BIODIVERSITY STRUCTURE FROM THE ROMANIAN MARINE AREA

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ABSTRACT

Biodiversity from the coastal area is mostly affected by human activities. In order to elaborate the proper measures for biodiversity conservation, its components assessment was necessary.

Between 2003 and 2005, a detailed species inventory of plankton, benthos and nekton from the Romanian coastal area was realized, as part of a project within the National Programme for Research-Development-Innovation. The present biodiversity status was compared with historical data, in order to estimate its trend in the near future. The conservation state of endangered species from the Red List and of exotic species was also evaluated.

The results suggest an improvement of ecological conditions reflected in the conservation status of some coastal populations.

KEY WORDS: biodiversity, coastal area, phytoplankton, zooplankton, macroalgae, zoobenthos, ichtyofauna, marine mammals, red list, conservation.

INTRODUCTION

In the early '60ies, an inventory of marine flora and fauna was initiated, followed by qualitative and quantitative studies of the populations from pelagic and benthic ecosystems. These studies showed that the ecosystems structure and functioning underwent numerous changes as a result of important modifications of the environmental conditions (PETRANU, 1997). The most important modification of the ecosystem has been increasing

of eutrophication, resulting in a massive reduction of marine flora and fauna, including fish stocks and fish catches, and a consequent decline in biodiversity.

During the last decade, due to the reduction of anthropogenic activities, a certain rehabilitation of the environment took place (pollution mitigation, decreasing summer algal blooms), with certain populations' restoration, and reappearing of some almost disappeared species.

The paper reviews the species inventory of the plankton, benthos and nekton in Romanian coastal waters, compared with the existent data, the Red List of marine endangered species and proposals for future update of the Black Sea Red Data Book.

MATERIAL AND METHODS

In order to realize the biodiversity inventory in the Romanian coastal waters, 52 locations between Sulina and Vama Veche have been established. From these sites, 70 phytoplankton, 70 zooplankton, 10 macroalgae and 75 zoobenthos samples have been collected. Phytoplankton has been sampled using Nansen bottle, zooplankton using Djedy net with 200 μm mesh size, and zoobenthos with Van Veen bodengreifer. The samples have been stored in formaldehyde, and processed in laboratory using inverse microscopes for taxonomic identification of phytoplankton, and classic stereomicroscopes for zooplankton and zoobenthos. The macrophytes have been collected by Scuba diving. Fish samples have been obtained through experimentally fishing with the trawl in offshore waters and from economic agents fishing with pond nets (fixed gears settled near the shore (4.5 to 9.5 m). Data regarding marine mammals have been collected by direct observations (including aerial view).

RESULTS AND DISCUSSIONS

Phytoplankton. As compared with reference period 1960 to 1975 (BODEANU, 1987/1988), in the last 15 years 410 phytoplankton species pertaining to seven taxonomic groups have been identified. The most numerous were the group of diatoms (41.3%), followed by Dynoflagellata (20.3%) and Chlorophyta (20%) (Table 1). Between 1960 and 1975, only 314 species of phytoplankton were identified along the Romanian littoral, showing a different proportion among groups: the percent of Chlorophyta significantly increased in the last decade from 4.7% to 20%; also, the percent of

Cyanophyta increased in the last decade from 4.4% to 11.5% (Table 1). The pontic autochthonous component of phytoplankton composed by marine and brackish water species represents 59%, and the allochthonous component, composed by freshwater and freshwater-brackish water species represents 41% of the present phytoplankton at the Romanian littoral.

