



# ATLAS OF RIVER NESTOS FISH FAUNA

Edited by

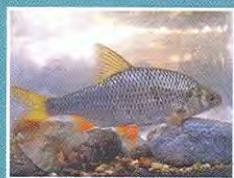
Panos S. ECONOMIDIS

Manos KOUTRAKIS

Apostolos APOSTOLOU

Milen VASSILEV

Luchezar PEHLIVANOV









# ATLAS OF RIVER NESTOS FISH FAUNA

Edited by

Panos S. ECONOMIDIS

Manos KOUTRAKIS

Apostolos APOSTOLOU

Milen VASSILEV

Luchezar PEHLIVANOV



*Suggested citation format*

Economidis P.S., M. Koutrakis, A. Apostolou, M. Vassilev & L. Pehlivanov (Eds.), 2009. *Atlas of River Nestos Fish Fauna*. Prefectural Authority of Drama-Kavala-Xanthi, NAGREF-Fisheries Research Institute and Bulgarian Academy of Sciences, Kavala, Greece, pp.181.

ISBN: 978-960-88902-6-8

© 2009 Economidis P.S., M. Koutrakis, A. Apostolou, M. Vassilev & L. Pehlivanov

Photographs © 2009 as attributed next to each photograph.

Printed by Telia+Pavla

Published by Prefectural Authority of Drama - Kavala - Xanthi.

Available from:

- Prefectural Authority of Drama - Kavala - Xanthi, Greece.
- National Agricultural Research Foundation - Fisheries Research Institute, Kavala (NAGREF-FRI), Greece.
- Bulgarian Academy of Sciences, Sofia, Bulgaria.



Υπερνομαρχία  
Δράμας-Καβάλας-Ξάνθης



Bulgarian Academy  
of Sciences

# Contents

## Preface

|                                                                                                                     |        |
|---------------------------------------------------------------------------------------------------------------------|--------|
| Konstantinos Tatsis, President of the Prefectural Local Authority of Drama-Kavala-Xanthi .....                      | 9      |
| Valeri Sarandev, Vice Mayor Gotche Deltchev .....                                                                   | 11     |
| Gerd Marmulla, FAO Expert .....                                                                                     | 13     |
| <br>List of Contributors .....                                                                                      | <br>15 |
| <br>A special forward by P.S. Economidis .....                                                                      | <br>17 |
| Prologue by M.T. Zivkov .....                                                                                       | 21     |
| The Nestos fish fauna project by M. Koutrakis .....                                                                 | 23     |
| The transboundary Nestos / Mesta River: An overview on hydrology and Environment by G. Sylaios & E. Burnanski ..... | 27     |
| The fishes: an introduction to study by P.S. Economidis, M. Vassilev & M. Koutrakis .....                           | 41     |



|                                                                                  |     |
|----------------------------------------------------------------------------------|-----|
| <b>Species Description</b>                                                       | 61  |
| How to use this book                                                             | 63  |
| Nestos/Mesta fish species identification key by P.S. Economidis and A. Apostolou | 66  |
| <i>Alburnoides strymonicus</i>                                                   | 70  |
| <i>Alburnus alburnus</i>                                                         | 72  |
| <i>Alosa fallax</i>                                                              | 74  |
| <i>Anguilla anguilla</i>                                                         | 76  |
| <i>Aphanius fasciatus</i>                                                        | 78  |
| <i>Atherina boyeri</i>                                                           | 80  |
| <i>Barbatula barbatula</i>                                                       | 82  |
| <i>Barbus strumicae</i>                                                          | 84  |
| <i>Carassius gibelio</i>                                                         | 86  |
| <i>Chelon labrosus</i>                                                           | 88  |
| <i>Chondrostoma vardareense</i>                                                  | 90  |
| <i>Cobitis strumicae</i>                                                         | 92  |
| <i>Cyprinus carpio</i>                                                           | 94  |
| <i>Dicentrarchus labrax</i>                                                      | 96  |
| <i>Esox lucius</i>                                                               | 98  |
| <i>Gambusia holbrooki</i>                                                        | 100 |
| <i>Gobio bulgaricus</i>                                                          | 102 |
| <i>Knipowitschia caucasica</i>                                                   | 104 |
| <i>Lepomis gibbosus</i>                                                          | 106 |
| <i>Leucaspis delineatus</i>                                                      | 108 |
| <i>Liza aurata</i>                                                               | 110 |
| <i>Liza haematocheilus</i>                                                       | 112 |

|                                          |         |
|------------------------------------------|---------|
| <i>Liza ramada</i> .....                 | 114     |
| <i>Liza saliens</i> .....                | 116     |
| <i>Mugil cephalus</i> .....              | 118     |
| <i>Oncorhynchus mykiss</i> .....         | 120     |
| <i>Oxynoemacheilus bureschi</i> .....    | 122     |
| <i>Perca fluviatilis</i> .....           | 124     |
| <i>Phoxinus strymonicus</i> .....        | 126     |
| <i>Platichthys flesus</i> .....          | 128     |
| <i>Pseudorasbora parva</i> .....         | 130     |
| <i>Rhodeus amarus</i> .....              | 132     |
| <i>Rutilus rutilus</i> .....             | 134     |
| <i>Salaria fluviatilis</i> .....         | 136     |
| <i>Salmo macedonicus</i> .....           | 138     |
| <i>Scardinius erythrophthalmus</i> ..... | 140     |
| <i>Silurus glanis</i> .....              | 142     |
| <i>Squalius orpheus</i> .....            | 144     |
| <i>Syngnathus abaster</i> .....          | 146     |
| <i>Tinca tinca</i> .....                 | 148     |
| <br>Bibliography .....                   | <br>151 |
| Index .....                              | 175     |



