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PLENNARY SPEAKERS

Bio-invasion of alien freshwater fish: a global analysis

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Since Roman period or earlier, freshwater fishes were the object of human transfers. Every country, including remote islands, was subjected to introductions of alien species. The Oceanic islands, which for biogeographic reasons have few native species, are the most involved. Among these, the island which experienced the most extensive introductions, are Guam (with about 89% of aliens), Hawaii (84%), Mauritius (51%), and Dominican Republic (33%). In less developed countries, the percentage of aliens, on all fish assemblages, is relatively low: Brazil (0.7% of aliens on about 2400 total species); Cambodia (1.8% on 500); Perù (2.0% on 791), Russia (1.7 on 385). In developed countries, percentage of aliens varies from 7% in USA and 13% in Japan to 14% in Germany and 22% in UK, up to 36% in Spain, 39% in France and 49% in Italy. Among extensively introduced species there are the carp, *Cyprinus carpio*, alien in 173 countries, the rainbow trout, *Oncorhynchus mykiss*, in 135, African tilapias as *Oreochromis mossambicus*, in 128, and *O. niloticus* in 119 and the North American black bass, *Micropterus salmoides* in 82. As mosquito eaters, *Gambusia affinis* was introduced in 77 and *Poecilia reticulata* in 60 countries. Among more recent invaders the topmouth gudgeon, *Pseudorasbora parva*, accidentally introduced in Europe in 1960 from China, is now reported in 35 countries. In less developed countries, especially these with high fish diversity, the percentage of aliens on total fauna is relatively low. But the process seems out of control as, for instance, in the last 4 years, the number of countries where the Carp was introduced rise from 154 to 173; *Oreochromis mossambicus*, from 100 to 128; *O. niloticus* from 97 to 119 and *Pseudorasbora parva* from 32 to 35, with a general increase of about 10-15%. Local transfer of native species is generally not taken in account, but their transfers can modify the local fish assemblages. The carp, for instance, should be considered as alien also in the native countries as the species is stocked in basins among its original range. Effect of introduced aliens is mainly by predation and competition on natives. The most dangerous introductions are of congeneric species or "conspecific" populations which can cause the extinction or the alteration of genomic structure of native populations. In spite of the energy employed in term of scientific investigations, protection laws and so on, very little could be done in practice against aliens. Freshwater fishes are taken in little consideration for conservation purpose, and also in protected areas they are in fact not really protected. The exponential increase of aliens cannot be really stopped, as so many are the facts which are around them. The investigations on aliens have many good proposals, which are only rarely taken in consideration by managers. In most cases the study of aliens is reduced to inventory science and native species must survive by their own as science is nearly impotent to contrast alien introductions.

Key words: Aliens, Freshwater fishes, fish assemblages

Why so many changes in fish systematics and taxonomy after Artedi?

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There have been enormous changes in our classification of fishes since Petrus Artedi, the Father of Ichthyology (as a science). The cladistic revolution, whose beginnings in fish systematics had its origins in Stockholm with Gary Nelson, brought about much change in classification and renewal in research. However, despite research since the 1700s by hundreds of ichthyologists, there is still much uncertainty about the evolutionary relationship of fishes. Extensive research on fish systematics by a diversity of workers employing morphological characters (on fossils and extant species, various ontogenetic stages, various body regions) and molecular characters, while often producing results that agree, has resulted in many conflicts. Despite this, we have made enormous progress in understanding the evolution of fishes. We will look at examples of conflicts in jawless fishes, chondrichthyans, and actinopterygians.

A yearly average of 100 valid new species of fishes have been described since the monumental list of Artedi. Estimating what the total species count might eventually be above the currently recognized 30,000 valid species, outnumbering tetrapod species and placed in about 515 families, has problems. Many workers are employing a species concept that is resulting in an inflation of species numbers. Diagnosability as the criterion is also being used to assist conservation efforts in countries/states that lack a solid means of protecting biodiversity other than by using the Linnaean species concept (versus lower categories). Scientific names will always change to meet the results of expanding knowledge, but, for the public's benefit, there are many successful efforts on a regional basis to standardize

common names in English. However, the misuse of common names by some vendors, thereby deceiving the public, is a serious problem.

For the future, in order to better understand global biodiversity of fishes, we must increase field collecting, lab studies on the species, and better enable the ability museums to properly maintain specimens and make them available to other workers.

Key words: Fish systematics, list of Artedi, Linnaean species concept

2352 year of aquatic biodiversity studies ... and the inventory is still not complete

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The history of ichthyology (and zoology) started in 343 BC with Aristotle's *History of animals*, which he drafted when he stayed the island of Lesbos. There has not been significant activity until the Renaissance and the publications of the first books on aquatic animals by precursors such as Bélon, Rondelet, Salviani, and Gessner. Modern systematic ichthyology started with Artedi. This also corresponds to the beginning of the great maritime expeditions and colonial explorations, which were coming back to Europe with collections of drawings and specimens revealing the diversity of the aquatic fauna of these remote areas. This material was studied by hundreds of naturalists, but much of the output in the middle of the 19th century was the fact of a few individuals, for example the unrivaled activity and productivity of Pieter Bleeker. This was also the time of the last book by a single author describing all known fishes at that time (Günther). Despite all this activity, hundreds of new species of fishes are still discovered every year, and the number has been strongly increasing in the last 15 years. This evolution is analysed based mainly on the fauna of European and Southeast Asian freshwaters. Some previously ichthyologically unexplored area has yielded hundreds of new discoveries, even in recent years. For example 130 new species have been discovered in Laos between 1996 and 1999. A reason of the discovery of so many species is simply because most of today's ichthyologists actively search for fishes in the water compared to earlier generations, which tended to mainly harvest them in fishermen catches. The next generation sometimes seems to have not yet discovered that not much fish are to be caught on-line. A great share of these new discoveries comes from habitats that were ignored or difficult to sample earlier, such as high gradient streams (rapids, mountains streams, etc.), caves, peat swamps.

Despite 450 years of cataloguing the European fish fauna since Rondelet, new species are still discovered in Europe. The pattern of discoveries is quite similar to the one in tropical areas. Some 215 native species were recognized in European freshwaters in 1976 and we now have 550. This increase in the number of species is attributable to several factors: discovery of new species; taxonomic revision, especially of groups carefully avoided by most authors (e.g., *Salmo*, *Coregonus*); and intrusion of taxonomists in areas 'controlled' by fishery biology. The introduction of modern species concepts has sometimes being blamed for a perceived artificial inflation of the number of species. Facts are simply that taxonomy of European freshwater fishes has been petrified for most of the 20th century and it is now reviving. Applying various species concepts does not influence much these figures; the most important factor is simply the application of the same criteria and methods to the taxonomy of European freshwater fishes as applied to the taxonomy of the fish fauna of any other area of the world.

Ichthyology started 2352 years ago with Aristotle stay on Lesbos island. It took until 2003 for the first ichthyologists to finally survey the island's freshwater. Out of the six species present, three were new to science.

Keywords: New species native species, taxonomy habitats

From whales to whalefishes: why bother with morphology?

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As recently as the mid 1960's the state of teleost fish classification was chaotic, consisting mainly of strings of orders and suborders listed roughly in sequence from primitive to advanced, with little hierarchical structure. Since publication of the provisional classification of Greenwood et al. (1966) progress has been nothing short of remarkable. Out of chaos has emerged not only a generally accepted hypothesis of relationships among the major groups of teleosts but also considerable phylogenetic structure within most of these groups, in many cases even to the species level. While there is no question that cladistics played a seminal role in this extraordinary progress, the new structure is all underpinned by morphological character data, most of it from the skeleton and much of it gathered anew or reexamined and refined during the last forty years. Another seminal innovation appeared fortuitously on the cusp

of the cladistics revolution – the use of trypsin digestion in cleared and stained preparations soon followed by the alcian technique for staining cartilage. Together these techniques revolutionized fish osteology. The teleost skeleton and its development offer a seemingly inexhaustible arena for exploration and discovery – a rich source of character information that continues to elucidate the complex evolutionary history of the Teleostei. In the last several decades we may have experienced the heyday of the morphological study of fishes, with more scientists studying more taxa in more parts of the world than ever before, often with extensive collaboration. Nonetheless, we must realize that the most morphologically dynamic part of the life history of fishes, their early ontogeny, has received short shrift. Most comparative anatomical and phylogenetic investigations still fail to take advantage of the rich and critical source of character information that larval stages can provide. The reasons for this lapsus are clear enough and can be easily enumerated, but are not excuses for turning our backs on a critical piece of the evolutionary puzzle. With the rising dominance of molecular systematics, morphology is often viewed by academic institutions and funding agencies as an old-fashioned science, much of the important work having now been completed. This is absurd, for molecular systematists and evolutionary developmental biologists have no engaging questions to ask without a deep understanding of morphology, and without ontogeny that deep understanding is unreachable. Can morphology based systematic ichthyologists afford to ignore the most morphologically dynamic part of the life history of their organisms? I think not. By embracing the study of development, we can so clearly demonstrate the value of our work and how much remains to be done. Comparative morphology is founded in exploration and discovery. Our challenge for the future is to instill in the next generation the same respect and passion for morphology-based systematics that has brought us to this point along with an appreciation that the descriptive work is the most important and lasting thing we do as systematists; without it the rest is meaningless. With that in mind, I will turn to the extraordinary tale of the whalefishes, where, with detailed study of skeletal ontogeny, we recently resolved a long-standing biological and taxonomic conundrum by documenting the most extreme example of ontogenetic metamorphoses and sexual dimorphism in vertebrates – and had fun doing it!

Key words: Whalefishes, teleost, skeletal ontogeny

ORAL PRESENTATIONS

Fish Systematics

Morphology of *Percarina* and its Phylogenetic Position in the Percidae

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The Percidae is composed of ten genera and over 190 species. North America has the most percids, seven genera and over 175 species while Eurasia has less diversity with six genera and 14 species. Despite extensive research done on the family, recent hypotheses of percid relationships have excluded the genus *Percarina*. The only hypothesized relationships involving *Percarina* were precladistic studies by Collette (1963) and Collette and Bănărescu (1965). *Percarina* has a limited distribution, occurring only in the northwestern Black Sea basin. Osteological characters used by Wiley (1992) were the basis for initial investigation but additional characters were also investigated. Phylogenetic analysis was performed using PAUP* 4.0b10. In both most parsimonious trees, Percidae was recovered as monophyletic supporting previous investigations. The recovered trees show *Percarina* sister to *Gymnocephalus*. *Percarina* possess very strong anal fin spines similar to the outgroups and *Perca* and *Gymnocephalus*. *Percarina* and *Gymnocephalus* are the only genera with preopercular spines although some other genera may have some preopercular serrations. *Percarina* is deep-bodied with standard length three times body depth, similar to *Perca* and *Gymnocephalus*; other genera are shallower-bodied with standard length five to nine times the body depth. *Percarina* has a short, stout interopercle, similar to that of *Gymnocephalus*, *Perca*, and *Sander*; other genera have a shallower more elongate interopercle. *Percarina* is similar to *Gymnocephalus* and *Zingel* in having enlarged foramina along the lower jaw. *Percarina*, *Zingel* and some *Gymnocephalus* have a reduced posterior ramus of the dentary. *Percarina* and *Sander* have an elongate premaxilla.

Taxonomic status and phylogenetic relationships of spined loaches (genus *Cobitis*) in Dalmatia

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According to the biogeographical division of the freshwaters, the region of the Adriatic watershed in Croatia together with the neighboring areas in Slovenia, Bosnia and Herzegovina as well as Monte Negro, forms a separate ecoregion – Dalmatia that has been recognized as one of the hotspots of the European freshwater fish biodiversity, with the great species richness and significant portion of endemics. That is especially truth for the freshwater genus *Cobitis* – almost each Dalmatian River is inhabited with its own *Cobitis* species, majority of which are stenoendems. Although few investigations, based primarily on the phylogenetic methods, have partially revealed the taxonomic status and relationships of the spined loach populations in Dalmatia and even enabled discovery of some cryptic species, no overall taxonomic investigation have been undertaken so far. Using both morphological and genetic methods, we have investigated all *Cobitis* populations from Dalmatia. The detailed analysis of morphometric, meristic and phenological, as well as molecular (both mitochondrial and nuclear DNA) markers on 260 samples from 14 localities (from Croatia and Bosnia and Herzegovina) have revealed the exact taxonomic status of each population, the distribution of all species and genetic lineages, as well as the intra- and interspecific genetic and morphological diversity. Based on the obtained results we will explain the evolutionary paths and mechanisms of emergence of such a great diversity of spined loach species in Dalmatia.

Phylogeny and diversity of *Pseudophoxinus*, a genus of small sized cyprinids

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Cyprinids of the genus *Pseudophoxinus* are little known, small sized fishes inhabiting the Middle East and North Africa. Several species have very small ranges and are therefore very much impacted by ongoing human activities. They are a nice example for the diversity of taxonomic problems related to practically unknown fishes which are mostly relevant to nature conservation.

Pseudophoxinus has been the object of phylogenetic and taxonomic studies during the last years. European species are split from *Pseudophoxinus* and placed into an own genus: *Pelagus*. *Pseudophoxinus fahirae*, known only from a single spring in Anatolia, is transferred to *Chondrostoma*. *Pseudophoxinus egridiri*, endemic to one lake in Anatolia, represent an own genus with close relations to *Pelagus* and *Delminichthys*. *Ladigesocypris*, endemic to the south-east Aegean was placed into *Pseudophoxinus* but was later again excluded from this genus. North African species are transferred to *Alburnus* and *Tropidophoxinellus* restricting *Pseudophoxinus* to the Middle East. Furthermore, nine new species have been described during the last 10 years, raising the number of *Pseudophoxinus* species to 25. Together with *Oxynoemacheilus* (Nemacheilidae), *Alburnus* and *Capoeta* (both Cyprinidae), *Pseudophoxinus* is now one of the largest genera of freshwater fishes in the Middle East.

Rasborin process, a synapomorphy for the genus *Rasbora* (Teleostei: Cyprinidae) and related genera

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Phylogenetic analyses were conducted based on 35 taxa, including 29 species of *Rasbora*. Forty-two informative morphological characters were used for phylogenetic reconstruction, analysed in PAUP according to the principle of parsimony.

A strict consensus tree from four equally parsimonious trees revealed that rasborin (*Rasbora* and related genera) taxa were characterized by (1) presence of dark supra-anal pigment and subpeduncular streak, (2) 5-6 branched anal-fin rays, (3) dorsal-fin insertion 1-3 scales behind pelvic-fin insertion, (4) lateral process of second vertebrae more

or less straight, (5) 1-5 more abdominal than caudal vertebrae, (6) absence of foramen on anterior wall of horizontal limb of the cleithrum, (7) presence of rasborin process on epibranchial 4, and (8) interhyal well ossified. *Rasbora* sensu stricto can be distinguished from all other rasborin genera by presence of the opercular canal.

To examine the phylogenetic significance of the rasborin process for rasborins, another phylogenetic analysis was conducted including 34 taxa of rasborins and representatives of the cyprinid subfamily Danioninae. Forty-three characters were coded, and the phylogenetic analysis confirms the rasborin process as a synapomorphy for the genus *Rasbora* and related genera.

Two species of trouts, resident and migratory, sympatric in streams of northern Anatolia (Salmoniformes: Salmonidae)

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Two species of trouts inhabit streams and rivers draining to the Black Sea in northern Anatolia (Turkey). One is restricted to the upper parts of streams and rivers and the other is migratory and found in the lower and middle parts. They are distinguished by their morphology, maximum size (250 mm vs 800 mm SL), colour pattern, and life history. The two species occur in sympatry in several streams, and occasionally in syntopy. Preliminary molecular analyses show that they belong to distinct lineages, congruent with morphological and life history characters. In our study, the resident trouts of different drainages are more closely related to each other than to the migratory ones in the same drainages. This contradicts the credo that resident and migratory trouts in a given stream are only 'forms' of the same species with different life histories. We do not extrapolate this to be the case in other drainages and for other species, but this calls for a more cautious treatment of the taxonomy, diversity and conservation of trouts in southern Europe and the Middle East.

New data on the karyotype of the kaluga *Huso dauricus* (Acipenseridae, Pisces) and their applications for sturgeon phylogeny, taxonomy, and aquaculture

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Taxonomy and Systematics

The karyotype of the kaluga *Huso dauricus* has been studied at first by imperfect methods resulted in incorrect value of 60 chromosomes, and later it was transformed in 120-chromosome karyotype without any special analysis (Burtzev et al. 1973, 1976). The recent karyological analysis performed by using lymphoid organ cells revealed the karyotype of the kaluga to be represented by 268±4 chromosomes. The number of banded chromosome is 100, and the number of chromosome arms 368±4. These results prove the kaluga to be octoploid fish (according to evolutionary ploidy scale) for the first time and reject previous indirect inferences of its 120-chromosome state presented by the nuclear DNA content (Birstein et al. 1993, Yin et al. 2004) and the microsatellite (Ludwig et al. 2001) analyses.

Most authors traditionally combine the kaluga with the great sturgeon *Huso huso* and separate them in a special genus *Huso*. Newly obtained karyological data confirm polyphyletic origin of *Huso* previously demonstrated by molecular studies (Ludwig et al. 2000, 2001, Robles et al. 2004, Krieger et al. 2008), since the great sturgeon belongs to tetraploid species, while the kaluga is octoploid. Moreover, re-examination of the set of morphological characters diagnostic for genus *Huso* (Berg 1948, Sokolov 1989) revealed that only two morphological features combine the kaluga and the great sturgeon, namely the shape of a mouth and the joining manner of gill membranes and the isthmus in adult specimens, whereas four morphological characters (the number of dorsal fin rays, mouth size, barbels structure and size relations of dorsal scutes) differentiate them. Consequently, revealed phylogenetic relations of sturgeon species and their observed morphological divergence may result in two different taxonomic conclusions: 1) the division of both former *Acipenser* and *Huso* into several genera of phylogenetically related and morphologically similar species, 2) the recover of the initial system with all sturgeon species united in the same genus *Acipenser*. The last opinion seems the most constructive in different aspects. It presumes the restoration of the old name *Acipenser huso* for the great sturgeon and *A. dauricus* for the kaluga.

Since the kaluga was assumed as 120-chromosome species and the Far Eastern analog of the great sturgeon, its hybrid with *A. ruthenus* was believed to have the same success in sturgeon aquaculture as already employed bester

has. But revealed octoploid level of the kaluga presumes that its hybridization with 120-chromosome species will result in sterile progeny, while the hybrids between the kaluga and 260-chromosome sturgeon species, namely *A. schrenckii*, will be fertile.

The study was supported by the Russian Foundation for Basic Research (grants nos. 07-04-00219, 06-04-96004-r_vostok, and 09-04-00211), by the Program “Dynamics of Gene Pools of Populations”, and the Program of complex investigations in the Amur River basin FEB RAS.

Discrimination of two picarel species (*Spicara flexuosa* and *Spicara maena*, Pisces: Centranchthidae) based on mitochondrial DNA sequences

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Introduction. Picarel (*Spicara flexuosa* Rafinesque, 1810) and blotched picarel, *Spicara maena* (Linnaeus, 1758) belong to Centranchthidae family. Due to the fact that both species are protogynous hermaphrodites, many systematic problems occurred in the family Centranchthidae. Nowadays, *S. flexuosa* appears as another scientific name of *S. maena*. In contrast, many researchers consider them as two different species. Some mtDNA segments, notably the rRNA genes, have been shown to be useful for determining relationships at different taxonomic levels. The aim of this study is the evaluation of the similarity/dissimilarity of *S. flexuosa* and *S. maena* species, using a mtDNA segment, i.e. a part of the 16S rDNA gene.

Materials and methods. In total, 39 individuals of *S. flexuosa* and 39 individuals of *S. maena* were analyzed. Total DNA was extracted from muscle according to the CTAB method. A universal primer set was used for the amplification of a part of the 16S rDNA gene, in both *S. flexuosa* and *S. maena*. A sequencing analysis on a 3730 x 1 DNA Analyzer (Applied Biosystems) was followed using both forward and reverse primers for crosschecking. The nucleotide sequences of all individuals were aligned using the Clustal X software and the BioEdit software, set to default parameters and corrected by eye.

Results. The size of the PCR products was approximately 600 bp for both species. In total 566 bp at the 5' end of the mtDNA 16S rRNA gene for both species, were sequenced. All the 39 individuals of *S. flexuosa* revealed the same haplotype and all the individuals of *S. maena* revealed another haplotype, which was different in fifteen nucleotides compared to *S. flexuosa* as a reference sequence. DNA sequences were deposited in GenBank (accession numbers FJ62583; FJ625836). The average nucleotide compositions of A, C, G, T, was 21.38%, 24.03%, 26.33% and 28.27% for *S. flexuosa* and 22.26%, 23.85%, 25.44% and 28.45% for *S. maena*, respectively.

Discussion. There was only a single study dealing with the genetic discrimination between *S. flexuosa* and *S. maena*, using allozyme electrophoresis. According to this study *S. flexuosa* and *S. maena* are conspecific despite morphological differences, as no discriminating monomorphic locus was identified between the two species and genetic distance was only $D = 0.006$. Contrary to that, our results show that the two species (i.e. *S. flexuosa* and *S. maena*) are well discriminated using genetic data, as the 16S rDNA haplotype of *S. flexuosa* can be differentiated from the *S. maena* haplotype in 15 nucleotide differences. Considering that the 16S rDNA gene is a very good species – specific marker, our data could be a first indication for a probable identification of the two species. This study is being continued with the use of the multivariate analysis technique of morphometric characteristics, in order to have more data for the discrimination of the species.

Populations of North-Eastern Europe with intermediate characteristics of vendace (*Coregonus albula*) and least cisco (*C. sardinella*)

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Northern Eurasia is traditionally considered to have *Coregonus albula* and *C. sardinella*. The habitats of the two species overlap in Pechora River area forming a wide hybridization zone (Reshetnikov, 1980; Sendek, 1998). However, our results allow reconsidering this point of view.

During 1993-2007 we have collected ciscoes from the catchments of White, Baltic and Caspian Seas and studied diagnostic morphological features for the two species. In addition, we analysed diversity of the mitochondrial DNA (mtDNA) ND-1 fragment and the creatine kinase isoloci.

Our results and data from literature indicate the absence of a hiatus between the two species according to morphological characters. The expression of the characters largely depends on the environment.

The polymorphism of the creatine kinase isoloci cannot be unambiguously used as a differentiation marker for the two species as the frequencies of least cisco-type alleles are sufficiently high in some populations of vendace.

PCR-RFLP analysis of the ND-1 fragment of mtDNA also provides evidence of a close relatedness between *C. albula* and *C. sardinella*. For example, no species-specific haplotypes were found for any of the species. Moreover, a widely distributed European haplotypes are also found in Siberia whereas the haplotype initially found in populations of least cisco have also been registered in the catchment of Baltic Sea. Analysis of nucleotide sequence of a mtDNA region also revealed no nucleotide substitutes that could consistently distinguish between widespread haplotypes of vendace and least cisco.

In our opinion, based on the above facts, *C. albula* and *C. sardinella* can be considered as conspecifics. This has been previously proposed in the 60s (Pokrovsky, 1967; Shaposhnikova, 1970). They suggested that vendace and least cisco could be considered as ecological forms with a number of morphological characters formed as a result of differing environmental conditions of their habitat.

The expansion of ciscoes from Siberia started, most probably, before the last ice age. This is supported by the finding of ancient haplotypes in some European populations (in Germany and in the Russian part of Baltic catchment). During the glacier's advance the great majority of North European populations became extinct and geographical distribution became fragmented.

The colonization of newly available territory after the retreat of the glacier was probably sourced from glacial refugia where only few haplotypes remained. As the ciscoes were expanding to the north and north-west the newly emerged populations accumulated unique nucleotide substitutes leading to the emergence of specific sets of haplotypes at each locality.

Thus, it appears that differentiation of species within the *C. albula* – *C. sardinella* complex is not yet completed.

The fish fauna of Slovakia

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Freshwater fishes, recorded in the territory of Slovakia, include 95 fish species. As much as one third of them are allochthonous fish species belonging to the 14 families, however, several of them were not recorded in Slovakia recently. At the present time, totally 76 fish species form a populations in Slovakia. There are 54 autochthonous and 22 allochthonous species, 8 of them are translocated and 14 are exotic fishes. The invasive characters in 13 allochthonous fish species were considered, the recent native/total fish ratio is 0.71. New and updated Red List of fishes in Slovak Republic evaluated 3 lamprey species and 59 fish species. 4 species and forms of 2 species are *Regionally Extinct*, 2 forms of 2 species are *Critically Endangered*, 6 species are *Endangered*, 9 species are *Vulnerable*, and 12 species are evaluated as *Near Threatened*. The remaining 28 species and 1 form of one species are *Least Concern*. Origins of the exotic species spread in Slovakia are on four continents – Africa (3), North America (7), Central America (3), Asia (13) and ten of them were translocated from different regions of Europe. The purposes of their intentional introductions were to fill up the vacant ecological niche in the ecosystems reshaped by human activities, fish stocking, angling or fish farming. Some of these species spread from their original ranges or they penetrated spontaneously from the adjacent countries via the river network system. NATURA 2000 sites, according to the specific EU Directives consist of *Special Areas of Conservation* (SACs) and *Special Protection Areas* (SPAs). The SPAs and the SACs, the latter selected as Sites of Community Importance (SCIs), will be incorporated into the NATURA 2000 network. For 3 lampreys and 20 fish species the territory of potential site of community interest (pSCI) has been limited and proposed. The selection of localities and examinations of population state in individual species of fishes presented in the Annex (II., IV. and V.) to the Council Directive No. 92/43/EEC were carried out in last years. The number of pSCI localities selected for individual species is different regards to their distribution within the river net of Slovakia.

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Review of fish fauna of the Chukchi Sea

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The Chukchi Sea situating northward of the Bering Strait is an intermediate water body between the Arctic and the North Pacific. The fish fauna could invade the area after the opening of the Bering land bridge in mid-Pliocene (3.5 Mya) (Briggs, 1995). The Chukchi sea fish fauna descends from elements coming from both the Arctic and the North Pacific. Huge offshore area is inhabited by complex of arctic species similar to those of the neighboring arctic seas. At the same time boreal pacific species, migrated mostly in post-glacial time, are rather numerous, especially in the south-eastern margin of the sea, influenced by Alaska warm current (Andriashev, 1939, 1952). The Chukchi Sea was included in the Arctic circumpolar zoogeographic province by content of the fish fauna (Andriashev, 1985).

The present work based on fish collection of the Zoological Institute RAS (more than 2500 specimens from 560 stations studied) and also critically considered literature data.

Previously 49 fish species (33 genera, 13 families) have been listed for the Chukchi Sea (Andriashev, 1952, 1954; Zenkevich, 1963 et auct.). On our data 98 species are recorded, and 14 more are those which possibly occur. The most diverse are families Cottidae (21 species, 11 genera), Zoarcidae and Pleuronectidae (10 species each). Together with Agonidae, Salmonidae, Coregonidae, Gadidae and Liparidae they contain 73% of total number of listed species. Each of the other 11 families is represented by single species. These species usually are solitary members of genera, which are diverse in the north Pacific area.

Nineteen species out of 98 (19.4%) are reproductively related to fresh waters, the other species are marine or brackish-water ones. Marine fishes are mostly benthic (86%). Anadromous fishes at sea are nerito-pelagic or benthopelagic. The main body of marine fishes in the Chukchi Sea consists of 38 marine and 12 anadromous species which are widely spread and rather common. Marine species are: *Mallotus villosus catervarius*, *Clupea pallasii*, *Boreogadus saida*, *Eleginus gracilis*, *Theragra chalcogramma*, *Arctodiellus scaber*, *Gymnocanthus tricuspis*, *Icelus spatula*, *I. bicornis*, *Megalocottus platycephalus*, *Myoxocephalus scorpioides*, *M. verrucosus*, *Triglopsis quadricornis*, *Triglops pingelii*, *Leptagonus decagonus*, *Podothecus veterinus*, *Ulcina olrikii*, *Eumicrotremus andriashevi*, *Lycodes mucosus*, *L. palearis*, *L. polaris*, *L. raridens*, *L. turneri*, *Anisarchus medius*, *Leptoclinus maculatus*, *Lumpenus fabricii*, *Eumesogrammus precisus*, *Stichaeus punctatus*, *Ammodytes hexapterus*, *Liopsetta glacialis*, *Hippoglossoides robustus*, *Platichthys stellatus*, *Liparis bathyarticus*, *L. herschelini*, *L. tunicatus*, *L. cf. fabricii*; *Gymnelus knipowitschi* and *G. platicephalus*. Another group of fishes spends only part of life cycle in the Chukchi Sea, migrating southward for reproduction. Some species are rare or occur mainly in marginal areas and do not take important place in ecosystem. The fish fauna is comparatively diverse in the south-eastern part of sea eastward of the Bering Strait, 34 boreal species are recorded in this area, and not elsewhere in the Chukchi Sea. The main area of their distribution lay southward of the Bering Strait.

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Identification and Distribution of Fish Fauna in Qanats and Standing Rivers of Qae`nat County (South Khorasan Province, I. R. IRAN)

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Qae`nat County is located in South Khorasan Province in east of Iran at 33°15'N to 34°12'N, 58°38'E to 60°56'E. Although this county lies in a desert, but it have several seasonal and standing rivers. The most important standing rivers of this county are: 1- Kalshoor River (Including: Ghoor ghoori, Asfshad, and Farrokhi tributaries), 2- Mardan Shah River, 3- Ahangaran River, and 4- Haji Abad River.

In order to identify the fishes of Qanats and Standing Rivers of Qae`nat County, a series of sampling were carried out in four sub area of this county (Including: Nimbolook, Zirkooh, Zehan, and Central sub regions) during 2007-2008, with covering 67 Qanat and 6 rivers. The samples were collected by net (mesh = 2mm) and after fixation in 10% formalin, they were transferred to laboratory for further species identification.

At the end, we identify 2 species: *Capoeta fusca* belong to Cyprinidae family and *Gambusia holbrooki* belong to Poeciliidae family. *Capoeta fusca* is a sub endemic species and geographically is only found in eastern parts of Iran.

From 73 surveyed water resources, we observed fishes only in 22 Qanat and 4 rivers (Fig.1).

Keywords: *Capoeta fusca*, *Gambusia holbrooki*, Iran, Qae`nat, Qanat, Standing River

Fig. 1. Water resources in which fish was observed, Qae'nat County, South Khorasan Province, IRAN

No	sub area	Location	Latitude & Longitude	Altitude	Observed Species	Water
1	Markazi	Shahyek Qanat	N33 42 04.3 E59 11 24.4	1450	<i>Capoeta fusca</i>	Fresh water
2	Markazi	Mahmoi Qanat	N33 44 12.3 E59 14 12.6	-	<i>Capoeta fusca</i>	Fresh water
3	Markazi	Ghoor ghoori River	N33 47 19.2 E59 09 20.1	-	<i>Capoeta fusca</i>	Brackish water
4	Markazi	Asfshad River	N33 46 72.8 E59 17 73.4	-	<i>Capoeta fusca</i>	Brackish water
5	Markazi	Namazi Qanat	-	-	<i>Capoeta fusca</i>	Brackish water
6	Markazi	Andarik Qanat	N33 45 16.5 E58 59 41.7	1891	<i>Capoeta fusca</i>	Fresh water
7	Markazi	Astash Andrik Qanat	N33 45 09.9 E58 59 25.0	1880	<i>Capoeta fusca</i>	Fresh water
8	Markazi	Kalathe no Mehanj Qanat	N33 46 46.2 E59 00 97.5	1673	<i>Capoeta fusca</i>	Fresh water
9	Markazi	Jaznan Qanat	N33 42 34.3 E58 58 20.3	1797	<i>Capoeta fusca</i>	Brackish water
10	Markazi	Bid Nasre Jabbar Qanat	N34 00 01.2 E59 18 24.9	1255	<i>Capoeta fusca</i>	Fresh water
11	Markazi	Mazar Maghari Qanat	N34 00 81.5 E59 16 17.7	1474	<i>Capoeta fusca</i>	Fresh water
12	Markazi	Tigab Qanat	N33 51 34.8 E59 44 02.6	1186	<i>Capoeta fusca</i>	Brackish water
13	Markazi	Bande Akhoond Qanat	-	-	<i>Capoeta fusca</i>	Brackish water
14	Markazi	Hatam Abad Qanat	N33 59 38.8 E59 16 83.7	1350	<i>Capoeta fusca</i>	Fresh water
15	Markazi	Dehmir Qanat	N34 00 15.7 E59 14 18.6	-	<i>Capoeta fusca</i>	Fresh water
16	Markazi	Farrokhi Qanat	N33 52 31.9 E59 33 24.8	-	<i>Capoeta fusca</i>	Brackish water
17	Nimbolook	Mardanshah River	N33 57 56.9 E58 43 20.4	1735	<i>Capoeta fusca</i>	Fresh water
18	Nimbolook	Gazdmoo River	-	-	<i>Capoeta fusca</i>	Fresh water
19	Nimbolook	Saghoori Qanat	N34 03 16.5 E58 43 46.1	1750	<i>Capoeta fusca</i>	Fresh water
20	Nimbolook	Dashte Bayaz Qanat	N34 02 34.2 E58 47 01.2	1620	<i>Capoeta fusca</i>	Fresh water
21	Nimbolook	Nozaj Qanat	-	1479	<i>Gambusia holbrooki</i>	Fresh water
22	Nimbolook	Rejang Qanat	N34 04 05.5 E59 14 21.1	1430	<i>Gambusia holbrooki</i>	Fresh water
23	Nimbolook	Shir Maghz Qanat	N34 04 05.5 E59 14 21.1	1389	<i>Gambusia holbrooki</i>	Fresh water
24	Zirkooh	Dashgaran Qanat	N33 28 57.2 E60 05 02.7	1108	<i>Gambusia holbrooki</i>	Fresh water
25	Zirkooh	Ardakool Qanat	N33 30 15.0 E60 03 39.9	1010	<i>Capoeta fusca</i>	Fresh water
26	Zehan	Afin River	N33 32 09.8 E59 45 40.8	1776	<i>Capoeta fusca</i>	Fresh water

The fishes of the Batang Hari drainage, Sumatra

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Fish surveys were conducted between 1994 and 2003 in the Batang Hari drainage, Sumatra. The fish fauna of the drainage now includes a total of 297 species of which 48 are new records (45 of them new records for Sumatra). 27 species new to science were discovered during these surveys. This presentation reviews the main faunistic findings.

Phylogenetic Informativeness of Amino Acid Substitutions and Protein Structure Changes in Four Nuclear Genes for Inferring Relationships of Cypriniform Fishes

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A recent phylogenetic analysis of four protein-coding nuclear genes (GH, RAG1, RH and IRBP2), involving both un-weighted and down-weighted 3rd position substitutions, resolved phylogenetic relationships among 49 cypriniform fishes with similar topology, but measurably less homoplasy, than a considerably larger mitogenome dataset. However, topologies were not resolved consistently in the two different character weighting schemes of the nuclear genes. Here we examine phylogenetic relationships inferred from a dataset of amino acid substitutions in the four nuclear genes for the same group of cypriniform fishes, a more conservative analysis than down weighting substitutions in the 3rd codon position. We use a Maximum Parsimony optimality criterion and show amino acid changes as character support for nodes on the resulting consensus tree. The tree resolves relationships of cypriniform fishes in a manner consistent with the nucleotide dataset: Catostomids are basal and sister to a large clade comprising a monophyletic loach clade (Gyrinocheilids, *Vaillantella*, Botiids, Cobitids, Balitorids) plus a monophyletic cyprinid clade. We describe the phylogenetic informativeness of amino acid substitutions in the four nuclear genes. We produce protein structure models for coding regions of two of the genes (GH and RH). We show areas of these proteins where amino acid substitutions are highly conserved and other areas where substitutions are relatively unconstrained.

Coevolutionary dynamics between the European bitterling and freshwater mussels in Central Europe and Pontic region

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Coevolution is a reciprocal evolution between two or more interacting species and it often gives rise to a rapid evolution of traits involved in interspecific interactions. Host-parasite relationships are especially amendable systems to study coevolutionary dynamics. Their reciprocal coevolutionary “arms race” results in an amplification of traits that enhance survival of the parasite on one hand and host defence on the other. To study complex coevolutionary interactions, we use a unique system of the European bitterling (*Rhodeus amarus*), that parasites freshwater mussels (Unionidae) by laying the eggs into the mussel gills. In turn, unionid mussels have larvae that parasitize fish. Both partners show a range of broad and special adaptations to exploit the other partner and counter-adaptations to prevent being exploited. We review current state of our understanding of the relationship in Europe where it has only recently become evident that the fish, *Rhodeus amarus*, has undergone extensive range shifts over the last centuries and continues to expand. We summarize costs and benefits for fish and mussels and discuss current

stage of the association. Specifically, we compare situation in Central Europe where the bitterling-mussel association is relatively recent with situation in Pontic Region (Turkey), where bitterling-mussel association is more ancient. We report differences in the level of specialization of individual bitterling to use particular mussel species, ability of mussels to eject bitterling eggs and ability of larval parasitic stage of mussels to parasitize bitterling.

Patterns and processes of evolutionary diversification in snakeheads

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One of the most emblematic fish groups of Africa and Asia are the snakeheads (Channidae). They are highly specialized airbreathing, primary freshwater fishes comprising roughly 30 species distributed in the freshwaters of Africa and Asia with a centre of diversity in the Indo-Burma and Sundaland biodiversity hotspots. Systematics of snakeheads is difficult, riddled with taxonomic confusion, and their phylogenetic history remains largely unknown. Part of the taxonomic confusion is due to the dramatic colour changes that may occur between juveniles and adults, a factor unknown to early taxonomists that greatly relied on colour patterns for species diagnoses. They are generally voracious piscivorous thrust predators with a partly amphibious lifestyle that enables them to cross short distances over land. Their constrained within-drainage dispersal leaves a perceptible imprint on present species diversity and therefore they are particularly well suited to test a variety of long debated and highly controversial historic hypotheses at different spatial scales (inter continental, continental, regional) and temporal scales (e.g. “Gondwana drift-vicariance” hypothesis, Southeast Asia palaeo-drainage” hypothesis). A molecular phylogeny based on roughly 4,500 base pairs of mitochondrial and nuclear nucleotide sequences of over 250 specimens is used to address their systematics and biogeography.

Species Boundaries and Evolutionary Lineages in the Blue Green Damselishes *Chromis viridis* and *C. atripectoralis* (Pomacentridae)

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The blue green damselfishes were described as a complex of two species (*Chromis viridis* and *C. atripectoralis*), mainly based on the colouration of the pectoral fin base. In this study, we analysed the mitochondrial control region of 88 blue green damselfishes from Indonesia, the Philippines, Red Sea, and the Great Barrier Reef. The phylogenetic analysis revealed four major monophyletic clades. Two clades included specimens of *C. atripectoralis* from the Great Barrier Reef; and individuals of *C. viridis* from the Red Sea, respectively. The remaining individuals of *C. viridis* from Indonesia and the Philippines were grouped into two clades without phylogeographic structure. The obtained results verified (1) that *C. viridis* and *C. atripectoralis* are distinct species; and (2) revealed three deep evolutionary lineages of *C. viridis* in the Indo-Malay Archipelago and the Red Sea.

Fish Conservation

Why Red List Tunas and Billfishes?

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The Red List Categories of the International Union for the Conservation of Nature have been widely used to provide an explicit, objective framework for the classification of a broad range of species according to their risk of extinction. This system has proved invaluable for the conservation of terrestrial and freshwater organisms but, until recently, it has not been widely used for marine organisms. There are nine clearly defined categories in the IUCN Red List system: extinct; extinct in the wild; critically endangered (CR); endangered (EN); vulnerable (VU); near threatened (NT); least concern (LC); data deficient (DD); and not evaluated (NE). Categories very similar to Red

List categories are used in Majkowski's 2007 FAO publication on global fishery resources of tuna and tuna-like fishes: N, not known = DD; M, Moderately exploited = LC; F, Fully exploited = VU; O, Overexploited, fishing above sustainable levels = EN; and D, Depleted = EN or CR. Several species such as the three species of bluefin tunas (*Thunnus thynnus*, *T. maccoyii*, *T. orientalis*), the Monterey Spanish Mackerel (*Scomberomorus concolor*), and the White Marlin (*Kajikia albida*), are under severe fishing pressure. Critical evaluation as to which category they belong may be helpful in persuading governments that some of these species need additional protection.

Freshwater fish of the Aegean Islands: Biodiversity and conservation threats

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The climate of the Aegean archipelago is semiarid and the distribution of freshwater on its islands is uneven both in space and time. Thus, although there are numerous wetlands on the Greek Aegean islands (Crete not included), they occupy less than 1% of the total islands' surface area, being usually small and ephemeral. Moreover, permanently flowing rivers are almost absent, due mainly to the small surface area of the river basins, the steep slopes of the drainage networks and the limited plant coverage combined with limited spring discharges. As a result of the above and the area's paleogeography (that in many cases prohibited the dispersal of freshwater fish on different islands), only four of the Greek Aegean islands are reported to have autochthonous primary freshwater fish populations, namely Lesbos, Evia, Samos and Rhodes. These fish populations belong to six genera, namely *Squalius* (Lesbos, Evia, Samos, with a new record of *Squalius* sp. in Samos's Potami stream, reported here), *Barbus* (Lesbos, Evia), *Petroleuciscus* (Lesbos), *Oxynemacheilus* (Lesbos), *Pelagius* (Evia) and *Ladigesocypris* (Rhodes), with the species' number rising so far to 10. Additionally, *Knipowitschia caucasica*, is reported in Samothrace, Lesbos and Samos, *Aphanius* in Evia, Lesbos, Samos and Kos, *Gasterosteus aculeatus* in Evia and *Salaria fluviatilis* in Lesbos and Ikaria (the latest being a new record reported here).

Although the largest river basin in the Aegean is found on Rhodes island (61 km² surface area, Gadouras stream), the highest fish biodiversity is recorded in Evia and Lesbos. The most endangered freshwater fish of the Greek Aegean islands are the two endemics of Evia, *Barbus euboicus* and *Squalius* sp. Evia (Manikiotiko stream), since only one population comprises each of the aforementioned species and, moreover, these species inhabit a rather small stream that is subjected to severe anthropogenic impacts (mainly water abstraction, deforestation and water pollution), thus facing an extremely high risk of going extinct in the near future. An extinction event has probably already occurred in the stream of Plomari in Lesbos (one of the few in the Aegean islands with permanent water flow) that had, according to the locals, freshwater fish, which have gone extinct about 30 years ago, because of heavy water pollution produced by the nearby olive oil extraction plants. Similarly, during a survey conducted in Samos in September 2008, no fish were found in the stream of Pythagoreion that previously supported a population of *Squalius* sp., the stream being at the time almost completely dry, due to the poor rainfalls of the previous years and excessive water abstraction. The remaining two populations of *Squalius* in Samos are also endangered, especially the one in the Amphilissos stream (the biggest stream in Samos) that is subjected to severe water abstraction. In Rhodes, the *Ladigesocypris ghigii* population in the Kremastinos stream is most likely extinct and the existence of the *L. ghigii* populations in the rest of the streams of western Rhodes precarious. Overall, water abstraction, water pollution and deforestation of the river basins from successive fires are the major threats imposed to all the streams that still hold freshwater fish on the Greek Aegean islands and if mitigation measures are not implemented urgently the loss of these fish will become inevitable.

Occurrence and conservation of the endangered in Poland cyprinid fish species, lake minnow *Eupallasella percnurus* (Pall.)

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Introduction. *Eupallasella percnurus* is widely distributed in the northern hemisphere from Poland in the west to the Pacific coast in the east. All Polish populations of this fish inhabit small (0.01-1 ha) and shallow water bodies, most often remnants of old peat excavations being highly vulnerable to drying off.

Status. Although globally not threatened (Kottelat and Freyhof 2007), in Poland *E. percnurus* is situated among the rarest and most endangered freshwater fish species. It is protected by law, included in the Polish Red Data Book of Animals (CR), and belongs to the priority species in the International Network Natura 2000.

Occurrence. According to all published data, in total 98 Polish *E. percnurus* sites were mentioned to exist in the XXth century, but merely 14 of them survived by today (Wolnicki and Sikorska 2009). Thanks to the largest ever

field studies, commenced in 2001, the total number of sites known to exist increased to about 150. All of them are situated within the historical range of its occurrence, in five voivodeships, with the maximum number of 85 sites recorded for the Pomorskie Voivodeship (Fig. 1).

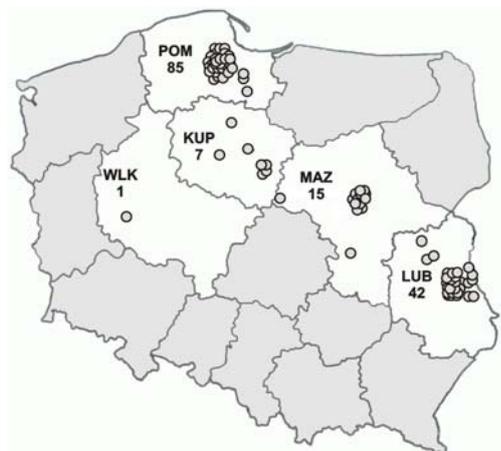


Fig. 1. Present distribution of *E. percnurus* sites (numbers in brackets) in Poland. Voivodeships: POM – Pomorskie; KUP – Kujawsko-Pomorskie; WLK – Wielkopolskie; MAZ – Mazowieckie; LUB – Lubelskie

Conservation. The long-term (approx. 15 yrs) project of *E. percnurus* conservation has been initiated in the Mazowieckie Voivodeship in 2002, as the only one undertaking of that kind in Poland (Wolnicki et al. 2008). Its framework includes among others: search for both the unknown sites and water bodies suitable for *E. percnurus* introductions, monitoring, broodstock management, captive reproduction, larval and juvenile rearing under controlled conditions. The project resulted in discoveries of sites formerly unknown to the knowledge (9) and setting up of 6 entirely new ones. The latter are formed by means of translocations of juveniles aged one or two years, originating from the controlled conditions (5 sites) or wild individuals, originating from a local population, were used for this purpose (one site). Up to now, one of those freshly established population proved to reach stability after three years (2004-2006) of introductions with the use of 1530 *E. percnurus* juvenile individuals. In 2008, density of this population was assessed at about 600 individuals at the age of 1+ and older (Wolnicki et al. unpubl. data).