Table1

Phytoplankton structure in number of species per group in Romanian Black Sea waters between 1960-1975 and 1996-2005

Phyllum	1960-1975		1996-2005	
	No. of sp	%	No. of sp.	%
Bacillariophyta	209	66.6	169	41.3
Dinoflagellata	60	19.1	83	20.3
Chlorophyta	15	4.7	82	20.0
Cyanophyta	11	4.4	47	11.5
Chrysophyta	14	3.5	12	2.9
Euglenophyta	2	0.6	9	2.1
Cryptophyta	3	0.6	8	1.9
TOTAL	314	100	410	100

A high proportion of rare species with occasional occurrence makes the establishing of endangered species in the phytoplankton communities extremely difficult; that is the reason of lacking of phytoplankton species in the Red Lists and Red Books. The existent data base evinces that in the last 15 years some rare species are not being signaled in the Romanian waters: *Thalassiosira antiqua* var. *septata*, *Prorocentrum minimum* var. *aralensis*, *Polycrikos schwarzii*, *Haplosphera viridis,* etc. Modifications displayed by phytoplankton during the intensification of eutrophication after 1970 have not been translated into modification of species composition, but by tremendous developing of blooming species. Among absent species in phytoplankton before eutrophication are *Chromulina* sp. and *Microcystis orae*. *M. orae* occurred in the Romanian waters in the late '80ies; in early 2000, it already registered frequent abundances of over 200 million cells per liter (BODEANU *et al*, 2000). The trend displayed by the phytoplankton communities under the present conditions of reduced occurrence of pollution/eutrophication is the reduction of algal blooms and the enriching of planktonic flora.

Zooplankton. In order to assess zooplankton diversity trends during the last four decades, two reference periods have been chosen: 1986 to 1991

and 1995 to 2005 (Fig. 1). Besides the two periods, another single situation registered at Mamaia permanent point of observation in 1960 (BACESCU *et al*, 1965) has been taken into consideration as well.
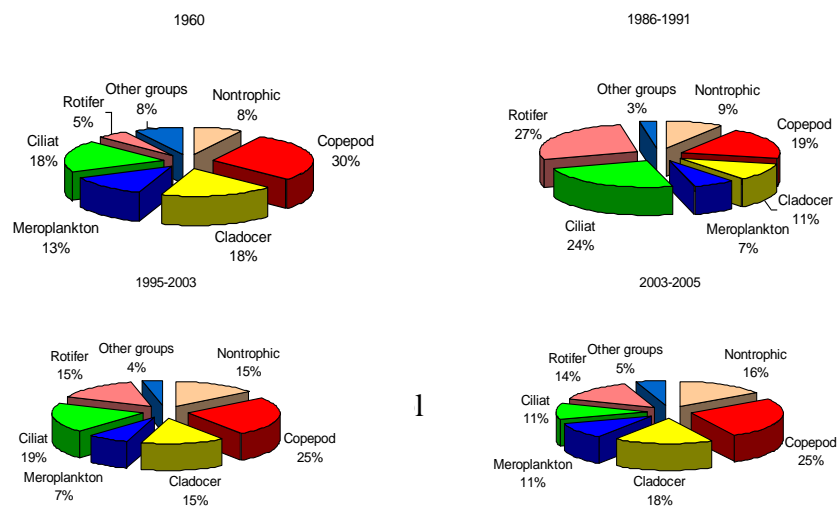

Fig. 1 – Evolution of qualitative structure of zooplankton communities in Romanian coastal waters in four different periods

In the first period zooplankton diversity has been reduced, and some exotic species entered and overdeveloped in the Black Sea with dramatic effects on the native species (e.g. *Mnemiopsis leidyi*). That fact induced changing of the balance between trophic and non trophic elements of the zooplankton. In the second period, the anthropogenic impact begun to slow down, influencing the quantitative and qualitative structure dynamics of the zooplankton communities (MOLDOVEANU, TIMOFTE, 2004). As result, the occurrence of some almost disappeared species has been registered.

Between 2003 and 2005, in the Romanian coastal waters, 41 species have been identified, among them, five meroplanktonic forms of the benthic organisms, and 36 holoplanktonic species. The opportunistic species *Acartia clausi* and *Pleopis polyphemoides*, eutrophication indicators, ceased to represent dominant species both in abundance and biomass; they are often replaced by some species previously affected by eutrophication/pollution: *Centropages ponticus, C. spinosus, Penilia avirostris*. Two species from the Pontellidae family (*Pontella mediterranea* and *Anomalocera pattersoni*)

considered as endangered, registered increasing frequencies in the last five years. On medium term, the conservation status of those species tends to improve, zooplankton diversity having an increasing trend.

