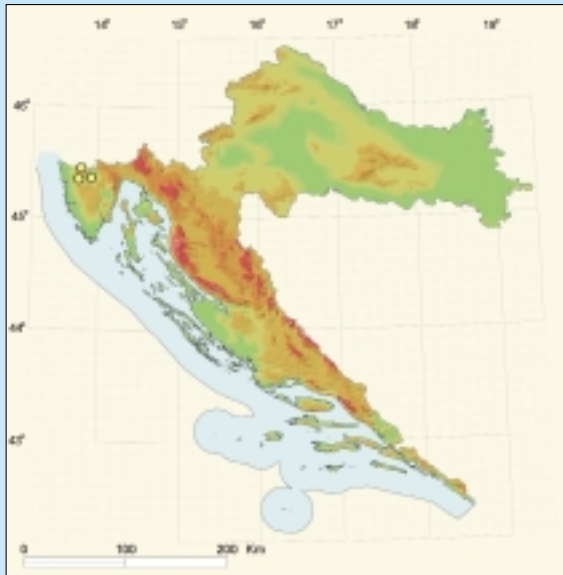
Table 17. Overview of the number of terrestrial and inland waters invertebrate taxa by major taxonomic categories and existing data (1subphylum; 2 subclass; 3 suborder; in some groups the number of taxa includes beside species the subspecies too)

PHYLUM / Class / Order	No. of families	No. of taxa	No. of endemics	% of endemics	PHYLUM / Class / Order	No. of families	No. of taxa	No. of endemics	% of endemics
PROTOZOA					<i>Cladocera</i> ³	8	35		
<i>Sarcodinea</i> ¹	50	54			<i>Bathynellacea</i>	2	2		
<i>Ciliophora</i> ¹	150	214			<i>Decapoda</i>	3	8		
Total	200	268			<i>Isopoda</i>				
SPONGIA					aquatic	5	24	12	50,00
<i>Demospongiae</i>					terestic	12	133	74	55,64
<i>Haplosclerina</i>	1	4			<i>Amphipoda</i>	7	73	22	30,14
Total	1	4			<i>Myriapoda</i>				
PLATODES					<i>Chilopoda</i> ²	2 ?	92		
<i>Turbellaria</i>					<i>Diplopoda</i> ²	22	175	75	42,86
<i>Tricladida</i>	3	12			<i>Pauropoda</i> ²	1	4		
<i>Trematodes</i>					<i>Symphyla</i> ²	1	2		
<i>Monogenea</i>	5	45			<i>Insecta</i>				
<i>Aspidobothria</i>	2	4			<i>Collembola</i>	13	105	3	2,86
<i>Digena</i>	3	10			<i>Protura</i>	1	4		
<i>Cestodes</i>					<i>Diplura</i>	1	7		
<i>Pseudophyllidea</i>	1	8			<i>Thysanura</i>	2	3		
<i>Taenioidea</i>	1	6			<i>Ephemeroidea</i> (= <i>Ephemeroptera</i>)	7	24		
Total	15	85			<i>Odonata</i>	9	68		
CNIDARIA					<i>Dyctioptera</i>				
<i>Hydrozoa</i>					<i>Blattodea</i> ³	3	21		
<i>Hydroina</i>	3	5			<i>Mantodea</i> ³	2	6		
	3	5			<i>Isoptera</i>	1	2		
ASCHELMINTHES					<i>Plecoptera</i>	7	24		
<i>Rotatoria</i>	22	199			<i>Cheleutoptera</i> (= <i>Phasmidae</i>)	1	2		
<i>Nematodes</i>	16	134			<i>Orthoptera</i>	13	169		
<i>Nematomorpha</i>	2	16	6 ?		<i>Embioptera</i>	1	1		
<i>Acanthocephala</i>	3	11			<i>Dermaptera</i>	3	11		
Total	43	360			<i>Coleoptera</i>	82	6000		
MOLLUSCA					<i>Megaloptera</i>	1	4		
<i>Gastropoda</i>					<i>Rhaphidioptera</i>	1	6		
aquatic	17	129	79	61,24	<i>Planipenia</i>	9	83		
terestic	28	481	304	63,20	<i>Mecoptera</i>	2	4		
<i>Bivalvia</i>	3	17	1	5,88	<i>Trichoptera</i>	18	58	2	3,45
Total	48	627	384		<i>Lepidoptera</i>	82	2505	7	0,28
ANNELIDA					<i>Diptera</i>	61	1850		
<i>Polychaeta</i>	1	1	1	100,00	<i>Syphonaptera</i>	4?	80	1	1,25
<i>Clitellata</i>					<i>Hymenoptera</i>				
<i>Oligochaeta</i>	7	141	18	12,77	<i>Terebrantia</i> ³	29	1003		
<i>Hirudinea</i>	5	17	1	5,88	<i>Aculeata</i> ³	26	718	4	0,56
Total	13	159	20		<i>Symphyla</i> ³	13	434		
TARDIGRADA	1	7			<i>Psocoptera</i>	12	61		
Total	1	7			<i>Phthiraptera</i>				
ARTHROPODA					<i>Malophaga</i> ³	4	5		
<i>Arachnida</i>					<i>Anoplura</i> ³	2	5		
<i>Scorpiones</i>	1	3			<i>Thysanoptera</i>	3	109		
<i>Araneae</i>	40	627	43	6,86	<i>Hemiptera</i>				
<i>Pseudoscorpiones</i>	6	80	27	33,75	<i>Heteropteroidacea</i> (= <i>Heteroptera</i>) ³	38	700	10	1,43
<i>Opiliones</i>	8	77	29	37,66	<i>Homoptera</i> (<i>Auchenorrhyncha</i> + <i>Sternorrhyncha</i>) ³	17	231	5	2,16
<i>Acarina</i>					Total	679	16060	320	1,99
aquatic	23	142							
terestic	58	136			GRAND TOTAL	1003	17575	730	4,15
<i>Crustacea</i>									
<i>Ostracoda</i> ²	2	63	1	1,59					
<i>Copepoda</i> ²	10	81	5	6,17					