# Konstantinos TATSIS

President of the  
Prefectural Local Authority  
of Drama-Kavala-Xanthi



The issue of environmental protection and sustainable development is certainly one of the major policy priorities of our time.

For some time the scientific community has identified the risks of overexploitation of ecosystems that surround us and the national governments and the EU have gradually made commitments aiming that growth, innovation and technological progress are combined with the moderate and careful management of natural resources and the protection of natural wealth.

It would be equally easy to downgrade the political effort anticipating the destruction of our planet or even to denounce it as an additional ideological chimera that hinders the development.

Politics, however, is the art based on a continuously moving blend of actions intended to help man to live with reality. Therefore our approach is to seek ways to contribute, to the extent of our possibilities and our responsibilities, to the overall effort.

For the Prefectural Local Authority of Drama - Kavala - Xanthi, the publication of this book on the fish fauna of the River Nestos, a result of the cooperation between Greek and Bulgarian scientists, represents another step in a long course designed to



highlight the natural richness of the region and especially to raise the awareness of our fellow-citizens, in the sense that our future is connected with the protection and enhancement of our natural environment.

The fish fauna of River Nestos, as rich and valuable might be, will not have a prosperous future if we, living in this area, do not realize, firstly its existence and then that it deserves our attention.

But for us, the fish fauna of this beautiful river that crosses three Greek prefectures is a unique treasure and the most reliable witness and judge of the quality and quantity of the water that is a key element of our living standards.

From mutually beneficial relationship, it would not be prudent and effective to downgrade, adapting neither obsolete development strategies, nor it served with inarticulate cries and fragmented representations on the imposition of extreme attitudes and actions.

A multilevel and multifaceted work is needed that seeks the continuous emergence of the binding clue between natural heritage and local communities, and in this fight the Local Authority should be involved playing a leading role.

# Valeri SARANDEV

Vice Mayor  
Gotse Delchev Municipality

Mesta/ Nestos River and its tributaries represent the artery of 8 Municipalities in Blagoevgrad region, and 3 more in the neighboring Greece. The tributaries of the river striate mountain slopes and narrow gorge valleys, which are of major potential for trekking tourism. The river and its tributaries cross several protected areas and reserves, as of Rila, Pirin, The Gorge and the Estuary with the Delta. It creates conditions for living and survival of many organism groups, many of which are almost extinct. In a constantly changing environment as a result of anthropogenic influence, it is important to know what irreversible changes have occurred in nature, and what could have been done to prevent them. Growing anthropogenic activities such as illegal riparian woodcut, seizing of inert material, changes in the watercourse, poaching and others, represent a serious threats not only to the alive, but also to inorganic nature.

Regional development and environmental protection are difficult to combine and often are in conflict, but the Municipality of Gotse Delchev has defined success in this direction. And last but not least, must be claimed the practical significance of this book:

- Determination of Municipalities in southwestern Bulgaria as attractive tourist destinations
- Successful use of natural potential for cross-border cooperation with

## Municipalities in the Hellenic Republic

- Enrichment of natural and eco-culture of the ordinary citizen, etc.

Within our unifying institution - the European Union, cooperation among scientists and citizens of different countries is a must nowadays. Therefore, the Municipality of Gotse Delchev is strongly interested in such initiatives as the edition of this book. The book is the fruit of joint efforts of Bulgarian and Greek scientists, which proves once again the good neighborly relations between Bulgaria and Greece. It represents the first step, but also the basis for even closer collaboration of the international team that prepared it.

## Gerd MARMULLA

Fishery Resources Officer  
Fisheries Management and Conservation Service  
Food and Agriculture Organization of the United  
Nations (FAO/UN)

“Ecological awareness” and “Protection of the environment” are two aspects that gained much importance in our life during the last decades as the destruction of the ecosystems and the problems associated with it became more and more serious. Natural rivers and their surrounding ecosystems can be home to a great diversity of species, such as freshwater fish species, amphibians, terrestrial animals, as well as plants, and affect positively the marine environment.

Despite this important role of the rivers, often only little is known about their fish fauna and the interactions of the fish with the aquatic environment. One such example of the lack of knowledge of the riverine ecosystems is River Nestos/Mesta. The Nestos/Mesta is a cross-border river, which originates from southern Bulgaria as River Mesta, enters Greece (there named Nestos) and becomes one of the major rivers of Greece, that outflows into the Thracian Sea.