Macroalgae. The decline of perennial algae belts of *Cystoseira* (Phaeophyta) and *Phyllophora* (Rhodophyta) resulted in the disappearance of their associated epiphytic flora (BOLOGA, BAVARU, 1998-1999). The diversity of macroalgae continued to decrease during the last five decades (BOLOGA, 1989). At present, along the Romanian littoral, the number of macroalgae species increased from North to South. The total number of species is 23, the most common being species of *Enteromorpha, Ulva, Bryopsis* (Chlorophyta), *Cystoseira* (Phaeophyta), *Ceramium, Polysiphonia, Calithamnion, Porphyra* (Rhodophyta) (Fig. 2).
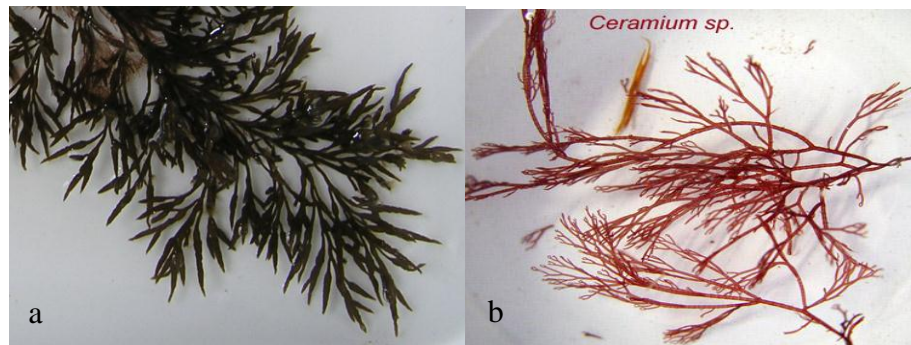

Fig. 2 – *Cystoseira barbata* (a) and *Ceramium* sp. (b)

The small number of species as compared with previous decades is compensated by high biomasses of opportunistic species with short life cycle and high degree of substratum coverage from the community *Enteromorpha – Cladophora – Ceramium*. In 2004, a new macroalga has occurred in the Romanian waters: *Desmarestia viridis*, considered among toxic algae. The main characteristics of macroalgae communities is developing of opportunistic species of *Enteromorpha*, *Ceramium,* etc. and a tendency of perennial macroalgae recovery (e.g. *Cystoseira*), representing an important habitat for a high variety of animal species.

Zoobenthos. Benthic populations have been very well studied between1960 and 1970, with over 800 species cited at that time (BACESCU et al, 1971). Benthic invertebrates suffered an important regress after 1970, their diversity declining from 585 species (1960 to 1970) to 220 (2001 to 2005) (Table 2).

Table 2

Number of species from different benthic invertebrate groups
between 1960 and 2005

Zoobenthic group	No. of sp. 1960-1970	No. of sp. 1996-2000	No. of sp. 2001-2005
Anthozoa	4	2	4
Nemertini	40	1	5
Turbellaria	34	1*	3*
Nematoda	19	**	48
Polychaeta	74	23	30
Polyplacophora	1	2	2
Gastropoda	56	10	19
Bivalvia	48	12	14
Cirripedia	3	1	1
Harpacticoida	114	7*	35
Amphipoda	90	26	28
Cumacea	18	3	4
Mysida	19	3	3
Isopoda	12	9	7
Tanaida	4	1	1
Decapoda	27	6	9
Halacarida	14	1*	2*
Phoronida	3	1	1
Echinodermata	3	2	2
Insecta	2	1	2
Total*	**585**	**112**	**220**

*) Figures do not reflect absolute number of species belonging those groups; **) There are not lists of species for this period; ***) Species with existent data only