Box 60. False ringlet (*Coenonympha oedippus*)

- Order: *Lepidoptera* (butterflies)
- Family: *Satyridae*
- Croatian name: močvarni okaš
- IUCN: endangered (EN)
- Protection in Croatia: not protected

False ringlet is spread in central lowland regions of Europe and Asia. The primary habitats are wet lowland meadows, often covered by purple moorgrass. In Europe its populations may be found mostly on the edges of moors and along natural watercourses. Inconspicuous green caterpillars of this butterfly feed on the grass of the genus *Poa* and *Lolium* and on reeds (*Carex* spp.). This species winters in form of a caterpillar. Adult butterflies are poor fliers and stay only several hundred meters far from the spot where they left the chrysalis. They have only one generation yearly and fly late in June and early in July. The populations of false ringlet in



Map 19. Distribution of false ringlet

(according to data by the Croatian Natural History Museum)

Europe have considerably declined in number due to drying up of wet habitats. Therefore its present spread is mosaic-like, limited to isolated sites and considerably less numerous than in the 19th and early in 20th century. For that reason on the IUCN Red List it has been classified among seven most threatened butterflies worldwide. False ringlet has already disappeared from Germany, Styria (Austria), Czech Republic and Slovakia, including some formerly known finding places in Hungary and Slovenia. It was discovered in Croatia as late as 1999, in wet lowland habitats on the flysch base of northern Istria. There are still no data on exact distribution, number and size of populations available. Consequently, there is no concrete information either on its threat in Croatia or the possibilities of protection. Since it is highly probable that its finding places in Istria are the only ones in Croatia, research and protection are to be organized as soon as possible.