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Dynamics of Fish Communities

Usefulness of gradient analyses and the SOM algorithm for estimation of species importance and distribution

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Abstract: Gradient analyses and the self-organising map (SOM, ANN algorithm) are both used for ordering/analysing plant communities and animal assemblages, but the results obtained by the two methods are of different quality. In indirect gradient analysis, a species is marked in multivariate space by a single point, the position of which is determined on the basis of all fish samples. In direct gradient analysis, species and sites can be located together on a biplot, and we know that certain sites provide the most convenient habitats for a species' existence. The SOM and the component plane, which both have the same hexagonal structure (i.e., division into neurons and clusters created with the same data set), show how the number or biomass of each species is fluctuating and changing through changes in shading from dark (maximum number or biomass) through grey (medium number or biomass) to white (absent). The importance of each species is easily visible on a component plane, especially if we enrich each species plane by the IndVal value and its significance, ranges of abundance or biomass recorded in samples, and a measure bar numerically describing greyness intensity.

Stability and persistence of fish assemblages in a small lowland stream

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This paper tests the hypothesis that fish assemblage composition was shaped as much by local climate changes as by engineering changes. This was possible owing to the monitoring protocols of the present study, which allowed estimation of the magnitude of anthropogenic changes and of changes naturally occurring in nature. Fish were sampled at the end of every growing season (October) for 23 years at five contiguous sites in a stream, before (1979-88) and after (1989-2001) regulation. In each sample, six successive electrofishing passes were used to calculate the density and mean biomass for assemblage analysis using the Zippin model. During the study, the natural, meandering stream with pools, riffles, and a moderate canopy was modified into a straight stream of uniform width and depth, stripped of all vegetation. The output layer of a self-organizing map (SOM, the Artificial Neural Network algorithm) applied in this study for site similarity analysis was partitioned into six subclusters placed in two main clusters. Subclusters in the upper part of the SOM were occupied chiefly by regulated stream samples and those in the lower part of the SOM by natural stream samples. Subclusters in the middle position, contained both natural (19) and regulated (20) samples in nearly equal proportion. In addition, the SOM contained one subcluster with sites only from the regulated period and another with only natural sites. Differences between subclusters were affected mostly by differences in climate, with some profound differences. Warming of the local weather, which became most evident in the late 1990s, may have resulted in changes in fish assemblages. This is shown in the SOM, in which samples from the 1980s, with cold years, dominate the bottom of the SOM, whereas those from the 1990s and later are at the top. Subclusters dominated by regulated or natural sites were not always significantly different when the number of species and diversity indices were considered. Clear differences between the regulated and natural samples involved qualitative characteristics and mainly concerned assemblage composition. They were also confirmed by significant IndVal values (indicator species) and no mixed subclusters contained important species in their assemblages.

Dynamics of fish community in a lowland stream: the impact of river channelization

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We investigated the impact of the river channelization in a lowland stream Ščavnica, north-east Slovenia. Fish community dynamics was compared between a reference site located in a natural section with meandering river pattern and a sampling site in a channelised section. Both sampling sites were described in terms of their hydromorphological characteristics including survey of bank vegetation, channel substrate, stream width and weekly measurements of water depth. In order to compare conditions at sites, also several physico-chemical parameters were measured weekly for one year. The fish community was sampled monthly between September 2007 and September 2008. Fish were caught by the standard electro-fishing method performing three-pass catches. The captured fish were measured (fork length), weighted and released back into the stream. Intra-annual and seasonal comparisons between sites and seasonal within site were conducted, but only cold and warm seasons were defined. Statistical significant intra-annual differences between sampling sites were observed in water depth and stream width, whereas no differences were observed between the measured physico-chemical parameters. In the cold season no differences were observed in the water temperature, whereas in the warm season up to 6 °C higher water temperatures were measured at the channelised sites than at the reference site. Altogether, 11 and 9 fish species were recorded at reference and channelised site, respectively. *Eudontomyzon mariae* and *Carassius gibelio* were recorded only at reference site. Non-native *Pseudorasbora parva* was present at both sites, but was regularly eliminated. Statistical significant difference between sites was observed in density of *Barbatula barbatula*, *Rhodeus amarus* and *Phoxinus phoxinus*, biomass of *Squalius cephalus*, *Rhodeus amarus* and *Alburnoides bipunctatus*. Of three abundant species significant differences between sampling sites were observed in density of some length classes of *Squalius cephalus* and *Rhodeus amarus* but not *Gobio obtusirostris*. Generally, larger specimens were observed at the reference site. Non-metric multidimensional scaling analyses revealed that at the channelised site, much greater temporal variability in the community composition and biomass was observed during the year in comparison to the reference site. No statistical difference was observed between the sampling sites in species richness and biomass, but statistical differ-

ences were observed in density, Shannon-Wiener diversity index and evenness. Comparison between sites within one season revealed that in the warm season only density differ significantly whereas in the warm season biomass and diversity. On the other hand, seasonal comparisons within sites showed that community diversity, biomass, density and evenness do not differ significantly at the reference site but differ at channelized site, whereas richness did not differ at any of sites. Also values of habitat, reproduction, feeding fish-guilds and Index of fish region were compared between sites and seasons. At channelised site significant seasonal differences were observed for more metrics than at natural sites. In the cold season differences between sites were observed for more metrics than in the warm season.

Is impoundment impact on fish diversity in lowland rivers less confused than formerly believed ?

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There are dozens of studies that analyse and assess the impact of dam reservoirs on fish communities, mostly in the tailwater. Yet the assessments usually much differ from researcher to researcher and from impoundment to impoundment as regards numerous aspects of this problem. In most of the aspects, two extremes are usually radical alterations of fish community structure in the tailwater, and no alteration at all. Perhaps, evaluations of many of these aspects will remain idiosyncratic of a given river, water body, or fish community there, and thus unexplainable by any simple models of general use. Yet it seems that at least as regards impoundment impact on fish diversity, diverse assessments may be an illusion largely ensuing from diverse and limited investigation approaches. The limitation is mainly temporal, i.e. monitoring of fish almost always concerns selected periods that are relatively very short as compared with the whole periods of reservoirs' existence. Most researches are probably aware of this limitation but their investigation intents are financially constrained. The problem is aggravated by usually even shorter, if at all present, preimpoundment investigation periods. Our over twenty year long annual postimpoundment monitoring of fish communities upstream and downstream of a reservoir on the large lowland Warta River, Poland detected a consistent pattern in fish diversity changes from year to year over the period: fish species richness and diversity have much returned to the preimpoundment level in the tailwater. Till now, the pattern is thus only a cosinusoid half-cycle, so it is too short yet to determine whether it will continue as a more or less continuous and predictable fluctuation or will be suppressed to some permanent value. Consequently, it is too early to attempt to formulate any decisive model relating the cycle to any river, impoundment or fish parameter, yet there is hope of much reduction in disagreement as data accumulate in the future. Thus, paradoxical as it may seem, both the extreme views of impoundment impact on fish diversity, including of course other intermediate ones, may be right, as the views are frequently dependent on which point of the cycle a given researcher happened to base his fish sampling and analysis.

Impacts from the construction of a dam on the autochthonous ichthyofauna of a mountainous stream and potential rehabilitation actions

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Geropotamos is a mountainous stream that belongs to the Axios River system (Florina prefecture, Greece). In this stream a large (70m high), earthen dam was recently constructed, to cover the needs for cooling water of a nearby Thermal Power Plant (TPP), as well as local needs for irrigation.

The aim of the present study was to investigate the composition, abundance, size structure and zonation pattern of the fish assemblage from Geropotamos, estimate the impact of human activities and, in particular, of the dam's construction on the fish assemblage and formulate mitigation measures for the fish and their habitats. Thus, between February 2007 (when the dam's construction was already advanced) and February 2009, ichthyological samplings were performed, with concomitant measuring of streamflow and standard physicochemical water parameters. Water samples were also taken for chemical analyses.

The stretch of Geropotamos upstream of the dam, is forested, with an elevation ranging from 700-1700 m and is subjected to water abstraction for domestic use. This part of the stream is a trout-zone, inhabited solely by the native *Salmo pelagonicus* Karaman 1938. The rehabilitation measures proposed for this stretch of the stream included limiting water abstraction, monitoring and protection of the wild trout population, banning of all allochthonous salmonids' introductions and the enforcement of sports fisheries' regulations. The construction of a fish passage at the

dam was considered to be purposeless, mainly because, on one hand, the local population of trout is resident and reproductively autonomous and, on the other, the deterioration of habitats in the stretch of the stream below the dam is prohibiting the survival of the species there. The stretch of the stream in the reservoir area became fishless during the period that the dam was being constructed, while before it comprised the mixed trout-barbel zone. Downstream the dam, with the elevation ranging from 600-700 m, anthropogenic disturbance is intense, including water abstraction (for irrigation), discharges of untreated, domestic waste waters and of the cooling waters of the TPP, agrochemical pollution and the existence of weirs and levees. Water quality appeared in general to be deteriorating with decreasing elevation. In this part of the stream four native cyprinids were present, while two introduced ones were caught locally and occasionally. The composition, abundance and size structure of the native cyprinids varied locally, following the fluctuating environmental pressures. During the dam's construction, the waterflow downstream was further altered and heavy loads of suspended solids were at times transferred from the construction site, causing high turbidity and altering the stream's substrata. Moreover, a dysfunction in the cooling water circuit of the TPP in summer 2008 further deteriorated water quality, causing local loss of almost all the fish in a 500 m stretch of the stream. The rehabilitation measures proposed for this stretch of the stream include restoration of ecological flow regime, of the natural substrata (by flash flooding) and of the fish assemblage (by introduction of individuals from other locations in the same river basin and construction of fish passes at the weirs), reduction of pressures to improve the water quality, etc. and will be soon implemented.

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Pike stocking as a tool in lake biomanipulation

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In Finland, the restoration of lakes has mostly been focused on eutroficated lakes. The methods involve mechanical control of macrophytes and removal of coarse species, usually cyprinids, which methods are both labour-intensive. Here, our main aim was to study the effects of pike (*Esox lucius*) stocking on crucian carps (*Carassius carassius*) and further to study how the possible reduction of crucian carps affects the water quality of the Lake Savijärvi. The lake is a small (40 ha), shallow (max. depth 2.5 m) and highly eutroficated. The main problem is low oxygen levels during the winter under the ice cover. Thus, the present fish fauna consist of almost entirely of crucian carps, which can stand anoxic situations. Other rarely caught fish species are tench (*Tinca tinca*) and roach (*Rutilus rutilus*), while piscivorous fish species pike and perch (*Perca fluviatilis*) and possibly also other fish species than crucian carps were lost during anoxic situations in winter 2002/2003.

In May 2008, we stocked 99 individually marked adult pikes ranging from 250 to 3040 g in weight, and about 12000 age 0 pike juveniles to the lake. The adult pikes originated from 5 lakes, and the juveniles from 3 lakes. We took scale-samples from all adult pikes to evaluate their growth before and after stocking, if caught later. The two specific aims were 1) to evaluate how the growth changes in the lake after the stocking, and whether there are differences in growth based on their original lake, and 2) to estimate the possible effects of pike predation on the abundances of crucian carps.

In autumn 2008, two pikes were caught in seining aiming to reduce the crucian carp stocks in the lake. Mean annual catches of crucian carps have been 81 kg per hectare in the lake during years 2003 and 2007. Both of the two pikes caught showed exceptional growth for such northern latitude. One pike stocked at 9th of May 2008 and caught at 17th of September 2008 had increased weight from 350 g to 1130 g, while another pike stocked at 23rd of May and caught at 18th of September had increased weight from 1620 g to 3150 g. Thus, according to bioenergetics model, these two pikes had consumed 2.57 kg and 5.98 kg of crucian carps, respectively, and the estimated consumption was 50% of the maximum rate (C_{max}). By applying this consumption level for all the 99 stocked pikes, these should have used 380 kg of crucian carps in 2008, which is about 10 kg of crucian carps per hectare. During the winter 2008/2009 oxygen levels were 3-8 mg l⁻¹, which should have not caused any extra mortality among adult pikes. We will continue to catch more pikes during 2009 to evaluate their growth and consumption.

Seasonal structure and diversity of the South-East Baltic Sea coastal zone fish communities

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Introduction: Baltic Seas coastal zones are zones in which populations of marine and freshwater fish species co-exist and migratory species transit it. Fishes inhabit these zones occasionally, cyclically or permanently. Composi-

tion and abundance of the ichthyofauna in the South-East Baltic Sea coastal zone have been scarcely studied. In particular there is lack of information on seasonal structure and diversity of coastal zone fish communities and evaluations of each species importance for whole fish community.

Methods: Data was collected in two constant Fisheries Research Laboratory monitoring sites (Smiltynė and Karklė) (Fig. 1.) in the Baltic Sea Lithuanian Republic coastal zone in 2001 – 2006. Standardized method that is used for Lithuanian national coastal fish communities monitoring programs was used for this study. Polyfilament gill nets series consisting of 3 meter deep, different mesh size (20, 38, 40,45,50,50, 55, 60, 70 mm respectively) nets were used. Species abundance and biomass indexes (CPUEa, CPUEb respectively) were calculated for each fishing effort. Descriptors of species diversity were richness of species and Shannon-Wiener diversity index (H' base e, used as a measure of heterogeneity of species composition). “Species importance value” was used for evaluation of each species relative importance in fish community. Cluster analysis (group average) employing the Bray-Curtis similarity index was performed to the standardized abundance values of the species using PRIMER algorithms, Plymouth Marine Laboratory. In order to normalize the data and avoid skew a square root transformation was applied to the abundance data prior to cluster analysis. 105 samples presented Smiltynė site, 153 samples – Karklė site fish communities.

Results: 51 species belonging to 25 families and to 10 orders were found during the study. Using cluster analysis identified 3 groups joining the months in accordance with the Smiltynė site fish communities similarity indexes:

- a) November, December, January (I group),
- b) April - October (group II),
- c) March (group III).

and 2 groups joining the months under Karklė site fish communities similarity indexes:

- a) November, December, March, April (group I),
- b) May - October (group II).

Established, that depending on Species importance value:

- in Smiltynė site I group demersal fish communities the most important species: flounder (34.8 %), herring (17.3 %), smelt (16.6 %), sea - scorpion (13.0%), II group: flounder (21.9 %), herring (21.1 %), perch (14.5 %), vimba (8.7 %), pike - perch (5.3 %), III group: smelt (32.6 %), herring (19.8 %), flounder (12.0 %);
- in Karklė site I group demersal fish communities the most important species: herring (35.0 %), cod (25.3 %), flounder (15.6 %), smelt (15.3 %), II group: vimba (31.2 %), flounder (17.7 %), herring (11.8 %), cod (9.6 %), roach (7.4 %).
- Evaluated that both in Smiltynė and Karklė sites species richness and Shannon-Wiener diversity indexes were more higher in warm season (Smiltynė site II group, Karklė site II group) than in cold season (Smiltynė site I group, Karklė site I group) demersal fish communities. Research has shown that the season have a significant impact on fish communities formation.

Invasive Fish

Do dispersal and abundance of Lessepsian fish migrants correlate with time elapsed since introduction?

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The Red Sea fish invasion of the Mediterranean via the Suez Canal continues in a constant rate since its onset at the beginning of the 20th century. There are currently 73 known Lessepsian fish species representing 41 families. The extent of success of the invasive species, as expressed by their current westward distribution and abundance in the Mediterranean, varies greatly. The general pattern of most Lessepsian invasive fish species is of gradual population growth and westward distribution. However, there are at least a dozen exceptional cases of Lessepsian fish migrants that undergo immediate population explosion and/or swift westward distribution, following introduction into the Mediterranean. In this presentation, the traits contributing to the rapid success of the most flourishing of the Red Sea fish migrants, as well as the biotic structure in the recipient ecosystem and the changing abiotic conditions, will be presented.

The new Mediterranean - the impact of biological invasions and climate change on the biodiversity of the Mediterranean Sea

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The ceaseless invasion of the Mediterranean Sea by Red Sea biota introduced through the Suez Canal and the recent increase in sea water temperature accelerated the expansion of Indo-Pacific fishes in the eastern Mediterranean.

A study of the shallow-water fish communities (to depth of 40m) conducted in the southeastern Levantine sea (Ashdod, Israel), the northeastern and northwestern Levantine sea (Iskenderun Bay, and Antalya, Turkey) aims to compare the alien species at the three study sites. The preliminary results, based on more than 250,000 specimens, reveal a decline in the presence of the alien species with the distance from the Suez Canal. The highest number of alien species, specimens and biomass were found in descending order in Israel, Iskenderun, with the lowest values in the cooler waters of Antalya Bay (fig. 1). The average size of fish was reversed: the smallest specimens were found in Ashdod and the largest in Antalya.

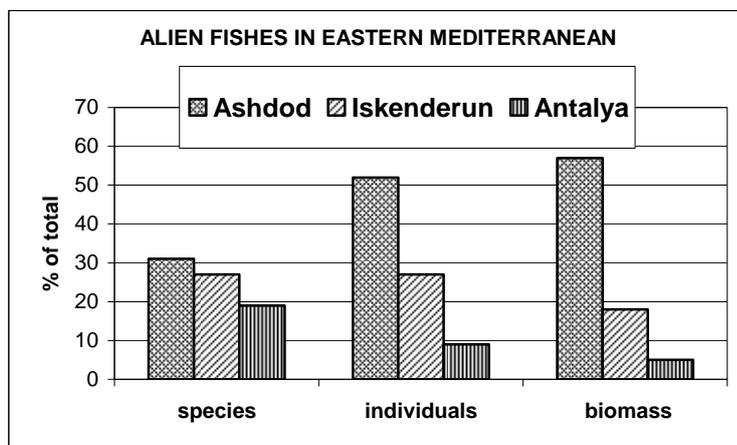


Figure 1. A comparison of the status of alien species at three sites in the Eastern Mediterranean

Population parameters of the invasive *Pterygoplichthys disjunctivus* (Webber 1991) in reservoir Adolfo Lopez Mateos (El Infiernillo), Michoacan, Mexico

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The Loricariidae family is broadly distributed in South America. It is considered the largest catfish family, with more than 700 species recognized species. As a result of the excessive development of the pet fish trade, some members of the Loricariidae family have been introduced to several countries, where they have adapted successfully, proliferating and causing alterations in the natural ecosystems. Ecological problems associated with these species have been reported in The United States of America, Taiwan, Philippines, Vietnam, Puerto Rico and Mexico (since 1995). The Loricariidae introductions have been blamed for the decrease of the commercial fisheries (Tilapia), substituting the normal harvest species, and for the destruction of the nets. "El Infiernillo" (Michoacan, Mexico) is considered as a very poor and undeveloped region of Michoacan. In this reservoir, *Pterygoplichthys disjunctivus* was recorded for the first time in 2003-2004, and a year later (2005) was considered as a plague even when in other places such as Brazil its meat is considered as excellent for human consumption. The local fishermen trash them into the dam and its surroundings, generating a focus of contamination. To be able to propose an alternative for its control by utilization, a basic knowledge of the population parameters was necessary. A monthly sampling was

performed during a year. Total (TL) and standard length (SL), weight, gonadosomatic and hepatosomatic index were measured and calculated. The bigger organism measured 51 cm SL and 1270 g W. The reproduction period was recorded from May to October. Complementary studies are necessary to understand the biology of this invasive species and how to exploit it.

Exotic and introduced fish species of Iran and their impacts on native fishes

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More than 27 exotic fish species belonging to 10 orders and 11 families (Cyprinidae, Percidae, Salmonidae, Acipenseridae, Anguillidae, Esocidae, Mugilidae, Centrarchidae, Heteropneustidae, Gasterosteidae and Poeciliidae) have been reported from Iran which are dominated by the Cypriniformes (10 species). Some of exotic fishes (ex. *C. carpio*, and *Gambusia holbrooki*) have already established breeding populations. Some others are regularly stocked by fisheries department of Iran (ex. *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Ctenopharyngodon idella*) and few others are occasionally recorded from natural waters. Aquaculture, sport fishing, control of malaria, ornamental purpose, research activities (*Cyprinus carpio*), demonstration in national fairs and accidental introduction have been the main reasons for these introductions. *Pseudorasbora parva* has been introduced accidentally along with the exotic carps and is now widely distributed in inland waters.

Introduction. In an effort to enhance, restore or re-establish fishery resources, species have been moved across the globe and introduced in totally new environments. The movement of fishes between countries contains apace as general review by Welcomme (1981, 1988) document. Generally exotic fishes consist of two groups including introduced and translocated (translocated) species. An introduced fish is one released by man into an environment outside its natural distribution and translocated species is found within the area but has been introduced to a new watershed or country. There are a variety of reasons for introduction of fish species to other areas, but the main reasons are; aquaculture, fish control, research, sport, mosquito control and ornamentation. As in many countries of the world, many fish species have been introduced to Iran and some of them have helped boost production in composite fish culture and also control of malaria. Introduction of fish species to Iran, dates back to the 1920s when mosquito fish *Gambusia* was introduced as an anti malaria agent, and to the late 1930s when *Cyprinus carpio* was introduced for aquaculture purposes. Since then, more than 27 fish species have been introduced to inland waters of Iran and many more have also been translocated. In this paper, we briefly discuss the issues related to the introduction of exotics and their possible impacts on native fish fauna with certain possible measures to protect ichthyodiversity.

Materials and Methods. This paper is mainly based on our field work data and also Armantrout (1990), Coad, & Abdoli (1993), Coad (1995, 2009) and Esmaceli et al. (2007).

Results and Discussion. Iran has approximately 192 freshwater fish species dominated by the family Cyprinidae which comprises about 70% of freshwater fishes of Iran (Esmaceli et al., 2007). About 27 fish species have been introduced to Iranian water sources. They belong to 10 orders and 11 families (Cyprinidae, Percidae, Salmonidae, Acipenseridae, Anguillidae, Esocidae, Mugilidae, Centrarchidae, Heteropneustidae, Gasterosteidae and Poeciliidae). The exotic fish species of Iran are dominated by the Cypriniformes with 10 species (Table 1). Aquaculture (*Cyprinus carpio*, *H. molitrix*, *A. nobilis*, *C. idella*, *Carassius aurata*, *Oncorhynchus mykiss*), sport fishing, control of malaria (*Gambusia holbrooki*), ornamental purpose, research activities, demonstration in national fairs and accidental introduction (*P. parva*) have been the main reasons for these introductions and translocations.

Some of exotic fishes (ex. *C. carpio*, and *Gambusia holbrooki*) have already established breeding populations. Some others are regularly stocked by fisheries department of Iran (ex. *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella*) and few others are occasionally recorded from natural waters. A number of species were introduced accidentally along with more desirable species. Many species are inadvertently brought into Iran along with the import of Chinese major carps, for example the common sawbelly, *Hemiculter leucisculus*, the stone moroko, *Pseudorasbora parva*, and the three spin stickleblack, *Gasterosteus aculatus* (Coad and Abdoli, 1993). Some species are used for experimental studies in behavior, physiology, biochemistry and other studies, e.g. *Cyprinus carpio* and *Carassius aurata*. *Cyprinus carpio* is the most important species for aquaculture in Iran. Due to lack of previous data, it is difficult to estimate the impact of these fish introduction on the native aquatic organism. However, predation, competition with native fishes, genetic changes through the hybridization, habitats changes, introduction of parasites and diseases are the main impacts of introduced fish species. Beside the invasion of exotic fishes, other threats including habitat degradation, environmental pollution, population growth, intensive aquaculture, unusual methods of fishing (toxin, dynamite) and drought have affected the ichthyodiversity of Iran. Some dangers of introductions are given:

Competition. Mosquito fish (*Gambusia holbrooki*) prey on the eggs of others fishes; they are aggressive, even attacking fish larger than themselves, thus discouraging feeding and reproduction, and compete directly for food with various cyprinid species, so the mosquito fish has been called "the fish destroyer" by Myers (1965) and is said to replace native species aggressively (Armantrout, 1990). In Iran, the native *Aphanius* species occurs alongside

Gambusia wherever the later has been introduced. *Pseudorasbora parva*, competes strongly with other fishes for food and is a predator on their eggs and young.

Habitat change. Some introduced species are changing the fish habitat. *Gambusia holbrooki* has been shown to have major effects on habitats under experimental conditions (Hurlbert et al., 1972). Grass carp removed the habitat vegetation and decrease the areas of refuge for larvae and smaller fishes and production of invertebrates on which many native species feed. The carp, gold fish, feeds on the bottom and in so doing muddies the water.

Table 1: Exotic fishes of Iran

Order	Family	Species	Sstatus	Distribution
Acipenseriformes	Acipenseridae	<i>Acipenser baeri</i>	E	Caspian sea
Anguiliformes	Anguillidae	<i>Anguilla anguilla</i>	E	Caspian sea
Cypriniformes	Cyprinidae	<i>Alburnus charusini</i>	T	Sistan
		<i>Carassius auratus</i>	E	Wide distribution
		<i>Carassius carassius</i>	E	?
		<i>Ctenopharyngogon idella</i>	E	Wide distribution
		<i>Cyprinus carpio</i>	T	Wide distribution
		<i>Hemiculter leucisculus</i>	E	Caspian sea/urmia
		<i>Hypophthalmichthys molitrix</i>	E	Wide distribution
		<i>Hypophthalmichthys nobilis</i>	E	Wide distribution
		<i>Pimephales promelas</i>	E	Namak lake
		<i>Pseudorasbora parva</i>	E	Wide distribution
Siluriformes	Heteropneustidae	<i>Heteropneustes fossilis</i>	E	Tigris
Salmoniformes	Salmonidae	<i>Coregonus lavaretus</i>	E	Namak lake
		<i>Oncorhynchus keta</i>	E	Caspian sea
		<i>Oncorhynchus mykiss</i>	E	Wide distribution
		<i>Salmo trutta</i>	T	Caspian sea
		<i>Salvelinus fontinalis</i>	E	Namak lake
Esociformes	Esocidae	<i>Esocx lucius</i>	T	Caspian sea
Mugiliformes	Mugilidae	<i>Liza aurata</i>	E	Caspian sea
		<i>Liza saliens</i>	E	Caspian sea
		<i>Mugil cephalus</i>	E	Caspian sea
Cyprinodontiformes	Poeciliidae	<i>Gambusia holbrooki</i>	E	Wide distribution
Gasterosteiformes	Gasterosteidae	<i>Gasterosteus aculeatus</i>	E	Caspian sea
Perciformes	Percidae	<i>Stizostedion lucioperca</i>	T	Wide distribution
	Centrarchidae	<i>Lepomis macrochinus</i> <i>Micropterus salmoides</i>	E E	Namak lake Tigris

Genetic changes. Many species exist in several water bodies in a desert environment and the systematic status of these isolated populations has not been examined (Coad, 1995). Movement of taxa between these water bodies may well eliminate a genetic diversity as yet unrevealed. Populations of the bighead (*Aristichthys nobilis*) in Anzali mordab of Iran are hybrids with silver carp (*Hypophthalmichthys molitrix*) (Holcik, 1989).

From ongoing account, it can be concluded that introduction of a new species may succeed in increasing the tonnage of fish; it might do so at the cost of ruining the biotope. To conserve the germplasm of endemic fauna, it is necessary to undertake experimental trials before importing any exotic species. Special care is warranted before considering proposal to stock the open water with any exotic fish. Any man made change in the delicately balanced species structure may upset the whole process of the community succession. Disease, higher level of predation, elimination and subsequent extinction of local species are the risk factors to be carefully considered before importing any new exotic species in the country. Ban on the trade of unauthorized introduction of exotic fish species and proper quarantine procedures should be strictly followed.

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Fish Reproduction, Nutrition and Development

The relationship milt quality parameters (spermatocrit and duration of sperm motility) with fertilization and eyed-eggs rate in different male ages of *oncorhynchus mykiss*

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Activation of sperm in 2⁺ years male, had Lowest duration of motility (21/86±0/47 sec) and between 3⁺ (26/40±0/24) and 4⁺ (26/5±0/026) years male were not significant difference and they were highest (P=0/007). There were significant differences in the spermatocrit in different male age (P≥0/05). 2⁺ years male were highest (32/66±0/46%) and 3⁺ years male were Lowest (23/26±0/18%) percentage of spermatocrit. Fertilization rate in 2⁺ years male were highest (86/52±1/16) and had significant difference in comparison of 3⁺ (79/39±2/2) and 4⁺ (80/45±2/02) male ages (P=0/031). Eyed egg in 2⁺ years male were highest (86/82±1/08) and had significant difference in comparison used of 3⁺ (78/62±0/67) but result of eyed egg in 4⁺ years (83/40±2/1) had not significant difference in comparison of other male groups (P=0/02). Correlation between spermatocrit in the different groups of male age with fertilization rate (r =0/804) and eyed egg (r =0/836) were positive significant. Correlation between spermatocrit in the different groups of male age with duration of motility were negative and not significant (r=-0/371) and correlation between duration of motility with fertilization rate (r = 0/271) and eyed egg (r = 0/031) were not significant.

Keyword: Spermatocrit, Motility, Sperm, Fertilization, oncorhynchus mykiss, Iran.

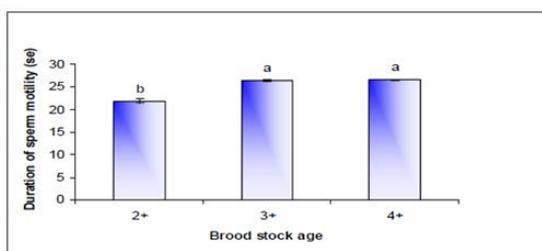


Fig. 1. Duration of sperm motility in 2⁺, 3⁺ and 4⁺ years fish

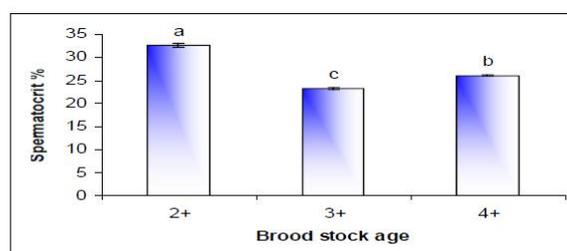


Fig. 2. The effect of male age on spermatocrit rate

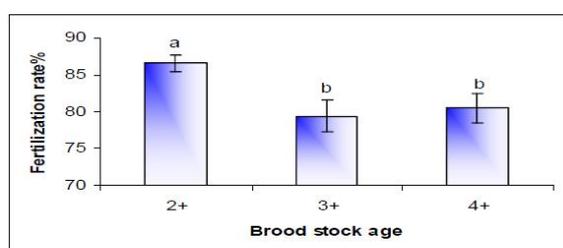


Fig. 3. fertilization rate of 2⁺, 3⁺ and 4⁺ years fish

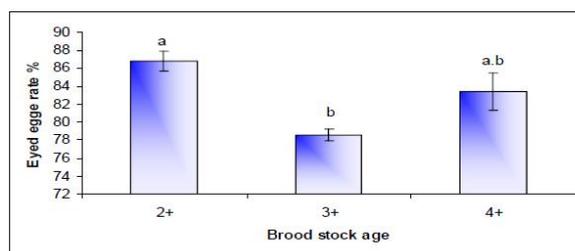


Fig. 4. eyed egg rate of 2⁺, 3⁺ and 4⁺ years fish

	\bar{x}	subsets
2+ years group	32/66	a
3+ years group	23/26	c
4+ years group	26/16	b

Tabl. 1. The effect of male age on spermatocrit rate

Sexual dimorphism in growth and length-at-maturity of pikeperch (*Sander lucioperca* (L.)) in a slow growing population in Lake Sahajärvi

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Pikeperch (*Sander lucioperca* (L.)) is one of the most common fishes in Finnish lakes and it is highly valued for both commercial and recreational fisheries. Pikeperch is the key pelagic predator in Lake Sahajärvi while other common fish species in the lake are roach (*Rutilus rutilus* (L.)), bream (*Abramis brama* (L.)), bleak (*Alburnus alburnus* (L.)), and perch (*Perca fluviatilis* L.). Lake Sahajärvi is a small (1.92 km²), clay-turbid (NTU 10-40), and eutrophic (totP 30-60 µg/l) lake in southern Finland.

Here our main aim is to study the possible differences at length-at-age, asymptotic length, and maturation of pikeperch between sexes in Lake Sahajärvi. The Lake Sahajärvi population is special, because the growth of pikeperch is very slow. Sexual dimorphism of pikeperch has so far been scarcely examined while a few literature data can be found on american species *Sander vitreus* (Mitchill). The results of our study showed that growth is slow in the lake, and no clear differences were found in the analysed variables between sexes. The 50 % probability of maturity was 24.8 cm at age 4 to 5 and asymptotic length was 65.3 cm for both sexes. Both of these values are among the smallest lengths described for the species in literature.

Keywords: Sexual size dimorphism, pikeperch, reduced growth

Changes in the diet of 0+ pikeperch (*Sander lucioperca*) in Lake Võrtsjärv (Estonia) during half of century

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Pikeperch is an important piscivorous fish in pelagialic zone of Lake Võrtsjärv – a large shallow eutrophicated water body in Estonia. Pikeperch as most species of piscivorous fishes, passes through a phase of feeding on smaller food items such as zooplankton and benthic invertebrates before switching to fish diet. Ontogenetic diet shift is an important aspect for growth acceleration; therefore the size and structure of pikeperch population depend on the success in the juvenile stage. The aim of this research was to investigate long-term changes in the 0+ pikeperch diet as a result of ecosystem shifts caused by changes in both human pressures (e.g. eutrophication, intensive fishing) and in climate (warming of the aquatic environment). The diet of 0+ pikeperch in Lake Võrtsjärv was last studied in 1950s by Vaike Erm (1961), when zooplankton community was considered to be very suitable for 0+ pikeperch – enough big cladocerans and copepods. Furthermore, smelt *Osmerus eperlanus*, as suitable first prey was quite abundant. However, due to eutrophication many of big cladocerans have now disappeared and because of warmer climate cold-water fish species populations like smelt have collapsed. In 2007 and 2008, the diet of pikeperch fries was re-examined. The stomach content of 202 pikeperch caught from L. Võrtsjärv in open water period was analysed. The focus was on the size-related as well as on seasonal changes in the prey selection of 4–20 cm (standard length, SL) pikeperch fry. Comparing these results, significant differences appear. In 1950s, *Daphnia* spp. used to be important food objects for pikeperch fry, as their frequency of occurrence in stomachs was 15%, while now only 1.6%. The frequency of occurrence of *Leptodora kindti* has decreased from 85% to 55%. To the contrary, importance of smaller zooplankters like *Bosmina* spp. and *Chydorus sphaericus* has risen significantly. In addition, the total number of different zooplankter species in pikeperch stomach was three times higher in 1950s than now. Furthermore, in 1950s most of 0+ pikeperch started to eat fish in the end of their first growing season, but now the diet shift is postponed. Pikeperch fry starts to eat fish not before the next summer, because there is no suitable prey fish – smelt is

absent and other fish fries are too big. Therefore, the first prey fish that are caught by pikeperch fry in summer are now ruffe *Gymnocephalus cernuus* and roach *Rutilus rutilus* fries.

Feeding Ecology of the Topmouth Gudgeon *Pseudorasbora parva* (Temminck & Schlegel, 1846) in the Gelingüllü Reservoir, Turkey

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Since 1960s the distribution area of topmouth gudgeon, *Pseudorasbora parva* has rapidly expanded through Europe and North Africa. *P. parva* has a very wide distribution in rivers and lakes of Turkey, including Thrace, the Aegean sea region, west Mediterranean Sea Drainage, Central Anatolia, and in some streams flowing to Black sea due to accidental introductions. *P. parva* is regarded as a pest by some authors and its competition with native species for food and space were observed, and also it was reported to be the host of a deadly pathogen. Turkey is a country highly rich in biodiversity of freshwater fish and the high level of endemism of native ichthyofauna is also very vulnerable to such introductions.

The Gelingüllü Dam lake located on the Kızılırmak drainage in Central Anatolia, has a rich ichthyofauna with native and introduced fish species including endemic species. Foregut contents of *P. parva* samples collected during the period between June 2004 and May 2005 from Gelingüllü Dam were examined. Seasonal and ontogenetic changes in feeding intensity were determined and the feeding intensity of *P. parva* was found to be high in spring months. Males, which were dominant in population, have lower vacuity index value than females. *P. parva* mainly feed on zooplankton such as Cladocera, Copepoda, Rotifera members. Basillariophyta and Cyanobacteria members were in high proportions in foregut contents of *P. parva* particularly in summer months. Vascular plant materials, fish eggs and many Cladocera eggs were found in gut contents of the samples.

Growth and fatty acid composition of early-juvenile burbot (*Lota lota*) reared on different live diets

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Changes in growth and fatty acid composition of early-juvenile burbot (*Lota lota* L.) were studied with the objective of determining the requirement for an optimum relation and amount of Omega-3 and Omega-6 fatty acids in the diet to maximize growth. After metamorphosis, artificially bred burbot were reared ad libitum on four different live diets: *Artemia salina*, *Daphnia magna*, chironomids and a mixture of these prey. The diets resulted in different growth and the fatty acid compositions of the diets were reflected by the fatty acid compositions of the early-juvenile burbot. The burbot fed on the mixed diet showed the highest growth rate whereas the *Daphnia magna* diet resulted in poor growth. The total amount of poly- (PUFA) and highly unsaturated fatty acids (HUFA) was highest in burbot fed on *Daphnia magna* (64.7 %) and it was lowest in burbot fed on chironomids (49.0%). The fatty acid profile and the stomach content of the burbot fed with the mixed diet showed that all prey types were ingested. Furthermore, early-juvenile burbot fed with the mixed diet showed the highest content of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) in relation to arachidonic acid (ARA). The amounts of EPA were high compared to those of DHA in the early-juvenile fish in all treatments and in all diets. In *Daphnia magna* and the fish fed on this diet the amount of Omega-6 fatty acids was higher as compared to the other treatments. The relation of Omega-3 to Omega-6 fatty acids, however, was low in *Daphnia magna* and the fish that received this diet. This may create an imbalance in the composition of the phospholipids and in the hormonal regulatory processes of the early-juvenile burbot leading to the poor growth shown in this experiment.

The morphology and sculpture of dermal units of Scorpaeniformes of the Baltic Sea

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The bone units such as protuberances, platelets, scutes, tubercles, pricles, fin ray rods and sensory canal segments of Scorpaeniformes inhabiting the Baltic Sea have been described, and for the first time illustrated with SEM images. Three species of three genera of the family Cottidae and two species of two genera of the families Cyclopteridae and Liparidae have been studied. The distinguished features of dermal units can be used for taxonomic identifications, similar to the use of elasmoid scales of many fishes.

The skin samples were chemically treated for one to three days with the solution of 30% hydrogen peroxide (H₂O₂) and distilled water, and buffered with 25% NH₄OH with the ratio of 200:100:50 ml, respectively. Such processing left the bony units and their surfaces unharmed.

The morphology and sculpture of units differ noticeably in different genera but dissimilarities occur also among males and females of some taxa. The roundish, quadrangular and crescent-shaped bony tubercles of the fourhorned sculpin *Trigloopsis quadricornis* (L.) are covered with concentrically arranged fine spinules lying rather close to each other. The spinules are smaller in the middle and larger at the margins of each tubercle. The spinules on tubercles have a common base; the visceral surface of the base is radially structured. The male and female specimens of the shorthorn sculpin *Myoxocephalus scorpius* (L.) have tubercles with different features, configuration of the basal plate, its upper surface as well as the number of spines and their arrangement. The total number of steeply erected, high spines on male tubercles varies from four to twelve and the basal plate is almost quadrangular. In females the number of tubercle spines is lower – from none to six. The spines are placed nearly horizontally or just slightly rise backwards from the flat and rather smooth, oval basal plate. Trunk tubercles were not found on the longspined bullhead *Taurulus bubalis* (Euphrasén); fine spinules are arranged in lines on their head plates. The scutes and tubercles of *Cyclopterus lumpus* L. are built from small denticles, each having its own cavity viscerally. Morphological transitions from a simple single denticle to large complicated denticulate tubercles are common. Tiny thumbtack pricles of *Liparis liparis* (L.) have a spinule in the middle of a spongy basal plate. Elongate minute openings, cavities and canals run radially from the middle towards the basal plate margin. The visceral side of prickles is less porous. The denticles and spines of the shorthorn sculpin and lumpsucker are often covered with nodular ultrasculpture.

The studied Cottidae have lateral line segments with characteristic features. The samples from the head of *C. lumpus* (Cyclopteridae) and from the anterior part of the trunk of *L. liparis* (Liparidae) also revealed sensory line segments. In *C. lumpus* the segment with a side branch and large openings represents the cephalic sensory canal. The lateral line segment of *L. liparis* has a thin, very porous wall and rather high septae on the surface.

The platelets from the swivel joints of the dorsal and anal fins are small- to medium-sized, paired, symmetrical structures with scanty sculpture (fourhorned sculpin, shorthorn sculpin, longspined bullhead, sea snail) or without it (lumpsucker) on the convex upper surface, and with a smooth and concave lower side.

Do otoliths and hearing abilities differ between cave mollies and their surface-dwelling relatives?

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Cave fish have rarely been investigated with regard to their hearing abilities. Here, we compare a cave form of the Atlantic molly, *Poecilia mexicana*, with two surface-dwelling populations. We tested two alternative hypotheses: (i) cave fish might have better hearing abilities than their surface-dwelling relatives as an adaptation to perpetual darkness, or (ii) cave fish might show poorer hearing abilities due to the lack of avian or piscivorous predation in the cave system. We also investigated the morphology of otoliths, which are massive calcium carbonate concretions in the inner ear of teleost fishes. Three different otolith types can be distinguished on each side of the skull: the otolith

of the utriculus (lapillus), of the sacculus (sagitta), and of the lagena (asteriscus). We utilized the auditory evoked potential (AEP) recording technique in order to determine differences in auditory sensitivities between 100-1500 Hz. To study otolith morphology, we performed scanning electron microscopy of the otolith's macula (= sensory epithelium) oriented face. We quantified the otolith contours from the SEM images and subjected them to Fourier shape analysis. Moreover, we weighed left lapilli, sagittae, and asterisci of each individual and calculated the otolith weight-to-area ratio. In contrast to our hypotheses, we found very similar hearing abilities in cave- and surface-dwelling fish, with greatest sensitivity between 200 and 300 Hz. The contours of asterisci and lapilli, however, differed markedly among populations, and asterisci also differed significantly in the weight-to-area ratio. Sagittae of surface-dwelling fish were characterized by large, circularly arranged crystals in the centre of the sulcus, a pattern that was absent in cave fish. Our results indicate that differences in otolith morphology such as otolith contour and sulcus morphology do not necessarily result in different hearing sensitivities. Future studies of the orientation patterns of hair cells within sensory epithelia will investigate whether there is an indication that populations differ in directional hearing.

Pharyngeal dentition of the common roach *Rutilus rutilus* (Cyprinidae) depends on ontogeny rate changed via hormonal manipulation

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Number of pharyngeal teeth and number of their rows are rather stable characters. Recently significant changes in number of pharyngeal teeth by change in developmental rate was shown (Smirnov, Levin, 2007). The purpose of the present work is to study how pharyngeal dentition depends on developmental rate in other teleost fish.

Progeny from artificial fertilization of a pair of common roach *Rutilus rutilus* was examined. Developmental rate was accelerated via treatment with exogenous thyroid hormone (triiodothyronine, T₃) and retarded via administration of thiourea, a goitrogen that blocks the synthesizing activity of the thyroid gland (see Smirnov et al., 2006 for details). Developmental rate of T₃-treated fish was accelerated, while developmental rate of goitrogen-treated fish was retarded compared with control. Usually *R. rutilus* has an asymmetrical formula of pharyngeal teeth 6-5. The same was found in control (94.3 %). In T₃-treated fish, the modal formula was another due to reduction of tooth number, 5-5 particularly (66.7 %). Formulae 5-4 (27.0 %) and 4-4 (4.8 %) also was found in T₃-group. Formulae 5-4 and 4-4 were not registered in natural populations of this species (for exception of variants with caverns). Goitrogen-treated fish with retarded development had mainly species-specific formula 6-5. However a short shift to formula 6-6 was observed (almost 20 % of individuals). Formula 6-6 was absent in control, and in nature this variant is very rare (1-3 %). We suggest that increased variability in dentition of progeny is caused by difference in developmental rate initiated via hormonal manipulation.

Fish Physiology, Immunology, Ecotoxicology, Parasitology and Pathology

Specific and nonspecific reactions of miosonephros cells of whiskered loach (*BARBATULA BARBATULA* (L.)) at influence of cadmium ions sublethal concentration

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Whiskered loach is a typical inhabitant of small rivers with rapid streams and sandy-pebble bottom. It leads a near-bottom life and belongs to typical benthophages (Reshetnikov, 2002). At the same time this species is absolutely unexplored in respect to its physiology and reaction at influence of toxicants. Small rivers are frequently polluted by runoffs of industrial and agricultural manufactures. Cadmium is one of the most dangerous heavy metals for hydrobionts. It is the most toxic for fish kidneys where it is accumulated in large quantities (Moiseenko et al., 2006). The information about composition and structure of mesonephros cells of this species of fish was absent. The analysis of leukocyte ratio in interstitial tissue was carried for the first time. The ultrastructure of cells of lympho-mieloid and renal tissue and the influence of cadmium ions on cells of this organ was studied in detail.