In an attempt to raise the awareness about River Nestos/Mesta, and to promote a basin-wide transboundary and concerted approach, an effort was made to draw up a common list, between Greece and Bulgaria, with all the fish species that live in the Nestos/Mesta River from its source to its mouth, and to resolve issues related to the

populations of various fish species that live in both parts of the river. The list was prepared in the framework of the research project «*Management actions, Protection and Promotion of the River Nestos fish fauna*» under the financial instrument INTERREG IIIA / PHARE CBC Greece-Bulgaria, carried out by the Hellenic Fisheries Research Institute (N.AG.RE.F.-FRI) under the auspices of the Prefectural Local Authority of Drama-Kavala-Xanthi. The Bulgarian Academy of Sciences helped in this effort by providing valuable recent information on the fish species that can be found in the Bulgarian part of the river and, in addition, made also available historical data about the presence of various fish species in River Nestos/Mesta in the past.

This book, being a product of a joined effort by Greek and Bulgarian scientists, is an attempt to create a record of, and to disseminate knowledge on, the River Nestos' fish fauna. The coordinators of this edition were Dr. Panos Economidis and Dr. Manos Koutrakis from the Greek side and Dr. Apostolos Apostolou, Dr. Millen Vassilev and Dr. Luchezar Pehlivanov from the Bulgarian side who, along with the rest of the collaborators, set out to address existing scientific problems with the aim to provide the public services and the wider audience with useful information on which to base the management, conservation and protection of this river and of its fish fauna.

## List of Contributors

- ✉ Dr. Panos S. Economidis, Professor Emeritus at the Aristotle University of Thessaloniki, Greece. Email: [PSEcon@bio.auth.gr](mailto:PSEcon@bio.auth.gr)
- ✉ Dr. Manos Koutrakis, Associate Researcher in N.AG.RE.F. F.R.I., Nea Peramos, Kavala, Greece. Email: [manosk@inale.gr](mailto:manosk@inale.gr)
- ✉ Dr. Apostolos Apostolou, Institute of Zoology, Bulgarian Academy of Sciences, Sofia, Bulgaria. Email: [apostolosfish@abv.bg](mailto:apostolosfish@abv.bg)
- ✉ Dr. Millen Vassilev, Institute of Zoology, Bulgarian Academy of Sciences, Sofia, Bulgaria. Email: [m.vv@abv.bg](mailto:m.vv@abv.bg)
- ✉ Dr. Luchezar Pehlivanov, Central Laboratory of General Ecology, Bulgarian Academy of Sciences, Sofia, Bulgaria. Email: [lzp@abv.bg](mailto:lzp@abv.bg)
- ✉ Teodora Trichkova, Institute of Zoology of the Bulgarian Academy of Sciences, Sofia, Bulgaria. Email: [trichkova@gmail.com](mailto:trichkova@gmail.com)
- ✉ Dr. Angel Tsekov, Associate Professor at the Faculty of Biology, University of Plovdiv, Plovdiv, Bulgaria. Email: [a\\_tsekov@abv.bg](mailto:a_tsekov@abv.bg)
- ✉ Argyris Sapounidis, scientific collaborator of N.AG.RE.F. - F.R.I., Nea Peramos, Kavala, Greece. Email: [asapoun@inale.gr](mailto:asapoun@inale.gr)
- ✉ Panos Leontarakis, scientific collaborator of N.AG.RE.F. - F.R.I., Nea Peramos, Kavala, Greece. Email: [pleon@inale.gr](mailto:pleon@inale.gr)
- ✉ Dimitris Lachouvaris, scientific collaborator of N.AG.RE.F. F.R.I., Nea Peramos, Kavala, Greece. Email: [dimlach@inale.gr](mailto:dimlach@inale.gr)



- ✉ Dr. Georgios Sylaios, Associate Professor at the Department of Environmental, the School of Engineering, Democritus University of Thrace, Greece. Email: [gsylaios@env.duth.gr](mailto:gsylaios@env.duth.gr)
- ✉ Dr. Emil Bournaski, Institute of Water Problems, Bulgarian Academy of Science, Sofia, Bulgaria. Email: [burnanski@netscape.net](mailto:burnanski@netscape.net)

## Photographs

Photographs of the species were provided by Mr. Aris Christidis, scientific collaborator of NAGREF - FRI, Dr. A. Sediva, Institute of Animal Physiology and Genetics, Libechov, Czech Academy of Sciences, Dr. Manos Koutrakis, Associate Researcher in NAGREF-FRI Argyris Sapounidis, scientific collaborator of NAGREF-FRI and the Forestry Agency of Kavala.

The elaboration of the photographs was made by Mr. Aris Christidis

Cover photo: Nestos' Gorge (Forestry Agency of Kavala)

## Maps

The preparation of the maps was made by Dr Luchezar Pehlivanov and Argyris Sapounidis.