N. Tvrković

Figure 97. False ringlet

(photo by B. Jalžić)

21.6% These are again comparatively well explored groups, but there are much more groups poorly explored or groups for which in the area of Croatia no data are available (Table 17).

Economically significant are edible snails of the genus *Helix* that are gathered for commercial purposes and mostly exported into foreign countries. By 1998 the crayfish (*Astacidae*) and the medicinal and horse leech were gathered too, but today these species are legally protected. Apart from them, 120 species of mainland snails are protected – mostly endemic species and species threatened in European proportions, then the forest ant and six species of butterflies.

The scarcity of data makes it difficult to speak about the threat posed to individual taxa. The most threatened are stenotypical species of invertebrates or species connected with clean water, such as, for example, dragon flies (representing more than 30% of threatened species), caddisflies, molluscs, aquatic snails, leeches and sponges. The most threatened species on the continent are those living in moors, sandy habitats, wet meadows, xerothermal habitats and conifer forests. The direct threat is a consequence of their being gathered for food or sale and of the vandalism, but the list of species threatened by such activities is incomparably shorter than the one referring to consequences

of threat posed by indirect factors. Two among several tens of species of mainland snails are threatened by such activities. The causes of disappearance and the dynamic of populations of numerous invertebrate groups are not known in full. Comparatively detailed data may only be found for mainland snails, orthopterans, bees, some butterflies and ants.

Invertebrates of the Adriatic Sea

The fauna of invertebrates is in general better explored in the north Adriatic than in its central or southern part. Some higher taxa such as, for example, decapods, crustaceans and echinoderms are comparatively well examined, as distinguished from other ecologically very significant groups.

This refers in the first line to meiofauna of sediments and phytal, all parasites and numerous groups of colonial macrofauna – *Hydroideas*, corals, sea mats, sea squirts, etc. From the aspect of fauna the river mouths along the coast, a line of open sea islands and the deep ravine of the south Adriatic are poorly explored.

Approximately between a half and three quarters of the total number of species associated with the Mediterranean have been found in the Adriatic. A total of 5,427 species

Table 18. Diversity of invertebrates of the Adriatic Sea on the basis of the existing data