Between 2003 and 2005, 90 macrobenthic species were identified: 25 polychaetes, 19 mollusks, 33 crustacean and 13 other species. In 2002, a diversification of decapods fauna has been observed. Invertebrate communities on soft bottoms from shallow waters have been affected by human activities, expressed by: decreasing of species diversity of the dominant species of the main communities in the northern part of the Romanian littoral (*Pontogammarus maeoticus* and *Lentidium mediterraneum*) and disappearance of some dominant species of midlittoral communities (e.g. *Ophelia bicornis* from the *Mesodesma cornea – Ophelia bicornis* community) in the southern part of the Romanian littoral. As an example, *Pontogammarus maeoticus* resisted to anthropogenic pressures exerted after 1970, reacting through its population's reduction from about 50,000 ind/sqm in the '60ies, to 200 ind/sqm in 1994. Beginning with 1995, this species restore its populations to comparable ones registered in the '60ies, frequently over 50,000 ind/sqm. The same situation fits to *Lentidium mediterraneum* (DUMITRACHE, ABAZA, 2004). After 1970, this community suffered the pressures exerted by the

penetration of other mollusk species (*Mya arenaria* and *Scapharca cornea*). In present days a balance between the three species has been established.

On hard bottoms the same tendency manifested due to destruction of the specific habitats (hydrotechnical constructions), terrigenous pollution and freezing. The most affected by changes of substratum have been the crustaceans from Natantia group (PETRANU, 1997). Previously, among macrobenthic species, decapods *Crangon crangon, Palaemon elegans* and *P. adspersus* were the most numerous. Now, they are not so frequently encountered in the samples (MICU, ABAZA, 2004). The abundance of vagile fauna from *Mytilus* community in the early '70ies represented 80% of the total fauna, reaching over 29% in the late '90ies (TIGANUS, DUMITRACHE, 1995). One of the major causes of the reduction both in species diversity and abundance was the reduction of macrophyte beds together with associated fauna.

Between 2003 and 2005, species diversity of the zoobenthos varied from North to South as shown in Fig. 3. Both Shannon-Wienner diversity index (H) and Equitability (E) of zoobenthic fauna have been calculated and graphically represented. Diversity index increases from North to South in relation with the composition of substratum, the higher ones referring to marine reserve Vama Veche – 2 Mai.

Among the meiobenthic species, only nematodes and harpacticoids have been studied recently. In 2003, 15 new species of nematodes, as compared to the'70ies, were identified. Harpacticoids regressed as compared the reference period. Other meiobenthic groups, also important from the ecological point of view, have not being studied in the last four decades (e.g. Turbellarians, Ostaracods, etc.).

In the last decade, a number of alien species penetrated into Black Sea waters, being signaled also in the Romanian coastal zone: *Doridella obscura* (1996), *Eriocheir sinensis* (1997), *Callinectes sapidus* (1998) (GOMOIU, SKOLKA, 1998).