The study of sublethal concentration influence of cadmium 50 µm/l (0,002 LC₅₀ at metal ion) was carried out on (to) whiskered loach (length 8,6±1,2 cm, weight 4,2±0,2 g). The intact fish was as a control. The samples of tissues (from every point of 5 fishes) in the experiment and the control were selected in 7, 14, 21 and 28 days and were investigated by the methods of light and electron microscopy.

It was determined that cadmium influenced on both secretory system and interstitial tissue of the kidney. It was displayed that the change of leukocyte ratio in interstitial tissue appeared in the first place in lymphopenia and neutrophilia. It is a characteristic nonspecific reaction of lympho-mieloid tissue for most of pollutants (Zabotkina, Lapirova, 2003). The damage of mitochondrions of all types of mesonephros cells was established with the help of electron microscopic research. Since the similar change of organelles' structure was noted of influence of other toxicants then it is also a nonspecific reaction for their influence (Balabanova et al., 2003). The devastation of specific granules was noted in nucleuses of some granulocytes. It is connected with secretion of granules' ferments in response of influence of the toxicant. The formation of nuclear loop as an effect of exfoliation of nuclear membrane was also noted. The increase of dimensions of macrophages due to growth of number and dimensions of phagosomes was observed. It indicates the increase in their phagocytal activity. The appearance of leukocytes in vessels of glomerulus and lumen of a capsule, the emigration of the lymphocytes from vessels to proximal and distal parts of tubules was studied. Besides the increase of quantity of secretory granules in epithelial cells and the desquamation of excrescences of apical part of the epithelial cells of distal segments were noted. In these parts the lumen of tubules was filled with leukocytes and dense secretion of albuminous nature possibly.

All above—listed histological changes caused by toxic influence of cadmium testify about the development of inflammatory processes in the organ and possible intoxication of fish as a result of violation of moving off the metabolic products. The destruction of leukocytes permits to suggest the decrease of fish resistance to different diseases.

The differential leukocyte count of Persian Sturgeon fingerlings *Acipenser persicus* exposed to sublethal concentrations of diazinon

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Diazinon is a pesticide widely used in agriculture areas (paddy fields) in Iran. Applied diazinon could be washed by run off and enter aquatic systems and affect living organisms in rivers where receive the run off. Persian sturgeon *Acipenser persicus* is an economically important species in the Caspian Sea, which enters Iranian rivers such as Sefidroud River for breeding. Fish eggs hatch in the rivers and fingerlings migrate to the sea after a period of time. The Iranian International Sturgeon Research Institute produces and releases millions of fingerling sturgeons into the Sefidroud River annually. Acute or chronic exposure to diazinon may result in low production or physiological disturbance of *A. persicus*. This study was carried out to determine sublethal effects of diazinon on differential leukocyte count of Persian sturgeon in laboratory conditions.

A. persicus Fingerlings (weight 6 ± 2 g) were obtained from the International Sturgeon Research Institute in Rasht, Iran and transferred to laboratory. They were acclimatized to laboratory conditions in maintenance tanks a week before starting the toxicity experiments. 500 liters fiberglass tanks were used for the experiments. The experimental tanks were containing 300L of dechlorinated tap water. Water quality parameters were regularly checked during experiments. Throughout experiment water temperature was $24.7-26.8$ °C, dissolved oxygen maintained $7.2-7.5$ mgL⁻¹, pH ranged $7.3-7.7$, and total hardness was 180-182 ppm. Control and experimental fishes were not fed for 24h before and during the toxicity tests.

Fishes were divided into five different groups each containing 15 individuals in three replicates. The aquariums were continuously aerated using air-stones. Sublethal concentrations were selected based on 96hLC50 value for *A. Persicus* (4.38 ppm). The first group of fish was kept in freshwater without toxicant as control. Other groups were exposed to 0.25, 0.5, 0.75 of 96hLC50 (1.095, 2.19 and 3.285 ppm, respectively) and 0.01ppm diazinon (toxicant concentration in the Sefidroud River) for 24 and 96 hours.

After 12h exposure to 2.19 ppm and 3.285 ppm diazinon the fingerlings showed a series of abnormal responses such as muscle paralysis, change in gills and abdominal color, meanwhile erratic swimming, rapid movement of operculum and loss of body balance were observed in all exposed groups. The Results of the leukocyte count of exposed fish are shown in table 1. Significant decrease of lymphocyte and increases of meta neutrophil, band neutrophil and total neutrophil counts appeared after 24 hours of diazinon exposure ($P<0.05$). The differential leukocyte count of *A. persicus* after 96 h of exposure to sublethal conciazinin is shown in figure 1. Significant decreases in lymphocytes and segment neutrophil and increases in meta neutrophil and total neutrophil levels were also observed after 96h ($P<0.05$). Based on the results it is suggested that diazinon could affect different physiological and hematological aspects of *A. persicus* which may finally affect the survival of the fish. Diazinon concentration of 0.01 ppm has already been recorded in water of Sefidroud River, where about 5 millions persian sturgeon fries are released annually. Since this level of pesticide was found to be toxic for fish fries, to avoid any toxic impact regular monitoring of diazinon level in the river water specially in releasing time is recommended.

Table 1. Changes of differential leukocyte count of *A. persicus* after 24 and 96 hours of exposure to different diazinon concentrations

Hematological parameter	Exposure time (h)	Diazinon Concentration (ppm)				
		Control	01.0	095.1	19.2	285.3
Lymphocyte (%)	24	82.67±2.52 ^a	79.33±1.53 ^a	73.00±2.00 ^b	69.67±1.53 ^b	65.67±2.08 ^c
	96	82.67±2.52 ^a	77.67±3.06 ^b	69.67±1.53 ^c	65.33±1.53 ^d	--
Meta neutrophil(%)	24	1.00±1.00 ^b	2.00±1.00 ^b	5.33±1.53 ^a	7.33±0.58 ^a	7.00±2.00 ^a
	96	1.00±1.00 ^c	1.67±1.53 ^{bc}	4.33±2.08 ^{ab}	5.67±1.53 ^a	--
Band neutrophil(%)	24	12.33±1.53 ^b	14.00±1.00 ^b	16.00±2.00 ^{ab}	14.67±2.08 ^b	18.33±2.52 ^a
	96	12.33±1.53 ^b	15.00±4.00 ^a	18.67±1.53 ^a	18.33±3.06 ^a	--
Segment neutrophil(%)	24	2.00±1.00 ^a	1.67±0.58 ^a	1.33±1.53 ^a	3.67±0.58 ^a	2.67±1.53 ^a
	96	2.00±1.00 ^b	1.33±0.58 ^b	2.00±1.00 ^b	4.67±1.15 ^a	--
Total neutrophil(%)	24	15.33±1.53 ^c	17.67±1.53 ^c	22.67±4.73 ^b	25.67±2.08 ^{ab}	28.00±1.73 ^a
	96	15.33±1.53 ^b	18.00±5.29 ^b	25.00±1.73 ^a	28.67±3.51 ^a	--
Meta eosinophil(%)	24	1.00±1.00 ^a	0.33±0.58 ^a	0.67±1.15 ^a	0.67±0.58 ^a	1.00±1.00 ^a
	96	1.00±1.00 ^a	1.33±1.15 ^a	1.00±1.00 ^a	1.33±0.58 ^a	--
Band eosinophil(%)	24	0.67±0.58 ^a	1.33±0.58 ^a	1.67±1.53 ^a	1.67±0.58 ^a	2.33±0.58 ^a
	96	0.67±0.58 ^a	1.33±1.15 ^a	1.67±0.58 ^a	1.33±0.58 ^a	--
Segment eosinophil(%)	24	0.33±0.58 ^a	1.00±1.00 ^a	1.33±0.58 ^a	1.33±1.15 ^a	1.67±0.58 ^a
	96	0.33±0.58 ^a	1.00±1.00 ^a	1.67±0.58 ^a	2.00±1.00 ^a	--
Total eosinophil(%)	24	2.00±1.00 ^a	2.67±0.58 ^a	3.67±2.31 ^a	3.67±1.15 ^a	5.00±1.00 ^a
	96	2.00±1.00 ^a	3.67±2.08 ^a	4.33±2.08 ^a	4.67±1.53 ^a	--
Monocyte(%)	24	0.00±0.00 ^a	0.33±0.58 ^a	0.67±0.58 ^a	1.00±1.00 ^a	1.33±0.58 ^a
	96	0.00±0.00 ^a	0.67±0.58 ^a	1.00±1.00 ^a	1.33±0.58 ^a	--

Blood parameter values in rows with different letters significantly differ ($p < 0.05$). Each value is a mean \pm standard deviation of 5 individual observations.

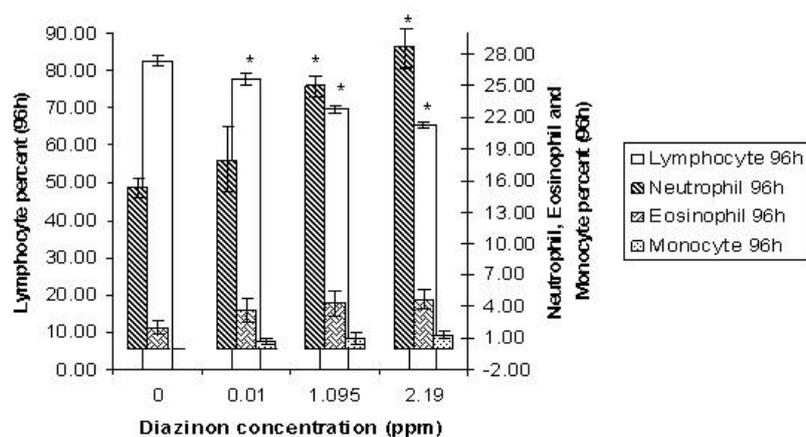


Fig. 1. Effects of different concentrations of diazinon on differential leukocyte count of *A. persicus* for 96 hours. The columns and vertical bars represent the means of three replicates \pm S.E.

* Different from control group.

Effects of industrial detergent for drilling purposes on cultured gilthead sea bream (*Sparus aurata*, L.) and goldfish (*Carassius auratus*, L.)

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Industrial detergents are widely used during drilling operations as lubricant for the machines and as a suspension mean for the drilling cuttings. They are often referred as the non aqueous phase of drilling fluids which may also contain aqueous phase, solids and gas. Sewage and industrial discharges containing detergents, degrade the quality of inland waters (lakes and rivers) and coastal marine environments. Marine and fresh water species are most probable to be effected by the effluent of detergents. The aim of this study was to determine the effect of an industrial detergent, commonly used during drilling purposes in Greece, on two fish species. Static acute toxicity experiments were conducted on *C. auratus* (fresh water species) and *S. aurata* (marine and brackish water species) to determine the LC₅₀ of the industrial detergent ALCOLAB. Ten different concentrations of the detergent, ranging from 0.5 to 80 ppm were tested, for 48 hours under controlled conditions on 100 individuals of each species. Mean weight for *S. aurata* was 183 g and for *C. auratus* 3.5 g. Mortality levels for *S. aurata* varied from 35 to 100% for concentrations over 5 ppm and the calculated LC₅₀ was 7.5 ppm. *C. auratus* responded differently to the detergent, and mortality levels varied from 10 to 100% for concentrations over 40 ppm and the LC₅₀ was 62.4 ppm. Apart from the mortality, concentrations over 5 ppm and 40 ppm respectively for *S. aurata* and *C. auratus*, caused behavioral changes, such as decreased buoyancy and reflexes, difficulty in breathing and spasms, and were rapidly and greatly induced as the concentration of the detergent elevated. Additionally, foam, blurriness and mucus were developed in the water. The LC₅₀ for *C. auratus* was almost ten times greater from the calculated one for *S. aurata*, indicating that the two species have different levels of resistance to the detergent. Based on our findings, it is suggested further, regular and integrated study in regard to how drilling fluids are disposed to the marine environment and fresh waters and the impact on marine and fresh water species of great financial interest.

Effects of weak low-frequency electromagnetic fields and copper ions action on early development of roach (*Rutilus rutilus* (L.))

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Studies were performed in 2004-2007. Action of the electromagnetic field (EMF) 75 μ T, 500 Hz on roach (*Rutilus rutilus* (L)) was studied in different intervals of early development. Another series of experiments was focused on the evaluation of the combined or separate action of EMF with «cyclotron» frequency for Cu²⁺ (150 μ T, 72.5 Hz) and solution of Cu²⁺ with 0.01 mg/l concentration (which is ten maximum allowable concentrations of Cu²⁺ ions in fresh water in Russia) on the roach eggs from the fertilization to gastrulation. These values of EMF are comparable with the value of magnetic density of natural magnetic field during disturbances or artificial magnetic field from working household appliances. Eggs and sperm were obtained from several fishes caught in the Rybinsk reservoir at the time of spawning. Larvae were placed in ponds after resorption of the yolk sac. Control and experimental individuals developed during 4 months in these conditions. Accounting of morphometric and morphologic characteristics was carried out in underyearlings.

Findings:

- It was shown that action of EMF on fertilized eggs from fertilization to gastrulation leads to reduction of mass and body length of roach underyearlings.

- EMF influence at the anlage of metameric structures is most effective within the interval from gastrulation to hatching of the prolarvae. Action of EMF at that time leads to alterations in total vertebrae number due to alterations of this character in the caudal region of the vertebral column.

- There is a dependence of the diversity of morphological characters from definite intervals of early development when roach was exposed to EMF. The earlier in the ontogenesis was the exposure to EMF the higher were indexes of morphological diversity.

- It was found that action of factors with different nature (EMF with «cyclotron» frequency for Cu²⁺ and solution of Cu²⁺ with 0.01 mg/l concentration) on the early development of roach may lead to similar effects concerning the survival of fertilized eggs, weight-length characteristics and the number of openings of the seismosensory system in dentale bones. Moreover combined action of these factors involves more expressed effects than action of each factor separately.

- Action of EMF with «cyclotronic» frequency for Cu^{2+} , Cu^{2+} solution and combined action of these factors decreased the survival of fertilized eggs. Weight and size of underyearlings were lower in comparison with control after exposure to combined action of both factors.

- Under the action of Cu^{2+} solution or combined action of Cu^{2+} solution and EMF with «cyclotronic» frequency for Cu^{2+} roach development was more stable. Dispersion of the fluctuating asymmetry did not increase and number of skeleton abnormalities was significantly reduced.

- Destabilization of bilateral structures' development in our experiments with roach is not correlated with the number of abnormalities in the vertebral column.

- Fishes with abnormalities of the vertebral column had an increased number of vertebrae in comparison with normal fish.

Influence of the electromagnetic pollution due to an increasing output of anthropogenic sources of EMF on aquatic ecosystems is discussed.

The immunoeological study of common carp (*Cyprinus carpio*) from experimental pond

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Nowadays, many studies concern with fish immune response especially for economically important species in aquaculture like cyprinids, salmonids etc. Although a progress in the characterization of the fish immune mechanisms have been recorded, there are still gaps in the complex knowledge focused on relationship between fish immune mechanisms and parasites and/or water temperature. It is known that physiology and immunity of fish, the representatives of poikilotherms, is strongly influenced by water temperature. Moreover, the parasite life cycle and also parasite abundance are affected by the seasonal changes of surrounding water. Nowadays, it is also known that parasites dispose by many mechanisms allowing to evade or cope with host immune response (e.g. parasite isolations in immuno-privileged host tissues, antigen-based strategies, exploration of the host immune reaction or immunodepression and immunomodulation) or other interactions with host-defence system (innate or adaptive immunity). In the present study we also took into consideration possible trade-offs between immune and physiological functions especially between immune defence and reproduction potentially mediated via steroid hormones.

The aims of the present study were 1) to analyze the potential associations between physiology, immunocompetence and parasitism in *Cyprinus carpio* and 2) to detect whether water temperature or parasitism is stronger factor affecting changes of fish's physiological and immunological system.

During four different periods from 2007 to 2008 (i.e. early summer, late summer, autumn and winter) a total of 120 individuals of common carp from farmed Vodňany population were studied.

The selected physiological (condition factor, gonado-somatic factor, concentration of 11-ketotestosterone) and immunological parameters (spleen-somatic index, count of leukocytes, phagocytes and lymphocytes, concentration of lysozyme, IgM antibodies, respiratory burst, activity of total pathway of complement) were measured and the fish were investigated for metazoan parasites. Metazoan parasites belonged into 14 parasite species. Among them Monogenea were the species richest and the most numerous group. The epidemiological characteristics and also majority of physiological and immunological parameters were influenced by seasonal effect. We detected several correlations between immunity and physiology e.g. gonado-somatic index was positively correlated to the concentration of 11-ketotestosterone, IgM and activity of respiratory burst. Moreover, we found a positive correlation between condition factor and both leukocyte and lymphocyte counts. Furthermore, fish condition was negatively affected by abundance of the most numerous group (Monogenea). Except the different associations between the immunity (measured by spleen-somatic index) and abundance of parasite groups i.e. a negative effect for Monogenea and a positive effect for Digenea, no correlation between immune parameter and parasite infections was revealed. These results may indicate some parasite's evasive mechanisms for surviving in immunologically hostile environment and physiological and immune functions are under the influence of water temperature.

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Ichthyophthirius multifiliis in skin, gill, eye and brain of fresh water aquarium fish (Parrot fish, Angel fish and Gold fish)

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Ichthyophthirius multifiliis is a ciliated protozoan which can cause Ich disease. This disease is a major problem to aquarists and commercial fish product world wide. The classic sign of an Ich infection is the presence of small white spot on the skin or gills. In present study presence the parasite in parrot fish with white spot on the body were confirmed by microscopic examination of skin and gill. Two infected parrot were transferred to a 70-l aquarium with 20 Angel fish in .After 12 h mortality were started in fish. The eyes in dead fish were cloudy. After disinfection the surface of the eyeball by means of alcohol and red-hot blade eye fluids were collected in clean Petri dishes separately and were checked microscopically by wet mount. Immature forms of parasite, tomites were detected in eye liquids. In the next step gold fish aquariums were infected with eye fluid from angel fish in room temperature. 12-48 h post challenge mortality were initiated in exposed gold fish, cloudy eyes was the main sign in the dead fish. Samples of eyes and brain suspension were provided following disinfect the outside of the fish by means of alcohol and red-hot blade. Hemorrhages were evident in brain and immature parasite were observed in eye liquids and brain suspensions.

Within-lake variation in macroparasite infection of perch and ruffe indicates local adaptation

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The littoral zone of lakes is the main area of contact for many fish species and their macroparasites. Particularly in large lakes like Lake Constance, Germany, littoral areas can differ substantially in various biotic and abiotic parameters like e.g. the invertebrate community, the wave exposition, the structural complexity or even the trophic state. We hypothesize that the geographic differences in ecosystem conditions are reflected in the specific macroparasite community of local fish populations. Accordingly, the differences in parasite exposure could provide a selective mechanism for local adaptation.

We investigated the macroparasite communities of two littoral fish species, the indigenous European perch (*Perca fluviatilis*) and the neozoon ruffe (*Gymnocephalus cernuus*) from diverse sampling locations in the Upper and Lower Lake Constance. We were interested in putative differences and feasible transmissions between the macroparasites of the established and the invasive fish species. Perch were sampled at ten, ruffe at six different sampling locations. 19 different macroparasite species were found for perch, 23 for ruffe. For both fish species, significant differences in the macroparasite community composition and in the intensity of macroparasite infection between nearly all sampling locations were found. This geographic variation in parasite pressure could lead to an adaptation of fish populations resulting in small scale population fragmentation. Primarily, the intensity of infection with specific digenean trematodes varied between perch and ruffe, even at the same locality. Furthermore, we found indications for a transmission of the digenean trematode *Cotylurus pileatus* from ruffe to perch.

Overwinter body condition and parasite infection in 0+ European bitterling with respect to fish size

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First overwintering of young-of-the-year (0+) fish represents a critical period in fish life history with increased mortality rate. Overwinter survival depends on fish condition related to fish size, energy resources and energy metabolism during the period of poor first-winter growth and resource scarcity. Parasite infection might be an additional factor influencing the survival success. European bitterling (*Rhodeus amarus*) is a fish species with very long spawning season (April – July/August). Therefore, it was possible to observe wide size spectrum of 0+ fish before the winter time.

In our study, we focused on two size groups of bitterling: (1) early hatched fish (40.8±2.2 mm SL) and (2) late hatched fish (31.2±1.6 mm SL). The fish were studied before and during winter (November – March) with respect to body condition and parasite infection.

Before winter, we observed no difference in parasite infection and condition factor between the fish groups. Parasite community was composed predominantly of metacercariae. The total parasite abundance was higher in winter compared to autumn in both fish cohorts because of seasonal increase of monogenean infection. The total parasite abundance was higher in early hatched fish compared to late hatched fish during winter months as a result of higher abundance of monogenean. Clear trend of decreasing metacercarial infection during winter was observed only in late hatched fish, indicating the mortality of heavily parasitized fish. Decrease of condition factor was recorded only in late hatched fish in January and February. In March, there was no difference in condition factor between both fish cohorts, probably as a result of mortality of the late hatched fish with low condition. Our results suggest that both fish cohorts were at similar state before the winter but during overwintering, early hatched fish kept energy resources better than late hatched fish and were not significantly influenced by parasite infection. On the other hand, late hatched fish probably faced increased energy deficit and mortality which might be supported by parasite infection.

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Temporal and spatial variability in the infestation of *Chondracanthus lophii* (Poecilostomatoidea: Chondracanthidae) in white anglerfish (*Lophius piscatorius*) from Northeast Atlantic

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Chondracanthus lophii Johnston, 1836 (Poecilostomatoidea: Chondracanthidae) is a parasite of white anglerfish, *Lophius piscatorius* (Lophiiformes: Lophiidae), a commercial bottom species in western and southern European fisheries. The aim of this study was exploring the influence of host variables (size and sex), time variables (year, season) and spatial variables (geographical area, depth, latitude and longitude) on the infestation variability of *L. piscatorius* with *C. lophii*. Commercial and survey samples of white anglerfish from S and SW of Ireland and N and NW of Spain collected in 2007 and 2008, between 180-800 m depth, were examined. Generalized Additive Models (GAM) were used to investigate the prevalence and intensity of infection relative to the studied variables. A binomial error distribution was assumed for the prevalence and a negative binomial distribution for infection intensity.

Differences in the prevalence and the intensity of infestation were explored with respect to the size and sex of host, year, season and geographical area. Year and host sex factors were eliminated through a stepwise process. The rest of studied variables were significant. An increment of intensity with the host size was observed and there was a clear effect of the geographical area, being the highest infestation levels found in the SW of Ireland (prevalence = 97.4 % and intensity = 10.5). The effect of the season resulted to be less evident.

A more detailed study, including depth, latitude and longitude, was carried out for areas from SW of Ireland. The host sex was eliminated through a stepwise process. None of the studied variables had a significant effect on the prevalence. However, the intensity increased with the host size and the geographical longitude and it decreased with the depth.

The results suggest that the infestation of the white anglerfish by *C. lophii* occurs in all studied areas with prevalence between 7.7 and 97.4, and intensity between 1 and 10.5, being the highest infestation levels from SW of Ireland. Both sexes of white anglerfish are equally parasitized and the infestation level increases with the size of fish. Although the parasite is found in the whole depth range sampled, the intensity of infestation slightly decreased with depth, being higher in the medium depth range (200-500 m) where it reaches a value of 8.7. There were no significant temporal trends in the infestation with *C. lophii*.

Parasite infection in common carp wounded by cormorant (*Phalacrocorax carbo sinensis*) attacks

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Fish affected by wounding caused by cormorants may suffer with increased susceptibility to the infections and consequently decreased body condition, especially during the energy demanding winter time. In this study, two-year common carp *Cyprinus carpio* originating from the Týnský pond, Czech Republic, were sampled in late March. Wounded and non-wounded fish were examined for ecto- and endoparasites, the extent of injuries caused by cormorant attacks, lysozyme concentration in skin mucus and several body condition indices were measured. Endoparasite infection occurred only scarcely and did not affect the attack probability. Ectoparasite infection was represented by six major groups: *Gyrodactylus* spp., *Dactylogyrus* spp., *Eudiplozoon nipponicum*, *Argulus* spp., *Trichodina* spp. and *Ichthyophthirius multifiliis*. Only monogenean *Gyrodactylus* spp. and *Dactylogyrus* spp. showed significantly increased abundances in wounded fish, the other parasites did not differ between the fish groups. The extent of damaged epithelium in wounded fish was positively associated with lysozyme concentrations in fish mucus, but the relationship with parasite infection was not clear. Concerning the fish body condition, there was no difference in Fulton's condition coefficient, hepatosomatic index and lipid content in the muscle and liver tissue between the wounded and non-wounded fish. No differences in fish condition may result from better overwinter survival rates of stronger individuals with sufficient energy resources. Higher values of spleen-somatic index in wounded fish corresponded to increased intensity of parasite infection, probably related to increased requirements on fish immune system. Although our results did not show the effect on cormorant attacks on fish condition, the wounded fish suffered higher intensities of ectoparasite infection what may have additional consequences in the subsequent year.

Spatial variation in species diversity and composition of metazoan parasite communities of the European bitterling across its geographical range

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Rhodeus amarus is a species characterized by enormous changes in its distribution and abundance over time. From approximately 1980, the European bitterling has rapidly expanded its geographical range and has colonised diverse habitats including rivers, backwaters, artificial canals and estuarine waters in many European countries. Recently, the European bitterling has been considered to be highly invasive species and a “parasite” of freshwater unionid mussels. In the present study, the metazoan parasite communities of 12 populations of the European bitterling were sampled across its wide geographical range and the effects of geographical and phylogenetic distances among host populations in the structure of parasite communities were tested. A total of 49 species of metazoan parasites were found across the area of *R. amarus* distribution. High parasite accumulate capability of the fish were observed. *R. amarus* may therefore represent potential resource of parasite infection for the whole ecosystem. The highest values of species richness and diversity were recorded in Polish and Turkish populations. The trend of negative relationship between similarity in parasite communities and phylogenetic distance was observed. Testing of the hypothesis of decay of biological similarity with increasing of geographical distance on the model of the European bitterling showed that geographical distance was more important as a determinant of similarity in parasite communities than phylogenetic distance.

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Metazoan parasites of fish like a potential indicator of environmental stress

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There are three different hierarchical levels at which parasites could be investigated as potential biological indicators in relation to environmental stress. First, it is the level of an individual; second, the level of a population and third, the level of a community. The examination of attachment apparatus of selected parasites revealed abnormal morphological changes. As a result of various types of environmental pollution, a decrease in parasite species richness, as well as an increase of homogeneity of parasite distribution within the parasite component community was also recorded. Based on parasite species richness and heterogeneity measures, the fractionation of parasite component community appeared to be ecologically reasonable. Relationships between composition and structure of parasite infracommunity with respect to the level of chemical contamination and biochemical markers of exposure in individual fish were found. It is evident from detailed analyse of hierarchically structured data, that parasites of fish seem to be a perspective non-specific indicator of freshwater ecosystem integrity.

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Effects of *Silybum marianum* on resistance against *Aeromonas hydrophila* infection in *Cyprinus carpio*

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Silybum marianum (Milk thistle) have a long history of medicinal use for a variety of conditions, particularly hepatitis, and as an immunostimulant. In this study the effect of oral administration of *Silybum marianum* extract on resistance of *C. carpio* to *Aeromonas hydrophila* has been evaluated. 120 apparently healthy carp (average weight= 22±3.43g) were divided into 4 equal groups in triplicate (10 fish in each) as follow: 1- fish were immunized with formalin killed *A. Hydrophila* and fed with food enriched with *S. marianum* extract (0.5%). 2- Fish were immunized with formalin killed *A. Hydrophila* and fed with normal food. 3- Non-Immunized Fish fed with food enriched with *S. marianum* extract (0.5%). 4 - Non-Immunized Fish fed with normal food. After 40 days fish were challenged with 2×LD₅₀ *A. hydrophila* in i.p route. Mortality in each treatment was recorded daily for 14 days and cumulative mortality curve were figured. Dead fish were investigated to ensure the cause of death. Results show that Cumulative mortality was 93.34% ± 5.78% and 76.67%±5.78% in non-Immunized groups fed with normal diet and *S. marianum* enriched diet respectively but, It was 53.33%±5.8% and 50%±10% in immunized groups fed with normal diet and *S. marianum* enriched diet. Oral administration of *S. marianum* in *C. carpio* enhanced resistance to *Aeromonas hydrophila* infection (P<0.05). No significant differences were seen in resistance to *A. hydrophila* in immune fish fed with *S. marianum* compare to group fed with normal food (P>0.05). According to the results of this study, although *S. marianum* can be used as an immunostimulator to increase resistance to bacterial infections. But, it doesn't have adjuvant activity in fish.

Key words: *Silybum marianum*, *Aeromonas hydrophila*, resistance, *Cyprinus carpio*

Histopathological study of Intestine in *Litopenaeus vannamei* caused by white spot syndrome in Iran

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White spot disease is one of the most important shrimp disease in the world that caused by white spot syndrome virus. It is affect most of the commercially cultured shrimp species. The clinical signs of this disease include white spots in the carapace and abdominal segments, the hepatopancreas was swollen and yellow, the intestine and abdomen was empty. The presence of WSSV has been described in a wide range of captured and cultured crustaceans and other arthropods. Until the middle of the year 2005, the occurrence of WSD in Iran has been limited to Khuzestan province. The used of cultured brood stock for the hatchery for producing the post larvae for next season is one of the most important part of cultured industry.

For this research fifty shrimp affected with white spot syndrome and fifty non affected *Litopenaeus vannamei* was collected from Choebde shrimp farming site in Khuzestan province. Shrimps were fixed in 10% neutral buffered formalin at farm site and later brought to the laboratory for histology processing. Information on case history and clinical signs was also collected for each sample. Fixed tissues were processed (washing, dehydration, clearing, embedding, blocking, sectioning, mounting & staining) for standard histological examination and photomicrography. The staining (H&E) and tissue section was used 5 to 6 micron.

Histopathological changes in tissues of affected shrimp with white spot syndrome was degenerated cells characterized by hypertrophied nuclei were observed in the cuticular epidermis and connective tissue. In the intestinal tissue cell necrosis and detachment of intestinal epithelium tissue in disease shrimp was observed. Disease outbreaks among cultured penaeid shrimp due to white spot syndrome have been observed in Taiwan since early 1992. The disease shrimp have obvious white spot on the carapace; appendages and the inside surface of the body and also display signs of lethargy and reddish coloration of the hepatopancreas. Thus in this study we propose the name white spot syndrome (WSS).

Keywords: Histopathology, white spot syndrome, *Litopenaeus vannamei*, Iran.

Bioaccumulation of heavy metals in *Euryglossa orientalis* from the Hendijan seaport (Coastal of Persian Gulf), Iran

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Heavy metal pollution of the marine environment has long been recognized as a serious environmental concern. This research, on determination of heavy metal pollution, was carried out for the first time for Hendijan seaport. Present specific objectives were to determine the distribution of heavy metals in *Euryglossa orientalis*. This species is a benthic economical fish in Persian Gulf.

The samples were caught by fishermen's nets seasonally from October 2006 to July 2007 from the Hendijan seaport and transported daily to the laboratory. Samples were divided in three length groups, A: 15 to 19.9cm TL, B: 19.9 to 24.9cm TL and C: ≥ 25 cm TL. All fishes were stored in plastic bags at -20°C until dissection. Each sample collected from the Hendijan seaport seasonally was dissected for its muscle, gill and liver tissues (N=50). Sediments were extruded and sectioned in 2–4cm thick slices, which were dried for 24 h at 105°C and digested with a hydrochloric–nitric acid mixture. The tissues digested with concentrated Nitric Acid and Perchloric Acid (2:1 v/v) (Merck) at 60°C for 3 days and all samples were diluted with double distilled water. Metal concentrations in sediments, liver, muscle and gill were measured by flame atomic absorption spectrometry.

Spring and winter seasons showed significantly lower levels of Pb whereas winter and autumn were contaminated by Cu. The average sediment concentration was taken into account for metal exposure: 25.63 mg Pb kg^{-1} and 12.79 mg Cu kg^{-1} . Concentrations of Pb and Cu in the liver, gills, and muscle were significantly different ($P < 0.05$) from each other. Gill contained Pb levels significantly higher ($P < 0.05$) than the liver and muscle. The mean concentration of Pb in the gill was higher in a group with a range of 7.77–14.97 mg kg^{-1} , than other groups and the highest concentration observed in a group in summer, while in the muscle and liver it was always below 5.20 and 7.03 mg kg^{-1} in all group and seasons, respectively. The level of Cu was significantly higher in the liver than in gill and muscle tissues ($P < 0.05$). Generally, there were significant seasonal changes for Pb and Cu concentrations in all tissues ($P < 0.05$) and concentrations of Pb and Cu in three groups were significantly different ($P < 0.05$).

The present study shows that metal concentrations in the sediments tended to vary among seasons and summer displayed particularly high levels. This variation may be due to the differences in the sources of metal pollution and physical–chemical conditions favoring sediment contamination in different seasons.

Keywords: Bioaccumulation, Heavy metal, *Euryglossa orientalis*, Persian Gulf.

Fish Genetics

Morphological and genetic variability of the genus *Gobio* in Poland

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Systematics of the gudgeons of the genus *Gobio* Cuvier, 1816 in Europe was investigated in recent years by many authors using various methods, mainly the external morphology. Most recently also genetic methods were applied in some studies. Systematics of European gudgeons of the genus *Gobio* tends to be very complicated. In the common gudgeon *Gobio gobio* (L.), previously considered a pan-Palearctic species, many independent evolutionary lineages (i.e., valid species) were recognised. However, it is far from definite solution and many ambiguities still occur. Aim of this study was to investigate the situation in Poland (the Vistula, Odra and Dniestr drainages) which has never been thoroughly studied.

Each specimen was over-anaesthetised, fixed with 4% formaldehyde for morphological studies (fin-clips for genetic analyses were fixed with 98% ethanol) and measured for 35 point-to-point morphometric characters. Additionally 13 meristic traits were checked. Measured distances were adjusted in order to eliminate size effect and processed by PCA and cluster analysis.

Meristic characters were, as usually in the genus *Gobio*, relatively stable, showing only very limited deviations. It was contrary to the morphometric data that revealed high variability. PCA, based on overall variability in morphometrics, suggests that all specimens were harvested from one meta-population and differences among them may be only accidental. Nevertheless, taking into account only precisely selected combination of characters, some significant differences among analysed populations can be indicated and they can be identified.

Direct sequencing of molecular markers from mitochondrial (control region) and nuclear (S7 r-protein) genomes showed sympatric occurrence of at least two species of gudgeons on Polish territory, *Gobio gobio* and *Gobio* sp. 2. Using of the combination of markers with maternal and biparental inheritance allowed us to discover rather frequent hybridization events between these species. In majority of cases, the mitochondrial haplotypes pointed to occurrence of the species *G. gobio* but the nuclear haplotypes showed significantly more complicated patterns. S7indel diagnostics identified an analogically frequent phenomenon of cytonuclear disequilibrium and interspecific sharing of nuclear haplotypes. The Polish region will require a specific approach in defining of the degree of hybridization and species participating in hybridization events.

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Genetic insight into different pelagic behaviour of European perch fry (*Perca fluviatilis*)

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In deep canyon-shaped reservoirs young-of-the-year European perch create simultaneously three different communities – epipelagic (EPF), bathypelagic (BPF) and littoral (LPF). The BPF stay in the open water from late May at least to early September. The BPF perform regular diel vertical migrations, which are under direct control of the

light intensity. Analyses of six microsatellite loci and mtDNA *Cytb* showed that all spatially segregated communities of young-of-the-year perch (EPF, BPF, LPF) belong to one population with the same phylogenetic origin. The results of the RNA : DNA ratio of all three communities showed that EPF bear highest variability among individuals in contrary to BPF that has the lowest ratio as well as variability. Presented study was supported by grants GAČR 206/06/1371, GAČR 206/09/P266 and IRP FAPPZ, ČZU MŠMT 6046070901 and IRP IAPG AVOZ50450515.

Genetic population structure of cobia, *Rachycentron canadum* G. using microsatellite analysis

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Cobia, *Rachycentron canadum* (Goode 1884), is an economically important, pelagic fish distributed in tropical warm waters worldwide. The main goal of this project is assess the intra- and inter-population genetic variation in six populations of cobia in the northern coasts of Persian Gulf and Oman Sea using the microsatellite DNA markers. Information on the genetic structure of fish species is essential for optimizing fisheries management and stock improvement programs.

184 specimens of *R. canadum* were collected from six locations between June and April of 2007. Total genomic DNA was extracted by proteinase-K digestion, phenol: chloroform: isoamyl alcohol extraction and ethanol precipitation. Ten primer pairs for cobia microsatellite markers, *Rca* 1B-A10, *Rca* 1B-D09, *Rca* 1B-E02, *Rca* 1B-E08A, *Rca* 1B-E08B, *Rca* 1B-F06, *Rca* 1B-F07, *Rca* 1B-G10, *Rca* 1B-H09 and *Rca* 1-A04, were used in this study. The PCR products were separated on an 8% denaturing polyacrylamide gel containing 19:1 acrylamide: bis-acrylamide and 5 M urea. Allele sizes were obtained by comparison to pBR322 DNA/AluI Marker, 20 sequencing ladders by their size in base pairs.

Of the ten microsatellite loci screened, seven were found to be polymorphic, while three locus, *Rca* 1B-D09, *Rca* 1B-E08B and *Rca* 1B-G10, were found to be monomorphic. The locus *Rca* 1B-H09 had the highest number of alleles (18). The average number of alleles in the Bandarabass population was the highest observed (14.29), followed by that in the Lengeh population (13.43). The average number of alleles in the Beris population was the lowest observed (10.57). The observed heterozygosity in the Bandarabass population was higher than those of the other populations. Population differentiation was modest, especially among populations from the same region systems. The population differentiation (F_{ST}) metric between the Dayer and the Pozm population was the highest (0.055) and significant among the population pair, while the F_{ST} metric between the Bandarabass and Lengeh population (0.000) was the lowest and not significant.

Result obtained from the present study show that at least 3 different population of *R. canadum* are found in the northern coasts of Persian Gulf and Oman Sea, which are including the Booshehr region population, the Bandarabass region population and the Chabaha region population.

Keywords: Microsatellites; Genetic variation; Polymorphism; *Rachycentron canadum*.

Microsatellite and mitochondrial DNA polymorphism reveals genetic structure and stocking impact in native trout populations from Axios (Greece) river system

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The Southern Balkan Peninsula is considered as a biodiversity hotspot region especially for *Salmo* species. Based on earlier morphological studies it is believed that the mountainous tributaries of Axios River (Greece) are inhabited by a distinct taxon, *Salmo pelagonicus* Karaman, 1938. However, a previous genetic study also revealed that the genetic integrity of some of the native trout populations in this area had been substantially changed due to stocking with allochthonous trout, originating from an Acheloos hatchery. The present study was designed to assess in detail the genetic structure and the effects of stocking into the native gene pools of the Axios's trout, using microsatellite and mitochondrial DNA (mtDNA) markers. Microsatellite polymorphism was analysed at nine loci, while mitochondrial diversity was investigated by PCR-RFLP analysis of the mtDNA control region, Cytochrome b and ND5/6 segments. In addition, a 300-bp fragment at the 5'-end, and a 441-bp fragment at the 3'-end of the control

region were also sequenced from representatives of the populations. The results revealed the presence, in some of the populations examined that inhabit different tributaries, of individuals that most probably originated from the Acheloos River. The introgression between native and stocked individuals differed between the various localities, while individual admixture analysis demonstrated a majority of non admixed individuals. Moreover, results derived from mtDNA RFLP analyses revealed extraordinarily strong genetic differentiation of one population (Drosopigi stream), separated only by a few kilometres from the other populations, pointing to an absence of migration among this tributary and the rest of the same river basin. The genetic changes, caused by stocking with trout from Acheloos, might be detrimental to the genetic integrity and possibly the fitness and survival of individual native populations and potentially to the long-term survival of the species. Therefore, it is recommended that stocking with non-native brown trout should be prohibited in the mountainous tributaries of Axios. Furthermore, given the extent of inter-population variation observed, genetic differences among tributaries of the same river basin should be taken into account in future management actions.

Studies of abundance and genetic structure of salmon (*Salmo salar* L.) and sea trout (*Salmo trutta trutta* L.) populations in the rivers of the Nemunas basin

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Atlantic salmon and sea trout populations were investigated in Lithuanian rivers in order to evaluate their abundance, current ecological status and genetic structure.

At present there are 12 major rivers in Lithuania, mostly belonging to the Nemunas basin, inhabited by salmon populations of different abundance. Wild salmon populations inhabit index river Žeimena and two of its tributaries. Mixed populations inhabit 5 larger rivers of the Nemunas drainage system and one stream of the Baltic sea drainage. Populations formed of reared salmon inhabit 3 major tributaries and some smaller streams. In 2008 m. the average density of salmon parr 0+ in the Žeimena was estimated at 2,8 ind./100 m²; and >0+ amounted to 0,08 ind./100 m². The maximum density was 13,3 ind./100 m². Wild salmon smolt production in Lithuanian rivers reached 32800 individuals in 2008. These numbers are the highest during the whole assessment period, indicating recent increase in abundance.

Wild sea trout inhabit 10 major rivers of the Nemunas basin and numerous smaller streams. Its populations are particularly abundant in the Western Lithuania. Average density of sea-trout parr was estimated at 8,84 ind./100m², smolt production amounted 8 200 individuals in the Minija River catchment. Total sea trout smolt production in all 87 sampling sites reached 31600 individuals in 2008, parr density on average estimated at 21,9 ind./100m².

Genetic structure of salmon and sea trout populations of the Nemunas River drainage based on mitochondrial NDA RFLP's indicated relatively low total genetic diversity which might be due to the historic bottleneck events caused primarily by the glaciation and later fragmentation of the habitats caused by human activities. Salmon population from the Nemunas basin displayed no genetic variation according to mtDNA ND1 segment RFLP and fell into the same phylogenetic group as the stocks from the neighbor streams of the region. Meanwhile sea trout populations were characterized by polymorphism at the same mtDNA marker. Five distinct haplotypes were identified in their stocks with significant levels of interpopulation diversity allowing determination of separate evolutionary significant units. Total genetic variation in the sea trout populations from the Nemunas basin was compared to the existing data from other populations within the Baltic sea drainage. Genetic structure of the Vilnia sea trout population preliminary demonstrated the influence of the artificial stocking of farmed sea trout into this river.

Genetic relationships between two seasonal migratory forms of endangered Caspian salmon *Salmo trutta caspius* Kessler, based on RAPD markers

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Salmo trutta caspius is an endemic, valuable and commercial subspecies of *Salmo trutta* in Caspian Sea basin which migrates to some Iranian southern rivers of Caspian Sea for spawning. phylogenetic relationships between two seasonal forms of Caspian trout were analysed by random amplified polymorphic DNA (RAPD) markers. 62 fin

samples were collected from southern part of Caspian sea and examined with 16 oligodecamer primer to asses of population specific bands and their genetic diversity .Totally 162 bands were generated, of these 71 bands (43.83%) were polymorphic and 91 fragments were monomorph. Although 69 and 53 bands (42.59% and 32.72%) were polymorphic for each population. No specific band was found for them. Nei's genetic identity and genetic distance between spring and fall populations were 0.9858 and 0.01430 respectively. The application of these results for the conservation of this subspecies, use of other genetic marker such as microsatellite and mtDNA markers, establishing selective breeding programmes ,are discussed. In this study, finding *S.t.caspicus* populations diversity for better broodstocks management and conservation of endemic populations have been done.

Keywords: genetic relationship, migratory forms, Caspian salmon , RAPD

Application of D-loop and Cytochrome *b* genes for detection of genetically differences between two migratory forms of endangered (*Salmo trutta caspius* Kessler, 1870) assessed by DNA sequencing and RFLP analysis

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Mitochondrial haplotype diversity in two migratory forms of Caspian Sea trout, *S. t. caspius* L., in Iranian coast-line was investigated by sequencing of D-loop and Cytochrome *b* mitochondrial DNA genes (mtDNA).42 samples for fall-run and 21 samples for spring-run were selected for sequencing and RFLP analysis. Furthermore, other samples from two forms were applied for RFLP analysis but considerable genetic differences have not been shown in these regions .Extreme low difference were only Single Nucleotide Polymorphism (SNP) in D-loop region. This subspecies of *S.trutta* is endemic to Iranian water and has been announced in endangered red list of IUCN. We proposed that very low genetic variability in D-loop may be due to severe bottleneck rather than to slow sequence evolution in salmonid fish and probably not using selective programs in artificial breeding caused low genetic variation in two populations but more studies by multilocus micro satellite for better judgment, is recommended.