Name of taxa		Number			Number of species		
Phylum	Class	Order	Family	Genus	Total	Threatened	Protected
SARCOMASTIGOPHORA	<i>Mastigophorae</i>	1	1	6	13	0	0
	<i>Granuloreticulosae</i>	1	69	192	583	0	0
	<i>Sticholonchea</i>	1	1	1	0	0	
	<i>Phaeodaria</i>	2	9	11	16	0	0
	<i>Polycistinea</i>	2	13	33	35	0	0
	<i>Acantharia</i>	12	22	27	0	0	
SPOROZOA	<i>Gregarinidea</i>	1	1	1	1	0	0
	<i>Coccidea</i>	1	3	6	23	0	0
MYXOZOA	<i>Myxosporea</i>	7	11	25	0	0	
CILIOPHORA	<i>Holotricha</i>	3	12	25	35	0	0
	<i>Peritricha</i>	1	5	6	21	0	0
	<i>Spirotricha</i>	3	21	67	151	0	0
PORIFERA	<i>Calcispongiae</i>	2	6	7	28	0	0
	<i>Demospongiae</i>	11	41	94	173	1	0
PLATYHELMINTHES	<i>Turbellaria</i>	7	19	39	56	0	0
	<i>Trematoda</i>		16	37	54	0	0
	<i>Cestoda</i>		4	6	8	0	0
	<i>Gnathostomulida</i>	2	3	4	5	0	0
CNIDARIA	<i>Hydrozoa</i>	3	59	136	215	0	0
	<i>Anthozoa</i>	9	33	67	91	2	0
	<i>Scyphozoa</i>	4	5	11	11	0	0
CTENOPHORA			6	8	10	0	0
ASCHELMINTHES	<i>Rotatoria</i>	3	6	19	34	0	0
	<i>Gastrotricha</i>	2	6	14	36	0	0
	<i>Kynorhyncha</i>		4	6	13	0	0
	<i>Acanthocephala</i>		3	4	5	0	0
NEMATODA	<i>Adenophorea</i>	2	34	131	281	0	0
	<i>Secernentea</i>		8	10	23	0	0
PRIAPULIDA			2	3	3	0	0
KAMPTOZOA			3	3	6	0	0
NEMERTINA		3	11	14	21	0	0
MOLLUSCA	<i>Caudofoveata</i>	1	2	2	3	0	0
	<i>Solenogastres</i>	1	2	3	4	0	0
	<i>Placophora</i>	2	5	6	11	0	0
	<i>Gastropoda</i>	16	117	253	524	4	3
	<i>Scaphopoda</i>	2	2	3	7	0	0
	<i>Bivalvia</i>	9	56	125	224	11	1
	<i>Cephalopoda</i>	3	13	26	41	1	0
SIPUNCULA			4	6	18	0	0
ECHIURA			1	2	2	0	0
ANNELIDA	<i>Archannelida</i>		5	6	9	0	0
	<i>Polychaeta</i>		55	279	568	1	0
	<i>Myzostomida</i>	1		1	2	0	0
	<i>Clitellata</i>	2	5	12	17	0	0
TARDIGRADA		1	1	3	4	0	0
ARTHROPODA	<i>Arachnida</i>	1	4	13	42	0	0
	<i>Pantopoda</i>		5	9	21	0	0
	<i>Crustacea</i>	23	223	643	1490	6	0
PHORONIDA			1	1	0	0	
BRYOZOA	<i>Gymnolaemata</i>	4	44	80	157	0	0
	<i>Stenolaemata</i>	1	10	16	32	0	0
BRACHIOPODA		2	2	5	7	0	0
HEMICHORDATA	<i>Enteropneusta</i>	2	4	4	0	0	
ECHINODERMATA	<i>Crinoidea</i>	1	1	2	2	0	0
	<i>Holothurioidea</i>	3	8	16	36	0	0
	<i>Asteroidea</i>	5	10	15	23	0	0
	<i>Ophiuroidea</i>	2	8	12	22	0	0
	<i>Echinoidea</i>	4	11	15	18	0	0
CHAETOGNATHA			4	11	0	0	
TUNICATA	<i>Appendicularia</i>	3	12	27	0	0	
	<i>Thaliacea</i>	3	5	9	0	0	
	<i>Ascidacea</i>	3	10	34	86	0	0
ACRANIA				1	1	0	0
TOTAL		151	1,034	2,608	5,427	26	4

Box 61. Threats to marine invertebrates

Anthropogenic factors

- pollution by waste waters
- pollution by solid wastes
- disposal of building wastes
- depletion of habitats
- introduction of foreign (allochthonous) species of flora and fauna,
- excessive fishing out (overfishing) and
- other causes of local significance.

Natural factors

- climate change
- eutrophication and stress conditions in the environment and
- earthquakes (locally).



Figure 98. Sunset cup coral, *Leptopsammia pruvoti*, in the undersea zone of the island Sv. Ivan – Rovinj

(photo by A. Jaklin)

have been recorded. The Adriatic fauna of invertebrates is generally very diverse which is to the most part dependent on the diversity of habitats and the cleanness of environment (Table 18).

In Croatia the Nature Protection Act has protected only four species of marine invertebrates: the Triton's trumpet, zoned miter, cask shell and the pen shell. The date-shell can also be considered protected, because its habitat has been protected by the Marine Fisheries Act. In accordance

with the available data on the frequency and abundance of individual species, adequate protection should be provided at least for the red coral, for snails of the genus *Janthina* and common paper nautilus.