## Acknowledgments

The photos and designs used in the chapter “Key of the species” are credited to the following authors to whom contributors of this work address worm thanks:

- Figures: 1, 10, 11, 12, 14, 15, 16, 17, 18, 22, 23, 24, 25, 26  
Maitland P., 2000. *Guide to freshwater fish of Britain and Europe*. Octopus Publishing Group Limited, London, 256 p.
- Figures: 2, 3, 4, 5, 7, 8, 9, 13  
Holcik J., P. Banarescu & Diana Evans, 1989. General Introduction to Fishes. In: *The freshwater fishes of Europe*, Vol, 1, part II. (ed. J. Holcik): 18-147.
- Figures: 6, 19, 20, 21, 27  
Kottelat M. & J. Freyhof, 2007. *Handbook of European freshwater fishes*. Edition by M. Kottelat, Cornol, Switzerland and J. Freyhof, Berlin Germany. 646 p.

# A special Foreword

by

Panos S. ECONOMIDIS

**A little history.** In the district of Eastern Macedonia (Greece) and Macedonia of Pirin (Bulgaria), Nestos/Mesta is the second greater river, after Strymon/Struma, traditionally forming the recent frontiers between Macedonia and Thrace. It is well known that this territory, the lowland especially, was a field of perpetual conflicts through centuries among old and new inhabitants of the area. As always happens everywhere in the planet, same situation is known from the classical Antiquity we have to remind the famous civil battle between Romans in the nearby old Filippi. Before that, it is known (see Herodotus) that two main people were dominated in the area: Greeks colonists near coasts and Thracian tribes in the interior, from whom we have the name of the river (Nestos in Greek, Mesta in Bulgarian). Later some other people tribes arrived and settled around and finally after a fruitful, usually peaceful but sometimes blooded, amalgamation arisen two main people: modern Greeks and modern Bulgarians, actually both member-states of the great, almost Pan-European, Community.

**Collaboration for fish.** It is worthy to note that when scientists are charged to study a water catchment which - from biogeographical point of view -, is shared between two or more adjacent countries, it is strongly recommended to examine all

variety of habitats, including those which may belong to the other side. But this is not every time easy to be done given the suspicion appearing habitually among neighbors. From this point of view, there is, for example, not any valid aquatic *Fauna of Macedonia* unless the study of estuaries of this region. Therefore, collaboration is absolutely necessary for better presentation in the eyes of all informed people around World, which recognizes only natural frontiers for any biological range, as a fish or a bird do, and not national. Precisely, anyone can understand that without collaboration among Greece, Bulgaria and Turkey it is rather impossible to study and to protect the innocent giant fish living in the conjoint river Evros, e.g. the European sturgeon, which seems to be critically endangered in this river. Regarding freshwater fish, another particularity is that these creatures have a very close relation with the habitat of the watershed where they are isolated. Consequently, without checking these habitats, dispersed from estuary to up-stream, any representation of fish fauna is incomplete. In the level of Europe, where there are many international rivers, and under the pressure of the urgent necessity to outline and to apply measures for protection of any environment and of all included biodiversity, the study of entire river catchment is crucial.

**The river and the fish.** To another aspect, freshwater fishes have many particular ecological requirements (water regime and zonation, spawning grounds, nursery grounds, food availability, palaeo-faunistical relations, etc), which actually distressed by public works, oblige them to stay and to die in its proper "home". Only the group of the so-called migratory or diadromous fishes can move from- and to- the sea - sometimes entering other rivers but usually propagated to return by "homing" -, under the condition there are not dams or weirs prohibiting these movements. On the contrary, a land animal, as a bird, when disturbed can fly or displaced easily, very frequently far away, to another perhaps better position, while a freshwater fish do not in such a scale. Furthermore, in each independent water system is living a fish community which is always exclusive, never be exactly the same even in the closest

systems. For other animals, as water birds, the community frequenting in the Nestos estuary have not great differences among same environment in Vistonis or Strymon, the remote wetlands, as in Evros or in Pinios of Thessaly, included. In other words Nestos aquatic faunistic complex, including fish, is absolutely unique, and this increases greatly its environmental quality.

**The book.** Having in mind all the above, a group of specialists from Greece and Bulgaria accepted with enthusiasm the idea to make a book for the fishes of our conjoint river Nestos or Mesta. The idea maybe was good but its realization, lasting almost two years, was especially tiring even painful, fortunately, having the support of the local authorities, who admitted the project, Bulgarian and Greek scientists had many closest discussions aiming to outline the proper form and the content, which would make the book more appreciated and helpful by all informed citizens of both countries, including various administrations desks or environmental agencies and schools. One central point was to be presented the book in both languages, side by side, just to give an example of fruitful and sincere collaboration and to promote friendship.



Contributors of the Nestos Fish fauna book during a meeting for the progress of the work in the Fisheries Research Institute (NAGREF), Kavala, Greece. From left to right: Prof. P.S. Economidis, Prof. A. Tsekov, Dr. A. Apostolou, Dr. M. Koutrakis, Mr. A. Sapounidis, Dr. M. Vassilev, Mrs. T. Trichkova and Dr. L. Pehlivanov.