A tendency of eurybiontic species (*Neanthes succinea, Polydora limicola, Capitella capitata*) development occurred, until a new and more stable equilibrium of the ecosystem will be set up.
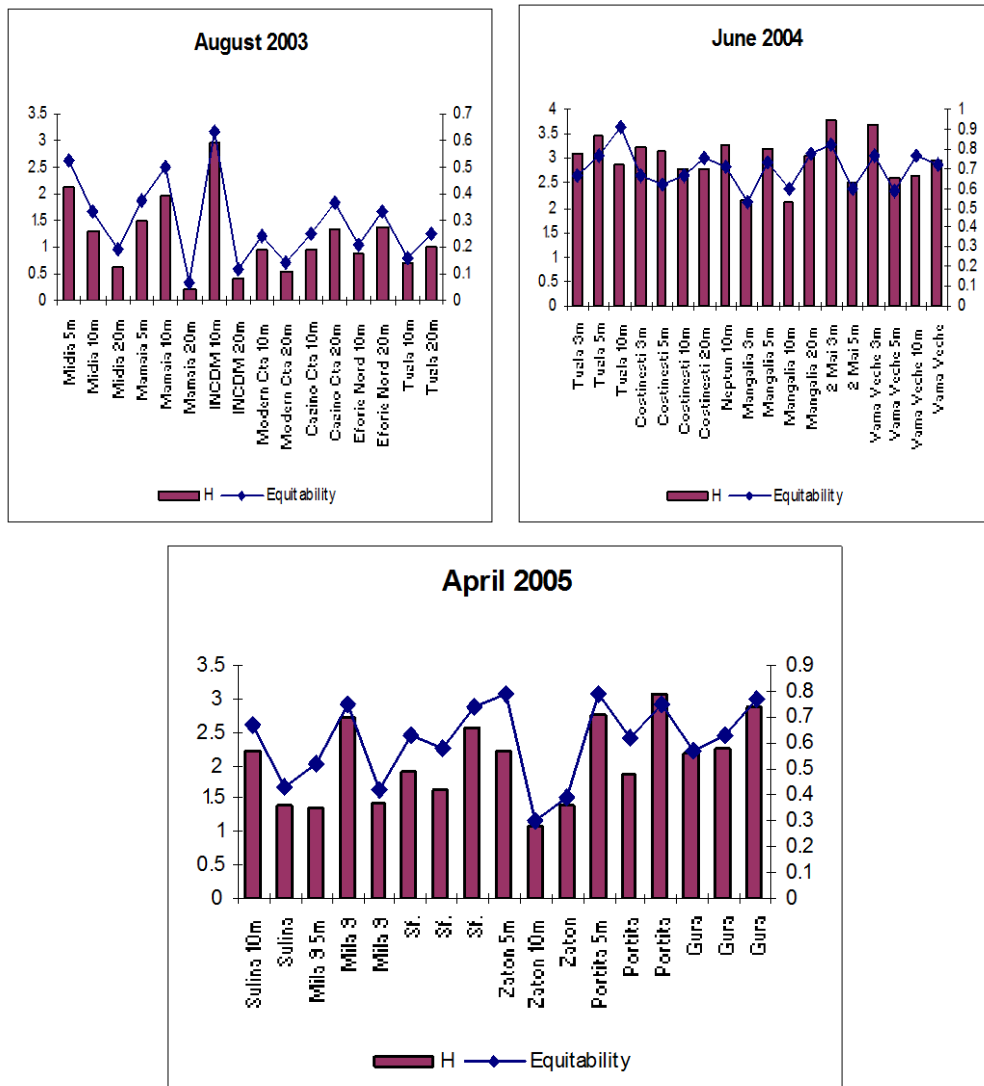
Fig. 3 – Diversity index (H) (Shannon-Wienner) and Equitability variation of
benthic invertebrates along the Romanian littoral between 2003 and 2005

Ichtyofauna. Ichtyofauna composition changed as response to the environmental conditions alteration. Potentially, ichtyofauna consists of about 140 species and subspecies at the Romanian littoral. Many of their populations declined dramatically (NICOLAEV *et al*, 1994). Between 1960 and 1970, there were about 26 commercial fish species. Their number decreased, so that in the present days only six commercial small sized species have left: *Sprattus sprattus, Merlangius merlangus euxinus, Engraulis encrasicholus, Neogobius*

melanostomus, Atherina boyeri and *Mullus barbatus ponticus*. Beginning with 1999, bluefish (*Pomatomus saltatrix*) reappeared; *Sardina pilchardus* was also signaled between 2000 and 2005.

After 2000, occurrence of better environmental conditions and reduced fishing determined: increasing of biomass of the gregarious pelagic species of economic interest (sprat, anchovy, horse mackerel); occurrence in the Romanian coastal waters after 1999/2000 of blue mackerel, bonito and shi drum (STAICU *et al*, 2004); recovery of the populations of Bleniidae, Labridae, Syngnathidae, Gobiidae, as result of recovery tendencies evinced by macroalgae beds (Table 3); enriching of fish fauna with two new species, *Centracanthus cirrus* and *Mugil soiuy*, the last one being frequently fished in the southern part of the Romanian littoral (GOMOIU, SKOLKA, 1998).