All those species of invertebrates may be considered **threatened** whose settlements are fished out for economic and other reasons in volumes that exceed the natural renewal of populations. Among economically significant species the Norway lobster and the Jacob's scallop are the most

Box 62. Pen shell (*Pinna nobilis*)

- Order: *Mytiloidea*
- Family: *Pinnidae*
- Croatian name: plemenita periska, periska, lostura, loščura, lustura, palastura, ljuštura, butovka
- IUCN protection: 2 (critically threatened locally)
- Protection in Croatia: protected according to the Nature Protection Act

The pen shell or giant Mediterranean pen lives in the sandy seabed of shallow coastal areas. It is a Mediterranean endemic, widely spread in the Adriatic Sea too, at a depth of 2 – 30 m. It is particularly significant in the meadows of marine flowering plants of lesser Neptune grass (*Cymodocea nodosa*) and eelgrass (*Posidonia oceanica*), but its settlement density exceeds rarely one specimen per 10 m² of the seabed area. With its (pointed) front of the shell this mollusc is buried into the sediment. Since it can reach a length of over 1 m, the pen shell scales offer a very suitable base for settlement of various algae and numerous colonial animals. The pen shell symbionts known are tiny pea crabs (genus *Pinnotheres*). Therefore the pen shell is sometimes

attached the importance of a special association centre. Its flesh is edible, but rather hard and thus not appreciated particularly. From ancient times the shell is used to produce lamps and various decorative articles and is admired as a souvenir. It is not surprising that with the development of tourism activities, especially diving, its settlements abruptly declined in number or were even

exterminated. For that reason the pen shell has been designated a protected species in the entire Mediterranean region and Croatia too, at the same time imposing ban on its gathering and marketing.

D. Zavodnik

Map 20. Distribution of the pen shell in the Croatian part of the Adriatic (according to data by D. Zavodnik)



Figure 99. Pen shell in the undersea zone of the island Smokevjenjak-Kornati

(photo by D. Zavodnik)

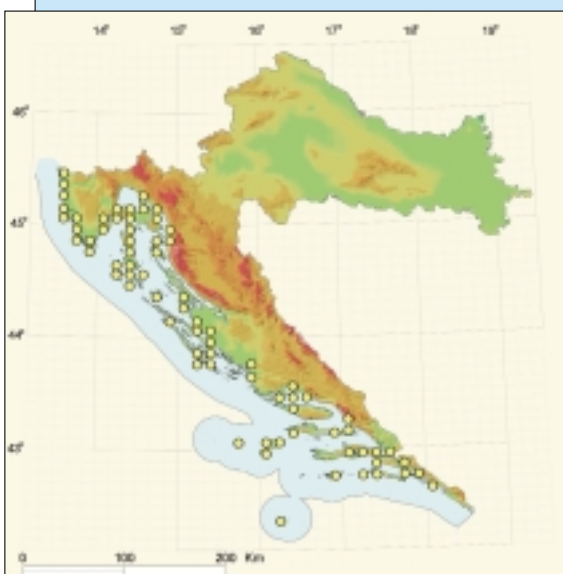


Figure 100. The snail *Discordis atromaculata* feeding solely on the sponge *Petrosia ficiformis* (Goli otok)

(photo by A. Jaklin)



GENETIC DIVERSITY

Genetic diversity of wild taxa

Genetic diversity is a necessary prerequisite for the ability of the species and populations to adapt to changing environmental conditions, i.e. for their survival. Formerly, very little attention was given to genetic diversity, but

threatened, including the settlements of pen shells despite long-standing legal protection (Box 62). Due to depletion of habitats and the uncontrolled fishing out aimed at the promotion of tourism, at least fifty more species of bigger invertebrates are threatened in the Adriatic, without our being aware of it because of the insufficient knowledge of the fauna of the sea bottom. Representatives of some groups of invertebrates living in the shallow sea have been long since used for food, but only a small number is given economic significance. These are predominantly large crabs, cephalopods and several species of bivalvs among which mussels and oysters are also grown. Several more kinds of snails and sea squirt of the genus *Microcosmus* are fished in minor volumes and for personal use. The economic significance of sponges and corals of the east Adriatic is presently negligible – the former are not in demand and the settlements of the latter have in some places disappeared due to overfishing.

nowadays various biochemical and genetic methods are applied to identify such diversity. Nevertheless, it is still very little known about the endangerment of genetic diversity in natural populations.