# Prologue

by  
M.T. ZIVKOV †

Fish always had great importance since humanity's rise. One could say that fishing is one of the most ancient human activities. Fish are one of the oldest branches of vertebrate animals and undoubtedly are of interest to scientists. Their aesthetic, medical, sports and psychological importance is also big. They give life and beauty in the natural and artificial water basins and also represent an important part of the circle of material in nature. The condition of fish stocks is an indicator of the ecosystem's health.

Although fish are an integral part of the surrounding world, only few people could recognize the different species inhabiting a certain basin, or know the details about their life cycle, except perhaps some scientists, nature-lovers and anglers. This fact is significant today, when so much is said and written about ecology and environmental protection, because it is hard to protect something unknown. There are many reasons for not knowing the fish. One of them is limited access to appropriate popular and

---

(†) Prof. Dr. Sci. Mladen Zivkov (†)(1941-2009), Director of the Institute of Zoology, of the Bulgarian Academy of Sciences passed away on on 6<sup>th</sup> January 2009. He was one of the most eminent and highly respected Bulgarian ichthyologists. He graduated as an ichthyologist from the Department of Biology, Faculty of Natural Science of Charles University in Prague, Czech Republic, in 1967. In 1981, he obtained PhD degree and in 1999 Doctor of Sciences (DSc) degree in Hydrobiology. Since 1967 he worked at the Institute of Zoology of the Bulgarian Academy of Sciences as a research scientist (1973-1984), Associate Professor (1984-2000) and Professor (since

scientific literature, with which even non-specialists could find and identify fish. This book -which describes the fish fauna from Mesta/Nestos River- is a try to combine these two seemingly contradictory goals: from one side to be in a necessary scientific level and from the other to provide comprehensive information for the public and thus it will be intelligible for nature-lovers, ecologists, anglers, fish-farmers, students and anyone else interested. The supplement of the species identification key, the color photos and the maps of distribution are imported for more clarity. Brief information on the main distinguishing features, biology and conservation status of species inhabiting River Mesta/Nestos are also included.

In this edition, the research results of several Bulgarian and Greek ichthyologists worked in this area, in the past and now have been used. This fact proves the successful international cooperation and good neighborly relations, which is one of the main goals of the book.

---

2000). Since 1994, Prof. Zivkov was the head of the Laboratory of Ichthyology and since 2000 the head of the Department of Hydrobiology. In the periods 1984-1993 and 1999-2003 he was the Secretary of the Institute's Scientific Council, and since August 2003 the Director of the Institute of Zoology.

His main research activities focused on diversity, faunistics and population biology and ecology of fresh water fishes. He studied different parameters related to growth, reproduction and feeding and developed methods to describe the relationships and regularities in population biological variability in fresh water fishes. His original scientific and methodological contributions have been widely applied in ichthyology, fish conservation biology, reservoir management, fishery, aquaculture, etc., and thus have helped the preservation and sustainable use of fish resources in the Bulgarian inland water bodies.

His expert work was highly valued both nationally and internationally. Prof. Zivkov was member of the National Scientific Coordination Council on Biodiversity, as well as of many other expert and scientific councils and commissions at the Bulgarian Academy of Sciences, Ministry of Environment and Water, National Agency of Fishery and Aquaculture, Ministry of Agriculture and Food Supply, Bulgarian Union of Hunters and Anglers, Institute of Fishery and Aquaculture Varna, Institute of Fishery and Aquaculture Plovdiv, Sofia University, Plovdiv University, etc.

Prof. Zivkov was much respected for his highly professional editorial work. Recently, he was the chief editor of "Fauna of Bulgaria", and member of the editorial boards of "Acta zoologica bulgarica" and "Ichthyologia" (Belgrade). He published many papers, books and monographs. He was also actively involved with teaching and training MSc and PhD students.

# The Nestos fish fauna project

by

**Manos KOUTRAKIS**

Scientific Responsible of the River Nestos'

Fish Fauna Research Project

Like most river systems, Nestos has undergone significant environmental changes, mainly due to human activities, which adversely affect the river ecosystem that alter habitats and differentiate qualitative and quantitative characteristics of the fish populations. These are: a) changes in the water quality of the river due to point and non-point pollution sources (urban, industrial and agricultural pollution), b) changes in the hydrological status of the system, with the construction of an irrigation in Toxotes (1966) and two hydroelectric dams in Thisavros and Platanovrisi (1996) in Greece and an irrigation dam in Dospat (1967) in Bulgaria that continually regulate the river flow. These constructions and also the numerous small dams and weirs in the tributaries of Nestos, however, prevent the movement of the fish species and the combination of all these human impacts leads to the deterioration of the habitat's quality and the gradual reduction and / or extinction of fish species



Nestos River close to Stavroupoli, Greece  
(Photo M. Koutrakis)





Platanovrysi dam on Nestos River  
(Photo M. Koutrakis)

populations.