Keyword: *D-loop and Cytochrome b*, *Salmo trutta caspius*, *RFLP*

A comparison of genetic variation at major histocompatibility complex and microsatellite loci in the wild populations of freshwater cyprinid *Leuciscus cephalus* across geographical scale

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The genetic diversity in the wild populations is the result of neutral evolutionary processes and natural selection. Therefore, investigating genetic variation at multiple types of molecular markers (neutral and “selective”) represents convenient approach that provides to separate the effect of selection from genetic drift or migration. In this study, we compared data from two molecular markers, namely microsatellites as a neutral marker that are affected above all by genome wild evolutionary processes, and major histocompatibility complex (MHC) gene as a “selective” marker that represent one of the best candidates to study natural selection in wild populations. Genetic variability at exon 2 of *DAB* genes belonging to MHC class IIB genes and twelve polymorphic microsatellite loci was analyzed within and between fifteen populations of freshwater cyprinid fish *Leuciscus cephalus* in Europe (including Czech Republic, France, Italy, Bulgaria, Finland, Spain, and Poland). The effect of geographical distance between populations on the genetic variation was also examined. The results indicated that MHC variation was affected by balancing selection rather than random genetic drift and emphasized the role of geographic distance (or isolation by distance) on the degree and sorting of genetic variation.

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Genetic characterization of common carp (*Cyprinus carpio* L.) populations from Greece using mitochondrial DNA sequences

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Introduction

Common carp (*Cyprinus carpio* L., 1758) is divided generally into two subspecies, *Cyprinus carpio carpio* from Europe and *Cyprinus carpio haematopterus* from Asia. The species is considered to be native to Greece. However, during the late 1980s and the 1990s many introductions with fry or fingerlings belonging to the Central European race (Hungary) were made into many natural lakes of Greece (e.g. Koroneia, Volvi) as well as into Greek rivers (e.g. Evros, Aliakmonas). The aim of this study was the genetic characterization of common carp from two lakes (Volvi, Doirani) and two rivers (Evros, Aliakmonas) in Greece as well as the study of the phylogenetic relationships of common carp from Greece with European and East Asian groups.

Materials and methods

Fourteen individuals of wild common carp were analyzed. PCR was applied to amplify a segment of control region and the complete sequence of cytochrome b gene of mitochondrial DNA. A sequencing analysis was followed and DNA sequences were deposited in GenBank (accession numbers EU 689059 – EU 689086). Phylogenetic reconstruction was implemented using MEGA v3.1 program and PAUP* 4.0b10. Similar sequences of one individual from Yangtze River (China- South East Asia) and of one individual from Volga River (Russia - Europe), were used for the phylogenetic analysis. *Carassius auratus langsdorffii* was used as outgroup.

Results

In total 646 bp at the 5' end of the mtDNA control region, as well as 1119 bp for the cyt b were sequenced. A total of 9 variable singleton sites and 7 unique haplotypes were found. A common haplotype was shared among one individual from Lake Volvi (H1), two individuals from Lake Doirani and among all three individuals from Evros River. This haplotype was the same also in the sample from Volga River. Neighbour – Joining dendrogram revealed that all Greek haplotypes were clustered together with the Volga River haplotype (H1) in the same group, whereas the haplotype from Yangtze River seems to be the most genetically distinct in a separate branch.

Discussion

In two out of the four populations studied, only one haplotype was found. Similar loss of sequence variation was reported for European common carp which suggests a history of founder effects and small effective population size. The five different haplotypes found in Lake Volvi, could represent different common carp stocks, after many introductions and translocations that have been made repeatedly in this lake. The H1 haplotype could be the ancestral one, which represents the European origin of common carp populations from Greece or could be justified by the introductions reported with fry or fingerlings belonging to the Central European race, into many natural habitats in Greece. The phylogenetic analysis reveals that populations of common carp from Greece belong to the European group of populations and to the subspecies *C. c. carpio*.

Karyotypes of the Sakhalin sturgeon *Acipenser mikadoi* and the Amur sturgeon *A. schrenckii*: how many polyploid events took place in Acipenserid evolution?

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Zoogeography and Evolution

The karyotypes of the Sakhalin sturgeon *Acipenser mikadoi* and the Amur sturgeon *A. schrenckii* were investigated. The karyotype of *A. mikadoi* includes 262 ± 4 chromosomes; the number of banded chromosome is 80, and the number of chromosome arms 342 ± 4 . The karyotype of *A. schrenckii* includes 266 ± 4 chromosomes; the number of banded chromosome is 92, and the number of chromosome arms 358 ± 4 . The obtained results prove the Sakhalin sturgeon to be octoploid species for the first time and reject its previous classification as 16-ploid species with about 500 chromosomes conducted from the nuclear DNA content study (Birstein et al. 1993). The comparative analysis of cytogenetic

and morphological data demonstrates the validity of this species which differs from the North American green sturgeon *A. medirostris* in the karyotype structure, the nuclear DNA content value, and several morphological characters.

Ludwig et al. (2001) suppose four polyploidization events in Acipenserid phylogeny: the first one occurred in the ancestor of polyploid Atlantic species, the second one occurred in the ancestor of *A. schrenckii* - *A. transmontanus* - *A. sinensis* subclade, the third one occurred in the phylum including *A. mikadoi* and *A. medirostris*, and the fourth one resulted in the origin of *A. mikadoi*. Birstein (2005) recognizes seven polyploidization events: three events occurred within Atlantic phylum, and four ones within Pacific group. (The karyotype of *A. brevirostrum* with 370 chromosomes was described later). Recent data on the karyotype structure of the kaluga *A. dauricus* and the Sakhalin sturgeon proving their tetraploid origins (Vasil'ev et al. 2008) assume at least three polyploidization events in Acipenserid evolution. According to these data, the only polyploidization event should be supposed for Pacific species group, whereas two polyploidization events should be presumed in Atlantic group: the origin of the common tetraploid ancestor with further speciation resulted in different tetraploid species, and the origin of hexaploid *A. brevirostrum*. However, if polyploid species originated by hybridization with triploid forms at intermediate stages, that seems most probable (Vasil'ev 1999, 2009), both triploid forms and final polyploids should possess genomes included haploid sets from different related diploid species. It means that polyploidization did not occur in different phylogenetic lineages, but resulted from the conjugation of phylogenetic lineages. In this case multiple polyploidization events should be presumed.

The study was supported by the Russian Foundation for Basic Research (grants nos. 07-04-00219, 06-04-96004-r_vostok, and 09-04-00211), by the Program "Dynamics of Gene Pools of Populations", and the Program of complex investigations in the Amur River basin FEB RAS.

Prehistory of sturgeon in the Baltic region

Stankovic A., Panagiotopoulou H., Baca M., King T.L. and Stefaniak K.

Two sturgeon species, *Acipenser oxyrinchus* and *A. sturio* are considered native for the Baltic region. According to Ludwig et al. (2002, 2008), *A. oxyrinchus* replaced *A. sturio* during the Middle Ages "little ice period". The last population of *A. sturio* still exists in the Gironde River in France while populations of *A. oxyrinchus* ceased to exist in Europe in the 20th century and survived only in the North American rivers along the Atlantic coast.

We have performed the genetic analysis of the extinct Polish population dated 2nd century BC - 13th century. The material for analyses was obtained from various archeological sites along the Vistula and Oder Rivers. We have analyzed 8 microsatellite loci and fragments of four mitochondrial genes (D-loop, 12S rDNA, 16S rDNA and cytochrome b). The same analysis was performed on five contemporary *A. oxyrinchus* populations from North America and one *A. sturio* population from the Gironde River.

The whole ancient Baltic population was monomorphic for the D-loop sequence (haplotype A). The 12S and 16S sequences were found to be identical both in Baltic and North American populations, different than in the Gironde River population. Only in the case of cytochrome b one half of the individuals forming the ancient Baltic population showed a single base substitution, typical for *A. sturio* and not found in any of the North American populations.

The population structure of all populations was deciphered basing on the microsatellite loci analysis. The genetic distance between Baltic and American (represented by the population from the St John River) populations was found to be much smaller compared to the distance between both of them and the Gironde River population. All three populations were found to pass through the bottleneck. The ancient Baltic population showed richer population structure than the remaining populations under study. It is therefore evident that already 2000 years ago the *A. oxyrinchus* population in the Baltic region was well established and was probably founded much earlier than it postulated.

Life History Strategies and Population Ecology

Salmon and Sea trout migration studies in Lithuanian rivers

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Among longest freely flowing salmon and sea trout migration routes in Europe few remains in Lithuania with Žeimena River (510 km), Neris River (505 km to Belarus border) and Siesartis River (410 km to first fish ladder) maintaining numerous salmon and sea trout populations. Therefore it's very important to understand and determine

main patterns of salmonids spawning migration in those natural rivers. Radio tracking studies in year 2007-2009 with 32 tagged specimens of sea trout and salmon in Siesartis river revealed some previously unknown features of salmonids migration, habitat selection and spawning. Manual and automatic radio tracking data analysis indicates 2 daily activity peaks for both species. Males activity, moving speed and distance traveled were significantly larger than of females. For males of both species multi-spawning with few females were often observed. Tagged females usually showed very strong site fidelity with most static specimens remaining in spawning river significantly longer than more active females. Majority of daily movements in the river were short, but relatively long and fast movements were also observed with one tagged sea trout male moving almost 20 km upstream in 2 hours and 4 minutes. Salmon migrates from small tributaries just after spawning and migration to the sea last up to 2 months. Sea trout post spawning migration mainly depends on weather conditions and river flow with most active downstream migration detected during flooding events and periods of low air temperature. For both species post spawning migration speed is almost the same as natural river flow. Anthropogenic impact was assessed with fish ladder effectiveness, angling, commercial and illegal fishing impact studies on tagged sea trout and salmon. Cascade type fish ladder effectiveness was 66 %, thought recommended necessary improvements significantly improved fish ladders effectiveness. All forms legal and illegal fishing are one of major threats for migrating salmonids in Lithuania with more than 30 % of tagged fish reported being caught, with one sea trout caught in the Vistula River (Poland) mouth. Homing were discussed as only 15 % of all tagged fish in year 2007 returned to the main river in year 2008 with only one being registered in the same spawning grounds.

Life history strategies in the most species rich notothenid genus, *Patagonotothen*

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With regard to the number of species (14), abundance and ecological diversity, fish of the *Patagonotothen* genus dominate fauna of Southern South America and the Falkland Islands. The genus *Patagonotothen* is known almost exclusively from the Patagonian region of South America. However, a population of *Patagonotothen guntheri* has been found to occur around Shag Rocks, south of the Polar Front. On the Falkland Islands Shelf, the three most abundant species are quite well separated spatially and bathymetrically. *Patagonotothen ramsayi* is the most abundant finfish on the Patagonian Shelf with over 60,000 tonnes reported as catch by the commercial fleet in the Falkland Islands in 2008. It has the greatest bathymetric range (52 – 996 m) and is distributed from the Burdwood Bank (55°S) to 35°58'S in the Atlantic. *Patagonotothen ramsayi* is not found in the Pacific; here it is substituted by its sibling species *P. longipes*. *Patagonotothen guntheri* is found in the southern parts of the Falkland Islands shelf in the sub – Antarctic waters of the Falkland Islands Current, a derivative of the Antarctic Circumpolar Current between the depths of 50 and 329 m. *Patagonotothen tessellata* has more of an inshore distribution ranging from 15 to 250 m and seems to be restricted to the eastern and south eastern parts of the Falkland Islands Shelf. In inshore waters the species also occupy very different eco-niches. The small *P. squamiceps* is laterally compressed and thus has a very different body shape to the others and occupies the kelp (*Macrocystis pyrifera*) canopy. On the other hand the small *P. cornucola* inhabits the kelp litter at the bottom of the kelp forest. The larger inshore species *P. wiltoni* and *P. brevicauda* prefer more rocky environments. One species, *P. sima*, has even managed to penetrate the intertidal environment. All of the species occupy the niches of small opportunistic predators, similar to sculpins in the northern hemisphere. They are also extremely important to the ecology of the Patagonian Shelf as predators and scavengers but also as prey to all of the larger predatory demersal fish species in the region. In this study we present data on age and growth, reproductive biology, trophic ecology and compare and contrast their population parameters and life history traits. The study demonstrates that this successful genus has radiated to fill a number of previously empty eco-niches in the Patagonian region.

Distribution and Characterization of Resident Spawning Aggregation Sites of the Parrotfishes *Chlorurus sordidus* and *Scarus schlegeli* (Labridae: Scarinae)

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Resident reef fish spawning aggregations form when participants migrate short distances from their home ranges or feeding grounds to an adjacent location in order to court and spawn. These events show predictable spatial and

temporal patterns in both aggregation form and function, and may occur on a daily basis at lower latitudes where water temperatures are relatively warm and stable. Parrotfishes (Labridae: Scarinae) form spawning aggregations that conform to this model, which makes them vulnerable to over-exploitation. On Guam, Mariana Islands, *Chlorurus sordidus* and *Scarus schegeli* typically form spawning aggregations daily between 0900-1300H, when terminal phase males establish and defend temporary mating territories and attempt to court with females that pass through the spawning aggregation site. Relatively little is known about the patterns of distribution of such sites nor why spawning aggregations form at certain locations but not others. We investigated the distribution of spawning aggregation sites for both species on reef terraces surrounding Guam. Surface-subsurface manta tows allowed divers to identify, enumerate and characterize these sites in relation to habitat structure at depths of 5-18m. Divers towed a GPS surface buoy directly behind them in order to determine the location of sites where five or more males were observed defending temporary breeding territories and courting females. Over 130 km of reef was surveyed with replication. The distribution of spawning aggregation sites followed a non-random pattern and appeared dependent upon specific habitat types and corresponding submerged geomorphological features. Knowledge of the geographical distribution of reef fish spawning aggregation sites relative to preferred reef habitat and geomorphology is essential for the design of effective conservation management strategies that protect spawning fishes from exploitation.

Habitat use by fish in Mediterranean streams: responses to fine-scale habitat heterogeneity

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Streams are heterogeneous over multiple spatial scales, and this patchiness is likely to affect the abundance, distribution and habitat use of stream fishes. Nevertheless, there are few studies of habitat use in stream fishes using multiple techniques or spatial scales. This is particularly the case in Mediterranean streams, where relationships between fish populations and their habitat have mainly been studied at intermediate spatial scales (i.e. single or multiple channel units) with electrofishing. We examined microhabitat use by an endemic chub *Squalius torgalensis* and three-spined stickleback *Gasterosteus gymnasium*, at two small scales of heterogeneity, corresponding to the fish's focal point and to sampling units of 1m². Fish and habitats were sampled in one 80-m reach in the Torgal stream (SW Portugal), between April and May 2009. Fish were observed underwater, identified to species, and standard length estimated visually. Focal observations were conducted for 137 chub and 18 three-spined stickleback and we quantified: 1) location, 2) water column depth, 3) distance of the fish from substratum and shelter (object capable of concealing > 50% of the fish's body), shelter type, distance and identity of nearest neighbour. We also measured focal and average current velocities, and visually estimated substratum composition (boulders - >30 cm; large cobble - ≤30 and >15 cm; small cobble - ≤15 and >2.5 cm; gravel - ≤2.5 and >0.2 cm; sand - ≤0.2 cm), vegetation cover, debris and tree roots under each individual. Additionally, we visually estimated the habitat characteristics and number of fish in 62, 1m² quadrats. Habitat availability was derived from independent records, obtained in 100 quadrats, randomly selected from a grid of 1x1m, covering the entire wetted area of the study reach. Habitat selection by each species and size class was assessed by comparing the characteristics of habitats used by fish with those of available habitats, for both types of analysis. We also examined the relationships between fish abundance and habitat characteristics. Multivariate regression and ordination techniques were mainly used in data analysis. Overall, there was considerable overlap in habitat use between chub and stickleback, and among large (80-99 mm), medium-sized (60-79 and 50-59 mm) and small chub (<50mm), with fish generally tending to favour microhabitats with lower velocities and coarser substrates. These results suggested that fine-scale habitat heterogeneity may influence habitat use by fish even in assemblages of limited diversity and ecological specialization as in Mediterranean streams, and emphasised the importance of multiple approaches in highlighting species-habitat patterns, and their underlying biological processes.

Seining the riparian zones of lowland rivers over 24-hour cycle

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Lowland rivers as endangered riverine biotopes covers high species diversity, however their diversity is still not well documented due to the many problems with the sampling methods. In this case, we aimed to test the suitability of small beach seine net (2x5m, mesh size 6 mm) on two lowland rivers in Slovakia. Latorica and Tisza Rivers are the most important lowland rivers in the lowland area of Eastern Slovakia. Considering their natural character, few recent studies were focused on these large rivers. We aimed to investigate one swallow beach (riparian area) on each river in early summer (June-July) and late summer (August-September). Seine netting was undertaken during the 24 hour cycle every 2 hours. Altogether, 4818 specimens of 20 species on Tisza River and 936 specimens of 26 species on Latorica River were recorded. Comparing the particular seasons on Tisza River, *Romanogobio albipinnatus*, *Chondrostoma nasus*, *Sabanejewia balcanica*, *Leuciscus leuciscus* and *Alburnus alburnus* were the most frequent in early summer (frequency >90%), while *Sander lucioperca*, *Chondrostoma nasus* and *Romanogobio albipinnatus* were the most frequent in late summer (frequency only up to 62%). In the samples from Latorica River, *Gymnocephalus schraetser*, *Romanogobio albipinnatus* and *Sander lucioperca* were the most frequent species in early summer (frequency >90%, while only *Gymnocephalus schraetser* reached frequency more than 90% in late summer. The number of species as well as the number of individuals varied during the 24 hour cycle reaching the highest values during dusk. The occurrence and the proportion of species varied over the diurnal cycle, however no significant differences (Kruskal-Wallis test, $p < 0.05$) between particular samples within the diurnal cycle was detected.

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Characteristics of the bitterling (*Rhodeus amarus*) population in a small lowland river

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We sampled the population of the European bitterling (*Rhodeus amarus*) from the Kyjovka River, a small lowland river in a southern part of the Czech Republic (Danube Basin). Regular sampling was conducted from April 2007 to March 2008 over a 200 m long stretch of the river. All sampled bitterling were sexed, measured (standard length) and reproductive status of females was examined. During reproductive season, 20 individuals of each sex from a different but adjacent stretch were preserved for further analysis (gonadosomatic index, fecundity, body lipid content). After reproductive season, 20 juveniles were preserved for analysis. The abundance of bitterling was relatively stable during the reproductive season, with a sudden decrease in June. Gonadosomatic index in males and females showed little variability during from April to mid June, but rapidly decreased in mid June, corresponding with the end of reproductive season. The sex ratio (males to females) changed from 1:1.5 at the start of the reproductive season to 1:4 after the end of the reproductive season. No seasonal changes in standard length and lipid content of adult fish were detected. Lipid content increased until the start of the reproductive season and decreased with an increase in gonadosomatic index. In conclusion, (1) the study bitterling population had an annual character with increase in adult mortality at the end of the reproductive season, (2) male mortality over the reproductive season was higher, and (3) lipid reserves appeared to be used for gonad maturation. Financial support for this study was provided by Czech Science Foundation (206-09-1163).

Application of recent developments in biodiversity partitioning to freshwater fishery research

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One of the basic ecological ideas is that biodiversity should be estimated at different, mostly spatial, scales, and the estimates related in a meaningful way. The practical realization of this idea was difficult as two contradictory methods, additive and multiplicative, appeared at the very beginning. The former assumed that average within communities, α , diversity, should be additive to that between communities, β -diversity, to form γ -gamma diversity; the latter that they should be multiplied by one another to produce γ -gamma. The γ -gamma of the given level should then be the α -diversity of another, higher level. Despite a multitude of diversity measures since then invented the idea of hierarchical diversity partitioning, or decomposition, has been first embodied in a formally coherent, additive system at the turn of the 70s of the 20th century. However, it became popular among scientists only when its theoretical basis was established, at the turn of the century, for three diversity measures: species richness, Shannon information and Gini-Simpson index. Mostly plants and invertebrates became objects of numerous studies that employed these measures in hierarchical diversity analyses. Advances in diversity analysis that were carried out in recent several years proved that the formal coherence of the system may mask its counterintuitive qualities. A multiplicative system that uses Hill's diversity numbers was proposed instead. In freshwater fisheries, the correct identification of diversity patterns, for example the local species richness vs. regional species richness, is of direct application importance as it may serve to identify regions that are of low species saturation and thus promising as sites of successful fish introductions. The present study compares the characteristics of additive and multiplicative diversity evaluation systems when applied in freshwater fishery analysis. It is shown that the multiplicative system, although free of the bias of the additive one, also has its drawbacks.

Present condition of Lake Paravani Ichthyofauna (South Georgia)

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Among the lakes of Georgia, Lake Paravani is the largest by its surface area (37.5 km²), it is located in the southern part of Georgia on the Javakheti upland about 2080m above the sea level. The maximum length of Lake Paravani is 10km, and the maximum width 5.75 km. Maximum depth is 3 m. Volume of the lake is 90.8 million m³. For the last 30-40 years there were no data about the fishes of this lake.

For fish sampling nets of different types (seines, trapnets and gillnets) with various mesh-size and length were used, as well as methods used by amateur fishermen were applied. Samples were collected from 3 horizontal strata during 2006-2007, in March, April, May, June, August, September and November. Thermal and chemical condition of water, zooplankton and zoobenthos was examined simultaneously.

According to our study the major species in the ichthyofauna of Lake Paravani are the introduced and acclimatized European vendace (*Coregonus albula*) (75% of total catch) and crucian carp (*Carassius carassius*) (15-20% of total catch). The living conditions of Lake Paravani are favourable for vendace. Biological peculiarities of Paravani vendace – high growth rate and fast maturation – are responsible for the fast renewal of fishery after exhaustion of resources. Fishes in their third year of life may become the targets of fishery. Besides these two species, there are a number of native fish species in the ichthyofauna of the lake, namely riffle minnow (*Alburnoides bipunctatus*), roach (*Rutilus rutilus*), khramulya (*Capoëta capoëta*), chub (*Squalius cephalus*), kura gudgeon (*Romanogobio macropterus*), murtsa (*Barbus mursa*) and in very small numbers brown trout (*Salmo trutta*) and the native carp (*Cyprinus carpio morpha hungaricus* Heck). All these eight species comprise combined only 5-10% of total fish catch. During the investigation the population of vendace in Lake Paravani was represented by five age groups, especially abundant were the 2+ and 3+ age groups. Crucian carp and khramulya showed six age groups, and in our data we obtained four age groups for chub, roach and gudgeon. Riffle minnow, murtsa, trout and carp were obtained in small numbers, and we were able to catch only three age groups of these fish species during our research.

The present uncontrolled fishery prevents the fish from utilising their ecological production potential to the benefit of the local population, and may threaten a balanced functioning the Lake Paravani ecosystem.

Potential reasons for the changes in the abundance of pike, *Esox lucius* L. in the western Gulf of Finland, 1939-2007

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Pike catch-per-unit-effort (CPUE) in rod and line fishing fluctuated considerably in the western Gulf of Finland during 1939-2007. Since the beginning of the 1980s CPUE has been only about 3 - 4% of the highest CPUEs during the period, suggesting a drastic decrease in population size. The collapse of the population coincided with a rise in the nutrient level in the Baltic Sea and consequent changes in productivity, turbidity and vegetation. The differences in the food web that have followed the environmental change may partly explain the variation both in CPUE and the mean weight of pike caught. The long-term fluctuations in salinity and temperature, however, did not seem to affect the population size. The mean weight of pike fluctuated inversely with CPUE, indicating changes also in the recruitment of pike to the study area.

Population dynamics of the Atlantic salmon in the Russian North during last four centuries

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Atlantic salmon *Salmo salar* was one of the most important commercial species in the Russian north and provided important resource for colonisation of this vast area where agriculture, due to severe climate conditions, is possible only in a very limited extent. Due to this, historical records on the salmon fisheries are quite abundant. We analysed salmon catch records for period from the 17 to 20th centuries from several locations of the Barents and White Seas areas. Historical records, found in Russian archives, allow analysis of long-term series of catches covering four centuries, firstly developed for this species. Salmon were fished mostly in the lower parts of rivers, using weirs which technologically were not changed over the centuries. This makes fishing effort commensurable and allows comparison of historical catch data of the 17-18th centuries with statistical data available since the last quarter of the 19th century and with data for latter periods.

In most locations of the Russian north population dynamics of salmon was driven mostly by natural factors until approximately 1930s, when the region experienced fast development during Soviet industrialisation. In particular, we did not find obvious decline of populations in the end of 19th - beginning of the 20th in comparison with the 17-18th centuries. For this entire period we correlated indices of population abundance with temperature time series and found that the salmon abundance decreased during relatively colder periods. Although it is predictable pattern for the boreal species occurring near the border of its distribution range, the value of the results is due to the long-term series, which clearly show that climate was the main force driving population abundance of salmon in this period.

Many European and North American populations of Atlantic salmon started to decline as early as the 18th century. In the Russian north salmon remained abundant much longer due to low population density and slow industrial development of the region. First signs of anthropogenic influence on salmon populations there became visible since the late 19th - beginning of the 20th. In this period we observed decrease of catch per unit effort in the northern parts of the White Sea, where fishing was more intensive because of absence of alternative occupations. Salmon of western and southern parts of the White Sea started to experience decline somewhere later, because timber industry and other types of industrial development provided alternative employment and therefore decreased fishing pressure for some time. But soon timber production, dam construction and chemical pollution resulted in serious decline of salmon populations in this area. Present abundance of Atlantic salmon in the Russian north is not comparable with historical, although number of rivers in the region maintain quite healthy populations of Atlantic salmon.

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The use a GIS technology for estimation of Greenland halibut fishable biomass

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The Greenland halibut is a high value target species in the Barents Sea. The fishable stock biomass is assessed by the ICES Arctic Fisheries Working Group by the analytical approach based on the theory of fisheries. The direct fishery of the Greenland halibut in 2000-2007 vary within 4.6 – 7.1 thousands ton and the main fishing grounds are located to the south of Spitsbergen. Daily VNIRO receives the reports of the Russian fishery on Greenland halibut, which contain the following information: date, coordinates, type of vessel, target object and its catch, type of trawl, duration trawling. It is known, that the fishery is carry out by bottom trawls mainly. However, due to a pelagic behavior of the adult Greenland, fish concentrations are observed not only near a bottom, but also at a long distance from a bottom. The stock assessment was calculated using GIS ArcView software, catchability coefficient 0.2 was used. The annual averages of biomass were determined as their arithmetical mean for the September-December period. The results showed that in 2001-2007 the fishable biomass ranged from 242 thousands ton to 366 thousands ton. The values of the fishable stock biomass ICES Arctic Fisheries Working Group, based on XSA, varied for this period from 91 thousand ton to 127 thousand ton.

Spatial distribution of threespine stickleback (*Gasterosteus aculeatus* L.) in Keret Archipelago (Kandalaksha Bay of the White Sea)

Ivanova T.S., Lajus D.L., Shatskikh E.V. Popov. V.A.

Threespine stickleback *Gasterosteus aculeatus* in the White Sea demonstrate considerable long-term fluctuations. Before 1960s this fish was very abundant, but then, up to late 1990s its abundance decreased. Last decade there is an evident growth of stickleback population and now this fish is probably the most numerous in the White Sea. Many researches correlate changes of stickleback abundance in the White Sea with seagrass *Zostera marina*, because stickleback are closely related to seagrass in reproduction period. Our previous quantitative studies showed that abundance of adult stickleback increased several-fold in 2007 in comparison with 2006, but that study included only few locations. Therefore in the present study we analysed spatial heterogeneity of stickleback in spawning grounds, what allows more reliable estimates of their abundance. Also, we studied juveniles distribution and compared patterns of adult and juvenile distribution.

Samples were collected during summer 2008 in Keret Archipelago (White Sea, Kandalaksha Bay) with a little seine, 7.5 m of length, 150 m² of catch area. Adults were sampled in 22 stations in June and July, and juveniles in 7 stations in August. The inshore spawning migration of sticklebacks begun since late May and during June abundance of both males and females increased. Spawning occurred from mid-June to mid-July. Soon after this females left spawning grounds, while males stayed there till late July guarding their nests. In August adult sticklebacks were only rarely observed nearshore. Maximal density of spawning stickleback (18 and 30 ind./m²) was observed in two protected inlets with dense seagrass beds. In other stations fish abundance was lower and ranged from 3 to 13 ind./m², (7 ind./m² in average). Overall, no association was observed between fish density and type of vegetation (seagrass or brown furoid algae), or salinity (estuaries or open sea coast). It is interestingly enough that fish density was notably near little islands (0.5 – 1.5 ind./m²) than near mainland with similar conditions. Comparison of 2008 data with data from 2006 and 2007 shows 15-fold growth of stickleback population in the White Sea during last three years.

Larvae started to hatch in late July –early August. Their spatial distribution was much more heterogeneous than that of adults. In brown algae biotopes juveniles were absent or rear, while in seagrass their density ranged from 40 to 2000 ind./m² in the beginning of August and then decreased up to 0.2 – 115 ind./m² in the second half of the month. Higher juvenile densities were associated with more dense seagrass beds.

Therefore our study showed that adult and juvenile stickleback demonstrate considerably different patterns of spatial distribution. Adult fish distribute quite evenly across different biotopes, while juveniles are much more attached to seagrass beds than to other biotopes. These results may have following explanations: (i) While spawners occur in both brown algae and seagrass, spawning takes place preferably in seagrass due to local migrations. (ii) Juvenile mortality (due to fewer predators, better feeding conditions or other reasons) is lower in seagrass beds than in other biotopes. (iii) Juvenile migrate to seagrass beds from other biotopes. In general, our results confirm critical role of seagrass in life cycle of threespine stickleback.

Stock discrimination of black seabream (*Spondyliosoma cantharus*) through otolith elemental fingerprinting at the SW Portuguese coast

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The black seabream (*Spondyliosoma cantharus* Linnaeus 1758) has a worldwide distribution and occurs in several locations, mostly inshore, in the European and African coasts of the Atlantic Ocean, in the Mediterranean and extending into the Black Sea. It is one of the most important commercial sparids species from the shores of Portugal and represents nowadays about 3200 tonnes/year of the Portuguese fisheries landings. Although there is some knowledge about the age, growth and reproductive biology of the species, the information about its population structure is scarce. The use of natural tags, such as otolith elemental signatures, proved to be efficient to study fish connectivity, to clarify population structure, to discriminate stocks and has been essential in resolving dispersal and mixture separation in high gene flow systems where environmental heterogeneity exist. In this study the otolith elemental fingerprint of a sample of 90 fishes of age group 2+ captured in Sesimbra, Sagres and Ria Formosa have been analyzed by inductively coupled plasma mass spectrometry (ICPMS). Two different methodologies have been applied: study of the entire lifetime of the fish (whole dissolved otoliths, ICPMS-SB) and of the larval stage (otoliths core, ICPMS-LA). Our goal was to detect a natural chemical marker, which could permit to distinguish between different stocks, nursery grounds and also tracks the migration of individuals. ICPMS-SB analysis detected informative concentrations of Ca, Sr, Ba Mg, Mn, Mg and Ni in whole dissolved otoliths. ICPMS-LA, sectioned and polished of otolith core, provide information based in concentrations of Ca, SR, Ba Mg, Mn, Mg, and Zn. Results of both techniques were analysed by univariate and multivariate statistical analyses. The data showed significant elemental differences among sites to whole otolith and core otolith analyses. Classification accuracy rate are determined by linear discriminant function analyses (LDFA). The data show a high classification rates to all sites (Ria Formosa 97%, Sagres 94% and 85% to Sesimbra) for ICPMS-SB. However LDFA for ICPMS-LA only accurately classify the specimens caught in Ria Formosa (73%). The data suggests that probably exist a single spawning area, which contributes mainly for the SW stock, and that the fishes are relatively sedentary during the juvenile phase, showing high fidelity to the growing zones and allowing to define three independent management stocks-units in this main fishery area.

Downstream migration of the 0+ Tubenose goby from Nové Mlýny Water Reservoirs, Czech Republic

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The first record of several specimens of Tubenose goby (*Proterorhinus marmoratus*) in the Czech Republic was registered at one site of stony bank of upper lake of the Nové Mlýny reservoirs in 1994, far away from its original distribution area. During following years, *P. marmoratus* spreads along the bank of all lake and penetrated downstream to the second and third lake and further downstream of the Dyje River. Recently the natural spreading of *P. marmoratus* upstream from the lowest Morava River and/or Danube River was recorded. At present Tubenose goby belongs to a dominant fish species in littoral zone of the lower Dyje River.

In 2002 and 2003, from May to August, an ichthyological research was carried out on the Dyje River under the Novomlýnská dam (Nové Mlýny Water Reservoirs). The study was focused on downstream migration of early stages of development of the Tubenose goby specimens. The fish-up was performed directly under the power station in Nové Mlýny which is a discharge from the Novomlýnská dam. During the above mentioned period, several field examinations were made, repeated in approximately ten-day intervals. The aim of our study was to evaluate spectrum of migrating fish from the point of view of size, seasonal and daily dynamics of downstream migration and observation of abiotic factors (water temperature, oxygen content in water, water stream velocity, water transparency and stream conditions) in the course of examination.

Application of fish otolith microchemistry to trace patterns of migration and habitat utilization in diadromous fishes: case study in Lithuania

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The study demonstrates potential of analysis of fish ear stones (otoliths) microchemical structure in tracing fish migrations through gradients of chemical markers in water; a particular case study on European eels (*Anguilla anguilla*) in Lithuania is presented as an example. Similar studies were performed on perch (*Perca fluviatilis*) and pikeperch (*Sander lucioperca*).

Glass eels purchased in the UK and France have been directly released into Lithuanian inland waters and mixed with naturally recruited eels for several decades. The study aimed to discriminate between both stocked and naturally recruited eels, to evaluate the contribution and interaction of the two possible eel origins to each population of studied sites. To distinguish the restocked eels from naturally recruited ones and to understand the migratory environmental history of the eel, strontium (Sr) and calcium (Ca) contents in otolith of the eel were examined by wavelength dispersive X-ray spectrometry with an electron probe microanalyzer; laser-ablation ICPMS was used for Na:Ca, Mg:Ca, Mn:Ca and Ba:Ca analyses, to distinguish between eels from the freshwater lagoon and lake. The eels were sampled from the brackish Baltic Sea and a freshwater Curonian lagoon and inland lake in the eastern part of the country. Stocked eels were identified by the freshwater signature (Sr:Ca ratios $< 2.24 \times 10^{-3}$) on the otolith after the glass eel stage. Naturally-recruited eels, that had migrated through the North and Baltic Seas, were characterized by an extended sea/brackish water signature (Sr:Ca ratios $> 3.23 \times 10^{-3}$) after the glass eel stage. Of 140 eels analyzed, 23 eels had otolith Sr:Ca ratio profiles consistent with stocking while 117 showed patterns of natural recruitment. Eels from the inland lake were all of stocked origin. However, stocked eels accounted for only 20% of the eels from the Curonian Lagoon and 3.75% of eels sampled in Baltic coastal waters. One-way ANOVA tests indicated that both Ba:Ca and Na:Ca ratios in eel otoliths were significantly higher for the eels in the lagoon than those of the lake ($p < 0.05$) and enables correctly assign 83% of the eels to their freshwater sampling locations, however, otolith Mg:Ca and Mn:Ca ratios were similar for eels from the two environments. This study does not support the hypothesis that the eel stocks in the lagoon and coastal waters are predominated by stocked eels and reveals some aspects of eel migration pattern.

The Baikalian amphipod *Gmelinoides fasciatus* in the diet of fish in the waterbodies of north-western Russia

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The Baikalian amphipod *Gmelinoides fasciatus*, the most successful invader in Eurasia, colonized coastal zone in a number of lakes and artificial reservoirs of European Russia in 1960-2000s. In the present study, we focused on the role of an invading, partly carnivorous macrozoobenthic amphipod (*G. fasciatus*) in food webs and particularly in the diet of diverse fish on example of two large aquatic ecosystems of European Russia (Lake Ladoga and Rybinsk reservoir), where the Baikalian invader has successfully established since 1980s. In Rybinsk Reservoir the biomass of *G. fasciatus* was maximum 19-25 gm⁻² (Skalskaya, 1994; Scherbina, 2008), whilst in Lake Ladoga and in native Lake Baikal it reached 100 gm⁻² and more (Bekman, 1962; Berezina et al., 2009).

The stomach content analysis of various fish from littoral area of Lake Ladoga showed that the *G. fasciatus* was an important item in the diet of the burbot *Lota lota* (in the age of 0-1+), perch *Perca fluviatilis* (1-3+) and ruffe *Gymnocephalus cernuus* (2-5+) constituting the most important proportions in their diets (perch-63.5%, ruffe-87.3% and burbot-76.4%). The role of *G. fasciatus* and the native amphipods *Monoporeia affinis* and *Pallasea quadrispinosa* in the diets varied significantly between northern and southern locations in the lake. In the southern part of the lake *G. fasciatus* was included in the diet by 100% of tested fish species while at the northern location invader was a regular (70-100% of occurrences) but very scarce item (3-4% of stomach content) in the diet of these fish which fed preferably on the native amphipods.

In Rybinsk Reservoir the stomach content of kilka *Clupeonella cultriventris*, vendace *Coregonus albula*, perch *P. fluviatilis* and ruffe *G. cernuus* from the main stretch were analyzed. The pelagic forms of *P. fluviatilis* fry and *G. cernuus* (0-2+) fed primarily on chironomids larvae, using the Baikalian amphipod as a secondary food item. In contrast, the amphipod *G. fasciatus* was a very important component in the diet of underyearling perch (0+, 55-73 mm of body length) in littoral zone of Volga Stretch and in other parts of the reservoir, reaching 80-100% in the mass proportion. The frequency of occurrence of the amphipod in the perch diet varied between 31 and 80% (Tyutin, Valtonen, 2003). Besides, the Baikalian invader was detected in the diet of the tubenose goby *Proterorhinus marmoratus* (Tyutin et al., 2007), the non-indigenous fish species. The 1/10 part in population of the invasive fish *C. cultriventris* (in the age 2+ and body length 89-95 mm) consumed on *G. fasciatus* juveniles, however mass proportion of this amphipod in its stomach did not exceed 11%. *Gmelinoides fasciatus* was recorded in 80% of *C. albula* stomachs. The using of benthic animals as food items by typically plantivorous fish species may be a result of low supply of usual items in autumn and is an example of the forced food choice of new abundant food object as *G. fasciatus*.

Therefore, the human-mediated introduction of *G. fasciatus* in lakes and reservoirs of European Russia resulted in a greater share of the benthic production available for fish, intensive use of new component by fish and obviously increase of the overall fish production.

Biological and Morphometric Characteristics of Siah Mahi, *Capoeta fusca* a Cyprinid Fish Living in the Qanats of Birjand County (South Khorasan Province, Islamic Republic of Iran)

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The qanat is a unique environment for fishes comprising an adit which taps groundwater and provides a permanent flow. In many areas of the Iranian plateau, fishes are only found in qanats, some of which have flowed for many hundreds of years. The siah mahi or black fish (*Capoeta fusca* Nikol'skii, 1897), a cyprinid, is one of the most important fishes in qanats of eastern Iran. Qanats are now rapidly being replaced by pump-wells which are faster and easier to excavate but do not provide fish habitat. Also schemes to restrict water flow from qanats for conservation reasons will presumably affect the available habitat for fishes.

In this study, morphometric characteristics, diet and reproduction of 600 specimens were studied in qanats of the central zone of Birjand County, South Khorasan Province.

The mean total length was 13.51 ± 1.43 cm and maximum length was 21.5 cm. The length-weight relationships of this fish was described by body weight = $0.0101 \times \text{total length}^{2.9477}$ ($r^2=0.9747$). The mean relative length of the gut was 4.42 ± 0.48 , suggesting that this species is an herbivorous fish. Similarly, the mean of the vacuity index was 30.95 ± 5.90 , and this fish was classified in a relatively gluttonous group. Besides plants as the primary food, mollusks, aquatic insects, and sometimes frog eggs were distinguished as secondary foods. According to the gonadosomatic index, the reproduction period of begins in March and lasts into May. Variations of the gastro-somatic index show that feeding is correlated with reproduction. Measurement of salinity resistance in 96 fish showed that this species can withstand up to 10 p.p.t. of salinity indefinitely. In the natural environment of this species salinity rang was from 0 to 6.3 p.p.t., pH was alkaline, and temperatures was 3.9 to 27.9°C. Another outcome of our study was observation of social behavior (schooling). Both in the natural environment and when fish were kept in aquaria, fish move or maintain station in one direction in groups.

Keywords: *Capoeta fusca*, siah mahi, qanat, biometry, diet, Birjand, Iran

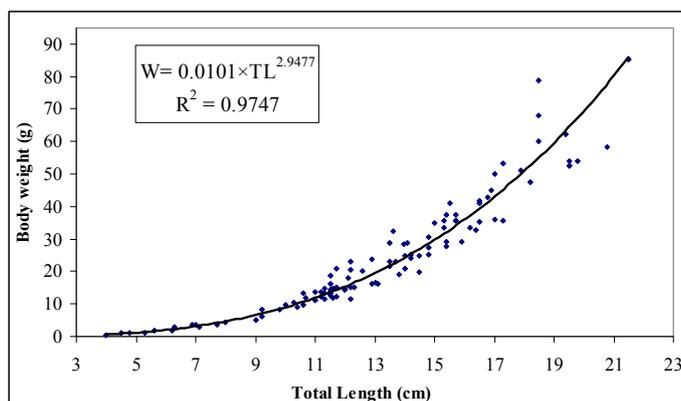


Fig. 1. Length-weight relationship (n=600)

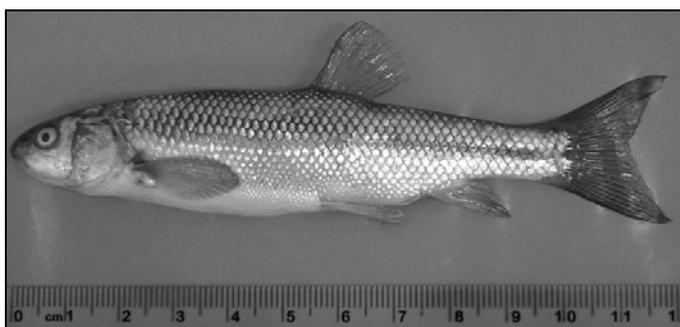


Fig. 2. A specimen of siah mahi from Birjand (S. A. Johari)

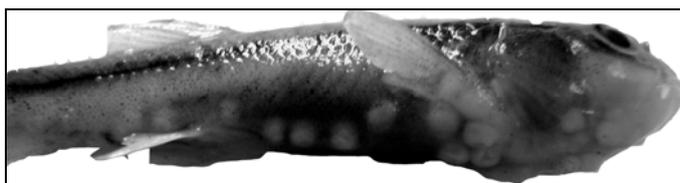


Fig. 3. A specimen of siah mahi from Mehdi Abad qanat, intensively stricken with the trematode *Clinostomum* sp.

Preliminary data on an invasive fish, *PSEUDORASBORA PARVA*, from Hirfanlidam lake in Turkey

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Pseudorasbora parva is a small cyprinid native to South-East Asia, but during last decades its distribution is greatly varied. This species has been accidentally carried to Europe and Asia and established successful populations.

P. parva is generally regarded as a pest due to its high reproduction potential and colonization rate which give rise to dense populations. This species is also known to have wide ecological and physiological tolerance. Recently, it is realised that *P. parva* is a vector of a deadly pathogen causing lethal infection. Thus, some countries have been eradicating *P. parva* from freshwater systems.

The occurrence of *P. parva* in Turkey was first recorded from the Thrace region in 1982; from then on, it has been rapidly expanded its distribution area due to its invasive capability and colonized most freshwater environments in Anatolia. On the other hand there is no data about life span, growth, reproduction and feeding properties from Turkey. In order to assess the potential impacts of this species we intended to determine some biological features of *P. parva* adapted to cold continental climatic conditions of Central Anatolia.

In this study, we present preliminary results on growth and reproduction properties of *P. parva* which is established a dense population in Hirfanlı Reservoir, where it was observed that *P. parva* shares the littoral zone with *Atherina boyeri*, *Aphanius danfordii* and sometimes with *Tinca tinca*. Local fishermen exploit mostly *Atherina boyeri* for its economical value which is another non-native fish species for Turkish inland waters. Although *P. parva* was appeared just a few years ago in the Hirfanlı Dam Lake, the increase of this invasive population becomes a threat for fishermen. This study summaries the preliminary data on *P. parva* population in Central Anatolia. A total of 3277 fish sample were caught between April 2008-April 2009, and data collection from different points of dam lake is still going on. The life span is similar as found in other countries; maximum age is found to be 4 years. In juveniles, females and males, fork length is ranged between 13.02-46.78 mm 15.68-93.36 mm, 16.68-98.93 mm respectively. These figures are higher than that of other *P. parva* populations in Anatolia. The growth rate of this species is very high and the length-weight relationship is $W = 8 \times 10^{-6} L^{3.10}$ (juveniles), $W = 2 \times 10^{-6} L^{3.43}$ (females), $W = 3 \times 10^{-6} L^{3.37}$ (males). Mean monthly condition factor values are varied between 0.758 (in January) and 1.065 (in August). The overall sex ratio is 1:1.08 (M:F). Matures very early, in next April after hatching and the minimum fork length of matured males and females were respectively, 24.36mm and 18.31mm. According to gonadosomatic index values, spawning period is between the beginning of May and the end of July. The first results of the ongoing studies on ovaries suggest that spawning takes place in batches. The gut content of *P. parva* specimens collected from Hirfanlı Dam Lake was partly investigated, however, Cladocera, Copepoda, Rotifera, Dipteran larvae and any other invertebrates members were observed in gut contents.