Table 3

Fish species signaled in the Romanian coastal zone after 2000

Species	IUCN Criteria[*]
Fam. BLENNIDAE	
Blennius ocellaris Linnaeus, 1758	NT
Coryphoblennius galerita (Linnaeus, 1758)	NT
Parablennius sanguinolentus (Pallas, 1811)	NT
Parablennius tentacularis (Brunnich, 1758)	NT
Lipophrys pavo Risso, 1810	NT
Fam. LABRIDAE	
Ctenolabrus rupestris (Linnaeus, 1758)	DD
Labrus viridis Linnaeus, 1758	DD
Symphodus (Crenilabrus) cinereus staitii (Nordmann, 1840)	DD
Symphodus (Crenilabrus) ocellatus (Forsskal, 1775)	DD
Symphodus (Crenilabrus) roissali (Risso, 1810)	DD
Symphodus (Crenilabrus) tinca (Linnaeus,1758)	DD
Fam. SYNGNATHIDAE	
Hippocampus ramulosus Leach, 1814	LC
Nerophis ophidion (Linnaeus, 1758)	DD
Syngnathus termirostris Rathke, 1837	LC
Syngnathus typhle Linnaeus, 1758	LC
Fam. GOBIIDAE	
Aphia minuta (Risso, 1810)	DD
Neogobius platyrostris (Pallas, 1811)	DD
Fam AMMODYTIDAE	
Gymnammodytes cicerelus (Rafinesque, 1810)	DD
Fam. CALLIONYMIDAE	
Callionymus pusillus Delaroche, 1809	NT
Fam. GADIDAE	
Gaidropsarus mediterraneus (Linnaeus, 1758)	LC
Fam. OPHIDIIDAE	

Ophidion rochei Muller, 1845	DD
Fam. SCIAENIDAE	
Umbrina cirrosa (Linnaeus, 1758)	DD

[*)]reevaluated in 2005; NT – Near threatened; LC – Least concerned; DD – data deficient

Marine mammals. Black Sea dolphins are endangered species according to IUCN criteria; they are mentioned in the Black Sea Red Book and protected by many international conventions. Although the dolphins are protected species, their stock continued to fall down due to accidental captures, habitats loss through marine traffic intensification, chronical pollution, illegal fishing and reduction of available food. Precarious status of dolphin populations at the Romanian littoral determined the necessity of studies regarding the groups' structure, frequency of emergence, populations' size, and distribution.

Between 2002 and 2003 as result of the monitoring of dolphins, higher frequencies of their occurring in Romanian coastal waters have been registered and suggest a possible recovery of the three species. Their conservation status could improve by reducing or eliminating bad or illegal fishing practices and by implementation of the National Action Plan for Dolphin Conservation (RADU *et al*, 2004).

Red List of marine endangered species. A number of 209 marine species are part of the Red List of marine endangered species at the Romanian littoral, elaborated in 2004 and revised in 2005 according to IUCN criteria (2004).

Those species were distributed as follows: 19 macrophytes and vascular plants (9%), 45 invertebrates (22%), 141 fish (67%) and 4 mammals (2%) (Fig. 4a). Six IUCN categories were applied for the 209 assessed species: *Extinct* – EX (6%), *Endangered* – EN (9%), *Vulnerable* – VU (5%), *Near threatened* – NT (13%), *Least concerned* – LC (16%) and *Data deficient* – DD (52%) (Fig. 4b). More than half of all species assessed according to IUCN criteria were *Data deficient* (DD), which means the necessity of further studies for clarification of their IUCN status.