The project “Management actions, protection and promotion of the Nestos River fish-fauna”, co-funded from the financial instrument INTERREG IIIA and carried out from the Hellenic Fisheries Research Institute (N.AG.RE.F.-FRI) under the auspices of the Prefectural Local Authority of Drama-Kavala-Xanthi consists of actions that contribute firstly to the knowledge and secondly the conservation of Nestos River fish species.

The final results of the project indicate that the fish fauna of Nestos River is characterized by a high biodiversity.

During the course of the project, in total, 20 freshwater fish species were identified in the Greek part of the river. Eleven of them are autochthonous ones, five are translocated from nearby systems, while the remaining four are alien. Most of the autochthonous species belong to the Cyprinidae family.

The Thracian barbel (*Barbus strumicae*) and the Thracian chub (*Squalius orpheus*) are the most common

species both in terms of abundance and in range density. Other species that live mostly upstream the dams are the Strymon spirlin (*Alburnoides strymonicus*), the Vardar nase (*Chondrostoma vardarense*) and the Aegean gudgeon (*Gobio bulgaricus*), while the Bitterling (*Rhodeus amarus*), the Thracian Spined loach (*Cobitis strumicae*) and the Strymon Stone loach (*Oxynoemacheilus bureschi*) live downstream the dams. The Nestos' Trout (*Salmo macedonicus*) is the only species that lives in high altitudes in the tributaries of Nestos.

The main species living in the two damlakes are the Roach (*Rutilus rutilus*) and the European perch (*Perca fluviatilis*), both not native. These are limnophile species that took advantage of the conversion of the river environment into a lake one and now boast large populations living mostly in the Thisavros damlake that receives most of the Nestos River's nutrients and sediments. Bleak (*Alburnus alburnus*) was also found in smaller abundance in the two lakes. The European perch (*P. fluviatilis*) along with the Common carp (*Cyprinus carpio*) and the Vardar nase (*C. vardarensis*) are the main commercial species of a small-scale fishing activity practiced in the area. Also, in the runoff channels of the Nestos estuary live the Eel (*Anguilla anguilla*) and the Sun bleak (*Leucaspis delineatus*).

In the river there actually are living some real alien species as it is the American native Rainbow trout (*Oncorhynchus mykiss*), Pumpkinseed (*Lepomis gibbosus*) and Eastern Mosquitofish (*Gambusia holbrooki*), and the Asian the Pseudorasbora or False raspora (*Pseudorasbora parva*). The "wild" population of Rainbow trout in the river actually is originating either from stocking of juvenile fish or escapes from the broader area's trout culture, the Pumpkinseed was most likely introduced accidentally or intentionally, probably in the Bulgarian part of the river and the Eastern mosquitofish was also introduced in the peatlands to combat mosquitoes, in the beginning of the century (1930). The presence of false raspora is a real mystery as it is for many rivers and lakes over European watersheds where this species appeared suddenly for unknown reasons. In any case it causes negative ecological effects.



Fish sampling in Nestos/Mesta River  
using an electrofishing device  
(from left to right Mr. D. Lachouvaris  
and Mr. P. Leontarakis) (Photo M. Koutrakis)

The results of the river Nestos/Mesta research project, along with the data provided by the Bulgarian colleagues, were widely used in the writing of this edition and have allowed for a detailed description of the river Nestos/Mesta fish species.

# The transboundary Nestos / Mesta River: An overview on hydrology and environment

by  
Georgios SYLAIOS and Emil BOURNASKI

## 1. General Description

Nestos/Mesta river is one of the 71 internationally shared river catchments of Europe (Wolf *et al.*, 1999), thus providing means for transboundary co-operation, resolving local conflicts and tensions and promoting administrative, technical and scientific collaboration, leading ultimately towards its effective water management (Mylopoulos *et al.*, 2007). In terms of the Water Framework Directive 2000/60/EC (Annex XIA), Nestos/Mesta river is located in the eco-region 7 (Eastern Balkans).

Nestos/Mesta river has its source in Rila Mountains (southwestern Bulgaria), the highest mountain range of the Balkans with its highest peak at an altitude of 2,925 m. In this northern part of Mesta basin, a significant number of small-to-medium sized lakes supply the initial streams and torrents of the river. Further downstream, the confluence of Bjala Mesta and Cherna Mesta streams near the town of Yakorouda is accepted as the origin of the Nestos/Mesta river. The valley of the river in Bulgaria is confined between the Pirin Mountain in the West, the Rila Mountain in the North and the Rhodopi in the East (Fig. 1).

The river drains an area of 5,613 km<sup>2</sup>, of which 2,768 km<sup>2</sup> (or 49.34% of the total basin) belong to Bulgaria, while 2,843 km<sup>2</sup> (or 50.66% of the total basin) is located in



Figure 1. The Balkan river drainages (Skoulikaris 2008).