Genetic diversity of cultivated plants and domesticated animals

Biological diversity is not demonstrated only by wild flora and fauna, or rather ecological systems, but also by nature that throughout the history man has changed in a way and adapted to his needs by growing and selecting particular properties. Over the last decades agriculture worldwide focused on intensifying production that favoured only a small number of sorts and breeds with marked desirable features. Such a production was becoming more and more unnatural. The sorts and breeds failing to adapt to local climate proved to be low-resistant, vulnerable to diseases and increasingly demanding in relation to the use of pesticides, fertilizers, chemical additives to fodder and similar – which again has an adverse effect on nature and man. Over thousands of years numerous domesticated taxa adapted to man-made habitats, developing “local” varieties of cultivated plants and “ecotypes” of domesticated animals. The protection of biological diversity implies keeping records and conservation of indigenous sorts of cultivated plants and breeds of domesticated animals in individual countries. These sorts and breeds, adapted to the local climate, are more resistant to diseases and often very well incorporated into the surrounding nature and landscape. Their diversity represents a genetic container that may always be used to improve the properties of the species grown. Besides, they represent a significant national cultural heritage, because a lot of effort and knowledge of numerous generations have been put into their growing, combined with the living and climatic conditions.

Unfortunately, in Croatia this problem area is still not legally regulated in an integrated manner. So far no comprehensive inventories of indigenous sorts of cultivated plants and breeds of domestic animals have been made.

The situation is slightly better in relation to data on indigenous breeds in cattle breeding. Original Croatian breeds raised in Croatia have been recorded. Some of them do not exist anywhere else in the world, and some have spread from Croatia to other countries (for example, the Istrian sheep is reared also in Slovenia). The subject of concern are also dog breeds of which some are today officially registered (Dalmatian dog, Istrian shorthaired pointer, Istrian longhaired pointer, pointer of Posavina, Croatian sheep dog) and for some the procedure is underway (shepherd breed of *tornjak*).

Box 63. Indigenous livestock and poultry breeds

1. Cattle

- Istrian cattle
- “buša” cattle of Lika
- Slavonian podolian cattle
- grey cattle of Dalmatia

2. Horses

- horse of Međimurje
- horse of Posavina
- island pony

3. Donkeys

- South-Dalmatian donkey
- donkey of Kvarner and Istria
- donkey of littoral and Dinaric area

4. Sheep

- ruda sheep
- Istrian sheep
- sheep of the island of Cres
- sheep of the island of Pag
- “pramenka” sheep of Lika

5. Goats

- Croatian white goat
- Croatian spotted goat

6. Pigs

- pig of Turopolje
- black Slavonian pig

7. Poultry

- turkey of Zagorje
- Croatian hen

Figure 101. Pig of Turopolje

(photo by M. Schneider-Jacoby)



Threatened are also some breeds which are not originally Croatian, but belong to a wider area or are imported into Croatia as breeds (Lipizzaner horse) that have over a longer period of breeding acquired some specific features.

Breeds standing out as **priorities** in the programme for genetic sources protection in **cattle breeding** are:

- Istrian cattle, “buša” cattle of Lika and Slavonian podolian cattle
- horse of Međimurje, horse of Posavina and island pony
- South-Dalmatian donkey, donkey of Kvarner and Istria and donkey of the littoral and Dinaric area,
- ruda sheep, Istrian sheep
- Croatian white goat, Croatian spotted goat
- pig of Turopolje, black Slavonian pig
- turkey of Zagorje.