Out of 19 macrophytes and vascular plants species, 11(57%) are EN, 2 (11%) are VU and 6 (32%) are DD (Fig. 4c). Among invertebrates, the 45 species from Red List are considered as follows: 13 (29%) EX, 3 (7%) EN, 6 (13%) VU, one (2%) LC, and 22 (49%) DD (Fig. 4d). Fish list contains 141 species, only two species (1%) being considerate as EN, two (1%) as VU, 28 species (20%) as NT, 31 species (22%) as LC and more than half - 78 species (56%) DD (Fig. 4e). Regarding marine mammals, the three dolphin species are EN and *Lutra lutra* is DD.
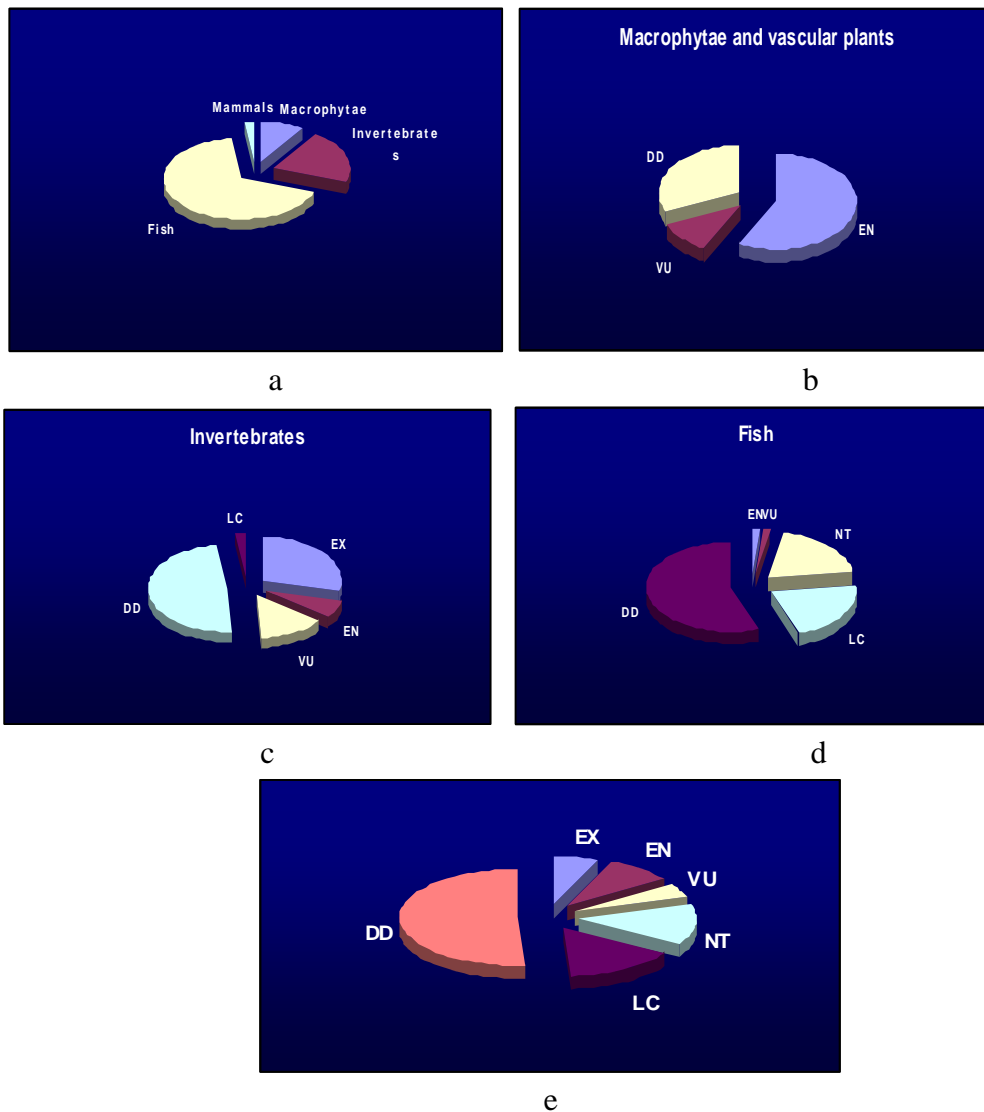
Fig. 4 - Structure of the Red List of marine endangered species
along the Romanian littoral

In order to future update the Black Sea Red Data book, 37 species have been proposed: two macrophytes, seven invertebrates and 28 fish (Table 4).