Nestos River outflow in the Thracian Sea  
(Photo: Forest Service of Kavala)

Greece (Ganoulis *et al.*, 2008) (Fig. 2). The Bulgarian part, known as Mesta river, has a length of 126 km, while the Greek part, known as Nestos river, has a length of 130 km. Nestos River outflows in the Thracian Sea, part of the North Aegean continental shelf. The relief in the whole drainage basin is mountainous and semi-mountainous, apart from the Delta area where a floodplain is formed covering 440 km<sup>2</sup>.

Population density in the drainage basin is low (33 inhabitants per km<sup>2</sup>), but highly variable (130,000 inhabitants or 47 inhabitants per km<sup>2</sup> in Bulgarian part and only 42,000 inhabitants or 15 inhabitants per km<sup>2</sup> in the Greek part). The largest towns in the watershed are: Razlog (12,600), Gotse Delchev (20,500) and Bansko

(9,500) in Bulgaria, and Chrisoupolis (8,500) in Greece. The leading economic sector in the River Basin is the primary sector/ agriculture. Production of energy, industry and tourism are also important economic activities (Darakas, 2002).

## 2. Geological Overview

Geologically the wider area of the basin belongs to the geotectonic zone of Rhodope and is formed from very old metamorphic rocks, mainly of gneisses and schists with marble intercalations, where granite penetrations and volcanic outflows are encountered (Zagorchev, 2007) (Fig. 3). In Bulgaria the river flows through a valley of granite geology (the granite surface cover 62% of the total basin), until it reaches the Rhodopi mountain chain, where it crosses the border between Bulgaria and Greece (Choleev & Baltakov, 1989). The Rhodope massif of southern Bulgaria and northern Greece is a rugged mountainous terrain of Precambrian and early Paleozoic

crystalline rocks. It is a fragment of a once much larger crustal block that began to break up in the Paleozoic and which has experienced uplift of 2,000 m in the Pliocene-Pleistocene. Two glaciations seem to have taken place in the mountainous part of the basin, leading to the partial crushings of the granite peaks and the formation of beautiful alpine edges, moraine fields and vertical cliffs.

After the borders the river continues to flow on metamorphic rocks (gneisses,



**Figure 2.** The transboundary catchment basin of Nestos/Mesta River.



Nestos Gorge (Photo: Forest Service of Kavala)



schists), until Paschalia area. The area from Paschalia to Toxotes consists mainly of karstified marbles (part of the karst area of Lekani Mountains), where the impressive "Nestos Gorges" are formed. Therefore, the narrow valley between Stavroupoli and Toxotes is characterized by the presence of steep slopes and meanders. Regarding the area of the Nestos delta, it is considered as the only part of the basin belonging to the tertiary geological period of Prinos Nestos (Xeidakis & Delimani, 2002). During the Quaternary geological period, the Delta region was subjected to tectonic subsidence of about 100 m.

### 3. Land Uses

#### & Economic Activities

The Mesta basin is mountainous, mostly covered by forests (60%), and therefore

forestry is the most important economic activity taking place in the watershed. Part of the territory, especially the high mountain areas and the headwaters, are included in the two National Parks of Rila Mountains and of Pirin Mountains. The latter is listed by UNESCO as a world natural heritage site. Arable land areas (20%) are located mostly along the stream channel and in the well irrigated southern part of the Bulgarian stretch (Nevrokopsko field). The dominating cultures are tobacco, potatoes, vegetables, corn, and grain. The agriculture is estimated as extensive, almost organic, with



**Figure 3.** Geological patterns in the Nestos/Mesta river basin.

application mostly of manure instead of synthetic chemicals (fertilizers, pesticides). Cattle breeding are also very important for local people, located in small farms, where wild grazing on hills and natural meadows is the most popular practice. Industrial activities follow a decline within the latest decades. There are, however, many small to medium enterprises manufacturing paper, card-board, textile, wood materials and furniture. In the Greek part of the basin, agriculture is concentrated at the Nestos Delta area (440 km<sup>2</sup>) (Fig. 4). The main crops produced in the delta region are cereals, rice, tobacco, sugar beet, asparagus and kiwifruit. The area is included in the Ramsar Convention as an internationally important wetland complex (Gerakis and Kalburtji, 1998). In this area several natural water bodies exist as small lakes, salt and coastal lagoons, covering 1.3% of the basin, in which fish farming takes place. Finally, urban areas cover only 1.0% of land use in the catchment area.