The breeds threatened are to be included into conservation programmes (*in situ* and *ex situ*) and their raising is to be encouraged by paying annual premiums to breeders. For indigenous breeds a full premium should be paid, and for other threatened breeds (Lipizzaner, tzigai, mangulica) 50% of the same amount. For other breeds that are not threatened neither annual premiums nor the *in situ* conservation programme are necessary, but rather a permanent monitoring and breeding programmes that would take into account the conservation of genetic diversity on a long-term basis and possibly the keeping of deep-frozen sperm and embryos (for species where the technique has been mastered) in embryo banks.

Beside the breeds mentioned the programme for genetic diversity conservation should by all means include other domestic animals too, in the first place other kinds of poultry (including pigeons), dogs, rabbits, bees and others.

It is also necessary to formulate and encourage a programme for **breeding** of tornjak, because this type of dog could be very useful for guarding flocks of sheep against wolves in places where this is a serious problem. The Ministry of Environmental Protection and Physical Planning

Box 64. Threatened breeds originally not Croatian

1. **Horses**
Lipizzaner
2. **Sheep**
tzigai
3. **Pigs**
mangulica



has already initiated the programme for distribution of tornjak among shepherds breeding cattle in areas most threatened by wolves (Fig. 102).

For conservation of genetic diversity methods of *ex situ* protection are also highly important. The conservation of genetic sources of **cultivated plants** in Croatia could be ensured by implementation of the project of **Croatian banks of plant genes** for which it is essential to build a central storage.

It would also be important to establish the **Croatian bank of domestic animals genes**.

Box 65. Threats to domesticated taxa

- change of the agricultural practice and strategy of cattle breeding (favouring a small number of highly productive taxa)
- socio-economic changes of the village (migration of rural population) and
- unsystematic care for genetic diversity and insufficient legislation

Figure 102. Take-over of young tornjak on the “wolves” ground (photo by Ž. Štahan)

Breed	Category	Signif. breeding outside Croatia	Status	No.
Slavonian podolian cattle	Belongs to the category of podolian cattle of Podolia and Volhina origin	Hungary, Romania, Ukraina	critical	14
“buša” cattle of Lika	Common origin with the “buša” from the Balkan peninsula. A special breed from Lika is different.	Balkan countries	unknown (critical)*	<10*
Istrian cattle	original	none	endangered	26
Dalmatian grey cattle	not fully defined as a breed	none	not endangered	>500*
Horse of Međimurje	original	Hungary	critical*	<10*
Horse of Posavina	original	none	endangered	76
Island pony	original; not defined as a breed	none	unknown (critical*)	<20*
Lipizzaner	imported as a breed from Slovenia	Austria, Slovenia, Hungary, etc.	not endangered	261
South-Dalmatian donkey	not defined as a breed	none	unknown (endangered*)	<80
Donkey of Kvarner and Istria	not defined as a breed	none	unknown (endangered*)	<50
Donkey of the littoral and Dinaric area	not defined as a breed	none	unknown (endangered*)	<50
ruda sheep	original	none	unknown (critical*)	<20*
Istrian sheep	original	Slovenia	unknown (endangered*)	<80*
Sheep of the island of Cres	original	none	unknown (not endangered*)	700*
Sheep of the island of Pag	original	none	not endangered	2000
“pramenka” sheep of Lika	similar to “pramenka” of Balkan countries	Balkan countries	not endangered	5000*
tzigai sheep	not original	Romania, Poland	critical	19
Croatian white goat	original	Italy	unknown (critical*)	<20
Croatian spotted goat	original, similar to that of Balkan	Balkan countries	unknown (threatened)*	<50
Pig of Turopolje	original	none	critical	<10
Black Slavonian pig	original	none	critical	<20
Turkey of Zagorje	original	none	unknown	<80*
Croatian hen	original	none	not endangered	300

Table 19. State of populations of Croatian livestock and poultry breeds; * – numerical strength of a population (estimated)