Table 4
Species proposed for the future update of the Black Sea Red Data
Book

No.	Species	IUCN Status	No.	Species	IUCN Status
	MACROPHYTES		18.	*Callionymus pusillus*	NT
1.	*Corallina elongata*	EN	19.	*Callionymus risso*	NT
2.	*Dasya baillouviana*	EN	20.	*Dicentrarchus labrax*	DD
	INVERTEBRATES		21.	*Diplodus puntazzo*	DD
3.	*Caprella acanthifera*	VU	22.	*Diplodus sargus sargus*	DD
4.	*Mesopodopsis slabberi*	EN	23.	*Lithognathus mormyrus*	DD
5.	*Bela nebula*	DD	24.	*Oblada melanura*	DD
6.	*Cyclope donovani*	DD	25.	*Ophidion rochei*	DD
7.	*Donax trunculus*	DD	26.	*Pagellus erythrinus*	DD
8.	*Irus irus*	DD	27.	*Parablennius sanguinolentus*	NT
9.	*Tellina donacina*	DD	28.	*Parablennius tentacularis*	NT
	FISH		29.	*Platychthys flesus luscus*	NT
10.	*Acipenser sturio*	EN	30.	*Serranus cabrilla*	DD
11.	*Alosa maeotica maeotica*	NT	31.	*Serranus scriba*	DD
12.	*Balistes carolinensis*	DD	32.	*Spicara flexuosa*	DD
13.	*Blennius ocellaris*	NT	33.	*Squalus blainvillei*	DD
14.	*Blennius sphynx*	NT	34.	*Symphodus roissali*	DD
15.	*Blennius zvonimiri ponticus*	NT	35.	*Symphodus rostratus*	DD
16.	*Boops boops*	DD	36	*Umbrina cirrosa*	DD
17.	*Callionymus lyra*	NT	37.	*Zeus faber*	DD

Analyzing the evolution of biodiversity in the Romanian coastal waters, it is important to stress that after 1970, as result of the modifications of the marine environment, a general tendency of regress, dramatically in some cases has been registered, expressed by reduction of some planktonic invertebrate populations; disappearance of species, by mass mortalities among benthic populations; significant reduction of exploitable fish stocks and their diversity; reduction of the diversity of marine mammals. In the last 10 years, marine environmental conditions improved, leading to recovery of some populations, and to increasing of biodiversity, expressed not only by penetration of some alien species in the Black Sea, but also by reappearance of native species not encountered in the past 15 years.

CONCLUSIONS

In the **phytoplankton**, during the last 15 years, 410 species from seven groups have been signaled in the Romanian coastal waters, most of them diatoms (41.3%). The proportion between the groups has been changed, between 1990 and 2005, with significant increasing of the percent of Chlorophyta (from 4.7% between 1960 and 1975 to 20% between 1990 and 2005) and Cyanophyta (from 4.4% between 1960 and 1975 to 11.5% between 1990 and 2005). The trend displayed by the phytoplankton communities under present conditions of reduced occurrence of pollution/eutrophication is the reduction of algal blooms and the enriching of planktonic flora.

In the last decade, the anthropogenic impact begun to slow down, influencing the quantitative and qualitative structure dynamics of the **zooplankton** communities. As result, the occurrence of some almost disappeared species has been registered. Two species from the Pontellidae family, considered as endangered, registered increasing frequencies in the last five years. On medium term, the conservation status of those species tends to improve, zooplankton diversity having an increasing trend.

At present, along the Romanian littoral, the number of **macroalgae** species increased from North to South up to a total of 23. In 2004, a new macroalga has occurred: *Desmarestia viridis*, considered among toxic algae. The main characteristics of macroalgae communities is developing of opportunistic species of *Enteromorpha*, *Ceramium,* etc. and a tendency of perennial macroalgae recovery (e.g. *Cystoseira*), representing an important habitat for a high variety of animal species.

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The **Red List** of marine endangered species contains 209 species, most of them fish (67%); over 50% of the Red List species are *Data deficient* (DD).

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