Long-term changes in fish assemblages in the impounded Warta River, Poland

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On the basis of fish biomass in CPUE samples collected in 1985-2002 at two sites adjacent to the Jeziorsko Dam Reservoir, its impact on fish assemblages in the Warta River ($MQ = 48.9 \text{ m}^3 \text{ s}^{-1}$) was assessed. Upstream from the reservoir (site AB) relatively small changes have been recorded, mainly declines in potamodromous barbel *Barbus barbus* and diadromous European eel *Anguilla anguilla*. Ichthyofauna in the river stretch downstream from the dam (site CD) was much more severely impacted. At the latter site the following three periods with use of a self-organizing map (Kohonen artificial neural network) were distinguished: P1) the pre-impoundment period (1985-1987), P2) early post-impoundment period including seven years after impoundment (1988-94), with a high variability in the fish assemblage, and P3) late post-impoundment period (1995-2002) with a much lower variability. This means that several years after the closing of the dam the fish assemblage at CD stabilised, though at a level drastically different from the initial one. The main changes at CD amounted to: 1) declines in rheophilic barbel, dace *Leuciscus leuciscus*, gudgeon *Gobio gobio* and burbot *Lota lota*, and 2) increases reaching even two orders of magnitude in biomass of eurytopic roach *Rutilus rutilus*, bream *Abramis brama*, perch *Perca fluviatilis*, pikeperch *Sander lucioperca* and ruffe *Gymnocephalus cernuus*. Species in the latter group successfully reproduce in the reservoir and their YOY migrate on a mass scale into the river stretch located downstream from the dam, thus determining a considerably modified structure of the fish assemblage and 5.5 times higher median of the total fish biomass at CD in P3 as compared with P1.

First data on the trophic interactions of the critically endangered *Valencia letourneuxi* and the introduced *Gambusia holbrooki* in a Greek river

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Non-native fish species have been long implicated in the decline and extinction of native species. In the case of *Valencia letourneuxi*, its rapid population decline has been partially attributed to aggression by and competition with *Gambusia holbrooki*. In this study, the gut content of 41 Greek valencias and 30 mosquitofish, captured in July 2006 in the River Acheron (Western Greece), was investigated in order to study interspecific diet overlap. Both species fed mainly on Gammaridae, small amphipods and Chironomidae larvae, with Veliidae, however, also contributing significantly to the diet of mosquitofish. In both species, during the juvenile-adult transition there is an increase in the importance of Gammaridae and a decrease in the importance of small amphipods, indicating a transition from smaller to larger prey. Feeding strategy plots revealed that both juvenile and adult *V. letourneuxi* follow a more generalist feeding pattern, in contrast to juvenile and adult *G. holbrooki* that have a more specialized diet. Schoener index showed a slight dietary overlap between the adults of the two species, and no overlap between the juveniles. The NMDS plots corroborated the above data. The implications of these dietary interactions are discussed.

The use of LHRH-a hormone for ovulation in saddled bream (*Oblada melanura* L.,1758)

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Introduction

The objective of this study was to evaluate the effects of luteinizing hormone releasing hormone analogue (LHRHa) dosage and delivery systems on oocyte size and ovulatory success for *in vitro* fertilization, of saddled bream broodstok.

Material and methods

Broodstok of saddled bream were collected from south Adriatic waters and were held in tank at the Institute of Marine and Coastal Research in Dubrovnik at the ambient salinity 37,2, average temperature was 21.8°C and natural photoperiod 10h dark-14h light. Fish were hand-fed once a day to satiation with european pilchard (*Sardina pilchardus*). Ovarian biopsy was obtained using tygon cannula (1,88 mm o.d. x 1,11 mm i.d.). Candidates for induced ovulation were initially chosen based on maximum oocyte diameters measured to the nerast 25 µm using stereo microscope (Wild Heerbrugg) fitted with an mesurmant devices (Wild Heerbrugg typ 325400). Body weight of individual fish ranged from 190,0-375,0 g. Four vitellogenic females with maximum oocyte diameters of 450-550 µm (Fig.1) were anesthetized in benzocaine 1 ml/l water. Females than given first injection of LHRH-a 20 µg/kg. After 24 h fish received second injection of 20 µg/kg.

Results and conclusion

Before hormonal tretman females had oocyte diameters of 450-550 µm. After 24h of first injection of LHRHa the oocyte diamaters were 600-850 µm, began formation of oil drop (Fig.2.). After 48h of first injection oocyte diamaters were 755-928 µm, oil drop is formed with range of 166-185 µm (Fig.3.), and fish are ready to spawn. The mature unfertilized eggs were pelagic and transparent with one oil globule, with the mean diameter 833±55 µm and the range from 755-928 µm.

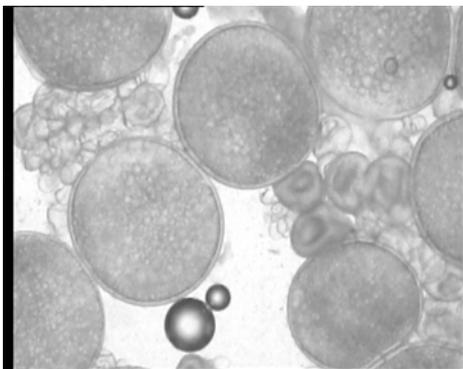


Fig.1. oocyte 500 µm before injection of LHRHa

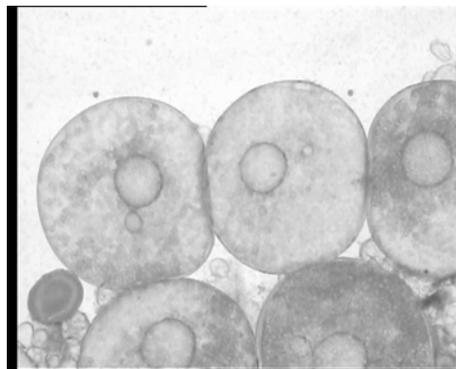


Fig.2. oocyte 700 µm 24h after first injection of LHRHa

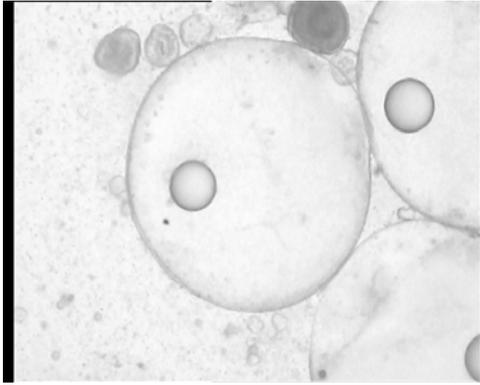


Fig.3. oocyte 920 μm 48h after first injection of LHRHa

These results demonstrate that injected LHRHa is effective for inducing ovulation in saddled bream with maximum oocyte diameters over 500 μm .

Freshwater ichthyodiversity, threats and conservation status in desert habitats of Iran with emphasis on Qanats systems

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Iran is one of the largest countries and it is a mountainous country in Southwest Asia which much of it is desert. This country is considered as a center of many species origins. In general, the climate of Iran can be classified as arid to semi-arid, with more than 80% of the country characterised by less than 250 mm annual rainfall. 19 major basins are recognized in Iran, based on field work, maps, fish distributions, history of research, works on hydrography and areas deemed important for an understanding of zoogeography. Among them, about 14 basins are located in which including; Bedjestan, Esfahan, Hormuz, Namak Lake, Kavir Namak, Jazmurian, Makran, Lut, Kerman, Mashkid, Tedjen, Persian Gulf, Karoun and Sistan. Inland fish fauna of Iran comprises more than 192 named fish. The freshwater fish diversity is almost high in arid and semi-arid areas of Iran because there are thousands of small springs and streams with no present or recent connection to other water bodies such as qanats. Cyprinid and Balitorid are dominating fish in these areas. Qanats (artificial irrigation channels tapping groundwater) are one of the most important habitats and refuge for fish species in these areas, because of their continual flow. Fish diversity in some basins such as Karoun, Persian Gulf and Hormuz is more than other basins. Freshwater ecosystems are being contaminated and destroyed the world over, and failure to protect these productive and diverse areas have resulted in many freshwater fish species becoming extinct, endangered or threatened. Many freshwater fishes in these basins are found only in individual lakes, springs and rivers and therefore they are very vulnerable to drought, habitat loss and pollution. Construction of dams, channelizing of streams, and capping or tapping of springs has endangered many fish species in arid and semi-habitats of Iran. Drought (many rivers in Center basins and Southeast of Iran are drained completely, many qanats have been dried recently), habitat loss and fish introduce are the most important threats for the ichthyodiversity in these areas.

Key words: Freshwater ichthyodiversity, threats, conservation, desert habitats, Qanats, Iran

Thermal requirements of weatherfish, *Misgurnus fossilis* (L. 1758), during early life history: Life dawn of cryptic fish of European marshes in dependence on temperature

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Weatherfish, *Misgurnus fossilis* (L. 1758), a small freshwater, cryptic fish inhabits stagnant or slowly flowing habitats with heavy water vegetation over-grown and muddy bottom in the floodplain areas of the Europe (from the North France to the Western Russia). However, weatherfish possesses the unique anatomical, morphological (outer filamentous gills in larvae) and physiological adaptations (skin and intestinal respiration), its density decreased rapidly through the whole Europe in the second part of the 20th century due to the degraded water quality (impact of

industry and agriculture), direct destruction and drying natural habitats (impact of water engineering). Nowadays its status in Europe is considered least concern, this species is listed under Annex II. of the Council Directive 92/43/EEC (involved into Natura 2000 network) and in many Red lists of endangered fishes in the Europe.

Weatherfish belongs to the fishes crucial for explanation of floodplain areas importance in respect to fish spawning, early ontogenetic stages distribution and dynamics. Fish early life history can be affected by many biotic or abiotic factors (temperature is considered one of the most important ones). Up to now, there is only limited knowledge dealing with the temperature limits of weatherfish during early ontogeny. Therefore, the present study experimentally evaluates the thermal sensitivity of embryonic and larval development (during interval from egg fertilization to the finish of hatching) in artificially propagated weatherfish in a wide temperature range (range: 9-36°C; interval: 3°C).

Both, the amplitude of the incubation period (evaluated in four crucial moments – start, finish of hatching, H_{50} and H_{75}), the total hatching period duration was inversely proportional to the incubation temperature and ranged from 1.8 days at 24°C to 17.5 days at 9°C (expressed at H_{50}) or from 9 hours at 24°C to 137 hours at 9°C, respectively. There was no influence of rising temperature on the total length of newly hatched larvae (T_L on average 4.30mm at 9, 15, 18, 21, 24°C vs. 4.67mm at 12°), in contrast to negative correlation with developmental stage (at 9-18°C: stage 37 vs. at 21-24°C: stage 36), i.e. the length might determine the age at hatching, rather than the age at hatching determines the hatching length. The thermal tolerance range in term of survival lies between 9°C and 24°C (with the thermal optimum at 15-24°C, i.e. weatherfish is a warm-mesothermic species). Temperatures above 24°C (in our study 27-36°C) are considered the lethal temperatures already during embryonic period (even before gastrulation). Nevertheless, it is highly recommended to distinguish an impact of suboptimal temperatures 9-12°C on development during explored interval only, in contrast to possible another effect of these lower temperatures in context of the whole early ontogeny (up to juvenile stage).

First record of dolphinfish juveniles, *Coryphaena hippurus* (Linnaeus, 1758), in the Eastern Adriatic

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One *Coryphaena hippurus* juvenile was found swimming in a bucket at the open sea in the Adriatic on July 29, 2008, about 12 miles south of Bisevo Island. These fishes are often attracted to various floating objects and this individual was probably swimming under the object, but was somehow trapped inside. The other specimen was found free swimming close to the sea surface on July 05, 2003 near the south-east side of the Bisevo Island (Veli Žardin cove) and was caught by the hand net. Prior to these findings, two larvae were found near Vis island. These findings suggests that actual spawning ground of this species could be located somewhere around the remote Adriatic islands Vis and Bisevo and that spawning in the Adriatic takes place in period from June to August which is corroborated by the fact that period of spawning in western Mediterranean is from June to July. In the last few years, records of larval and juvenile stages of the species that were previously rare or relatively rare in the Adriatic became more common. Findings of early life stages of *C. hippurus* could be a consequence of new climatological and oceanographical conditions in the Adriatic as well as in the Mediterranean Sea. These conditions are probably also a key reason for the increased abundance of *C. hippurus* in the Adriatic in the recent years. Prior to these, no records of such early life stages existed for the Adriatic, therefore, it is reasonable to conclude that reproduction of dolphinfish in the Adriatic is a recent adaptation to a new and changing environment.

Fish Community Based Ecological Quality Index for Atlantic Andalusian Transitional Waters

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Introducion

Transitional waters are functional units with fluctuating and unstable dynamics, which leads to a high abundance and species diversity. The reference condition for a water body is the description of the biological quality elements

that may exist with little or no water altered by human activities. Atlantic Andalusian rivers are subject to a Mediterranean regime with a wide drought station which can interrupt the channel to produce a variable in its duration, absence of discharges in the estuary.

Material and Methods

The estuarine fish community index described is based on data that was collected within Atlantic Andalusian estuaries from several studies.

Metrics were chosen base partially on a review of measures included in other estuarine fish community indices as well as their ecological relevance of measurements (Coates et al. 2004; Harrison & Whitfield, 2004). The metrics were tested against a calculated reference, derived from the upper quartile average of each dataset to that metric. For some indicators it was found two different reference conditions for large estuaries (LE) and for small estuaries (SE). Each metric has an associated score; the addition of all scores provides the final quality classification.

Table 1 Indicators scores for large and small estuaries

Metric	scores		
	1	3	5
Number of taxa	LE ≤ 11	12-45	≥ 46
	SE ≤ 3	4-9	≥ 10
Endangered species		absent	present
Alien species	present	absent	
Species that make up of 90% of the abundance	≤ 2	3-7	≥ 8
Estuarine resident taxa	≤ 2	3-5	≥ 6
Relative abundance of estuarine resident taxa	$\leq 4\%$ or $\geq 75\%$	4-25% or 60-75%	25-60%
Benthic invertebrate feeding taxa	LE ≤ 3	4-10	≥ 11
	SE 1	2	≥ 3
Relative abundance of benthic invertebrate feeding taxa	$< 4\%$	4-8%	$> 8\%$
Piscivorous taxa	LE ≤ 7	8-28	≥ 29
	SE 1	2	≥ 3
Relative abundance of piscivorous taxa	$< 0.5\%$	0.5-2%	$> 2\%$

Proposed index have been applied to bibliographical data collected in the Bay of Cadiz salt marshes, the Guadiana estuary and the Castro Marim marsh. For the estimate in these water bodies, the reference value for the large estuaries was taken.

Table 2 Ecological quality index scores and EQR values

Ecological Quality	Scores	EQR
High	43-50	> 0.8
Good	35-42	0.6-0.79
Moderate	26-34	0.4-0.59
Poor	18-25	0.2-0.39
Bad	10-17	< 0.2

Results and Discussion

The results seem to come close to define the current state of the habitats surveyed. The Guadiana river basin is regulated by numerous dams that discharge water regularly, so that, there is a cleaning phenomena that control the water pollution. In Castro Marim marsh, index score is lower because the water renewal is slower than in the main channel.

Table 3 Index scores and EQR obtained

Water body	Scores	EQR
Guadiana	46	High
Castro Marim	40	Good
Bay of Cadiz	34	Moderate

The moderate quality of the Bay of Cadiz salt marshes is, in our opinion, a combination of high anthropogenic impact on the area, the low rate of water renewal and the progressive silting of the channels by decreasing the force of currents, or times to reach cease completely, either naturally or by the abandonment of the salt activity in some areas.

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The oarfish *Regalecus glesne* (Teleostei: Regalecidae): a new occurrence and previous records from the Adriatic Sea

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The oarfish or the king-of-the-herrings *Regalecus glesne* Ascanius, 1772, occurs in most circumtropical oceans, very rare in the Mediterranean. On May 8 2009, one specimen of the oarfish was caught with a simple hook in a Stobreč Bay (near Split, Croatia) at the depth of 1.3 m. The total length before preservation was 194 cm (weight, $W = 813,2$ g). This record represent the first record for the eastern Adriatic Sea. All other previous records (2) in the Adriatic Sea are questionable and object of scientific discussion. This record and the records of other rare and relatively rare species in the Adriatic Sea in the last decade are discussed in relation to the water masses circulation and the species biological characteristics.

The present distribution of non-native fish species in Belarusian and Polish parts of the European central invasion corridor

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We examine the role of the waterways and in particular the central European invasion corridor, which consists of the Dnieper-Bug, Vistula-Oder and Oder-Elbe-Spree-Havel connecting canals. Historical and recent data are assessed, in particular the results of a survey during 2003–2008 at 50 sites along the Belarusian and Polish parts of the central invasion corridor. Since the construction of these canals at the end of 18th century, at least six fish species of Ponto-Caspian origin have spread into new river basins via these waterways, with five species found in recent surveys i.e., monkey goby *Neogobius fluviatilis*, round goby *N. melanostomus*, racer goby *N. gymnotrachelus*, tubenose goby *Proterorhinus marmoratus* and white eye-bream *Abramis sapa* and migrated westwards to the Baltic basin. The mean rate of spread of monkey goby and racer goby in the Vistula system was ≈ 122 km/year and 66 km/year, respectively. In the River Dnieper, racer goby expanded with the rate 70 km/year and for round goby this rate was much lower i.e. 10 km/year. Four other non-native species were also found within the corridor, i.e. Amur sleeper *Perccottus glenii*, gibel carp *Carassius gibelio*, brown bullhead *Ameiurus nebulosus* and topmouth gudgeon *Pseudorasbora parva*. Their presence is related to numerous accidental introductions into many localities in Belarus and

Poland rather than to using the corridor as an invasion route. However, the rate of natural spread of Amur sleeper in the River Vistula after introduction with ≈ 88 km/year. One species (ninespine stickleback *Pungitius pungitius*) has migrated from the Baltic basin to the Black Sea drainage systems.

Dependence of latency interval duration on temperature during hormonally stimulated induction of ovulation (using hormonal preparation with GnRH) in several freshwater fish species

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Hormonal stimulation of final oocyte maturation and ovulation have, for decades now, been an important aid in the effective reproduction of a majority of economically important fish species (Mylonas and Zohar, 2001; Podhorec and Kouril, 2009). Yaron and Sivan (2006) have summarized and provided partial information about latency interval duration by hormonally induced reproduction in several freshwater fish species. The present study shows the results of experiments aimed on latency interval duration (i.e. time between application of hormonal preparation and ovulation and/or stripping) depending on temperature during controlled propagation (hormonally stimulated ovulation) in eight different freshwater fish species.

The single injection administration of different hormonal preparations (GnRH only or combined hormonal preparations - containing GnRH and metoclopramide as DI) was applied for the induction of ovulation. One dose of GnRH ([D-Ala6, Pro6, NEt]-GnRH and/or [D-Tle6, Pro9, NEt]-GnRH) applied intramuscular or intraperitoneal was used in females of rudd (*Scardinius erythrophthalmus*), tench (*Tinca tinca*), Euroasian perch (*Perca fluviatilis*) and pikeperch (*Sander lucioperca*). For induction of ovulation in other fish species, grass carp (*Ctenopharyngodon idella*), crucian carp (*Carassius carassius*) and European catfish (*Silurus glanis*) were used combined hormonal preparations, i.e. either Ovopel (containing [D-Ala6, Pro9, NEt]-GnRH and DI) and/or Dagin (containing [D-Arg6, Pro9, NEt]-GnRH and DI).

The latency interval duration ranged from 10 to 50 hours in dependence on temperature (see. Table I.).

Fish species	Minimal temperature (°C)	Latency interval (hour)	Maximal temperature (°C)	Latency interval (hour)
Rudd	14.9	37	20.8	31
Tench	19.4	51	25.4	27
Grass carp	21.3	21	24.7	14
Crucian carp	16.0	32	24.0	16
European catfish	20.2	41	25.3	27
Pikeperch	10.8	94	13.7	58
Euroasian perch	12.3	123	17.2	77

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Endemic fish fauna of the Hutovo Blato Wetland (Neretva River Basin, Bosnia and Herzegovina) and their conservation status

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The present work analysed endemic fish fauna of the Hutovo Blato, a small Mediterranean-type wetland of the Neretva River basin (Adriatic watershed), southern Bosnia and Herzegovina. This wetland is of considerable ichthyofaunistic and conservation importance because of the presence of endemic species with very restricted distribution, i.e. *Chondrostoma knerii*, *Cobitis narentana* and new species of *Knipowitschia* (*Knipowitschia hutove* sp. nov.) and other endangered endemic species of Dalmatia division, Euro-Mediterranean subregion. Nevertheless, the taxonomic designations of a large number of species in this area are in need of revision, questions remain over their systematics, with little information available on distribution, abundance and conservation status. For the moment, there is no published list of endangered species in Bosnia and Herzegovina and no conservation actions were implemented. This small wetland area hosts 39 fish species, with 11 currently recognised endemic fish taxa. The fish community is dominated by lacustrine species, primarily cyprinids. These endemic species are, as follows: Adriatic brook lamprey *Lethenteron zanandreae* (Vladykov, 1955), tooth trout *Salmo dentex* (Heckel, 1852), marble trout *Salmo marmoratus* (Cuvier, 1829), Balkan brook trout *Salmo farioides* (Karaman, 1938), soft-muzzled trout *Salmo obtusirostris* (Heckel, 1852), Dalmatian roach *Rutilus basak* (Heckel, 1843), Adriatic dace *Squalius svallize* (Heckel and Kner, 1858), Neretvan rudd *Scardinius plotizza* (Heckel and Kner, 1858), Neretvan nase *Chondrostoma knerii* (Heckel, 1843), Neretvan spined loach *Cobitis narentana* (Karaman, 1928), Croatian goby *Knipowitschia croatica* (Mrakovčić et al., 1994). Moreover, ongoing morphological and genetic studies indicate several new fish species presence (Hutovo dwarf goby *K. hutove* sp. nov., Neretvan dace *Squalius un. sp. nov.*) as well as from other authors (Neretvan bleak *Alburnus neretvae* Buj, Šanda et Perea, sp. nova), respectively. Also, the exact systematic status of the local stickleback population *Gasterosteus* sp. is unclear requesting further investigations. Taxonomic study is currently ongoing. Historical factors, like the origin, formation and evolution of the wetland and ecological ones like local hydrological conditions, may explain such high level complexity of the Hutovo Blato wetland fish fauna. The current status of the Hutovo Blato wetland and wider area fish fauna can be described as threatened under many negative factors affecting the survival of the native, mostly endemic species. Water capacity lowering, habitat degradation to water bodies and the impacts of invasive alien fishes have had a major detrimental impact on the conservation status of indigenous species. Effective habitat protection, together with improved water management and measures to prevent the dispersion of exotic species are particularly important in order to protect high ichthyofaunal diversity of this wetland.

Key words. - Endemical ichthyofauna - Hutovo Blato wetland – Conservation.

Morphology and sculpture of the dermal skeleton elements of gasterosteiforms and syngnathiforms inhabiting Estonian coastal waters

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Using SEM images, the morphology and sculpture of postcranial dermal bone units of five fish species inhabiting Estonian coastal waters have been described: *Gasterosteus aculeatus* L., *Pungitius pungitius* (L.) and *Spinachia spinachia* (L.) of the order Gasterosteiformes and *Syngnathus typhle* L. and *Nerophis ophidion* (L.) of the order Syngnathiformes. The study shows that the shape of the dermal skeletal elements varies substantially and is dependent on the position on the body, whereas the sculpture of elements is taxon-specific.

In *G. aculeatus* and *S. spinachia* the surfaces of dermal bone units, such as plates, spines and their basals, are covered with nodular ridges. These ridges can form both linear and network patterns. The location and size of the nodules on dermal plates of *G. aculeatus* are more uniform than in *S. spinachia* whose nodules are concentrated in the crest area. Unlike the above-mentioned gasterosteiforms, *P. pungitius* has dermal bone units bearing ridges without nodules. Nodular sculpture is observed only on top of the crest of the keel plate.

Bony plates of *S. typhle* and *N. ophidion* are covered with a network of ribbon-like flattened ridges, which by visual observations lie on several levels. The plates of *S. typhle* have a much stronger crest than those of *N. ophidion*.

The results of the study show that the dermal skeletal elements of gasterosteiforms and syngnathiforms have characteristics that are useful for fish classification and determining the diet of piscivores.

Distribution, colour polymorphism and habitat use of four *Nothobranchius* species in Mozambique

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The genus *Nothobranchius* (Nothobranchiidae, Cyprinodontiformes) comprises small, short-living (3-12 months) fish inhabiting temporary savannah pools throughout eastern Africa. Mozambique is at the southern limit of their distribution. The southern and central part of Mozambique (south of the Zambezi River basin) is inhabited by three species complexes; *N. furzeri*, *N. orthonotus* and *N. rachovii*. Each species is represented by at least two colour morphs. We have conducted field expeditions in February 2008 and 2009 to investigate the distribution of individual species, their colour morphs, and geographic and habitat segregation between species and colour morphs. We found partial geographic separation of colour morphs with geographic clines in the relative abundance of the two colour morphs in *N. furzeri*. We have found a sister, yet undescribed, species of *N. furzeri*, with allopatric distribution to that of the *N. furzeri*. In *N. rachovii*, we found largely allopatric distribution (with one case of parapatry) of different colour morphs. In *N. orthonotus*, male colouration does not fall into discrete morphs. Within the range of sympatry, individual species differed in their habitat use. The highest interspecific segregation was across the gradients of water turbidity, bottom composition and water conductivity. Nevertheless, sympatric occurrence of two or three species was common, with consistent differences in relative species abundance.

Pink salmon on the edge: genetic and biological adaptation to novel habitat

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Annual transplantations of fertilized pink salmon eggs into the European North of Russia in 1956-1979 did not result in forming of self-reproducing population, despite in some years the significant returns of adult pink salmon in Russian and Norwegian rivers were observed. It was suggested that the main reason for this failure was the choice of the donor stocks from the southern parts of the native range (mainly from Sakhalin Island), and new habitat has proven suboptimal for natural reproduction of transplanted fishes. After introduction in 1985 of relatively small number of odd-year eggs from northern part of native range (Ola River population, north coast of Sea of Okhotsk) a stock of commercial size was formed. We suggested that large-scale temperature change of the North Atlantic waters since mid-1980s leading to warming in the whole European North region may positively influence on reproductive success of pink salmon. Despite of this, four introductions of even-year pink salmon from the same donor population were appear to be unsuccessful. Because of its rigid two-year life cycle, pink salmon have two reproductively isolated broodlines, which spawn in alternate (even or odd) years. Since 1999 we carry out the population genetic and phenotypic monitoring of transplanted pink salmon through 5 odd-year generations (i.e. 8-12 since introduction) and 2 first even-year generations after introduction in 1998.

We have detected adaptive shifts in some life history traits of transplanted odd-year pink salmon as compared with donor population (dates of return and spawning, embryo development rate). Analysis of variation at polymorphic 13 allozyme loci, *D-loop/cyt b* region of mtDNA and eight microsatellite loci showed that level of genetic diversity of odd-years pink salmon decreased, but it may be caused not only by genetic drift. We suppose that decrease of variation at allozymes is at least partially explained by natural selection. In first, protein markers revealed much greater proportional losses of allelic diversity and heterozygosity than did more neutral microsatellites on average. In second, level of multilocus allozyme heterozygosity decreases during life cycle of transplanted fishes. In third, examined allozyme loci were experimentally shown to have selective value of different alleles (Beacham, Varnavskaya, 1991) and overall heterozygosity level (Altukhov et al., 1987). In fourth, we had not detected any genetic changes and adaptation in transplanted even-year pink salmon. Since it was accompanied by decrease in the number of returning fishes, we can suppose the «catastrophic» selection.

Our data indicate that transplanted odd-year pink salmon is likely to has small effective population size primarily because of limited spawning-grounds and unstable temperature conditions during early development. Significant differences in some allele frequencies between populations indicated that partial genetic isolation and phylopatry

(homing) can arise very quickly. The genetic variance between rivers was more than twice the variance among years within rivers based on analysis of molecular variance.

Different success of numerous introductions of odd- and even-years pink salmon which made both in the USSR/Russia and USA during the last century imply the different adaptive mechanisms of lineages sympatrically inhabiting the same rivers in the most part of native range.

Applying of microsatellite markers to identify population genetic structure of The stellate sturgeon, *Acipenser stellatus pallas* 1771 in the north (Volga and Ural rivers) and south Caspian Sea (Sefidrud drainage)

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Introduction The stellate sturgeon, *Acipenser stellatus*, were listed as an endangered species in IUCN Red list. Molecular genetic research on stellate sturgeon in Caspian Sea was so far limited to a few studies using RFLP methods and low genetic variation was stated while no significant differences in haplotype frequency there found. The objectives of present study was to investigate on genetic structure of stellate sturgeon in northern and southern Caspian Sea and also to test the hypothesis that stellate sturgeon has identical population in each original spawning river in the Caspian Sea.

Materials and methods Totally 140 tissue samples included fin clips of adult stellate sturgeon were collected from Volga (Russia), Ural (Kazakhstan) and Sefidrud drainage (Iran).

Results Fifteen sets of microsatellite primers were developed on genomic DNA of stellate sturgeon. Allele frequencies, H-W equilibrium, the fixation index F_{ST} , R_{ST} and observed heterozygosity were determined at disomic loci amplified from fin tissue samples. At this point only the ten successfully used primer sets should be mentioned, and were used to analyze the genetic variation in adults of the stellate population. The average number of alleles found at regions was 14.33. Out of 199 observed alleles, 130 alleles occurred at frequencies of <0.05 in all samples. All sampled populations contained private alleles at the significant ($P>0.05$). Average observed and expected heterozygosity were 0.677 and 0.871, respectively. In most of cases, significant deviations from Hardy-Weinberg equilibrium were ($P\leq 0.01$).

These results together with highly significant F_{ST} and R_{ST} of genotypic differences between these pairs of collections support the existence of more than genetic populations formed in this species along the Caspian Sea coast. The genetic distance value obtained in the present study falls within the average value of congenics, which indicates that the genetic difference among the studied populations is pronounced.

Discussion Based on F_{ST} estimate ($P\leq 0.01$), more than one population of stellate sturgeon are identified in the south Caspian Sea. Therefore, fishery management for restocking and conservation of gene pool is highly recommended.

On problem of occurrence of strange species of fishes in the basin of the White Sea

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During the last ten years a problem of biological invasions has gained special urgency all over the world. Biological invasions are all cases of penetration of live organisms in ecosystems located outside their initial (usually natural) area. These species (ASLO, 2000; Intital risk 1999) can influence population, species and communities of local faunas and floras, which frequently results in irreversible modifications of ecosystems. In the White Sea basin strange fishes appeared as a result of acclimatization activities (Far East - *O. gorbusha*, the Pechora river - *C. peled*), of directed (*S. lucioperca*) and accidental (*P. glenii*) introduction, and also self-settling of Caspian (*A. sapa*, *A. aspius*) or Baltic (*A. aspius*) species.

Acclimatization. Far East— *O. gorbusha* is acclimatized in the basins of the White and Barents seas. It is widely spread in water bodies of the Kola peninsula, Karelia and Arkhangelsk area, it is observed on European coasts of Norway, Sweden, Iceland and Spitsbergen, it is met in the Pechora river basin, in the east it reaches the Yamal peninsula. Biological effect of acclimatization is revealed in rather high number of naturalized *O. gorbusha* as trade object. At the same time the question of its competitive interspecific relationships with native species - Atlantic salmon and salmon trout remains debatable. The Pechora *C. peled* - was taken to varied water bodies of the White Sea basin. As a result of broad ecological plasticity three ecological forms were formed - lake, lake-river and river. During acclimatiza-

tion *C. peled* did not have problems with native species of fishes in food due to almost full divergence of their food spectrums. The scheme of organization of lake white fish farms with the formation of their own parent stocks is developed.

Introduction. *A. aspius* has a restricted area in water bodies of the Arkhangelsk area and is met only in a number of lakes of the Baltic basin (lakes of the Monastyrskaya and Nosovsko-Luzskaya systems). It in the Northern Dvina river it appeared as a result of directional introduction in the Su-khona river from lake Kubenskoe. It was acclimatized in lake Vozhe of the Vologda area, from where it was spread in lake Lacha and further in the Onega river. *P. glenii* - as a result of accidental (not directional) introduction by the aquariumists-fans to Mirnyi city in lake Plesetskoe. It is characterized by considerable number, intensive food and high growth rate. The further expansion of rotan goby in water bodies of the area with commercial structure of ichthyofauna by spread of gummous embryonate spawn by waterfowls is possible.

Self-settling. During the last decades species of fishes living in the Caspian and Baltic Sea basins have penetrated into the Northern Dvina river. *A. sapa* is not valuable commercial fish of the Caspian complex. For the first time it WAS found in the Vychegda river in 1971, then it appeared in the Northern Dvina river, fast increasing its number. For a long time in commercial statistics it was included into the catches as young of *A. brava* or *B. bjorkna*. Now *A. sapa* is met practically along the whole Northern Dvina river, having spread up to the sites of the pre-mouth coastal waters, where it can constitute a severe food competition to the White fish of the Northern Dvina river. *A. aspius* - predatory, representative of carp fishes which appeared in the N. Dvina after *A. sapa*. Its number is not high.

It is necessary to note that strange species can cause irreplaceable damage not only biological diversity of the regions, but also social and economic concerns of the man. In this connection, at the present stage it is expedient to consider the problem of biological invasions as one of the aspects of ecological safety of the country.

The black bullhead *Ameiurus melas* – another invasive fish species in Poland

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The black bullhead *Ameiurus melas* (Rafinesque, 1820) is an ictalurid catfish, native to North and Central America. In Europe it was introduced in the end of the 19th century. Since that time, the species has spread throughout Europe. In June 2007 it was recorded for the first time within the territory of Poland. Nine specimens identified as *A. melas* were caught in Kielecki Dam Reservoir in Kielce City (50° 53' N, 20° 37' E), Poland. The reservoir is located on Silnica Creek in the Nida River system, within the Vistula River drainage.

The bullheads were of 67.4-147.8 mm in total length and 54.1-122.2 mm in standard length. They had 20 (21 in 1 specimen) rays in the anal fin, 17 rays in the caudal fin, and 1 spine and 6 branched rays in the dorsal fin. Spine of the pectoral fin was poorly serrated and the tip of the ray was clear. Anal-fin membrane was black and coloration of the body was dark and plain, without any mottled design. In all specimens base of the anal fin had fatty thickness. Thus, the fin was not clearly distinguished from the body.

A. melas is a second ictalurid species known to occur in this country. The first one, the brown bullhead *Ameiurus nebulosus* (Lesueur, 1819), was introduced most probably in 1885 to commercial ponds in Barnówek near Szczecin. That territory belonged then to Germany and now is a part of Poland.

It has not been established yet whether *A. melas* is a 'real' new invader in Poland or has been introduced much earlier, even in the end of the 19th century together with *A. nebulosus* and has stayed unrecognised for some 100 years. Definitely, detailed studies in both, field and museum collections, are needed to solve this question. Due to potential invasiveness of *A. melas*, sustain monitoring of its distribution in the country seems to be an urgent matter.

Histological structure of the digestive tract in Amur sleeper (*Perccottus glenii*)

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The Amur sleeper *Perccottus glenii* Dybowski, 1877 (Teleostei: Odontobutidae) is an invasive alien species in Poland. It is native to Far East of Russia, northern North Korea and China. In Poland it was recorded for the first time in 1993 in the middle stretches of Vistula River. Since that time *P. glenii* has been found throughout nearly the

whole Vistula River drainage. Its colonizing success is stunning and the species has been subjected to various investigations, including its morphology, ecology, trophic relationships, impact on native fauna, and others. However, as far as the authors are aware, there has been no study carried out on histological structure of the digestive tract, which may be crucial to understanding of the invasion of this species in Europe.

Investigations were performed on ten individuals of *P. glenii* of either sex. The fish were prepared under the stereomicroscope and the 5 mm pieces of esophagus, stomach and intestine (middle and terminal) were collected. The material was fixed in 4% formaldehyde, rinsed and embedded in paraffin. The serial, 4 µm, slides were stained with modified H&E method (Hall 1980) and toluidine blue.

The wall of the digestive tract of *P. glenii*, a predatory fish, consists of mucosa, submucosa, muscularis and serosa. The height of mucosal folds was different in each part of digestive duct, varied from 512.06 to 1032.78 µm in stomach, from 179.21 to 700.50 µm in middle intestine and from 226.56 to 582.00 µm in terminal intestine.

The esophagus of investigated fish was rather short, about 5 mm long. At the border, between the esophagus and the stomach, the sphincter was observed. The stomach was U-shaped structure and its mucosa formed longitudinal zigzag folds. The single layer of epithelium with a high density packed columnar cells (about 38 µm in height) was visible. Moreover the numerous goblet cells (13.8-17.01 µm in diameter) among the enterocytes (3.63-3.80 µm in diameter) and gastric glands were observed. The intestinal villi at the surface of the folds were not found. In the rest part of the intestine the numerous goblet cells (9.95-11.82 µm in diameter) of epithelial layer (about 38 µm height) were observed. The most number of goblet cells was in the terminal intestine where they formed characteristic layer.

Moreover the autonomic ganglia which belonged to submucosal and myenteric plexus were visible.

Cellular structure of epidermal hyperplasia (fish pox) in koi carp (*Cyprinus carpio* L) in final stage of long time regression in warm water

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On 20% of 50 koi carp (*Cyprinus carpio*), which were kept in cages in a pond in Southern Estonia proliferative cutaneous lesions developed in the autumns of 2007 and 2008. They consisted of single to multiple whitish to pink fleshy masses usually associated with fins and had size of 3-35 in mm diameter. In wet mount preparation from lesions epidermal hyperplasia was detected. It is expressed as extensive hyperplasia of malpighian cells, absence of secondary cells and also as peg formations of basal layer. 62 days after transfer of infected fish to warmer water (from 10 to 20°C) large proliferation of eosinophilic enlarged club cells was detected in section from the basement membrane to the surface of the hyperplastic epidermal tissue from neoplasm. Our data indicate that in conditions, where strong environmental irritants are missing, club cells support healing of epidermal hyperplasia (fish pox) after the temperature elevation.

A new species of freshwater goby of the genus *Knipowitschia* (Teleostei: Gobiidae) from Hutovo Blato wetland (Neretva River basin), Bosnia and Herzegovina

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The Dalmatia division of the Euro-Mediterranean ichthyological subregion, is characterized by a high number of endemic freshwater fishes. This also includes a stock of gobiid fishes of the Ponto-Caspian genus *Knipowitschia*. Subsequent vicariant events (the Messinian salinity crisis of the Mediterranean during the Miocene, Holocene eustatic sea level fluctuations) probably led to diversification of an ancestral stock of euryhalin *Knipowitschia* and to adaptation to habitats characterized by different salinity levels (from brackish to fresh waters). Adriatic *Knipowitschia* have undergone isolation and seemingly as a response to a wide spectrum of habitats populations show morphological differences. A key feature is obviously reduction in size and subsequently reduction of morphological characters e.g. in squamation and of the lateral-line system. Several east Adriatic drainage systems inhabit morphological distinct and biologically isolated *Knipowitschia*-forms. This holds also true for the Neretva drainage system which is characterized by geographic isolation from other catchments, complicated geological history and characteristic climate conditions. In the catchment of the lower Neretva a few small shallow karstic lakes of the Nature park Hutovo Blato are inhabited by an undescribed species of *Knipowitschia*. The collected specimens repre-

sents a new species, *Knipowitschia hutovae* sp. nov. which formal description is given. This new species is characterized by a high variability in morphological characters. A combination of varying reductions of the head lateral-line canals up to the complete loss of these canals and subsequently their replacement by free neuromasts is observed. Accompanied are these reductions by a reduction in squamation. Adaptation to distinct environmental conditions in these small shallow lakes with silty bottom and characteristic vegetation on their banks seemingly also led to an unusual spawning behaviour and to a characteristic nuptial colouration.

Dorsal scutes development in *A. naccarii*, (Bonaparte, 1836), during morphogenesis

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Introduction

Sturgeons are condostrean Acipenseriformes fish. The Acipenseridae family, which *Acipenser naccarii* belongs to, has great scientific interest for its phylogenetic position and antiqueness, plus most populations, in decline or endangered are subject of conservation programs (Birstein, 1993).

Research on the morphology and functionality in Acipenseriformes plays an essential role in understanding the evolution of organ systems. This paper studies the formation of the dorsal scutes (DS) of *A. naccarii*.

Material and methods

The ontogenetic development from the fertilized egg up to three months of age (after-hatching) of sturgeon *A. naccarii* (Bonaparte 1836), were studied in farm conditions. The eggs, embryos and youth descended from parents reared F1 and F2 born in Riofrio (Granada), from wild parents. After hatching, the embryos was maintained in polyester pools with 15 ± 1 °C, pH 7.4 ± 0.3 , with an artificial photoperiod 12/12. Embryos were supply with live food until there were tree month old. Sampling frequency has been spaced over time to match the development speed. Each sample had 9 individuals (zygotes, embryos and youth, according to the state of development) photographed in vivo using a digital camera coupled to a Leica MZ10 stereo microscope. Some specimens were stained with a specific cartilage - bone staining (alcian blue - alizarin red). The study is based on macroscopic embryos (Balon, 1999) whose stages of development correspond to those described in Dettlaff *et al.* (1993) and Cabrera (2009).

Results and discussion

First manifestation of dorsal scutes (DS) take place at 6 days after hatching (dah) (144 hours after hatching (hah)) as a dense area that stretches along the dorsal fin. This area is then divided into smaller areas between 8 and 14 to fully separate at 7-8 dah (180 hah) (Fig.1). Dorsal scutes present a triangular-shaped radio that will grow to fill the entire height of the dorsal fin at 10 dah (240 hah) (Fig. 2). Among 11-13 dah (288 hah) DS sideways touch each other at the base and beyond the dorsal fin, that begins its reabsorption in both width and length from dorsal to caudal area. At this time, emerge new dorsal scutes (SD secondary) (Fig.3). There are no previous reports of these secondary scutes in other Acipenseridae. First DS are free between 14-26 dah due to the complete resorption of the dorsal fin at the dorsal area. In the following days the membrane continues to fall and bent over backwards radios. First DS are fully shaped between 66-81 dah while secondary DS are still appearing. Secondary DS probably appears in individuals with few initial scutes (8-11) but present the characteristic among (10-14) for *A. naccarii* beyond 3 months (Cabrera, 2009).

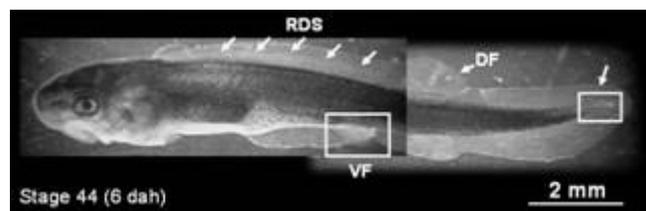


Fig. 1. Begins to rudiment appearance of dorsal scutes; dah: day after hatching

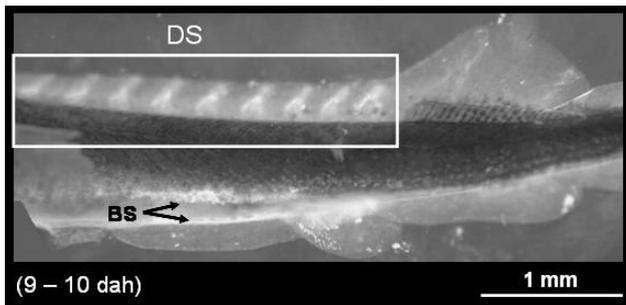


Fig. 2. Independent dorsal scutes

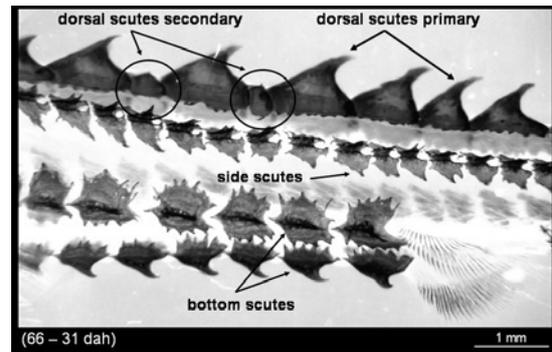


Fig. 3. Secondary dorsal scutes development

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Phylogeography of Atlantic salmon (*Salmo salar* L.) based on the mtDNA *16S rRNA/ND1* gene region: synthesis of current knowledge

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Population structuring in the Atlantic salmon, *Salmo salar* L. has been studied by different genetic markers, including protein and allozyme polymorphisms, mtDNA sequence variants, microsatellite polymorphisms and recently, SNPs. Studies of mtDNA became widespread in 1990s with the advent of PCR based methods. Data is now available on variation in thousands of salmon from hundreds of rivers and we present here a synthesis of existing studies by focusing on variation of the 16s rRNA/ND1 gene region, the most intensively studied mtDNA region in Atlantic salmon.

We compiled data on 7448 salmon from 143 populations in Europe and 3062 salmon from 100 populations in North America and established the correspondence for the described haplotypes. Phylogenetic analysis of the *16S rRNA/ND1* sequences revealed two major mtDNA clades separating the haplotypes typical to North America from the haplotypes prevailing in Europe. The average sequence divergence between these clades, ~1.0 % (net divergence ~0.8%) suggests an approximate divergence time of more than 500000 years of the two main clades. Of the 15 observed haplotypes, one was exclusive to North America, 11 were exclusive to Europe, and three were shared at low frequency between the continents. In contrast to North America, where only four haplotypes were found, the number of observed haplotypes in Europe (14) was much higher. Majority of European populations of Atlantic salmon can be considered monophyletic, i.e. they possess haplotypes from only one of the two main clades. The most significant division within Europe is that between the Atlantic and Baltic populations of salmon, strongly supported also by nuclear markers. Despite numerous studies, the post-glacial origin of north European Atlantic salmon is still debated. The main glacial refugia are thought to have existed in the Iberian peninsula, the North Sea, and the ice lakes east of the Baltic Sea. For Baltic salmon, both Atlantic and eastern freshwater refugia have been proposed, as well as combination of both. The distribution of mitochondrial haplotypes supports initial colonization of the Baltic Sea and the north-eastern river systems along the White Sea coast and further to the east up to the Petchora River from a non-Atlantic fresh-water refugium. Along the coast from Spain to Kachkovka river in the Barents Sea, including the British Isles and Norwegian coast, mtDNA variation due to differentiation between populations is two times higher than due to differences between regions. This is in accordance with the early recolonization of the whole coast by anadromous salmon from a southern refugium (Iberian peninsula). Along the coast of the Kola peninsula, haplotypes of both European and North American clade are observed, indicating contribution of both Western and Eastern Atlantic salmon populations to the colonization of this region. Non-anadromous populations have evolved independently in most river systems and regions from anadromous colonizers.

Fishing allochthonous ichthyofauna in the Mediterranean Vransko lake, Croatia

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Introduction

The Vransko lake is an oligotrophic lake that covers 3000 ha in the southern Croatia. It is connected to the Adriatic sea by 1 km long channel and by several natural underwater karstic holes. Out of 24 registered fish species, only few are autochthonous ones (*Knipowitchia caucasica*, *Rutilus basak*, *Salaria fluviatilis*). The other species either come from the sea (*Anguilla anguilla*, *Atherina boyeri*, *Chelon labrosus*, *Dicentrarchus labrax*, *Liza aurata*, *L. ramada*, *Mugil cephalus*, *M. saliens*, *Platichthys flesus*, *Solea solea*, *Sparus aurata*) or have been introduced, mostly disorganized, from the northern Croatian freshwaters since the late 1940s (*Esox lucius*, *Carassius gibelio*, *Cyprinus carpio*, *Leuciscus cephalus*, *Pseudorasbora parva*, *Scardinius erythrophthalmus*, *Lepomis gibbosus*, *Silurus glanis*, *Tinca tinca*). One of them (*Gambusia affinis*) was introduced to fight mosquito larvae. However, as only few of these species are really important for fishing in the lake, the aim of this study was to look into the significance of those species.

Material and methods

The fish were caught three times during the vegetation period in 2008. Unit effort was determined as 25 m trammel net, left overnight for 12 hours.

Results and Discussion

The results of fishing by the commercial tools (Table 1) show absolute domination of introduced freshwater species (the rest were eels and mullets). Upon the introductions in the late 1940s, the first decade was dominated by common carp (*C. carpio*). Over the last three decades the catch is typically composed of Prussian carp (*C. gibelio*) which along with rudd (*S. erythrophthalmus*) represent basic food source for European catfish (*S. glanis*).

Table 1. The ratio of fish mass (%) of main freshwater fish species in total fish catch by commercial tools in Vransko lake, during last six decades (Ržaničanin et al., 1986; Treer, 1989; Mrakovčić, 2004)

Species	% of catch			
	1950.	1985.	2004.	2008.
<i>C. carpio</i>	89,1	5,2	12,5	13,4
<i>C. gibelio</i>	-	61,3	58,1	13,8
<i>S. erythrophthalmus</i>	-	-	14,9	47,1
<i>S. glanis</i>	-	31,3	6,9	23,1
Total	89,1	97,8	97,8	97,6

The best catches were registered at the beginning of the summer (in June). Although there were no significant differences at various locations, the coefficient of variation was the highest in the closest spot to the sea, probably as a result of the highest change in salinity (Table 2).

Table 2. Catch per unit effort – CPUE [g x (25 m trammel net during 12 hours overnight)⁻¹] with respective coefficients of variation (CV) obtained in 2008 catches from the Vransko lake

Location / Date	12th June	16th July	1st October	Mean	CV
North-west (small freshwater inflow)	20960	15550	7312	14607	47
North-east (underwater spring)	17400	12862	9045	13102	32
South-east (channelling the lake's freshwater to the sea)	19850	2450	13745	12015	73
Mean	19403	10287	10034	-	-

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The preliminary study of the selected immune and physiological parameters in diploids and triploids of *Carassius auratus*

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The genus *Carassius* is represented in the Czech Republic by four taxa, native crucian carp *Carassius carassius*, introduced goldfish *Carassius auratus auratus*, gibel carp *Carassius auratus gibelio* and rare ‘ginbuna’ *Carassius auratus langsdorfii*. The populations of *C. a. gibelio* distributed in Czech Republic form diploid-polyploid complex with the presence of both sexes and dominance of triploid females. The rarely present populations of *C. a. langsdorfii* are formed only by triploid females. A negative impact of the *C. a. gibelio* presents its hybridization with native fish species. Diploid population of *C. a. gibelio* forms the hybrids with *Carassius carassius* and *Cyprinus carpio*. The aim of the study was to analyse the selected immune and physiological parameters in diploids and triploids of *C. a. gibelio*, triploids of *C. a. langsdorfii* as well as the hybrids between *C. a. gibelio* and *C. carassius* and hybrids between *C. a. gibelio* and *C. carpio*. Following physiological and immune parameters were analysed: differential leukocyte counts, erythrocyte count, spleen size, luminescence analysis of oxidative burst, bacteriolytic activity of complement system, lysozyme concentration in skin mucus, condition factor, gonad size and gonado-somatic index.

The erythrocyte count decreased significantly with increasing ploidy level. The highest lysozyme concentration in skin mucus was found in diploids of *C. a. gibelio* comparing to *C. a. langsdorfii* and hybrids. The luminescence analysis of oxidative burst revealed the highest values in diploids of *C. a. gibelio* and hybrids *C. a. gibelio* and *C. carassius*. Concerning to bacteriolytic activity of complement system the highest activity was found in both diploids and triploids of *C. a. gibelio*. The smallest values of bacteriolytic activity of complement system was found in *C. a. langsdorfii*. The preliminary analyses suggest that the immunity of *C. a. gibelio* is weakened compared to triploids of *C. a. gibelio* and *C. a. langsdorfii* and interspecies hybrids of *C. a. gibelio*.

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The epidermis structure of *Carassius auratus*: a link with sex and ploidy status

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Highly abundant gibel carp *Carassius auratus gibelio* and rarely present of ‘ginbuna’ *Carassius auratus langsdorfii* occurred in the rivers of Czech Republic. The populations of *C. a. gibelio* distributed in Czech Republic form diploid-polyploid complex with the presence of both sexes and dominance of triploid females. The rarely present populations of *C. a. langsdorfii* are formed only by triploid females with gynogenetic reproduction. The aims of this study were (1) to compare the epidermis structure (i.e. proportion of goblet and club cells) between two subspecies *C. a. gibelio* and *C. a. langsdorfii* and (2) to analyse the effect of the sex, ploidy status and reproductive period (i.e. spawning versus non-spawning) on epidermis structure in *C. a. gibelio*. The significant differences in the proportion of club cells between diploid males and diploid females as well as between diploid and triploid females during the spawning period were found. No significant difference in the proportion of goblet cells was found when comparing ploidy groups in spawning or non-spawning periods. A significantly higher proportion of goblet cells and a decrease of club cells was found in triploid females of *C. a. langsdorfii* when compared with all ploidy categories of *C. a. gibelio* (i.e. diploid males, diploid females, triploid females). The study of the epidermis structure in *C. auratus* showed differences linked to subspecies, ploidy status and sex.

This study was supported by the project of Grant Agency of Czech Republic no. 524/09/P620 and no. SP/2d4/55/07 from the Research Programme of the Ministry of Environmental of the Czech Republic.

Trace metal incorporation in fish otoliths: a chronological indicator of exposure to metal contamination

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Fish otoliths have the potential to contain many elements that substitute for calcium in the aragonite crystalline matrix. The acellular material deposited in otoliths is not resorbed or reworked during the fish lifetime, is metabolically inert and the trace elements uptake during the otolith growing process reflects the physical and chemical environment. The annular structure offers also the possibility of examining metal incorporation over time, providing a historical record of past and recent exposure of fish to trace metals. However, the studies about the potential use of the chronological properties of the otoliths as an indicator for the aquatic contamination are scarce and inconclusive. In this study we used 120 wild yellow eels (*Anguilla Anguilla*) to test the incorporation of three important metals (zinc, cadmium and lead) through the water into the marginal otolith zone corresponding to a chronic exposure time of 28 days. Prior to the experiments the juvenile eels had a quarantine period of 2 weeks. Three individual experiments (one for each metallic contaminant: Zn, Cd and Pb) took place in a photoperiod and temperature controlled room using 8 aquaria of 50 liters of artificial freshwater (2 psu). We tested three different ecotoxicological relevant concentrations and an additional control group (no contamination). The animals were feed daily (basal rate of 0.8% body weight) with a commercial food free of contaminants. We used a static system with a water renovation rate of 100% every two days. We used also an independent experiment to estimate the otolith growth rate during the exposure period using a die marker (tetracycline peritoneal injection). This information has used to fix the beam electron diameter of the ICPMS-LA. The objective was to test the hypothesis that the trace metal concentrations in the otoliths collected from eels are related to the metal contamination exposure during the experiment. This work was supported by the Portuguese Foundation for Science and Technology (PTDC/AMB/70431/2006).

Extensive introgression of brown trout from the Atlantic basin into the Danube basin populations in the Czech R. and Slovakia: Selective anthropogenic impact or better adaptability and/or higher aggressiveness of Atlantic lineage?

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Hybridization between different phylogenetic groups is one of the most serious threats for the brown trout populations in the central Europe. To detect the distribution of these groups and the current state of brown trout in the Czech Republic and Slovakia, the genetic structure of populations from four river basins has been studied. The analyses were based on the sequence variation of mtDNA control region, ten microsatellite loci and RFLP analysis of mtDNA (NADH5/6) and nuclear (LDH1) fragment. Very high level of introgression of brown trout from North/Baltic Sea basin into the Black Sea basin has been confirmed based on mtDNA as well as nuclear markers. We found several populations in the Danube basin with exclusively Atlantic haplotypes and we did not find any population with exclusively Danubian mtDNA haplotypes. Although a significant level of genetic differentiation between population pairs was indicated based on microsatellite data, it was not possible to resolve any structure using Bayesian approach in Structure software nor Factorial Correspondence Analysis in Genetix software. This is caused to a great extent by anthropogenic transfers during the last century. However, some Atlantic lineage haplotypes found exclusively in the Danube basin could indicate a penetration of Atlantic lineage into the Danube basin

already during the Pleistocene. Considering the bidirectionality of anthropogenic transfers between North and Black Sea basins during the last century, the absence of Danubian haplotypes in the North Sea basin could be explained by lower competitive strength of the Danubian lineage compare to the Atlantic lineage. Management and conservation of brown trout in the central Europe should take these findings into account.

The study was supported by the grant 1QS500450513 of the Academy of Sciences of the Czech Republic.

Age and growth of *Melicertus (Penaeus) kerathurus* (Forskäl, 1775) in the shallow Sicilian coastal waters

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The king prawn (*Penaeus keraturus* Forskäl, 1775) lives on the sandy or muddy seabeds of the coastal area where it burrows. It is a species that easily adapts to changes in salinity and comes close to the coasts and the estuaries of the rivers during the reproductive period. In Sicily, it is caught solely through artisanal fishery using trammel and/or gill net. The catches are made in spring and summer, rarely in autumn and hardly ever in winter. The data of this study were collected in the framework of the project "Testing of a restocking strategy with *Melicertus (Penaeus) kerathurus* (Forskäl, 1775) between Cape San Marco and Cape Granitola" in the years 2002 - 2005. The population's structure was determined for males and females per each one of the investigation year. The age and growth parameters were estimated by the software "Fish Stock Assessment Tools" (FiSAT II). The Bhattacharya analysis showed 3 groups for females and 2 groups for males. The growth parameters were estimated by the Von Bertalanffy's growth function and the value of L_{∞} (67, 37 mm) for females was clearly higher than the one for males (55, 79 mm). Indeed, as it was expected, females, at equal age, are always bigger than males. It also seems that the growth speed of females is higher than the one for males since the K of females is bigger than that one of males. Finally, considering the highly prized species and its price, fluctuating between 30 and 45 € per kg, the population structure in Sicily should be monitored year after year.

Reproductive aspects of *Coelorhynchus coelorhynchus* (Risso, 1810) (Pisces: Macrouridae) in the central Mediterranean Sea

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Coelorhynchus coelorhynchus (Risso, 1810) (Pisces; Macrouridae) is widely caught and discarded by the commercial bottom trawlers in the Mediterranean Sea. This species lives on mud bottom between 140 m and 630 m (Stefanescu et al., 1992, 1994; Ungaro et al., 1994; D'Onghia et al., 2000). Despite the Macrouridae are species with high longevity and slow sexual maturation (Motais, 1960; Orsi Relini e Wurtz, 1979a, 1979b; Haedrich, 1996; Kelly et al., 1997) and, so vulnerable to exploitation, we have poor information on the reproductive aspects of *Coelorhynchus coelorhynchus* in the central Mediterranean Sea. In this study we focus our attention on sex ratio analysis, monthly state of gonadosomatic index (IGS) and estimation of the first maturity length, L50%.

The results showed a long reproductive period with an increase of females with the length. The maximum value of IGS was recorded in winter for males (0.30 sd=0.15) and females (3.08 sd=1.7). The comparison between the females' IGS values and length frequency showed as the IGS values grow with the length. However, a great heterogeneity can be noticed among the specimens. The estimation of L50% was lower than the mean value of females' length.

Considering the greater interest in deep-water fishery, mainly thanks to deeper trawl surveys, further investigation like the ones carried out in this work are suggested for the management of the deep water species.

Genetic diversity of grayling (*Thymallus thymallus* L.) populations in the Czech Republic inferred from microsatellite markers

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The grayling (*Thymallus thymallus* L.) is an economically important fish which is widespread across most of the European continent. Together with the brown trout, the grayling represents the most valuable fish species in salmonid waters of the Czech Republic, highly valued by sport anglers. For more than 150 years, the grayling has been subject of intensive artificial spawning, resulting in much broader current distribution and abundance of grayling populations in comparison with the past. As the fish management encompasses nearly all water courses in the Czech Republic, existence of genetically indigenous populations is very problematic. Based on results of genetic analyses, the artificial management of grayling populations should be re-evaluated and re-designed, and eventual original local populations should be preserved.

Genetic diversity of grayling populations in the territory of the Czech Republic has been assessed by two multiplex analyses of nine microsatellite loci (BFRO005, BFRO006, BFRO008, BFRO010, BFRO011, BFRO014, BFRO015, BFRO016 and BFRO018). Grayling populations from all three watersheds (Baltic Sea, North Sea and Black Sea) of the Czech Republic were sampled by electrofishing. Allele and genotype frequencies, deviations from the Hardy-Weinberg equilibrium, gene diversity indices, genetic distances and relationships between respective populations were assessed.

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Reproductive biology of the freshwater goby *Knipowitschia croatica* Mrakovčić *et al.* 1994 (Actinopterygii, Gobiidae)

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The reproductive biology of the Vrgorac goby, *Knipowitschia croatica* Mrakovčić *et al.* 1994 is described. The species displays sexual dimorphism during the spawning period, with males developing a black head and more intense dark colouration of the body and fins, while females display a yellow belly and luminescent green spot on the first dorsal fin. The gonadogenesis cycle is described. Sexual maturity is achieved at an early age, with 50% of males and females sexually mature at total lengths of 40–45 mm. Batch fecundity of captive females ranged from 190 to 254 eggs, on 5 spawning events. Mean relative fecundity of gravid females ranged from 188 to 593 eggs, with an egg diameter of 0.22 to 1.11 mm. Though the extended spawning period lasts from March to November, and throughout the year in the aquarium, the highest intensity spawning in the wild occurs from April to September. During spawning, females entered the nest alone and laid a single layer of eggs on the underside of the nest ceiling, regardless of the surface. A high degree of cannibalism by the guarding male was recorded.

Structure of the epidermal crests in *Romanogobio* species

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Epidermal crests are among morphologic traits distinguishing species of the *Gobio* and *Romanogobio* genera. The crests are half-round shaped on the cut (Fig. 1C), their thickness being comparable to thickness of the epidermis. The crests consist of several layers of live epithelial cells, secretory cells do not occur here. Breeding tubercles, occurring particularly in fish of the genus *Gobio* during spawning period (Fig. 1B), differ from the crests both in shape (conical) and in cell structure (epithelial cells transformed into keratinized layers).

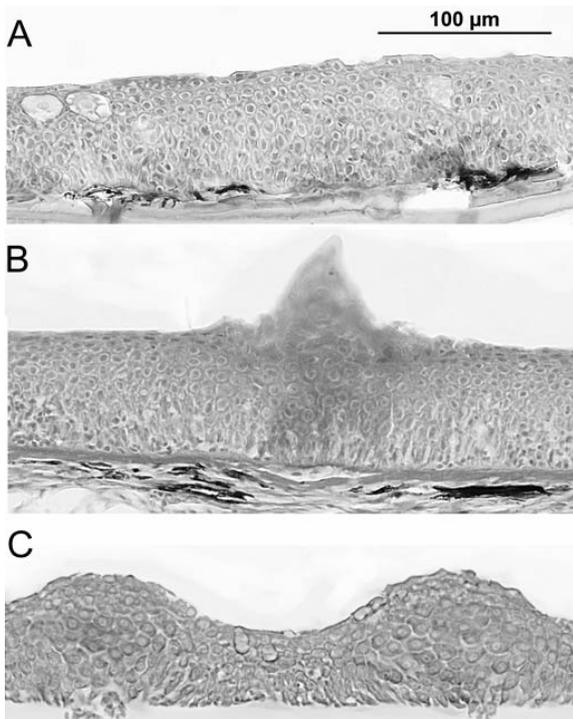


Fig 1.: A – general structure of the epidermis of Gobio/Romanogobio individuals with secretory cells (Gobio obtusirostris), B – keratinized breeding tubercles (Gobio obtusirostris), C – epidermal crests (Romanogobio belingi), trichrome Mallory stain.

This study was supported by the project of Grant Agency of Czech Republic no. 206/09/P608 and no. SP/2d4/55/07 from the Research Programme of the Ministry of Environmental of the Czech Republic.

Structure and histochemistry of the epidermis of the grayling (Thymallus thymallus)

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Thickness of the epidermis of adult graylings varies from 90 to 170 µm. Particularly during the spawning period, the epidermis tends to be thicker in males than in females. However, the differences are not statistically very relevant because of great individual differences (Fig. 1).

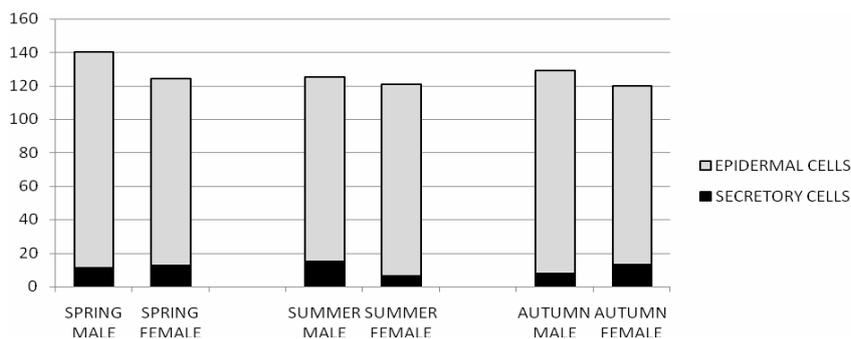


Fig. 1.: Thickness of the epidermis and proportion of secretory cells

In the upper and middle layers of the epidermis, secretory goblet cells are present (Fig 2). Using histochemical colouring, it has been shown that dominant part of their content consists of acid-sialated and acid sulphated glycoproteins. Less represented are neutral and acid carboxylated glycoproteins.

This research was supported by a grant IQS500450513 from the Grant Agency of the ASCR.

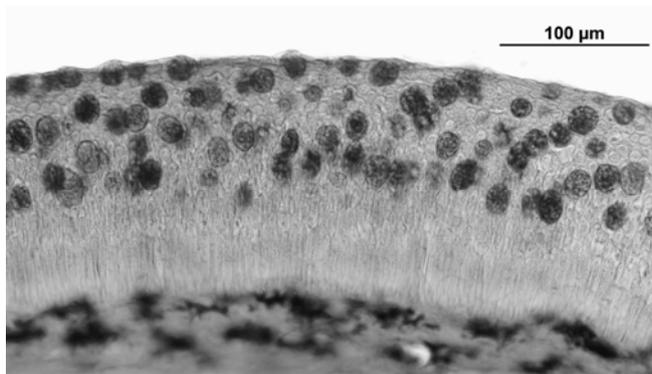


Fig. 2.: Epidermis of the grayling – upper and middle layer contain alcianophilic secretory cells (alcian blue at pH 2.5)

Ichthyofauna of the upper plateau of the Jizera Mts (Czech Republic), and the impact of air pollution (with special attention to metals) on brook charr (*Salvelinus fontinalis*) populations

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In 2008, ichthyofauna on the upper plateau of the Jizera Mts (Northern Bohemia, Czech Republic) was studied, with focus on its structure and individual fitness in the era of recovery of the area from anthropogenic acidification. The research was conducted in six sampling periods to represent the whole range of physical and chemical parameters of streams during the season. In each of these periods, stream water was sampled for chemistry, benthic organisms for determination of the quality and quantity of food for the fish, and fish (electrofishing) to learn about the structure of fish populations in the studied streams. In September and October, fish tissues were sampled for the content of metal pollutants.

In September and October (spawning), fish from the Černá Nisa stream were caught and analyzed for deformations on their branchial apparatus. Our samples lie within four age categories (0⁺, 1⁺, 2⁺, 3⁺). A small part of the 1st branchial arch was collected and examined under microscope. Altogether 39 samples were analyzed.

Among the histopathological findings, there were hyperaemia occurring equally in all age categories (84,62% samples), angiectasia (Fig. 5.), which was most frequent in the 2⁺ category (23,08% samples), intrusion of erythrocytes between branchial lamellae (Fig. 6.), which was also most frequent in

the 2⁺ category (15,38% samples), capillary congestion was observed only in individuals of the

1⁺ category (5,13% samples), and a strong activation of chloride cells (Fig. 4.) and epithel desquamation (Fig. 3.) (2,56% samples for each symptom in the 1⁺ and 3⁺ age category, respectively). By 56,41% samples, distributed equally within the age categories, the occurrence of odd cells was observed between branchial lamellae, probably immature blood cells. In 4 individuals (3 in the 0⁺ age category and 1 in the 1⁺ category) no changes of the branchial apparatus were observed.

Second part of our research was aimed at measuring physical and chemical parameters of water in three water reservoirs (Bedřichov, Souš, Josefův Důl) and their main inflows. Collecting of water samples was realized in vertical profile of reservoirs and on selected parts of inflows. In these samples pH, conductivity, main cations (Ca²⁺, Mg²⁺, Na⁺, K⁺ a NH₄⁺), main anions (SO₄²⁻, NO₃⁻, Cl⁻, F⁻) and toxic metals (Al, Fe, Cu, Zn, As, Cd, Pb, Cr, Co, Hg) were determined.

The results of water chemistry of reservoirs were compared with results from 1994. Based on this comparison, water chemistry changes are evident. We noted increase of average pH value (15,3%) and strong increase of alkalinity (Fig. 1., 2.). As a result of gradual deacidification in the area of the Jizera Mts, decrease of the average weight concentration of acid anions was expected and later confirmed in this order: NO₃⁻(67 %)>SO₄²⁻(24 %). In case of Cl⁻ anion, increase of concentration (28% in average) was found. Concentration change of F⁻ could not be determined, because in 1994 this anion was not monitored.

Decrease of average weight concentration of basic cations is also linked with deacidification. The decrease was recorded in this order: K⁺(49,2 %)>Mg²⁺(32,2 %)>Ca²⁺(21,2 %). There was also observed increase of Na⁺ concentration (31,4 % in average).

	pH	Alk. ($\mu\text{eq/l}$)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	Na^+ (mg/l)	K^+ (mg/l)	NH_4^+ (mg/l)	Cl (mg/l)	NO_3^- (mg/l)	SO_4^{2-} (mg/l)
average 1994	5,25	9,2	3,93	0,9	1,93	0,65	0,06	0,68	3,33	13,07
average 2008	5,78	22,4	2,5	0,63	2,8	0,35	0,07	1,02	0,73	11,2
Δ [%]	\uparrow 9,5%	\uparrow 143%	\downarrow 36%	\downarrow 30%	\uparrow 45%	\downarrow 46,2%	\uparrow 16,7%	\uparrow 50%	\downarrow 78,1%	\downarrow 14,3%

Fig. 1.: Water chemistry changes in reservoir Bedřichov (values from 1994 and 2008)

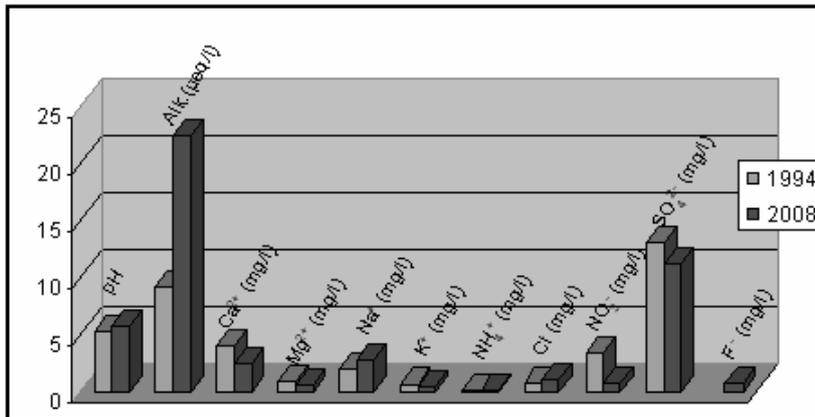


Fig. 2.: Comparing values of water chemistry in reservoir Bedřichov (1994 and 2008)

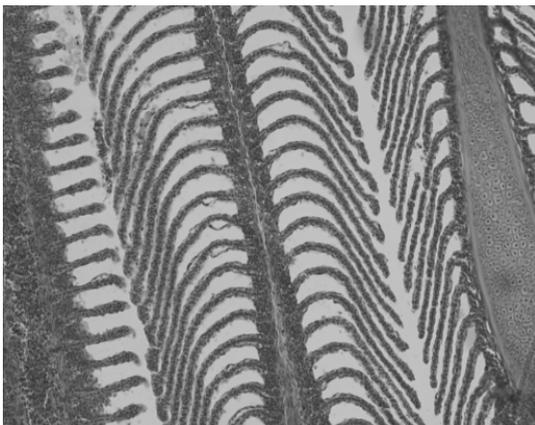


Fig. 3.: desquamation of gill epithel

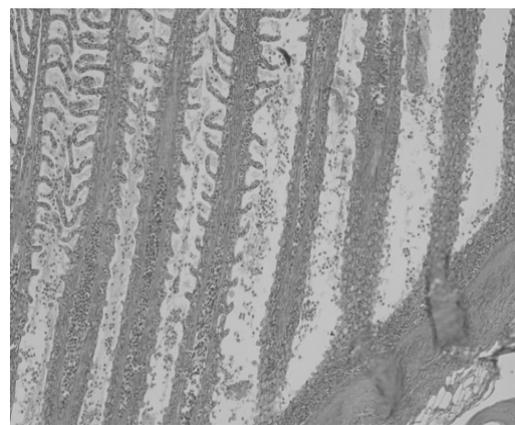


Fig. 4.: activated chloride cells



Fig. 5.: angiectasia



Fig. 6.: intrusion of erythrocytes

Angola headwaters: the white spot on the *Serranochromis* phylogeographic map

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Although the African cichlids can be considered as enormously studied group of fishes, there is no record of this group from central Angola since 1975 due to lack of any field work in the area. Up to now our project comprises first molecular study on cichlids from Bié Plateau. This Angolan headwater region includes five important river basins in relatively small area and we have collected samples from three of them, i.e. Kubango (Okavango), Kwanza (Cuanza) and Kunene (Cunene). In the presented work we focused on phylogeographic study of serranochromine cichlids, based on four genes, three mitochondrial (16S rRNA, cytochrome *b*, NADH 2) and one nuclear marker (S7 intron). We included additional sequences from GeneBank, especially from specimens originated from two other river systems missing in our sampling, i. e. Congo and Zambezi. 1) We found separate lineage of upper Cuanza and upper Okavango serranochromine fishes. 2) Our results further show the possibility of fish colonisation from Okavango River system to the Cuanza River system. 3) Finally, we combined our data with previous analyses in haplochromine cichlids and we thus significantly enlarged sampling area of this fish group in Africa.

The work was supported by Official Development Cooperation Program of The Czech Republic specifically by project “Poradenství v oblasti chovu ryb a drůbeže, Angola” No. MZe/B/2. Further support was realized within Centre for Biodiversity LC06073 (MSMT), IRP IAPG AVOZ50450515 and IRP FAPPZ, CZU MŠMT 6046070901.

Maximum body mass in fish samples from the Warta River and its oxbow lakes

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Electrofishing was carried out in 2003-2007 at two sites in the Warta River ($MQ = 48.9 \text{ m}^3 \text{ s}^{-1}$, Odra River system) named WI and WII, and in adjacent oxbow lakes A-D of which C was largest (maximum depth 2.3 m, total area 12100 m²) and B and D smallest (B: 1.5 m and 1350 m², D: 1.5 m and 500 m², respectively). Because the mean depth of the latter two oxbow lakes was about 0.5 m they were most vulnerable to frost penetration in winters. Additionally the oxbow lake D suffered most from water warming in summers because of little canopy.

The following total number of species was recorded at the sites: WI – 21, WII – 21, A – 18, B – 21, C – 19 and D – 12. The biggest specimen was wels *Silurus glanis* from WI weighing 6.32 kg. In over 50% of samples the largest specimens were pikes *Esox lucius* reaching almost 3.80 kg in the river and 2.45 kg in the oxbow lakes. The second largest species in the oxbow lakes was tench *Tinca tinca*. Though no significant difference between sites in maximum body mass (MBM) in fish samples was found, the highest medians were recorded for C, WI and WII (large space available for fish), and the lowest ones for B and D (limited space, unstable environmental conditions).

Rheophilic species were present in all the samples collected in the river and only in about 2/3 of samples from the oxbow lakes. The biggest rheophilic specimen was chub *Leuciscus cephalus* from WII weighing 2.10 kg. In a half of samples the largest rheophils were ide *Lecuscus idus* reaching 1.56 kg in the river and over 0.40 kg in the oxbow lakes. Ide was also the biggest rheophil in the oxbow lakes. In the river MBM of rheophils in fish samples was significantly ($p < 0.01$) higher than in the oxbow lakes A, B and C.

Limnophilic species were present in all the samples collected in the oxbow lakes and only in 50% of samples from the river. The biggest limnophilic specimen was tench from D weighing 1.60 kg. Tench was also the biggest limnophil in a half of samples. In the river the biggest limnophil was gibel *Carassius gibelio* from WI weighing only 73 g. In three samples from the Warta the largest limnophil was three-spined stickleback *Gasterosteus aculeatus*. MBM of limnophils in samples was significantly ($p < 0.01$) lower: 1) in the river as compared to oxbow lakes, and 2) in the small oxbow lake B as compared to the largest oxbow lake C.

Erytopic species were present in all the samples. Though no significant difference between sites in MBM of erytopic species in samples was found, the highest medians were recorded for C, A and WII, and the lowest ones for D and B.

The results suggest that MBM may serve for detecting and expressing differences between habitats in the quality of aquatic environment and probably also in human pressure along with other popular variables like species richness, fish abundance and biomass. MBM in this study was found to poorly correlate with biotic (Shannon, Simpson,

CDI, ABC) indices, which means that it may cast additional light on ecological analysis. Moreover, MBM data are easily obtained in contrast with data for the standard growth analysis.

Male or female? Some differences between the sexes in Chinese sleeper *Percottus glenii* (Perciformes)

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Sexual dimorphism of Chinese sleeper (*Percottus glenii*), expressed in the ventral fin length (VL), was investigated in 518 specimens (270 females and 248 males) captured on 13 sampling occasions in the Włocławski Dam Reservoir (Vistula River). The sex ratio (F:M) was 1:0.92, and neither of the sexes displayed any seasonal dominance. The mean VL (\pm SD), of females was 10.46 mm (\pm 2.17) at the mean total length, TL (\pm SD), of 95.49 mm (\pm 27.58); the values for males were 9.24 mm (\pm 1.34) and 95.47 mm (\pm 20.44), respectively. The maximal value of VL was 14.36 mm at TL of 169 mm for females and 11.74 mm at TL of 150 mm for males. In both sexes VL was correlated with TL, while regression equations describing this relationship were: $VL = 0.072TL + 3.565$; $R^2 = 0.840$ for females and $VL = 0.049TL + 4.533$; $R^2 = 0.566$ for males. Also, considerable differences in the shape of the ventral fin between sexes were observed. A comparison of the regression equations proved the occurrence of statistically significant differences in the regression coefficient (b) ($t=6.551$; $df = 514$; $p < 0.0001$). Differences in VL between females and males changed together with fish size (TL), and a statistically higher mean VL in females occurred in individuals longer than 81 mm. Meanwhile, no significant differences in the fin length occurred in specimens smaller than 81 mm.

Seasonal variation in fish assemblage in the shallow littoral zone of Eru Bay (Gulf of Finland)

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The littoral areas of Northern Baltic Sea are dominated by small-sized fish species, which are important components of the food web. However, while the importance of the structure of the shallow littoral fish assemblages is widely recognised in the ecological systems of local food webs, the knowledge on these species assemblages remains poor. The seasonal variation in shallow littoral zone fish species composition and species occurrence frequency (V%) are presented in the current study on the example of monthly beach seine samplings in Gulf of Finland during 2008.

Restitution of vimba (*Vimba vimba*, Cyprinidae) in Poland

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Until 1960s vimba occurred abundantly in the Odra and Vistula rivers and it used to be an important species for the fish industry. At the end of the 20th century vimba practically ceased to exist in the Oder River system while in Vistula its population was heavily reduced in size and became stationary due to construction in 1963 of the Wloclawek Dam.

We have performed the genetic analysis to of several remaining vimba populations. On the basis of the mtDNA D-loop sequences we have selected the population of the Barycz River (an Oder River tributary) as the one characterized by the biggest number of haplotypes. Spawners from this population were used for the baby-fish production and the young fishes were released (approximately 1 million per year) in the period 2000 – 2008. In 2004 the first batch of the fish released returned to the spawning grounds in the Barycz River and since then their number was growing constantly. In 2008 the number of fishes approaching spawning grounds exceeded 1000 fold the original number reported in 2000.

The genetic analysis of returning fishes revealed that the number and proportions of haplotypes has not changed comparing to the original population. One can therefore assume that the vimba restitution program was a success

and we estimate that natural reproduction of vimba supported by artificial spawning will bring in 5 - 8 years the Odra River population to the shape it had 60 years ago.

Determination of nitrites lethal effect (LC₅₀) IN FRY OF *Skiffia multipunctata* (Pisces:Goodeidae)

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The central part of Mexico includes diverse water bodies with a high ichthyofauna richness of native and endemic fish. The Goodeinae subfamily, which is distributed in the Mexican central plateau, is part of it. Originally, the highest concentration of these fish was found in the Lerma River. Nowadays their distribution is decreasing as a consequence of the loss of habitat caused by anthropogenic factors. The distribution of *Skiffia multipunctata* (endangered conservation status IUCN 1998) has diminished by 43%. As the Goodeinae group has a low economical importance, it has been ignored in the effort of conservation even though it plays an important ecological role in the ecosystems. The contamination of the water through nitrates leaching from agriculture (nitrogen fertilizers) and farming feces results in a reduction in the water quality, affecting the aquatic life. Nitrites (NO₂⁻) is a toxic compound that aquatic organisms tolerate in low quantities, and its presence affects the growth and reproduction of various species. The use of toxicity tests can help assess the damage to the organism (survival) caused by a specific toxin. A common test is the lethal dose (LC₅₀) test, which was performed as a first effort to establish the tolerance levels of *S. multipunctata* fry to nitrites. The concentrations: 0.0 (control), 0.016, 0.028, 0.049, 0.085 and 0.15 mg/L were tested. Observations on behavior and survival were recorded at 0.30, 1, 2, 3, 4, 6, 9, 12, 24, 36, 48, 72 and 96 h of toxin exposition. Results showed difficulties to swim and loss of equilibrium. Hemorrhages were more evident in high concentrations and survival was affected after 24 h of exposition. Complementary studies are necessary to know the tolerance levels of the species.

Variation in proliferation of the epidermal club cells in the epidermis of mirror carp *Cyprinus carpio* (L) by ichthyophthiriasis – part of innate defence or innate immunity system?

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Epidermal club cells (ECC) may form part of the fish immune system by opinion of some investigators. The skin pathology of ichthyophthiriasis was investigated in a group of naïve mirror carp infected with large number of *Ichthyophthirius multifiliis* (F) theronts and small trophonts during postichthyophthiriasis healing in laboratory conditions.

Club cells were missing in case of high invasion level, when density of theronts and trophonts was 3-7 (maximum 12) per mm. Proliferation of club cells during healing suggests that these cells have stabilizing role through influence on the cellular kinetics of the filament cells and via phagocytic cleaning of injured epidermis. Our data indicate that the function of club cells is universal cleaning of damaged epidermis after effective local immune and inflammatory responses to pathogen. In this sense epidermal club cells may function as part of the fish innate defences system, however they do not act directly as immune cells (part of the innate immune system).

Phylogenetic relationships of Monoamine Oxidase genes in Teleosts

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Monoamine oxidase (MAO), a mitochondrial enzyme, plays a key role in the biodegradation pathway of biogenic amines both in the nervous system and peripheral tissues. In mammals, monoamine oxidase exists in two forms, A and B, which may be distinguished biochemically by the difference in their substrate affinities and inhibi-

tor sensitivities. By cloning cDNA for MAO A and MAO B, convincing evidence was found that the two forms are encoded by different genes.

As well as in mammals, MAO A and MAO B activities have been detected also in other vertebrates such as birds and reptiles. It is noteworthy that both A and B forms are also present in adults of anura while in anura during development and in urodela (both with an aquatic lifestyle) the only form is MAO A. These results suggest that MAO A is the ancestral form, and MAO B represents an adaptive physiological response to a terrestrial life style. In agreement with this hypothesis, the presence of a single form of MAO has been demonstrated in teleosts. Biochemical data have indicated that in some teleostean species the enzyme resembles MAO A (MAO A-like), while in other species it has been defined as a form of MAO, distinct from A and B forms (MAO novel form).

To further clarify these findings, nucleotide and amino acid sequences were analysed in several teleostean species, and then compared with sequences obtained in other *taxa* to reconstruct the phylogenetic relationships of monoamine oxidase on the basis of most of the currently available MAO sequences.

31 sequences obtained from different species were used for the analyses. Two maximum likelihood phylogenetic trees were constructed using nucleotide and amino acid sequences, producing similar results.

The phylogenetic analysis involving the nucleotide sequences roughly indicates the presence of four groups: a first group comprising MAO sequences of non-vertebrates species so far examined, a second group including the sequences of fish MAO genes; a third and fourth group consisting of mammals MAO A and MAO B sequences respectively. The phylogenetic analysis produced by amino acid sequences shows a quite similar pattern showing the same four groups.

The main conclusion that can be drawn from our study is that the fish MAO appears to be equidistant from A and B isoforms. Owing to this result, the phylogenetic analysis does not support the hypothesis that in vertebrates, the common ancestral form of the two isoenzymes is a MAO A-like, as suggested by biochemical characteristics of MAO in some species of teleosts. The comparison of nucleotide and amino acid sequences seems to confirm the hypothesis that the only form present in fish is a novel form distinct from the MAO A and MAO B of terrestrial vertebrates.

A more detailed comparative analysis of vertebrates and non-vertebrates monoamine oxidase sequences is thus deemed necessary to better elucidate the most probable evolutionary relationships of MAO isozymes and the significance of their functional diversification occurred during transition from aquatic to terrestrial life style.

Expansion, feeding and parasites of the round goby, *Neogobius melanostomus* (Pallas, 1811), a recent invader in the Curonian Lagoon, Lithuania

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Since late 1950-ies, the round goby *Neogobius melanostomus* (Pallas, 1811) a Ponto-Caspian bottom-dwelling fish, has started gradual distribution outside its native range. In 1990, it was recorded in the Gulf of Gdansk, the Southern Baltic. In Lithuanian coastal waters of the Baltic Sea *N. melanostomus* was first discovered in 2002, near the Klaipėda Strait, and was later recorded in the Curonian Lagoon. In Northern Europe the round goby proved to be an invasive species. When its density is high, it becomes an important link in the food web of aquatic ecosystems capable of disturbing their dynamic equilibrium. Therefore, the development of the *N. melanostomus* population in the Curonian Lagoon and its possible impacts on fish community and the entire ecosystem are of great scientific and applied interest.

The present study was undertaken chiefly with a view to determine potential impacts of the recent newcomer on the ecosystem of the Curonian Lagoon. Studies of these effects covered the following aspects: (1) the current distribution and abundance of the round goby in the Curonian Lagoon (Lithuanian part), (2) its diet in the invaded area, and (3) the possibility of alien parasites' transference into the system by this new fish species.

During the 2007 survey, 5 locations inhabited by the round goby were recorded in the northern part of the lagoon. Expansion of the species was primarily observed along the western coast, i.e. along the Curonian Spit, which contains hard bottoms. Information received from anglers indicates that the newcomer occurs in wharf localities as far to the south as Nida Town and Ventė Cape. The quantitative food content analysis in the northern part of the Curonian Lagoon suggests that during their first year of life *N. melanostomus* juveniles rely on chironomid larvae, ostracods and amphipods, while beginning with the second year of life, mussels, zebra mussels in particular, constitute over a half of their diet. Moreover, feeding specialisation of *N. melanostomus* seems to increase with body size growth. Analysis of food items in the round goby's diet showed that its diet is broad. However, molluscs and higher crustaceans, including amphipods, appeared to be of primary importance for 2+ year gobies in the Klaipėda Strait and the northern part of the Curonian Lagoon. Our study suggests that the round goby did not transfer alien metazoan parasite species to the ecosystem of the Curonian Lagoon. Seven metazoan parasite taxa of local origin were recorded in round gobies from the Curonian Lagoon.

In conclusion, the recent invader round goby has potential for becoming a keystone species at least in some environments and may induce changes in the ecosystem of the Curonian Lagoon. If the round goby stock continues increasing dramatically, undesirable impacts on fisheries in the Curonian Lagoon may be presumed. However, the growth of the round goby stock may be stabilized by predation pressure from local piscivorous fish species and/or fish eating birds, or some other factors. The development of the round goby's population in the Curonian Lagoon definitely warrants further research.

The use of fish behavioural responses in identifying sublethal exposure to heavy metals

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Heavy metals are widely used in industry and are common aquatic pollutants (Moore 1991). In industrial wastewaters they are usually found in mixtures which are specific to a particular pollution source. At present the controlling of pollution of aquatic environment by heavy metals is performed basically by use of analytical investigations.

However, the evaluation of effluent quality by physical-chemical measurements does not provide information regarding the possible synergetic or antagonistic effects that complex effluents may have on aquatic life. Therefore, it is necessary to perform biological control of effluent toxicity, before effluents are discharged into receiving waters. For rapid determination of waste-water toxicity level, bioassay testing is used.

Bioassay testing is defined as a rapid experimental evaluation of water toxicity level by use of biological objects and processes (Flerov, 1989). Test-objects must be easily available and maintainable. Their test-functions must be sensitive not only to acutely toxic effluent levels, but also provide information about sublethal concentrations.

Fishes are considered to be among the best test-objects. Alterations in fish behavioural responses are sensitive indicators of sublethal exposure to heavy metals and other pollutants (Giattina and Garton, 1983; Atchison et al., 1987; Little and Finger, 1990; Scherer, 1992; Kane et al., 2005).

Laboratory tests were conducted in a flow-through apparatus on one-year-old rainbow trout *Oncorhynchus mykiss* Walbaum to evaluate the sensitivity of a number of their behavioral responses to heavy metal model mixture of seven metals (Cu, Zn, Ni, Cr, Pb, Cd, Mn) in comparison with a reference toxicant - hexavalent chromium (Cr⁶⁺). Test fish were exposed to a series of toxicant concentrations corresponding to 0.001 – 1 parts of the rainbow trout 96-hour LC50 in short-term (15 min) tests. Sensitivity of the responses studied coincided completely and could be arranged into the following sensitivity order: avoidance response > latent period of detection response = locomotor activity > gill ventilation frequency > coughing rate. All the rainbow trout responses were sensitive behavioural indicators of sublethal exposure to heavy metals. Behavioural responses studied meet the criteria as rapid tools for early warning systems and bioassay testing of treated and untreated industrial wastewaters, while hexavalent chromium could be successfully used as a reference toxicant in standard fish behavioural toxicity tests.

Arctic Marine Fishes of Canada

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The Arctic marine fish fauna of Canada is reviewed. It comprises 53 families with 192 species. Additionally, 83 species occur extraliminally in waters adjacent to Canada and may eventually be recorded from the arctic ichthyofauna. A further 36 species of primarily freshwater fishes may occasionally enter brackish marine areas.

Most arctic marine families have 4 species or less (42 or 79.3%), with the most speciose families being Zoarcidae with 31 species, Salmonidae with 16 species, Cottidae with 14 species and Liparidae with 10 species.

A distributional database has been built up from museum collections, particularly those of the Canadian Museum of Nature, but also collections in other museums in North America and Europe, and an extensive survey of the literature including consultant reports. The database contains over 52,370 records.

The aim of this work is to produce a book on the fauna with illustrations, maps, descriptions of species and their biology, keys and an extensive bibliography. The bibliography currently comprises over 4060 entries.

The poster reviews biodiversity, distribution and hotspots and gives an overview of the fauna.

Unexplained questions on European anglerfish (*Lophius piscatorius* and *L. budegassa*): can we infer reproductive strategies?

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Certain biological processes related with reproductive strategy in European anglerfish (*Lophius piscatorius* and *L. budegassa*) still remain unsolved challenges for science. Both species are considered sedentary, but medium and large displacements have been reported in the northeast Atlantic, probably associated with the maturity or spawning. The reproductive season extend from November to June, following different authors, and the spawning behaviour, areas, and batch process fecundity are poorly documented in the Northeast Atlantic. Spawning males are observed year round, while ripe or spent females are rarely found in the commercial fisheries or during research surveys. Detailed information on larval distribution and recruitment process are also lacking. In this study, reproductive strategies of anglerfish are revisited in the light of the current literature and different sources of data.

Seasonal patterns of the parasite infestation by *Anisakis* Type I and *Pseudoterranova decipiens* (Nematoda: Anisakidae) in white anglerfish (*Lophius piscatorius*) from the South and Southwest Ireland

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Anisakis Type I (sensu Berland, 1961) and *Pseudoterranova decipiens* (sensu lato) (family Anisakidae) are worldwide spread and have an indirect life cycle. Many teleost species may act as paratenic hosts of the larva stages of these parasites while adult stages live in the marine mammals (definitive host). A paratenic host of these parasites is *Lophius piscatorius*, a commercial bottom species in the western and southern European fisheries.

In this study, the seasonal patterns of the *L. piscatorius* infestation with *Anisakis* Type I and *P. decipiens* were analysed. White anglerfish, obtained from the Spanish trawl fleet operating in South and Southwest of Ireland, were surveyed for *Anisakis* Type I and *P. decipiens* in muscle and body cavity. The variation of infection levels (prevalence and intensity) through the year was discussed taking into account the aspects of white anglerfish behaviour (migrations, feeding habits) and the distribution of the definitive host of the parasites.

Age, Growth and Reproduction Features of an Endemic Fish: *Ladigesocypris ghigii* (Gianferrari, 1927) Inhabiting SW Anatolia

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Ladigesocypris ghigii is endemic to Western Anatolia. The body is slightly laterally compressed, covered in rather large scales regularly arranged on the body. Eyes are large and mouth is oblique and terminal. There is a flattened keel in front of the anal fin. The dorsal, anal and caudal fins have dark points. Dorsal is silver dark and ventral silver is bright with a purplish coloration along the flanks in living specimens.

The age, growth and reproduction characteristics of 122 *Ladigesocypris ghigii* from the Mugla-Dalaman region were determined. Ages ranged from 1 to 7 years. The length- weight values according to ages were found as: 46.53/1.18, 54.95/2.02, 68.21/3.14, 74.34/5.61, 92.10/9.91, 107.53/17.54, 13.50/24.14 (mm/g). Average condition factor was calculated as 1.04. Male/female ratio was found 0.2/1. Spawning period was from April to May.

Key Words: *Ladigesocypris ghigii*, Growth and Reproductive Properties

Threespine Stickleback (*Gasterosteus aculeatus* L.) from Upper Zones of Dalaman River- Turkey

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Threespine stickleback (*Gasterosteus aculeatus*) is a widespread teleost characterized by having a modal count of three isolated strong spines in front of the dorsal fin. There are two forms of threespine stickleback; oceanic form has a complete set of bony lateral plates along the sides while freshwater form has reduced set of bony lateral plates. In freshwater they are primarily inhabitants of shores along large lakes and rivers.

In this study, threespine stickleback *Gasterosteus aculeatus* was interestingly caught from upper zones of Dalaman River, nearly hundred kilometers far from sea connection. The altitude of the locality was 970 meters and electricity conductivity was $740 \mu\text{Scm}^{-1}$. A total of 104 specimens were caught and the maximum length and weight were 61 mm and 3.07 g, while the length and weight values of most of the caught specimens varied between 31-37 mm, 0.45-0.22 g. Habitat features were observed and the water quality parameters were analyzed in the sampling point.

Key Words: *Gasterosteus aculeatus*, Dalaman River, Habitat Features

Fish assemblages in ne Iberian Peninsula overtime: biodiversity, conservation status and introduces species

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Here we examined the changes in freshwater fish assemblages in Mediterranean watersheds in the NE of the Iberian Peninsula. For this purpose, we used an extensive data set from 2002-2003 and historical information to characterize freshwater fish diversity and to establish conservation priorities. This region of the Iberian Peninsula is a hot spot of alien fish introductions and its native fish fauna is one of the most endangered worldwide. Diversity indices were used to characterize fish diversity at basin scale. To estimate the conservation status of each species, we applied an index developed in the Guadiana basin which considers the occurrence, abundance and endemism of each species. We used indirect ordination methods to test the relationship between basin features and to identify the most correlated variables. To identify physical, biotic and environmental characteristics that make a basin particularly susceptible to invasions, we performed a step-wise multiple regression to examine the relationship between the number of native, translocated, and introduced fish species, and landscape variables, including the diversity of autochthonous fish. From historical data to 2002-2003, the distribution area of native fish fauna decreased on average by more than 23%. The populations of *Squalius laietanus* and *Anguilla anguilla* dropped by over 40%. The highlighted species according to conservation value index were *Gasterosteus gymnurus* and *Salaria fluviatilis*. Basin area and the type of watershed explained 70% of variation in native species richness whereas the number of dams and the basin surface area accounted for more than 80% of variation in the richness of introduced species. When translocated species were included in the analyses, our model showed 73% of variation and only variable selected was the surface area of basins. No biotic resistance to invasion was found either when including only exotic species or when including translocated species at basin scale. The restoration of natural hydrologic processes and the development of specific management tools to protect native species, such as the prioritization of areas for fish conservation and the eradication of local populations of exotic species, are required to restore native fish fauna in watersheds in NE Spain.

Features of distribution and biology of three eelpout species (Zoarcidae) in the Pacific waters off the northern Kuril Islands and southeastern Kamchatka

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Eelpouts (Zoarcidae) are one of the most diverse fish families in the North Pacific. In many areas of the Russian Far Eastern seas some representatives of this family, particularly Soldatov's eelpout *Lycodes soldatovi*, ebony eelpout *L. concolor*, and *Bothrocara soldatovi*, are common and even rather abundant. They play considerable role in bottom fish communities and are potential fishery targets. Since the abundance of these species in the Pacific waters off the northern Kuril Islands and southeastern Kamchatka is quite low, their distribution and biology in this area are poorly understood.

This report presents the results of long-term research (1992 to 2002) conducted by Russian Federal, Kamchatka, and Sakhalin Research Institutes of Fisheries and Oceanography in the Pacific waters off the northern Kuril Islands and southeastern Kamchatka (47°50' - 52°10' N, depths 80 to 850 m, over 11,000 bottom trawl hauls in total).

Judging from the frequency of occurrence and catch rates, abundance of the three species under consideration in the study area is rather low. In 1992-2002, proportion of ebony eelpout in catches did not exceed 3.1% and that of Soldatov's eelpout 6.1% by number of fish, composed at the average about 0.3 and 0.4% respectively. In contrast to these species, proportion of *B. soldatovi* in some catches reached 24%, however, most often comprised less than 1%. Maximum catches of all these three species were characterized by similar values and did not exceed 45-50 specimens per hour of trawling.

All species considered were distributed within the entire study area. However, maximum catches of *B. soldatovi* were observed permanently opposite the Fourth Kuril Strait while those of Soldatov's eelpout in the same area and on the eastern slope of underwater elevation in the southern part of study area (48°10' - 48°40' N). In contrast to these species, highest catch rates of the ebony eelpout were registered mostly off the southeastern Kamchatka. Most frequently (> 70% of hauls) these eelpouts were accompanied in catches by shortraker rockfish, broadbanded thornyhead, darkfin sculpin, Greenland halibut, Kamchatka flounder, and Commander squid.

Soldatov's eelpout was found within 111-655 depth range, while ebony eelpout at depths 105 to 824 m. However, maximum catches of these two species (10 individuals per h and more) were observed at depths < 250 m and < 300 m respectively. *B. soldatovi* was found in catches within 204-775 m but overwhelming majority of its individuals was registered between 400 and 500 m, where its maximum catches (11-15 ind. per h) occurred. All three species during the whole year occupied wide range of positive bottom temperatures: Soldatov's eelpout 0.0 to 4.2, ebony eelpout 0.4 to 4.2 and *B. soldatovi* 0.8 to 4.3°C.

Relationships between mean fish size and capture depth and length and body weight are provided, data on size composition are presented, multi-annual, seasonal, and diurnal dynamics of catch rates and occurrence of species considered in the study area are analyzed.

Age and growth of spiny dogfish *Squalus acanthias* in the northwestern Pacific

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The spiny dogfish *Squalus acanthias* occurs in the Pacific waters off the Kuril Islands and Kamchatka relatively rarely, mostly during the summer and autumn feeding migrations when it is caught incidentally by driftnets, as bycatch in the Pacific salmon fisheries. The information on its biology found in published sources is most scarce. Some sporadic studies of its age and growth are limited by the work made in the 1930s (Kaganovskaya, 1933, 1937).

Some material needed to evaluate the age and growth of the dogfish on the Pacific side of the Kuril Islands and Kamchatka (44°00' - 50°20' N) was collected from driftnet catches of salmon in 2005-2006 (second dorsal spines). The fish were aged visually which is a common practice in respect of the spiny dogfish from various regions of the

global ocean (Kaganovskaya, 1933, 1937; Probatov, 1957; Holden and Meadows, 1962; Sosinski, 1974; Ketchen, 1975; Avsar, 2001; Henderson et al., 2002; Demirhan and Seihan, 2007; Vega et al., 2009; Campana et al., 2009). Totally, 267 spines were examined of which 132 were fit for age determination. Several of the earlier papers also confirm that a part of the spiny dogfish spines are not suitable for ageing which obstructs the study (Kaganovskaya, 1933; Probatov, 1957; Sosinski, 1974; Demirhan et al., 2006).

The dogfish found in catches were individuals of 67 to 123 cm, weighing 1140 to 5970 g, aged 10-24 years. Comparison of the growth rate of dogfish from various regions shows that on the Pacific side of the Kurils and Kamchatka the fish grows somewhat faster than in the Sea of Japan (Kaganovskaya, 1933) and the Northeast Pacific (Bonham et al., 1949). At the same time its growth rate before the age of 15 is commensurate with that of the individuals from the North Sea (Sosinski, 1974); the older Pacific dogfish grow quicker than the same fish from the North Atlantic.

The growth rates in males and females are somewhat different. Virtually the males from all the classes of the same age are somewhat longer than the females, though in by far most cases the females are heavier than the males of the same age. Our data indicate that the female life span is longer since no males over 20 years were recorded in catches while the females would reach 24 years. Estimates of parameters of von Bertalanffy growth function support the above conclusions. Coefficient K for growth rate in males and females was 0.06 and 0.04 respectively. The asymptotic length values L_{∞} for males and females were 121.4 and 158.8 cm respectively.

The length and body weight ratio equation shows the rate of body weight increment with length. In overwhelmingly most dogfish populations in the ocean globally the power coefficient of this equation is within 2.92-3.22, whereas in our study area it was 2.81 which may be an evidence of lower rate of body weight increase with greater length of dogfish of the population in question.

The analysis shows that the size of spine (length, base width and base length) agree with the age of dogfish which might be used in future to facilitate the study of its age structure in the surveyed region. The best correlation is observed between the age and width of the spine base ($R^2=0.68$), and age and length of the spine base ($R^2=0.66$). The correlation between the length of spine and age is much lower ($R^2=0.45$) since in many individuals the upper part of the spine wears off or breaks in the course of life.

Fish parasites in the Lake Turkana, Kenya

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Lake Turkana is located in the Great Rift Valley in arid northwestern part of Kenya. Covering an area of 6,750 square km it is the world's largest permanent alkaline desert lake, forming with its only permanent inlet, the Omo River, a closed-basin. Around 300,000 people of five tribes inhabit vicinity of the lake and large proportion of population relies on the wild fishery. According to various sources it can be estimated that the Turkana basin is inhabited by 64-76 fish species. Significant proportion of Turkana basin fish species belongs to widespread Nilo-Sudaninan fish assemblage and only 13 species are endemic. Live fish were obtained from local fisherman in three localities characterised by different levels of salinity. Locality Todoyang on the west bank near Omo delta has the lowest salinity. The latter localities, Kalokol on the west bank in middle part and Loiyangalani on the southeast part of the lake are moderately saline. A total of 32 fish species of 16 families were observed. Complete sample examined for presence of metazoan and selected protist parasites consisted of 359 fish individuals from 30 species; ten of which are the most common species fished by local fisherman by gill and seine nets.

The most common parasites were Crustaceans found on the gills and body surface of 22 fish spp. Likewise, heavy loads of Monogeneans were recorded on the body surface, fins, and gills and rarely in the stomach of 18 fish spp. Other groups of parasites were represented by both larval (*Contracaecum* sp. in 6 fish spp.) and adult stages of nematodes in most fish spp., Digeneans in 8 fish spp., larval gryphorhynchid cestode larvae and numerous adult cestodes in 12 fish spp., acanthocephalans in 3 fish spp., hirudineans in 3 fish spp. and myxosporidians in 6 fish spp.

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Total mercury concentration in muscle tissue of five shark species from the Eastern Mediterranean Sea

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Shark species exhibiting intense predatory behavior, higher longevity and lower metabolic rate, belong to higher trophic levels and tend to have higher mercury concentrations than other fish. In muscle tissue of five shark species total mercury concentration was determined with Cold Vapor Atomic Absorption Spectrometry (CVAAS) and analysis was validated with DORM-2 certified reference material. A total of 31 *Centrophorus granulosus*, ranging from 600 to 950 mm in length, 93 *Galeus melastomus* ranging from 345 to 563 mm, 15 *Heptranchias perlo* ranging from 606 to 1060 mm, 24 *Mustelus mustelus* ranging from 428 to 720 mm and 103 *Squalus blainvillei* ranging from 410 to 712 mm, were collected with bottom trawl from the Aegean and Levantine Sea. Mercury concentration was expressed in ppm wet weight (w.w.) and ranged from 0.09 to 3.91 ppm in *C. granulosus*, from 0.08 to 3.42 ppm in *G. melastomus*, from 0.68 to 1.69 ppm in *H. perlo*, from 0.13 to 1.83 ppm in *M. mustelus* and from 0.01 to 5.90 ppm in *S. blainvillei*. Statistically significant differences were examined among mercury concentrations in all species and between females and males of each species separately. The highest mean mercury concentration was found in *S. blainvillei*. In about 38% of all muscle samples (N=266) total mercury concentration exceeded the maximum permitted level of 1 ppm w.w. for human consumption.

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Thyroid level affects developmental rate and changes the number of infraorbital bones in common roach *Rutilus Rutilus*

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Infraorbital bones (io) are arranged as interconnected series of circumorbital ring and normally are associated in teleost fishes with the infraorbital sensory canal. Number of io is quite stable character and often used in both taxonomy and phylogeny (Nelson, 1969; Bogutskaya, 1989; Arai & Kato, 2003). There is indication that io numbers can be changed through evolutionary significant heterochronies at least for group of Acheilognathinae (Cyprinidae) (Arai & Kato, 2003). To check the role of heterochronies in change of io numbers we applied special experiment during which we could control individual developmental rate in fish (see Smirnov et al., 2006 for details). Progeny from artificial fertilization of common roach was divided into two experimental groups. Developmental rate was accelerated in one group (TH) via treatment with exogenous thyroid hormone (triiodothyronine, T₃) and retarded in another one (THIO) via administration of thiourea, a goitrogen that blocks the synthesizing activity of the thyroid gland. Developmental rate of TH-treated fish was accelerated, while developmental rate of goitrogen-treated fish was retarded compared with control. Fish were kept till 120 dpf when four io were ossified in all groups. Usually *R. rutilus* has five io, fifth io is “dermosphenoticum” which appears rather late in ontogeny. The most common sequence of ossification of io in roach was: io1 (lacrimale), io3, io4, and lastly io2. This sequence of ossification is different from the one observed in zebrafish *Danio rerio* (Cubbage & Mabee, 1996). Timing of io ossification was different among groups. In TH and control lacrimale became visible (from the alizarin staining) concurrently at the age of 22 dpf, however at different total body length (8.8 mm in TH and 11.3 in control). Formation of io series have been completed at different time (45 dpf at 20.1 mm and 50 dpf 25.1 in TH and control respectively). In THIO lacrimale appeared at 30 dpf (11.8 mm) and io series was fully completed at 120 dpf appr. (25.1 mm). In this age TH-fish started manifesting fifth io, “dermosphenoticum” (3.6 % of sample), when in both control and THIO-fish had no “dermosphenoticum”. Control fish had mainly four io (90 %), rarely possessing five io due to fragmentation of one of three io following lacrimale (10 %). TH-fish had mainly four io (52.4 %), but variants three io (33.3 %) or two io (10.7 %) were also found. When reduction of io occurred, seemingly fusion of some bones took place. Thus change of developmental rate resulted in heterochrony and affected the number of infraorbitals. Further study should clarify how ontogenetic rate influence definitive state of io numbers.

Comparison of the vertebra and dorsal fin spine methods for ageing bluefin tuna from the Mediterranean Sea

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The aim of this study is to estimate the age of bluefin tuna, *Thunnus thynnus* (L., 1758), using two hard structures, the caudal vertebrae and dorsal fin spines, with a view to compare the two ageing methods and to estimate their precision. Both hard structures were collected from specimens sampled either from the long-line fishery catches in the Aegean Sea (wild individuals) or from the Greek Bluefin Tuna farm, in the Ionian Sea (fattening individuals). Samplings were accomplished between November 2007 and January 2009. A total of 181 bluefin tuna, ranging from 112 to 272 cm in fork length and from 26 to 475 kg in round weight were aged using both dorsal fin spines and caudal vertebrae. The age of each fish, using the two structures, was determined from the number of visible growth bands. In dorsal fin spines, a binocular stereoscope (transmitted light) equipped with an image analysis system was used for reading and measuring each spine section. Opaque zones, assumed to be indicative of fast growth, were separated by translucent zones, which were often present in clusters or groups of two or more and were interpreted as representing periodic events indicative of slow growth. A single translucent zone, (or tight cluster of zones) and the associated opaque zone together were assumed to represent one year of growth. The 35th and 36th caudal vertebrae were used to estimate age by counting the annual growth zones observed on the inner surface of the cones of whole vertebrae. One annulus was interpreted as one ridge and one groove. For each dorsal fin spine and vertebra, three independent counts were performed without knowledge of fish size. The range of the estimated ages was from 4 to 17 years using the dorsal fin spines and from 4 to 16 years using the vertebrae. Both calcified structures are proved to be very suitable for ageing bluefin tuna. The percent agreement between the two methods was high in fish up to 10 years of age but lower in older fish. Specifically, the results showed that there is a tendency to estimate fewer years in vertebrae than in spines in fish older than 10 years old. The rate of agreement between the two ageing methods amounted in 34.2%, whereas the percentages of cases where were observed differences of one, two, three, four or even five years amounted in 34.2%, 17.7%, 9.9%, 3.9% and 0.5%, respectively. The precision or the reproducibility of repeated measurements was estimated using the average percent error (APE), the coefficient of variation (CV) and the index D. Comparing the two ageing methods, the dorsal fin spines presented higher values of measures of precision, against the vertebrae.

Maternal and paternal effects in some quantitative morphological characters in reciprocal hybrids between *Acipenser stellatus* and *A. huso* (Acipenseridae)

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The comparative morphological analysis of three-year old alive reciprocal hybrids between the sterlet *Acipenser stellatus* and the great sturgeon *A. huso* and the young of both parental species was conducted by using quantitative features diagnostic for parental species: both traditional morphometrics (Berg 1948, Sokolov & Berdichevskii 1989) and craniological indices (Vasil'eva 2009). Mean values of most studied morphometric characters (11 from 13) are significantly different in reciprocal hybrids with the hiatus observed for five head features. The hybrids *A. stellatus* x *A. huso* demonstrate maternal effects in each of 13 morphometric characters, whereas in the hybrids *A. huso* x *A. stellatus* maternal effects are observed in five characters only. The hybrids *A. huso* x *A. stellatus* have intermediate number of lateral scutes and demonstrate paternal effects in the rest six morphometric characters. Contrary to morphometrics, reciprocal hybrids are more similar in craniological indices with significant differences in the half of cases only. The hybrids *A. stellatus* x *A. huso* demonstrate maternal effect in each of craniological indices, whereas only one character, namely barbel position, has mean value slightly shifted to maternal species in the hybrids *A. huso* x *A. stellatus*. The other seven craniological indices demonstrate paternal effects in the hybrids *A. huso* x *A. stellatus*.

Maternal effects usually are observed in early stages of fish development (up to one year old) (Kirpichnikov 1987), but they were also revealed in older sturgeon specimens and were treated as a result of prolonged effects of maternal mRNA (Vasil'eva et al. 2001). Paternal effects in early development are poorly studied in fish and need special analysis in the case of their manifestation in quantitative characters with polygenic inheritance at the age of three years. The results of such analysis assume that *A. stellatus* possesses mainly dominant alleles in its genome, as distinct from *A. huso* with predominant recessive gene alleles. This phenomenon should be related with more ancient origin of the sturgeon phylum including *A. stellatus* that was revealed by molecular studies (Birstein & DeSalle 1998).

Maternal effects, in reality, are observed in three-year old reciprocal sturgeon hybrids in a few characters related with head parameters, particularly a volume of brain cranium section. Evidently, maternal effects in these cases are caused by the fact that the number of segments and their arrangement in larvae are determined by maternal organism during oogenesis. Genes with maternal effects are then expressed during embryogenesis and determine further morphological differentiation of every segment. Thus, these processes leave certain marks upon related morphological structures. Prolonged maternal effects, to a certain extent, should be caused by prolonged life history in sturgeons (Vasil'eva et al. 2001).

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Genetic and environmental variations in quantitative characters in fishes: a comparative analysis of monoclonal triploid form and bisexual spined loach species (*Cobitis*, Cobitidae) and tetraploid forms of different origin

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A unique possibility for estimation of heritability of quantitative characters in vertebrates is offered by clonal forms, reproducing by parthenogenesis or natural gynogenesis. In both cases, the progenies are genetically homogeneous and their phenotypic variation depends only on the environmental component. Recent study represents heritability estimates calculated for 23 craniometric indices, and 25 external morphometric characters from data sets of the monoclonal all-female gynogenetic triploid spined loach from the genus *Cobitis* and co-existing two bisexual species, *C. taenia* and *C. melanoleuca*, and unisexual and bisexual spined loach tetraploids have been collected in the same biotope. The heritability of a character is determined in the following way: $H = (V_{BT} - V_T)V_{BT}^{-1}$, where V_{BT} is variance of a character in the sample of bisexual or tetraploid individuals, and V_T is variance in the sample of triploid individuals.

The low values of the coefficient of heritability (≤ 0.198) in most of external morphological characters (63 %) indicate their phenotypic variation to be predominantly caused by non-genetic factors. These results correspond to low diagnostic value of aforementioned features in *Cobitis* species. The craniological indices demonstrate "higher heritability": only a few studied indices (21.7 %) are characterised by low heritability (≤ 0.181). This result differs from data previously obtained for gynogenetic and bisexual Prussian carp *Carassius auratus* and testified to the similarity between craniological and morphometric characters in the ratio of the genetic and environmental components in general phenotypic variation (Vasil'eva, Vasil'ev, 2005), but agrees with widespread opinion about less environmental influence on craniological characters. Besides, it seems that relative low heritability in external morphological characters of spined loaches should be interpreted as a result of strong selection for evolutionary developed specific body shape. The differences in heritability estimates revealed between males and females in studied diploid loach species apparently are caused by the linkage between some genes controlling the character and sex chromosomes.

The heritability estimates in spined loaches look significantly lower than similar estimates earlier obtained for Prussian carps (Vasil'eva, Vasil'ev, 2005). This difference seems to be caused by the difference in conditions of investigated spined loaches groups and Prussian carps. Prussian carps were artificially produced and raised in special ponds, whereas spined loaches were collected from natural water body with more variable conditions. But the more diverse the conditions, the higher the environmental variation is and thus the lower are the coefficients of heritability.

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Morphological and meristical properties of endemic neretvan rudd, *SCARDINIUS PLOTIZZA* HECKEL AND KNER, 1858 (ACTINOPTERYGII: CYPRINIDAE) from the Hutovo Blato wetland, Neretva river basin, BOSNIA AND HERZEGOVINA

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The genus *Scardinius* comprises a number of allopatric warm-water adapted phytophagous species living mainly in lowland lakes and still waters of rivers and streams. Recent investigation on molecular relationships and karyol-

ogy among European species of *Scardinius* evidenced several problems in the taxonomy of the genus. The identity of several nominal species living in waters of Adriatic watershed of Italy, Slovenia, Croatia, Bosnia and Herzegovina is still in need of further investigations. Twenty-three morphometric and nine meristic body characteristics were examined in 95 specimens of Neretvan rudd (*Scardinius plotizza*) (55 females and 40 males) caught in the Hutovo Blato wetland (Neretva River basin, southern Bosnia and Herzegovina). This species is endemic for Neretva River basin of Croatia and Bosnia-Herzegovina. It was found that dorsal fin (D) encountered III unbranched and 8 branched rays, anal fin (A) III unbranched and 9 branched rays, pectoral fin (P) I unbranched and 13 branched rays, ventral fin (V) with I unbranched and 8 branched rays, caudal fin (C) with 16-17 rays. Lateral line scales number is 37 – 40. Number of gill rakers on first gill arch vary from 11 – 14, average 11.988. Percentual relation between some plastic characters and standard length: head length 26.60%, depth of head at occiput 19.98%, antedorsal distance 57.38%, postdorsal distance 32.37%, body depth 29.88%, the smallest body depth 10.78%, length of caudal peduncle 17.96%; in relation to the head length the following was determined: eye diameter 22.23%, antieye distance 31.90%; and posteye distance 51.08%. Also, a short description of this species and its distribution is given on the basis of analysed characters. The differences between the mean values of the measured morphometric characteristics in the males and females were not statistically significant. Modes were identical in males and females for most analysed morphometric relationship. There were no differences in meristic characters, overall shape, coloration pattern between sexes. Thus, the male and female Neretvan rudd population in the Hutovo Blato is homogeneous. Data on morphometric and meristic characteristics corresponds with the other reports and distinguished Neretvan rudd from other species of *Scardinius* in Balkan Peninsula.

Key words. – *Scardinius plotizza* – morphometric and meristic characteristics – Hutovo Blato wetland

Experimental study of substrate preference by juvenile threespine stickleback *Gasterosteus aculeatus* L.

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Marine ecosystems are subjected to short- and long-term changes which mechanisms are rarely known. Notable changes in the coastal ecosystems of the White Sea, manifested in fast growth of populations of threespine stickleback *Gasterosteus aculeatus* and seagrass *Zostera marina* are observed last decade. It is thought that changes in stickleback depend on seagrass population because stickleback are closely connected to seagrass in reproduction period. In our recent study we found that distribution of stickleback spawners is quite even across different locations of Keret' archipelago (Kandalaksha Bay of the White Sea). In particularly, density of fish is similar in brown macroalgae (*Fucus spp* and *Ascophyllum nodosum*) and in seagrass, whereas juveniles are obviously more dense in seagrass habitats (Ivanova and Lajus 2008). It is unclear whether spawners move to seagrass from brown macroalgae habitats to spawn, or juvenile move to seagrass after hatching, or juvenile's mortality is lower in seagrass beds. In this study we tried to address these questions by performing experiments analyzing preference of different substrates by juvenile stickleback.

The experiment was carried out at the marine biological station of St. Petersburg State University (Keret archipelago, Kandalaksha Bay) in period from 12 to 26 August 2008 in a plastic pool 50 x 70 x 450 cm. The juveniles were offered the following types of substrates: brown macroalgae, seagrass, artificial seagrass, sand, and reference (no substrate). The substrates were placed in metallic cuvettes 21,5 x 31,2 cm. Number of juveniles in pool ranged between 1500 – 1600 fish, and their size ranged from 8,5 to 18 mm. The fish were fed with marine zooplankton from the sea. To calculate juveniles associated with particular substrate, we put cuvettes in nets, which were put down during the experiment and did not prevent juveniles to choose substrates. In the end of experiment the nets were elevated to prevent the juveniles to go out. Then fish were put in other cuvette where were pictured and then calculated and measured using free software Image Tool. Each experiment continued for about 12 hours and had three replications.

Experiments demonstrated that the most preferred substrate was brown macroalgae, the second preferred was seagrass, and the difference between them was significant ($p < 0.05$). Artificial seagrass, sand and empty cuvette attracted fewer juveniles than brown macroalgae and seagrass, and did not differ significantly from each other. Last three substrates were not attractive for juvenile at all, showing average density of fish associated with them similar to average density of juveniles in the pool. Among these results some need special discussion. First, difference between natural and artificial seagrass shows that protective capacity which is likely similar for both types of substrates, is not the only factor causing differences in juvenile's preference. Other factors could be absence of epibioses in artificial plants in comparison with natural ones, as well as specific characteristics of artificial plants such as coloration, thickness, and material they are made of. Probably because of these factors artificial seagrass did not attract juveniles. Second result is higher attractiveness of brown macroalgae in comparison with seagrass. This may mean that very low densities of juveniles in fucoids in comparison to seagrass in natural environment are rather

caused by preference of seagrass by spawners or higher mortality of juveniles in macroalgae, rather than by active migration of juveniles from macroalgae to seagrass.

Lead accumulation in goldfish (*Carassius auratus gibelio* Bloch.) as the effect of 12-months period of dietary exposition on various doses of this metal.

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Lead (Pb), a heavy metal with limited biological function, is widely distributed in the aquatic environment as a result of natural and anthropogenic activities. In inorganic forms gets into waters where the mean concentration of this metal is in a range from 0,021 to 0,035 mg kg⁻¹ (Kabata-Pendias and Pendias 1993). Lead easily accumulates in land and water organisms where it enters mainly with food (WHO 1987). The aim of this work was to determine the concentration of Pb in goldfish (*Carassius auratus gibelio* B.) tissues during 12-month period of dietary exposition on four various doses of that metal.

One-year old goldfish females were kept in aquariums at the temperature of 12°C and fed different Pb doses in the fodder: 10, 15, 25 and 50 mg kg⁻¹. Control fodder contained 0,1 mg Pb kg⁻¹. In the 3rd, 6th and 12th months of the experiment samples of fish tissues: kidney, gill, gonad, proximal and distal intestine and muscle were taken to determine lead concentration, using atomic absorption spectrometry (AAS) method. Also Bioaccumulation Trophic Factor (BAF) (Besser et al., 2001) and Contamination Factor (CF) (Nimis et al., 2002) were estimated.

The highest lead concentration was observed in kidney (4,890 mg·kg⁻¹), next in distal intestine (2,446 mg·kg⁻¹), proximal intestine (1,389 mg·kg⁻¹), gills (1,134 mg·kg⁻¹), muscles (0,727 mg·kg⁻¹) and the lowest concentration in gonads (0,539 mg·kg⁻¹). The highest value of BAF (in the 12th month) was estimated in kidney of control group 76,35, and the lowest 0,028 in muscles of group exposed to the dose of 50 mg Pb kg⁻¹. The lowest CF value 0,974 (in the 12th month) was observed for muscles of group exposed to the dose of Pb 50 mg kg⁻¹, and the highest in gonads 8,652 of the same group (in the 6th month). The constant increase of Pb level during the exposition was observed in kidneys, gills and gonads. In proximal and distal intestine as in muscles the decrease of Pb concentration was noted.

These results indicate that lead accumulation is dependent on the tissue, the dose of Pb and on the duration of the exposition.

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The effect of 12 months period of dietary exposition on different doses of lead on LH plasma levels in goldfish (*Carassius auratus gibelio* B.) at spawning time.

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Lead is one of the toxic heavy metals which is known to accumulate in fish tissues. This accumulation may have deleterious effects on fish reproduction. Long time exposition on Pb causes cell degeneration in NPO and NLT – brain nuclei responsible for secretion of neurotransmitters (DA) and neurohormones (GnRH) regulating gonadotropine function of pituitary gland. The aim of this study was to investigate the effect of 12 months dietary Pb exposition, on GnRH_a stimulated LH secretion in female goldfish (*Carassius auratus gibelio* B.).

One-year old goldfish females were fed with different Pb doses in the diet: 10, 15, 25 and 50 μg g⁻¹. Control fodder contained 0,1 μg Pb g⁻¹. Fish were kept in aquariums at the temperature of 12°C. After the period of 12 months, 2-years old fish were ready for their first spawning. Then the experiment was conducted. Blood samples for the analysis of LH concentrations were taken just before the GnRH_a and pimozide injections and then at 6, 12 and 24 h after injections. ELISA method was used for goldfish LH levels determination.

Significantly lower LH plasma level was observed in groups exposed to Pb at the doses of 10 and 15 $\mu\text{g g}^{-1}$ at 6h. Significantly higher LH concentration was reported in groups exposed to higher Pb doses 25 and 50 $\mu\text{g g}^{-1}$ at 24 h. These results indicate that 12 months period of dietary exposition on Pb dependent on the dose, modify LH secretion in sexually mature goldfish.

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Biology of juvenile *Diplodus sargus* (Linnaeus, 1758): Use of rocky intertidal platform in the Gulf of Cadiz

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In the Gulf of Cadiz, white seabream juveniles, *D. sargus*, settled in the intertidal rock pools, where the abiotic characteristics, fluctuating and often extreme, mean a challenge to the life cycles of resident species. At the age of three months, juveniles leave this area and begin to integrate into the adult population (Macpherson, 1998), because the rocky intertidal platform is used as a nursery area for this species, acting as a temporal and spatial refuge against predators.

In this study, juveniles of *Diplodus sargus* were examined to evaluate juvenile settlement, feeding ecology and trophic relationships in the intertidal rock platform.

Material and methods

White seabream juveniles were collected from two rocky coastal areas in the Gulf of Cádiz. The samples were taken once a month for a year. For each specimen, total length, standard length, total weight, gutted weight and full weight of the digestive tract were determined. The content from the full digestive tract was preserved in alcohol 70%. All prey items were separated by taxon and counted. Depending on the level of digestion, prey items were identified to species or to the lowest possible taxon.

The composition of the diet was determined by frequency of occurrence (Guziur, 1976) for each prey taxon, the number of tracts where a particular resource were found, total of preys in each gastrointestinal tract and the numerical proportion.

The occupation of space was determined by the possible relationship between the total abundance of species and three variables of size of the pool (depth, area and volume) and between the total abundance of species and the physiography of the different pools. The index of Schoener was used for the diet overlap.

Results and discussion

Diplodus sargus is the species, inside of Family Sparidae, with greater abundance in the study area. A total of 191 specimens of that species were captured at different sampling points of the rocky intertidal platform. The average total length of the population was 41.95 mm, while the minimum was 14.94 mm and the maximum was 97.32 mm.

Settlement was seasonal, starting in April with maximal settlement in June – August. The clear pattern of entry of this new cohort in April and the absence of larger specimens indicates that the rocky intertidal platform act as a nursery area for juvenile white seabream.

Diet was quantitatively analysed, and the results suggest that this specie is largely omnivorous and is fed on multiple trophic resources (Fig. 1) that change with the increase of juvenile size. For the smallest juveniles the most important prey items are copepods, whereas for the biggest juveniles the most important prey items are gammarids and other amphipods.

These results were compared with other studies on feeding behaviour of rocky intertidal fish species. Diet analysis suggests a strong feeding niche overlap between this species and *Diplodus puntazzo* and *Gobius paganellus*, since all three species share the same resources. However, the diet overlap of the rocky intertidal fish is scant and probably insignificant, due to a high prey density in the rocky intertidal areas.

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Algae	Other Cirripedia	O. Cumacea
Phylum Mollusca	Cl. Malacostraca	F. Bodotriidae
Cl. Gastropoda	SubCl. Eumalacostraca	Other Cumacea
F. Fissurellidae	SuperO. Eucarida	O. Isopoda
F. Littorinidae	O. Decapoda	F. Sphaeromatidae
Other Gastropoda	InfraO. Brachyura	<i>Dynamene edwardsi</i>
Phylum Annelida	Megalopa larvae	<i>Sphaeraena serratum</i>
Cl. Polychaeta	<i>Brachynotus sexdentatus</i>	F. Idoteidae
F. Nereidae	InfraO. Caridea	F. Janiridae
F. Eunicidae	F. Palaemonidae	F. Paranthuridae
Other Polychaeta	F. Processidae	<i>Paranthura</i> sp.
Phylum Arthropoda	InfraO. Anomura	Other Isopoda
Subphylum Crustacea	Other Decapoda	Order Tanaidacea
Cl. Ostracoda	SuperO. Peracarida	<i>Tanais dulongii</i>
F. Leptocytheridae	O. Amphipoda	Other Tanaidacea
F. Cytheridae	SubO. Caprellidea	Other Crustacea
<i>Cythere lutea</i>	F. Caprellidae	Subphylum Chelicerata
Other Ostracoda	F. Phtiscidae	Cl. Arachnida
Cl. Maxillopoda	Other Caprellidea	O. Acarina
SubCl. Copepoda	SubO. Gammaridea	Cl. Pycnogonida
O. Harpacticoida	F. Ampithoidae	SubPhylum Atelocerata
SubCl. Thecostraca	F. Corophiidae	SuperCl. Hexapoda
InfraCl. Cirripedia	F. Lysianassidae	O. Diptera
Cypris larvae	Other Gammaridea	F. Chironomidae
		Other Diptera

Fig. 1. Prey categories identified

Postglacial range extensions of the loach *Oxynoemacheilus bureschi* in the Balkans

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The rivers on the Balkan Peninsula can be separated into different ichthyofaunistic areas with different endemic fish species. Especially the river Vardar contains a high number of endemics, indicating its complete and long-term isolation from neighbouring river systems. One of the few species shared with other rivers is the loach species *Oxynoemacheilus bureschi*. Using one mitochondrial and one nuclear marker, we analysed 175 individuals of *O. bureschi* from 17 sites covering the whole distribution area of the species, the drainage areas of Vardar, Struma, Mesta and Danube. The genetic differentiation among populations was in general low, shared haplotypes were very common and occurred even between distant localities and different river systems. This points to a high degree of gene flow among populations and rejects the hypothesis that the population in river Vardar represents a relict from early colonisation of the Balkan Peninsula. In contrast, it suggests that populations in the Vardar River as well as in the Danube R. are of recent origin, and a human-mediated introduction cannot be excluded. On the other hand, the populations from the Aggitis R., a left tributary of the lower Struma R., were clearly separated from the rest of the species and represent a long-term isolated lineage. Demographic analyses suggest a recent population expansion for *O. bureschi*, in which the Aggitis R. was not involved. Because of the highest genetic diversity, the Struma R. basin is considered to be the probable centre of dispersal.

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A new stenoendemic cyprinid species from Danube drainage

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The Croatian dace (*Telestes polylepis* Steindachner, 1866) is a critically endangered stenoendemic species of the Danube basin in Croatia. Historical data show that its range extended to the river courses and springs around the Velika Kapela and Mala Kapela Mountains, the Zagorska Mrežnica basin, creeks around Josipdol and the Dobra River. However, recently it was recorded from only few localities. Such a great range reduction and a small number of specimens found led to concerns that the Croatian dace was facing an imminent threat of extinction, and was thus cause for immediate conservation action. For the purpose of drafting a conservation action plan, the distribution and population status of the Croatian dace were assessed. During this study, sampling of the Croatian dace was conducted throughout the entire historical range of the species. Specimens were recorded at five localities and morphological and genetic analyses were conducted. The results show that the populations sampled consist of two different species, one of which is described in this paper. *Telestes karsticus* sp. nov. differs morphologically from *T. polylepis* in the total count of lateral line scales and the shape of the posterior margin of the anal fin. Morphological differences were corroborated with mtDNA analyses.

LH secretion after intraperitoneal delivery of Aroclor 1254 (PCB) and tamoxifen (anti-estrogens) in female goldfish (*Carassius auratus gibelio* Bloch) at the time of natural spawning and gonadal recrudescence

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Polychlorinated biphenyls are known as endocrine disruptors which can affect endocrine system through estrogen receptors. That is why in this study tamoxifen (anti-estrogen) and Aroclor 1254 were used simultaneously to investigate their influence on the LH secretion in female goldfish (*Carassius auratus gibelio* Bloch) at the time of natural spawning (June) and at the time of gonadal recrudescence (November).

Aroclor 1254 and tamoxifen were given (intraperitoneally) during 3 days at the following concentrations: Aroclor 1254 – 0.01; 0.1 mg kg⁻¹ body weight; and tamoxifen – 1 mg kg⁻¹ body weight. After this treatment all fish were injected with GnRH-A, to evaluate stimulated LH secretion after PCB intoxication. Blood samples were taken after Aroclor intoxication (time “0”) and next after GnRH-A injection at: 6, 12, 24 hours. The levels of LH were estimated by the ELISA method. The results were analyzed statistically by means one-way ANOVA followed by Mann – Whitney test (p<0.05).

There were no statistically differences in LH level at time “0” between control group and groups treated with Aroclor 1254 and/or tamoxifen neither at the time of natural spawning nor at the time of gonadal recrudescence. At 6 hours after GnRH-A injection the LH level increased twofold in all groups but there were no significant differences among them. There were also no significant differences in the levels of LH among all groups after GnRH-A injection at: 12, 24 hours.

Taking into considerations these results it is not possible to confirm/ or deny that Aroclor 1254 is able to act on reproductive system through the estrogen receptors. Maybe the time of intoxication (only 3 days) were probably too short to observe the influence of Aroclor 1254 and tamoxifen on LH secretion in female goldfish at these two tested periods of gonadal development.

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Age and growth of the invasive Chinese sleeper *Perccottus glenii* in the Włocławski Reservoir, Central Poland

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Chinese sleeper *Perccottus glenii* Dybowski, 1877, a species native to the Amur River system in northeastern Asia, is now widely distributed across Central Asia and is now being recorded in areas west of its origin. It was first found in Polish waters in 1993, i.e. in the oxbow lakes of middle course of the Vistula River. Since then the Chinese sleeper has been noted in many other locations along the Vistula River.

The age and growth of *P. glenii* were studied in the Włocławski Reservoir located on the Vistula River. A total of 602 specimens were examined. Total length was correlated with body weight in both sexes (females: $\log W = 3.1127 \times \log TL - 4.9826$; $R^2 = 0.992$; males: $\log W = 3.1815 \times \log TL - 5.1097$; $R^2 = 0.976$). The values of slope ($b > 3$ in case of both sexes) revealed allometric growth pattern. The comparison of these regression coefficients showed significant differences between sexes ($t = 1.982$; $df = 2$; 520 ; $p < 0.05$).

On the basis of the number of annuli detected on scales it was found that population of *P. glenii* was represented by eight age groups (0+ to 7+) with 4+ age groups dominated in the population. The female lifespan was 1 year longer than males. Back-calculation of length revealed that males grew faster than females up to the 3rd year of their life when females achieved larger sizes. The von Bertalanffy growth function was fitted to back-calculated length-at-age data and displayed variation in growth rates between sexes. The maximum observed standard length for females was 142 mm and 130 mm for males. The asymptotic length of females (181 mm ± 14.9) was slightly overestimated according to the Taylor criterion, but suitable for males (141 mm ± 12.3). The Gompertz function fit well for weight-at-age data for females and sexes pooled, but for males the values of the estimated parameters showed very high standard errors.

Habitat preference and activity of two Salmonids in small streams of the Jizera mountains - a telemetry study

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In the summer 2006 we implemented 6 diurnal observations (in 2-week intervals) specialized on habitat preference and activity of brook trout (*Salvelinus fontinalis*) - non-native and brown trout (*Salmo trutta m. fario*) - native fish species in the Czech Republic. The research held on three locations in the Protected Landscape Area Jizera Mountains: stream Malá Jeřice, Černá Nisa and Malý Štolpich (northern Bohemia, Czech Republic). The radio-telemetry was used. Fish were tagged after the electro-fishing. We implanted 16 radio-transmitters into body cavity. Altogether 441 positions we located and described. Both species moved greater distances during night than during daytimes. The brown trout moved more than the brook trout during a 24-h cycle (Fig. 1). No important differences we found in habitat preferences of fish in sympatry and allopatry. Fish preferred habitat with deeper and calm water and differed only in the substratum preference (Fig. 2). We observed food preference in sympatry (brook trout preferred terrestrial food more than aquatic one).

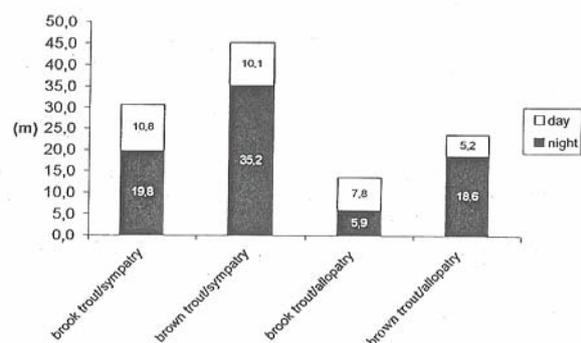


Fig. 1. Diurnal activity of brook trout and brown trout in allopatry and sympatry (axis y - mean distances in meters/24 hour).

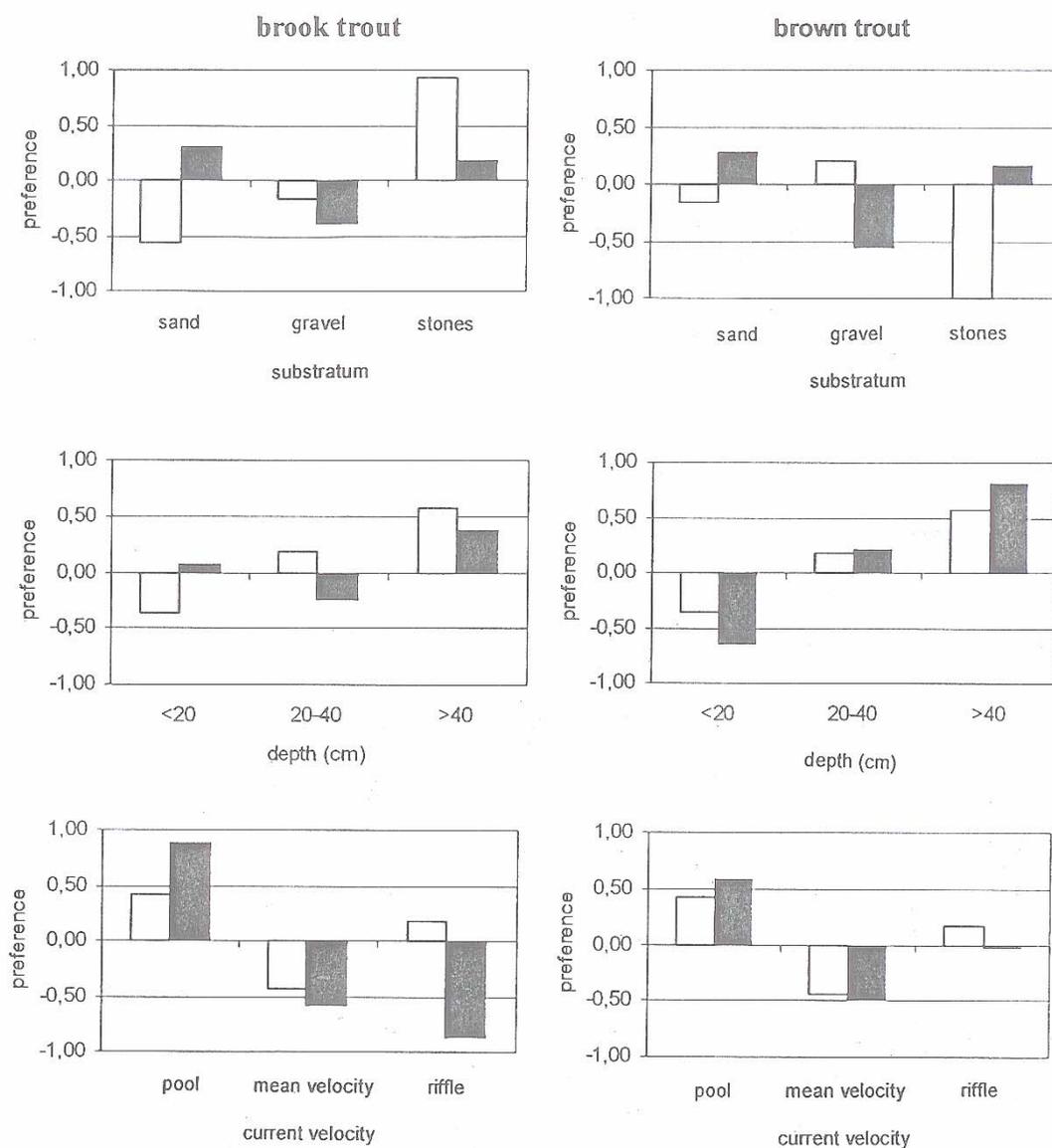


Fig.2. Habitat preference of brook trout and brown trout as value of coef. electivity D for selected type of habitat in sympatry (□) and allopatry (■).

Influence of di-*n*-butyl phthalate (DBP) on the embryonic development and hatching of the common carp *Cyprinus carpio*

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Di-*n*-butyl phthalate (DBP) belongs to the most often used plasticizers. Phthalates are not chemically bound up with any matter they are part of and they are released into the environment (including waters) during manufacturing processes and by leaking from consumer products. Thus all aquatic organisms are at risk of phthalate exposition. In our study the influence of DBP on the embryonic development of the common carp *Cyprinus carpio* was investigated.

In the experiment the eggs obtained from 4 females were placed in Petri dishes containing water without DBP addition and fertilized with common carp sperm obtained from 5 males. 10 μl of sperm was added into each dish. After one minute the water was replaced with DBP containing water (45 ml). The following concentrations of DBP were used: 0 (control group), 0.011, 0.11 and 1.1 $\text{mg}\cdot\text{dm}^{-3}$. The samples of eggs obtained from each female were incubated in duplicates. Fungi Stop Konzentrat (TETRA, Germany) at the concentration of 75 $\mu\text{l}\cdot\text{dm}^{-3}$ was used to prevent fungal diseases development. Mortality, hatching rate and the number of deformed larvae were determined. The significance of the differences between groups was calculated using the Z test at $P\leq 0.05$ or $P\leq 0.01$ levels of significance.

DBP was found to decrease the number of hatched larvae (in a dose-dependent manner). The increase of the number of deformed larvae was also observed. Obtained results suggest that DBP can significantly disturb the embryonal development of common carp, which is still one of the most important species in polish aquaculture. It is also possible that such effect can occur in other fish species from *Cyprinidae* family.

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Influence of shelters, water depth, and vegetation on habitat-related behaviours under predation risk in the cyprinid fish *Ladigesocypris ghigii*

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Behaviour and habitat use under predation risk were studied in semi-natural conditions in *Ladigesocypris ghigii* (Gianferrari 1927), a small cyprinid fish (9-10 cm) particularly exposed to avian predators in its natural environment. *L. ghigii* lives in the extreme environment of intermittent streams, with or without vegetation, on the Greek island of Rhodes. The observations were carried out using an artificial stream (current of about 0.2 m/s) divided into four areas of identical size (1.25 m each), corresponding to different environmental conditions, under constant temperature (18 or 21°C) and photoperiod (14L/10D or 10L/14D). The head of four realistic grey heron (*Ardea cinerea*) models was rocked in water at a distance in order to simulate predatory attacks in the desired areas. To simulate attacks in an ecologically plausible way, the experimenter was hidden behind a black screen and manipulated the heron models by means of nylon threads and pulleys. The anti-predator strategies studied were avoidance, the fountain effect, skittering behaviour, vacuole, group jump, and flash expansion. Other behavioural patterns were also noted: pursuit, foraging, inspection, visit at the water surface, and 'header' hunting between two individuals. In a first experiment, we tested the effects of the presence of shelters on the behaviour of fish. One shelter was merely placed in two areas (water column of about 0.3 m and no vegetation in all four areas). The results indicate that the fish used the areas provided with shelters more frequently and exhibited stronger aggressiveness when shelters were present. In contrast, the fish shoaled less, they tended to be more scattered, performed more displacements, and preferred to shoal in central areas in the absence of shelters. Under predation risk, the fish displayed more careful displacements, which occurred at the same frequency as when there was no predation risk. The anti-predator strategies mainly observed were avoidance and flash expansion, irrespective of the presence of shelters. A second experiment assessed the effects of water depth and vegetation on the behaviour of fish. Three habitats were tested with and without predation risk. The first habitat consisted in two deep areas (water column of 0.37 m) and two shallow areas (water column of 0.22 m) containing no plant. The second and third habitats were identical to the previous one but contained some plants in the shallow areas and in the deeper areas, respectively. The results suggest that the fish preferred the deeper areas with plants because they guaranteed a better protection. The fish were indeed observed to hide among plants under predation threat. The absence of vegetation reduced the number of displacements. In the safest habitat (the third one), the number of behaviours exhibited by animals was decreased, apart from soil foraging behaviour. We also studied the anti-predator behaviours and it appeared that *L. ghigii* used only avoidance and flash-expansion strategies in response to avian predatory attacks.

Comparison of the vertebra and dorsal fin spine methods for ageing bluefin tuna from the Mediterranean Sea

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The aim of this study is to estimate the age of bluefin tuna, *Thunnus thynnus* (L., 1758), using two hard structures, the caudal vertebrae and dorsal fin spines, with a view to compare the two ageing methods and to estimate their precision. Both hard structures were collected from specimens sampled either from the long-line fishery catches in the Aegean Sea (wild individuals) or from the Greek Bluefin Tuna farm, in the Ionian Sea (fattening individuals). Samplings were accomplished between November 2007 and January 2009. A total of 181 bluefin tuna, ranging from 112 to 272 cm in fork length and from 26 to 475 kg in round weight were aged using both dorsal fin spines and caudal vertebrae. The age of each fish, using the two structures, was determined from the number of visible growth bands. In dorsal fin spines, a binocular stereoscope (transmitted light) equipped with an image analysis system was used for reading and measuring each spine section. Opaque zones, assumed to be indicative of fast growth, were separated by translucent zones, which were often present in clusters or groups of two or more and were interpreted as representing periodic events indicative of slow growth. A single translucent zone, (or tight cluster of zones) and the associated opaque zone together were assumed to represent one year of growth. The 35th and 36th caudal vertebrae were used to estimate age by counting the annual growth zones observed on the inner surface of the cones of whole vertebrae. One annulus was interpreted as one ridge and one groove. For each dorsal fin spine and vertebra, three independent counts were performed without knowledge of fish size. The range of the estimated ages was from 4 to 17 years using the dorsal fin spines and from 4 to 16 years using the vertebrae. Both calcified structures are proved to be very suitable for ageing bluefin tuna. The percent agreement between the two methods was high in fish up to 10 years of age but lower in older fish. Specifically, the results showed that there is a tendency to estimate fewer years in vertebrae than in spines in fish older than 10 years old. The rate of agreement between the two ageing methods amounted in 34.2%, whereas the percentages of cases where were observed differences of one, two, three, four or even five years amounted in 34.2%, 17.7%, 9.9%, 3.9% and 0.5%, respectively. The precision or the reproducibility of repeated measurements was estimated using the average percent error (APE), the coefficient of variation (CV) and the index D. Comparing the two ageing methods, the dorsal fin spines presented higher values of measures of precision, against the vertebrae.

Sperm motility pattern of the gilthead sea bream *Sparus aurata* (L., 1758): its use as evaluation parameter during short time semen storage

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Introduction

The evaluation of the broodstock rearing conditions and the specimens selection for artificial reproduction procedures need for a rapid and sensitive tool to assess sperm quality and to predict its fertilizing ability to overcome the problem of the sometimes limited eggs availability (Rurangwa et al., 2004). The assessment of sperm motility is one of the most commonly used tool as it can be easily performed also on a high number of specimens and it does not need the animals are sacrificed or irreversibly stressed. The use of computer assisted sperm motility analysis provides a rapid, quantitative and above all not subjective assessment of sperm quality, giving in real-time information on sperm motility characteristics which are not observable manually and can reliably predict sperm fertilization ability. Milt characteristics (i.e. concentration, sperm size and velocity), may affect the quality of results and have to be taken into account for the set up of the recording and analysis protocols, which need to be optimized just according to the specie-specific semen feature.

The Sperm Class Analyzer (Microptic s.l.) acquisition parameters have been standardized for the characterization of the motility pattern of the sperm of the gilthead sea bream (*S.aurata*), an euryhaline teleost fish with economic interest in Europe and in the Mediterranean area.

Methods

Semen samples were collected by stripping from reared adult sea breams. Sperm was diluted in sea water 37% and the following parameters were analyzed by SCA sytem: % of motile spermatozoa, curvilinear velocity (VCL), straight line velocity (VSL), angular velocity (VAP). These parameters trend has been analyzed during 30min after the activation on just collected semen samples and after 4h, 24h and 48h of storage at + 4°C.

Results

The percentages of rapid motile spermatozoa (average velocity > 100µm/sec) and the relative velocity parameters are reported in Figures 1 and 2. The % of rapid sperm remains constant up to 10min after activation, then it slightly declines; samples stored up to 24h at + 4°C have about 50% of high quality sperm.

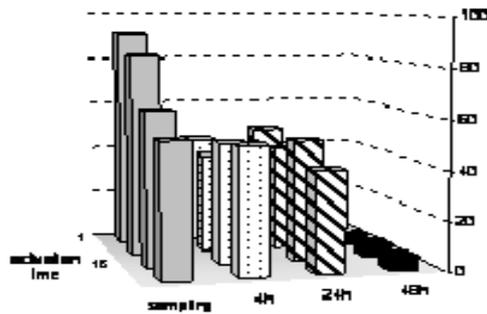


Fig. 1. Percentages of rapid spermatozoa at 1, 5, 15 and 30min after activation on collection and after 4h, 24h and 48h of storage at + 4 °C

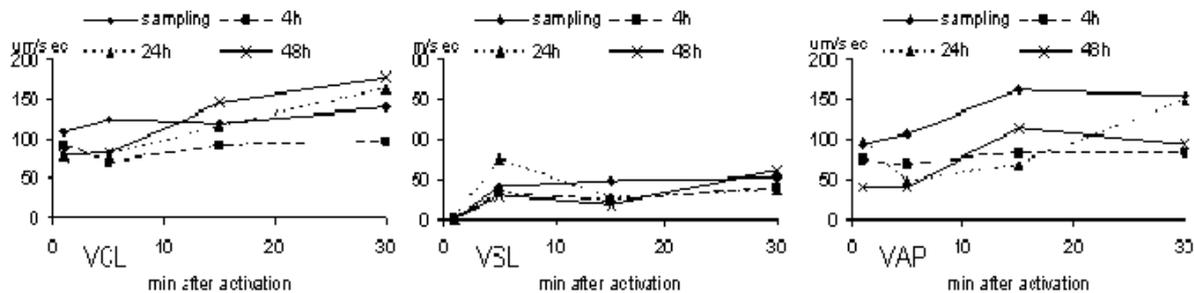


Fig. 2. Velocity parameters of rapid spermatozoa at 1, 5, 15 and 30min after activation on collection and after 4h, 24h and 48h of storage at + 4 °C

Discussion and Conclusions

The motility parameters recorded by the SCA system show levels comparable to those recorded for the sea bass by Felip *et al.*, 2006. VCL, VSL and VAP levels remain constant even when the number of rapid spermatozoa decreases. The evaluation of these parameters can be used to quantify in each semen sample the amount of spermatozoa characterized by a high quality motility, in order to discriminate, in real time, samples potentially able to give the best fertilization results. The obtained Sperm Motility Pattern of gilthead sea bream can be used not only for aquaculture purposes but also for ecological and ecotoxicological aims.

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Bioystematic of two isolated population of *Aphanius* sp. from Iran central Plateau

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Aphanius, the only genus of cyprinodontidae in Iran, with seven known species, four of which endemic, is widely distributed in the country. There are some populations in this genus in Iran that have unique coloration or scale characteristics, but show overlaps in some other morphological characteristics with the known species. This study is attempting to compare two unknown populations of *Aphanius* sp.(from two isolated endorehic basin of Cheshmeh-Ali spring and Shour River in central plateau of Iran) with two known population of *A. sophiae* (from

Dendrogram using Ward Method

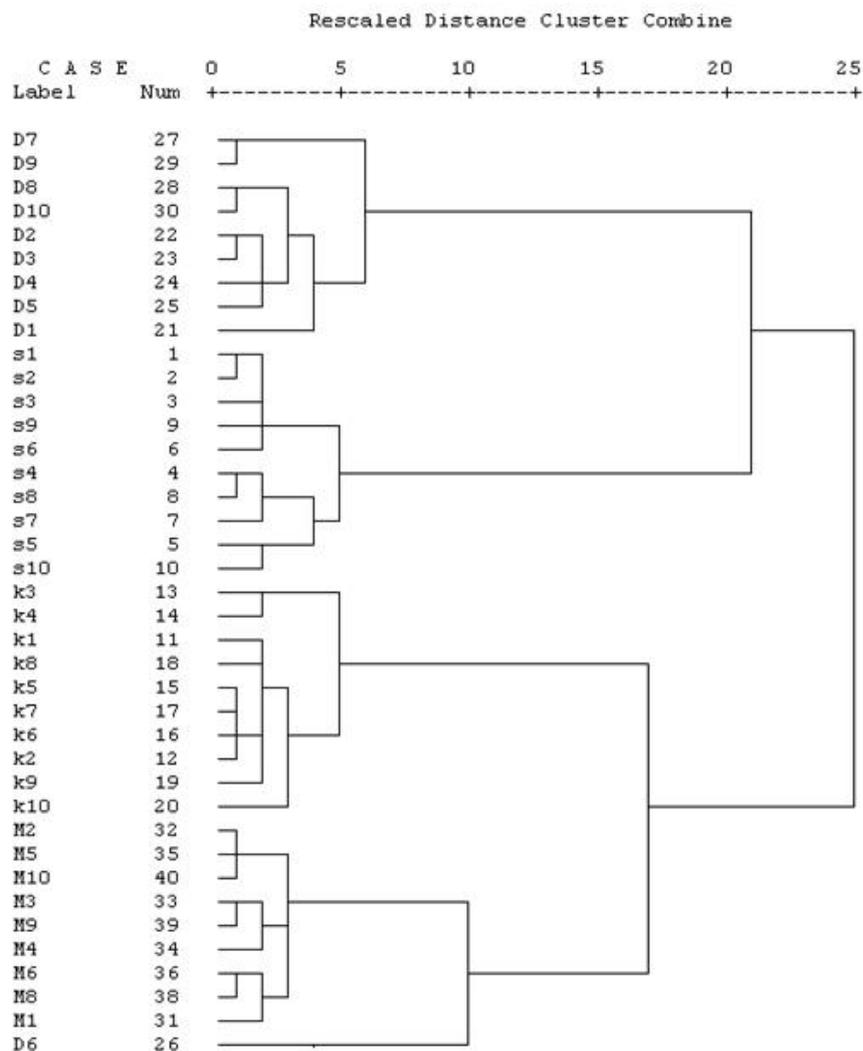


Figure 2- Dendrogram of cluster analysis using Ward method for females (D: Damghan, Cheshmeh-Ali; S: Shour River; M: Malaskoh spring; K: Kor River)

State of Lake Plescheevo vendace (*Coregonus albula* (L.)) population

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Lake Plescheevo is situated in the southern part of the Yaroslavl region of Russia. Its area - 51,5 km², length – 9,5 km, maximum width – 5,4 km, maximum depth – 24,3. The lake is of glacial origin.

Lake's ichthyofauna is represented by 16 species common for Volga river basin. Despite its long-term connection with Volga river specific composition of lake's fishes is rather peculiar. First of all it is the presence of large forms of vendace and absence of blue bream, sablefish, sander and other species widely distributed in waterbodies of the Upper Volga basin.

Vendace inhabiting the lake is a zooplanktophage considered to be a representative of Arctic freshwater complex.

The presence of vendace population is sustained due to its high flow rate, big depth, presence of many springs supplying the lake, presence of summer stratification of water masses.

In the lake vendace forms local monospecific aggregations which are well registered by echosounder in the period of open water. Combined (trawl, acoustics) surveys allowed determining that during the summer, zone of its habitation is confined to the deepest part of the lake constituting only 5-6 km². Vertically, vendace distributes below the thermocline formed in this part of the year (deeper than 12-14 m).

Information on vendace catches is available from the mid-1500's. From 1506 to 1668 catches fluctuated from 33600 to 77640 individuals, in 1891 – 150000 at average weight being around 100 g. Mass development of algae caused by intensive agriculture and their subsequent die-off lead to the appearance of anoxic zone in the deepest-most part of the lake. This threatened vendace's existence as it tends to inhabit lower layers of hypolimnion during the summer. Such conditions caused vendace to inhabit 1.5-2 meter water layer limited by high temperature (20-23°C) from above and absence of oxygen from below.

In the period of 1991-1992 this waterbody was transformed into a National park and appropriate limitations of economic activity were introduced. At present, level of lake's eutrophication decreased, oxygen content in the deepest part of the lake during the summer came back to normal.

The table below gives a summary of abundance and biomass characteristics of Lake Plescheevo vendace.

Therefore we may conclude that vendace's biomass is no longer declining and abundance of the unique population of this species has stabilized.

Year	Average density of vendace in aggregations, ind./m ²	Area of aggregations, km ²	Fish abundance, thousands of ind.	Biomass, t
1978 - 1979	0,02	15,1	302	30,6
1980	0,04	6,2	248	26
1981	0,03	7,5	220	24,2
2004	0,02	8	159	16,8
2006	0,016	10,6	173	18,3

Growth and reproductive biology of the chub *Leuciscus cephalus* (Linnaeus, 1758) in the Tiber River (Umbria – Italy).

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The chub is one of the most widespread freshwater fish in Italy, but biological data on Italian populations of this species are scarce. The aim of this study was to analyze growth and some features of reproductive biology of the chub population *Leuciscus cephalus* (L.) in the middle stretch of Tiber River (Umbertide, Umbria). Sampling was carried out monthly from March 2008 to May 2009 by electrofishing. A total of 536 specimens were caught; the sample was composed by 253 males and 143 females. Total length (TL, ± 0.1cm), standard length (SL, ± 0.1cm) and weight (± 1g) of each specimen were recorded; the age was assessed by means of scalimetry. The total length of the specimens varies from a minimum of 4.6 cm to a maximum of 48.8 cm, for a weight of 0.6 g and 1197.7 g, respectively. The length-weight regression was $W = 0.006LT^{3.1445}$ (males) and $W = 0.0053LT^{3.1918}$ (females). The LS/LT regression was $LT = 1.1498LS + 0.4972$ for the total sample; any significant differences between sexes were observed at ANCOVA. For both sexes, theoretical growth in length was estimated using von Bertalanffy's model and the condition was evaluated by relative weight. Sex was determined by microscopic examination of the gonads. The study also enabled some aspects of the reproductive biology of this species to be investigated (fecundity, age at maturity, egg size, reproductive period).

Proposed standard weight (W_s) equations for vairone (*Telestes souffia* Risso, 1826) in the River Tiber basin (Italy).

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Relative weight is one of the condition indices used to assess the general health of fishes. The index provide a measure of the well-being of a fish population by the comparison between the actual weight of a specimen and the ideal weight of a specimen of the same species in good physiological condition (standard weight). Relative weight is calculated as $W_r = 100 (W / W_s)$ where W is weight of the specimen in grams and W_s is the length-specific standard weight predicted by a weight-length regression constructed to represent the species ($\log_{10} W_s = a' + b \log_{10} TL$).

Two methods of calculating the standard weight are proposed in the literature: the RLP method and the EmP method. Although the RLP method is widely used to calculate standard weight, it was been criticized because it appear influenced by the size distribution of the specimens. The main difference between two method to calculate the index is that RLP method uses the weights derived from the TL/W regressions of different populations while EmP method uses the actual weights of the individual specimens.

The main aim of our research was to develop the equations for calculating standard weight with both two method (RLP and EmP) that would be valid for the populations of vairone (*Telestes souffia* Risso, 1826) in the River Tiber basin. To this end 9186 specimens from 94 different populations were examined.

The resulting equations for the River Tiber basin are: $\log_{10} W_s = -3.7056 + 1.68537 \log_{10} LT + 0.348598 \log_{10} LT^2$ for EmP method and $\log_{10} W_s = 3.081 \log_{10} LT - 5.0854$ for RLP method. A further aim was to compare the validity of the two proposed methods (RLP and EmP) of calculating relative weight.

Fish microhabitat use in undisturbed Carpathian foothill streams

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Foothill rivers characterized by a relatively high slope are widely dammed and used for hydropower purposes or are highly regulated. These river sections are inhabited by many rheophilic species that are endangered by habitat degradation. Restoration/rehabilitation projects and fish ways constructions could increase species favorable status, but relevant ecological requirements for several fish species are missing. We focused on two undisturbed foothill streams (Udava and Ulička) in the Tisza basin in Slovakia, where data on habitat preferences on 8 sites were collected in September 2005, May 2006 and August 2006 (24 samples) using point sampling method (570 points). Ivlev's electivity index modified by Jacobs was used to evaluate the habitat use for particular species. The statistical significance of the electivity index was evaluated by Fisher's exact test. As to the substratum type, *Cottus poecilopus* and *Cottus gobio*, *Barbus carpathicus* and *Sabanejewia balcanica* are significantly linked with particular substratum category. The substratum particles size descended from boulders and cobbles in the case of *Cottus* species to gravel in the case of *Barbus carpathicus* and to fine substratum particles in the case of *Sabanejewia balcanica*. The presence of particular refuges type has significant influence on several fish species. *Cottus poecilopus* shows significant preference to stones, *Salmo trutta* to bank potholes, *Leuciscus cephalus* prefers woody refuges and roots as refuges types and *Barbus carpathicus* significantly does not require any refuges. In the case of relative distance from bank, except of the significant preference of *Leuciscus cephalus* to the bank area, no other preferences were apparent. Preferences to water depth are significant for *Cottus poecilopus* in the case of shallow water and for *Sabanejewia balcanica*, *Phoxinus phoxinus* *Leuciscus cephalus* and *Chondrostoma nasus* in the case of deep water. The preferences for average and maximum water velocity show similar patterns nearly for all species. Significant preferences to water velocity, where *Phoxinus phoxinus*, *Gobio gobio* and *Sabanejewia balcanica* prefer no velocity or low water velocity and only *Barbus carpathicus* prefer medium to high water velocity.

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Biology of invasive fish species of Slovakia

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Seven ecological features (morphological characteristics, age composition, sex ratio, growth, reproductive characteristics, feeding ecology, parasites, habitat preferences and coenological affinity) of 9 non-native invasive fish species of Slovakia were examined:

A total of 7 species of endoparasitic helminths have been recorded in 9 non-native invasive fish species examined. Six of them are the native generalists that infected invasive species. One introduced exotic species, namely the cestode *Nippotaenia mogurndae* (syn. *Amurotaenia perccotti*) has been observed. Finding of adult cestodes *Proteocephalus percae* and cestode plerocercoids *Triaenophorus nodulosus* in *L. gibbosus* represents the establishment of new parasite-host relationships. This non-native fish is reported as the definitive host for *Proteocephalus percae* for the first time. Gobies served mostly as paratenic host for acanthocephalan *Pomphorhynchus laevis*. This was the most prevalent helminth species in all three gobies. The other adult trematode *Nicolla skrjabini* was abundant in intestine of bighead goby, less in monkey goby.

By the analysis of 176 specimens of brown and black bullheads, the prevailing of males in both species was ascertained. The black bullhead prevailed on all of the investigated localities, but it reached lower average of body length and body weight. Spawning of brown bullhead was realized about two weeks earlier. The reproductive characteristics were estimated on 30 specimens of both species. Black bullhead reached higher coefficient of fertility and higher levels of absolute and relative fertility. Ascertained values were higher than information from the original area of occurrence. Likewise, higher fertility of brown bullhead in Slovakia in the first years of its expansion here, and decrease of fertility at present is probably one of the adaptive mechanisms. The higher fertility was accompanied by weak body growth.

Age composition, sex ratio, and growth of *Carasius gibelio* in some localities of the East Slovakia were examined.

We analysed 75 gobiid fishes, belonging to *Ponticola kessleri*, *Apolonia melanostomus* and *Apolonia fluviatilis*. Morphological characteristic was based on the measurements of 4 plastic and 32 meristic features. The food spectrum of *A. fluviatilis* was composed only of Chironomids and Copepods. Similar poor variability was in diet of *P. kessleri* with dominancy of Amphipods. The rest was composed of Chironomidae and Anostraca. The diet spectrum of *A. melanostomus* was the widest, the most frequent components were Gastropoda and Amphipoda, less frequent were Chironomids and Copepods, rarely Bivalvia and Trichoptera

The expansion of *P. glenii* since its first occurrence in Slovakia during 9 years (1999-2008), on the model area of East Slovakian lowland, was monitored. Stomach contents of 331 specimens of *P. glenii* were analysed. Chironomids and ephemeropterans dominated the diet of all size classes of fish. According to diet, two feeding size class groups were recognised: the first < 70 mm and the second ≥ 70 mm.

Age and rate of growth of a random sample of 52 specimens of *L. gibbosus* from the flooded zone of Latorica river have been studied. It was found that there is a wide variation in the growth between particular age groups, which indicate various natural conditions in particular years. The body length - scale length relationship indicates that the scales start appearing at 15.5 mm standard length.

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Population structure and phylogeography of brown trout in eastern Balkans: Separation of the populations from upper and central Danube basin from the remaining Black Sea basin

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The evolutionary history of brown trout in Europe has been extensively studied during last decades. Nevertheless, there are still unexplored regions across its distribution area and questions to be answered, mainly regarding the location and number of glacial refugia and the taxonomy of this species complex. Anthropogenic transfers and domestication of brown trout during the last Century, causing changes in the geographic distribution and erosion of its genetic structure, also challenge such investigations. In the present study we analysed mtDNA and microsatellite variation of more than 200 individuals from unsearched eastern part of the Balkan Peninsula and Turkey. We found substantial divergence between haplotypes from the most of Danube basin and haplotypes from the rest of Black Sea Catchment, including lower part of the Danube basin. It evidenced an allopatric evolution and existence of a Pleistocene glacial refugium in the central/upper part of Danube basin. In Aegean Sea Catchment we found substantially high frequency (61 %) of the central haplotype of Adriatic mtDNA lineage (Adcs1), previously thought to be exclusive for Iberian populations. We therefore suggest a late Pleistocene contact between the western and eastern Mediterranean populations and a recent expansion of Adriatic lineage in to Aegean Sea Catchment, as well as in to the most of Mediterranean basin. The position of *Salmo platycephalus* within the *Salmo trutta* complex has been confirmed based on mtDNA. However, we found high differentiation between both taxa based on microsatellite data. The geographic distribution of mtDNA lineages as well as microsatellite-based groupings corresponded to the particular basins and we found only low level of admixture. Compare to the most of brown trout populations in Europe the recent impact of transfers and stockings on the eastern Balkan populations seems to be rather low. The study was supported by the grants 58/2007/P-VÚRH of the University of South Bohemia and 1QS500450513 of the Academy of Sciences of the Czech Republic.

Postglacial connection between the Black Sea and the Baltic Sea Basins in the Western Carpathians indicated by genetic traces in the stone loach populations

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Northern part of the Western Carpathians represents the watershed between basins of the Black Sea and the Baltic Sea, and could potentially serve as a postglacial dispersal barrier for freshwater fauna. This theory is also supported by the presence of highly divergent genetic lineages of the stone loach (*Barbatula barbatula*) on each side of the mountains, reflecting different postglacial colonisation routes of this rheophilic loach from distinct glacial refugia. On the other hand, a postglacial river connection in this area was hypothesised based on the distribution pattern of the carpathian barbel (*Barbus carpathicus*). In general, populations of the stone loach have deeper genetic structure than more vagile barbel on the same geographic scale, which offers more precise localisation of the connection. Therefore we focused on the stone loach populations from both sides of the watershed in order to find out any connection between both lineages. To detect any sign of introgression, localise eventual contact zones and specify the direction of penetration, we sequenced mitochondrial as well as nuclear marker, and analysed five microsatellite loci. No mitochondrial introgression has been revealed. However, nuclear markers indicate a recent gene flow from some tributaries of the Tisza River Basin to the streams of the Vistula R. Basin in two potential contact zones. Based on the results of all used markers we conclude, that the most plausible explanation for the observed pattern is the

river captures event after the last Pleistocene glaciations rather than the ancestral polymorphism or human mediated dispersal.

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Growth and Reproduction properties of *Garra rufa* in the Balıklı Spa and in the Çermik Stream, Turkey

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Garra rufa, a bottom-dwelling fish in the Balıklı spa in Kangal-Sivas has long been of intensive public interest owing to its role in ichtyoterapy of patients with psoriasis. This fish is also biologically worthy of note because it lives at water temperature as high as the lethal level for many fish species. Although *Garra rufa* has a wide distribution range through Anatolia and Middle East, there is very little information about its life history. In this study, some population properties such as age, sex, length and weight distributions as well as growth and reproduction parameters were studied in order to reveal some biological properties of this fish living in extreme conditions. The specimens were collected from the Kangal Termal Spa and the Çermik Stream where pools of the Spa discharge. The temperature of Balıklı Spa and the Çermik stream varied between 33.6-35.4 °C and 13.9-30.7 °C respectively. The age of the individuals of the Balıklı spa population was found to range between 0 and III, whereas individuals of age IV were identified in the Çermik stream population.

The collected data showed that the fish in the Çermik stream have a faster growth rate than that of in the Balıklı Spa. Spawning period in the Çermik stream starts in April and ends in September. In the Balıklı Spa spawning commences one month later, in May. The ovaries of females contain both mature and immature eggs concurrently which implies fractional spawning in both populations.

Diameter of eggs, is larger in Çermik stream than those in the Balıklı spa. Fecundity was found to increase with age in both populations. It is higher in the Çermik stream than the Balıklı Spa. Based on the fact that the size of the eggs is much more larger than expected for a fish of this length, it was presumed that this species is a lithophilic, that lays eggs on stones and gravel zones. Substrate of the Çermik stream and pools of the Balıklı Spa consist mainly of coarse grained material as cobble, pebble and gravel. The results obtained from the study suggest that the high temperature speeds up the metabolism of the fish, and may cause an earlier sexual maturity. Low oxygen associated with high temperature results in slowing down the growth rate of the individuals. However, longer spawning period may be an advantage for this species.

The South American freshwater fish *Prochilodus lineatus* (Prochilodontidae: Characiformes), new invader in freshwater ecosystems in Vietnam

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Many of non-indigenous and invasive fish species that adversely affect the habitats are known. Accordingly, early revelation or better prevention of such introduction is highly important. During our work in Northern Viet Nam we found non-native fish in the local market. Later we identified it as characin freshwater fish *Prochilodus lineatus* (Valenciennes, 1836), which is endemism of the Paraná and Paraguai River basins in South America.

This Species is detritivorous, i.e. it can eat periphyton represented by microscopic plants, animals, and detritus that adhere to vegetation and other available surface in aquatic environment. This ecological specialization allows them to skip the intermediate step in the food chain of insect detritivory and directly utilize detritus and periphyton. For this purpose its mouth is specially adapted. *P. lineatus* is conspicuous among the migratory species of the Paraná River basin and is considered to be the one of the most important species in fish catch in the Itaipu Reservoir. Aquaculture

introduction of this species was recorded in China. *P. lineatus* was brought to Asia probably due to economic interests.

We here report it for the first time from Vietnam, basing on six specimens obtained from the market in Tu Son, Vinh Phuc province. Based on information from local fish breeders, the species is gaining increasing interest in local aquaculture and its spreading can be expected. Considering their detritus feeding habits and their high abundance and migration, prochilods play a significant role in the energy flow of the tropical aquatic systems they inhabit.

Introduction of *P. lineatus* into Vietnamese fresh waters may cause serious impacts to the local aquatic ecosystems.

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Common species of Angola headwaters in Province Bié

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Province Bié (70,314 km²) is situated in central Angola plateau. Most of the province lies in the altitude around 1,500 m.a.s.l. Several major rivers of Sub-Saharan Africa originate or have tributaries in this area. Upper parts of Kwanza (Quanza, Cuanza), Cubango (Okavango), Kunene (Cunene), Zambezi and Zair (Congo) River systems can be found here. Due to long period of civil conflicts, there is almost no information about the fishes of this African headwaters region. Recently, collecting of the samples remains still complicated by problems such as land mines, lack of infrastructure, security or logistic. Herein, we simply report on fishes, that we collected during our work in the area from 2007 to 2009 in cooperation with local authorities. We collected 23 indigenous species in following genera: *Marcusenius*, *Clarias*, *Synodontis*, *Schilbe*, *Doumea*, *Barbus*, *Labeo*, *Hepsetus*, *Parakneria*, *Brycinus*, *Aplocheilichthys*, *Serranochromis*, *Haplochromis*, *Tilapia*, and *Ctenopoma*. Although our records are the first from the area, they are most likely not complete. More detailed study is necessary in the field of determination, taxonomy and faunistic.

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New Danubian haplotype of brown trout (*Salmo trutta* L.) population from the Plitvica River revealed by mitochondrial DNA control region analysis

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Brown trout (*Salmo trutta* L.) has a widespread distribution across Europe. It is characterized by a complex genetic structure and high genetic population differentiation throughout its distribution. Based on the sequence variation of the mitochondrial (mt) DNA control region, five major evolutionary lineages were proposed: Atlantic, Danubian, Adriatic, Mediterranean and *marmoratus*. However, some regions remain understudied and there is still a deficiency of data from particular areas of the brown trout native range. One such understudied area with importance to the evolutionary history of the species is Croatia. Individuals originating from the Plitvica River were investigated. In order to assess phylogenetic lineages affiliation, and address the question of autochthony of population in the river, mtDNA control region variations were analysed. Complete sequencing of the mtDNA control region revealed that all sampled individuals possess the same haplotype. Identified haplotype was a new, previously undescribed haplotype belonging to the Danubian lineage. Phylogenetic analysis with other Danubian haplotypes demonstrated that this new Danubian haplotype was most closely related to the Da9 haplotype. Thus, this novel haplotype has

been named Da9a. It was concluded that brown trout population from the Plitvica River represent native population and should be protected from introduction of domesticated strains of brown trout.

Parasite diversity of European bitterling *Rhodeus amarus* in western Turkey

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Eastern lineage of European bitterling *Rhodeus amarus*, represented by four populations from western Turkey, was studied for diversity of metazoan parasites. Field studies on bitterling populations belonging to Sapanca lake drainage (Masukiye and Kurtkoy streams) and to Omerli reservoir drainage (Eski Riva and Ballica stream) were conducted in late autumn 2008. Of the 140 fish examined for parasites, 99.3% were infected by at least 1 parasite species from among the 29 taxa observed. The parasite species richness (23 spp.) was higher in Sapanca lake drainage compared to 18 spp. found in Omerli lake drainage. Six species were found in all four host populations: specific monogenean *Dactylogyrus bicornis* and *Gyrodactylus rhodei*, generalist monogenean *G. laevis/prostae*, metacercariae of *Paryphostomum radiatum* and unspecified digenean, and nematode *Pseudocapillaria tomentosa*. Parasite diversity indices were relatively high and reached comparable values in all four bitterling populations. Larval trematodes dominated in the parasite community of all four fish populations, metacercariae represented 78-94% of all parasite individuals in particular samples and also showed maximum species richness. Population from Kurtkoy stream, the one with highest species richness and total parasite abundance, was significantly affected by the infection of *Ligula intestinalis* plerocercoids. Presence of this parasite in other bitterling populations was very rare. In general, parasite community showed relatively high species richness and total parasite abundance in comparison to the fish from western lineage of European bitterling.

Coincidence in timing and places of brown trout fry emergence and spawning of lampreys: could the lampreys affect an emergence of salmonids?

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Abstract: Emergence from the native nest gravel is one of the crucial life moments for young salmonids. Emergence success depends on the depth in which the eggs were laid and the structure of the gravel, mainly the porosity and content of fines. In the middle latitudes the fry of brown trout *Salmo trutta* L. emerge from the gravel in the mid spring, as well as the lampreys spawn. We hypothesized that the timing and places of these two processes could coincide together and there could be an effect of lamprey spawners on emerging brown trout fry. The research was conducted in small lowland stream Blendziava, where intensive brown trout and lamprey spawning are observed. The emergence period of brown trout fry were observed by catching emerging fry from 14 natural spawning redds capped with traps. The spawning places and timing of brook lampreys and river lampreys were registered too. Our hypothesis was supported by research results; the peak of trout fry emergence and lamprey spawning highly coincided. The spawning sites of trout and lamprey at the microhabitat scale also were strongly overlapped. In the downstream reaches where the spawning activity of river lampreys were the highest, up to 90 % of brown trout nests were partly or fully overdigged by spawners of lampreys. One of the main requirements for lamprey spawning site is proper streambed angle against the flow. Brown trout also select these sites for spawning, moreover the structure of spawning nest of brown trout itself create the suitable bed gradient for lamprey spawning. These makes the redds of salmonids to be highly susceptible to overdigging by lamprey spawners. There will be discussed the possible effect of lamprey digging activities during their spawning on the emerging brown trout fry.

Key words: brown trout, emergence, fry, lamprey, spawning site.

Effectiveness of two ovulation-inducing agents (Ovopel and Ovaprim) for reproduction of the barbel, *Barbus barbus* (L.)

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Introduction

The aim of the present experiment was to compare effectiveness of two GnRHa based ovulation-inducing agents (Ovopel and Ovaprim) for reproduction of the barbel, *Barbus barbus* (L.), an important sport fish in many European countries.

Material and Methods

The experiment was carried out with 6-year-old *B. barbus* females of 0.3-0.8 kg BW. Two separate runs of the experiment, each with two experimental groups, were performed according to the identical scheme. Experimental groups consisted of 16-18 females stimulated with intraperitoneally injected Ovopel (Interfish, Hungary) or Ovaprim (Syndel Laboratories, Canada). Ovopel is obtainable as pellets containing 18-20 µg of mGnRHa and 8-10 mg of dopamine antagonist metoclopramide. Prior to use, it was homogenised with 0.7% NaCl water solution and applied in two doses (0.2 and 1.0 pellet kg⁻¹) injected at 12 h interval. Ovaprim is a liquid ready-to-use preparation containing 20 µg cm⁻³ sGnRHa and 10 mg cm⁻³ of domperidone. It was used in a single dose of 0.5 cm³ kg⁻¹.

All fish groups were held in separate tanks (V = 1 m³). Water temperature was 17°C, and photoperiod was 12L:12D. Females were checked for ovulation 24, 36, 48 and 56 hours after the last injection. Eggs stripped from each female were weighed. Samples of 179-346 eggs were taken from up to 5 randomly chosen females from each group, then fertilised using dry method and, separately for each female, incubated at 18°C. Mixture of semen used for egg fertilisation was obtained from 10 males not stimulated hormonally. Incubation was performed in flow-through aquaria (V = 5 dm³, water-flow 0.2 dm³ min⁻¹). All dead eggs were counted and removed. After 6 days (105-106D^o) mass hatching took place. Two days later all larvae were counted and the hatching rate was determined.

Results and Discussion

Ovulation started after 24 h in groups of females treated with Ovopel, while in groups treated with Ovaprim ovulation latency was at least 36 h (Tab. 1). In contrast, ovulation rates, spawning indexes, stripping fecundities and hatching rates differed insignificantly. In view of the above, none of both stimulants proved its superiority. For the practical purposes, however, it should be stressed that Ovopel is considerably cheaper than Ovaprim, but the latter can be effectively used in a single injection what is both more convenient for the personnel and less stressful for fish.

Table 1. Results of *B. barbus* reproduction and hatching rate of eggs

Run of experiment/ ovulation-inducing agent	Ovulation latency (h)	Ovulation rate (%)	Spawning index (% of BW)	Stripping fe- cundity (eggs)	Hatching rate (%)
1/Ovopel	24-48 (n = 6)	33.3 (n = 18)	4.3 ± 1.1 (n = 6)	1942 ± 995 (n = 6)	87 ± 12 (n = 5)
1/Ovaprim	36-48 (n = 4)	25.0 (n = 16)	3.1 ± 2.0 (n = 4)	1460 ± 878 (n = 4)	71 ± 20 (n = 4)
2/Ovopel	24 (n = 4)	22.2 (n = 18)	7.3 ± 1.1 (n = 4)	2874 ± 532 (n = 4)	96 ± 2 (n = 4)
2/Ovaprim	36 (n = 2)	11.8 (n = 17)	6.3 ± 1.2 (n = 2)	2377 ± 60 (n = 2)	95 ± 1 (n = 2)
Hormonal treatment (ANOVA)			F = 2.2 P = 0.16	F = 1.2 P = 0.29	F = 1.6 P = 0.23

Data for ovulation latency is presented as range. Ovulation rate was normalised using angular transformation (differences are insignificant at $P \leq 0.05$). Spawning indexes, stripping fecundities and hatching rates are means ± SD.

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Survey on natural feeding of commercial Juvenile *Cynoglossus arel* fishes (Sciaenidae) in Khozestan Coastal Waters (Persian Gulf)

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Marine fish are an important source of protein in the Persian Gulf Region. The identification of stomach contents allows us to know about food consumption, feeding and assimilation rates, cannibalism and even habitat segregation. Khozestan coastal water environments may function as important nursery habitats for juvenile *Cynoglossus arel*, yet little ecological research has been conducted in ocean habitats. This survey was conducted to study diets and some feeding indices of dominant and commercial Juvenile *Cynoglossus arel* in Khuzestan coastal waters. A number of juvenile *Cynoglossus arel* species was captured in main fishing areas, the west side (Buseif-Lifeh) and eastern side (Bahrekan), north of Persian Gulf. These animals were sampled randomly by shrimp trawl net every month, during March 2006 to December 2007. The stomach contents of 85 individuals juvenile *Cynoglossus arel* were analysed. The small size of the individuals collected and the high percentage of full stomachs (76%), corresponding with high food availability in the region indicated that Khozestan coastal water is used as a nursery ground. Relative measures of food item quantity were estimated by the Index Relative Importance (IRI). The results of IRI showed (31.99%) for Crustaceans followed by Polychaetes (25.32%), Bivalves (15.46%), Shrimp (10.34%) and were high important and (9.86%) Copepods (3.53%), Diatoms (3.41%), Sponges (5.42%) were less important. Diet of both Juvenile *Cynoglossus arel* species varied with length. Smaller individuals were microphagous (Copepods, Diatoms, Sponges, Algae) while bigger specimens included larger prey (Crustaceans, Polychaetes, Bivalves, Shrimp) in their diet. Prey diversity for Juvenile *Cynoglossus arel* was highest in spring and Summer, the lowest percentage of stomachs with food occurred in winter.

Key words: Juvenile fish, feeding, Khozestan Coastal Waters