#### **4. The Legislative Framework for River Basin Management**

The Mesta/Nestos river is the most important water resource in this region and has been the subject of bilateral negotiations for many years. The negotiations between the two countries on water allocation started in 1964, when the first agreement upon a governmental level was signed regarding the common management of the water resources of the Nestos/Mesta transboundary river. This agreement was followed up by more meetings in 1975, 1982, 1988 and 1991, leading to the latest signed in 1995, stating as Greece's rights to the water of Nestos the 29% of the total volume that is generated in the Bulgarian territories, under the provision that the total volume will be updated every seven years. A critical issue of the agreement in question is the establishment of



Mesta River near Hadjidimovo, Bulgaria  
(Photo: Luchezar Pehlivanov)



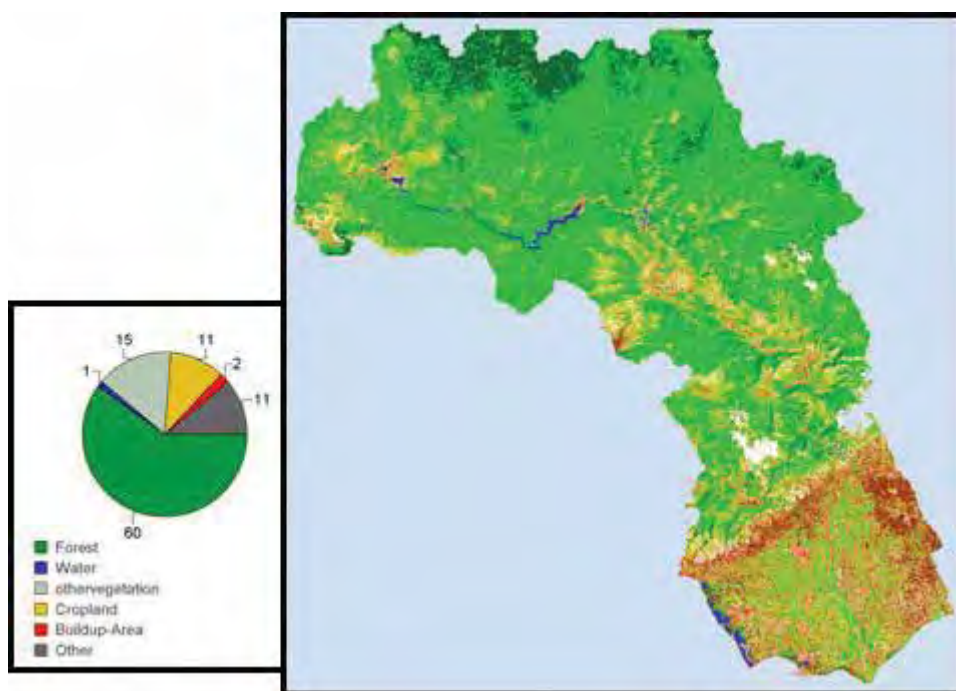


Mesta River near Gotse Delchev, Bulgaria  
(Photo: Teodora Trichkova)

a Permanent GreekBulgarian Hydro-economic Committee, in order to inspect and monitor that the agreement in question will be always implemented. Nevertheless, this agreement has not yet been enforced, due to the lack of financial resources and the weakness and reluctance of local authorities to move towards its implementation (Mylopoulos *et al.*

2004).

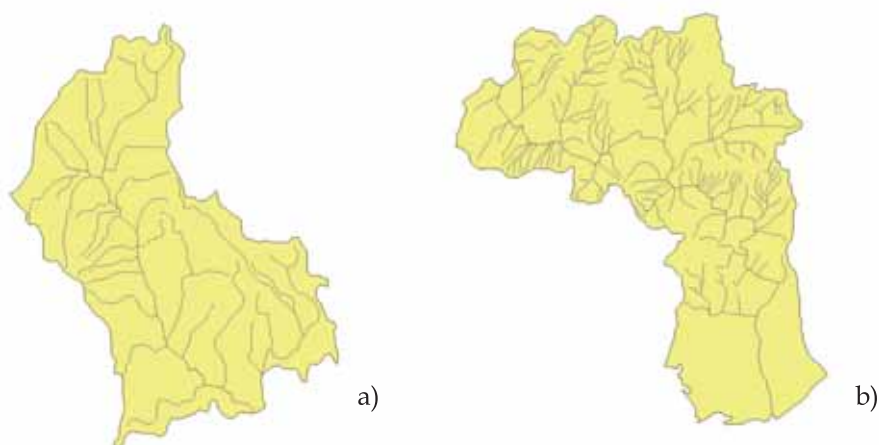
The administrative body regarding the cooperation between Greece and Bulgaria for the Nestos/Mesta region is mainly composed by the Joint Administrative Council which is related to the joint planning of the activities of the two countries at international level, and the Joint Working Groups which deal with the implementation of additional activities of the wider riparian area (Kallioras *et al.*, 2006). The establishment of a Nestos/Mesta Euroregion as a non-governmental organization between Greece and Bulgaria could lead to a successful example of cross-border co-operation (Ivanova, 2001). In December 2005, an agreement was established between the European Communities and their Member States, of the one part, and the Republic of Bulgaria, of the other part. By this agreement a common monitoring system of water quantity and quality should be developed, aiming towards the pollution levels reduction, the establishment of floods warning system, the promotion of efforts against soil erosion, the effective protection of riparian flora and fauna and the rational use of the water resources. Overall, it can be observed that both countries tend to ratify international agreements regarding the management of the river basin but they fail to put this agreement in practice.



**Figure 4.** Land uses in Nestos/Mesta watershed (CORINE Land Cover).

## 5. River Hydrology

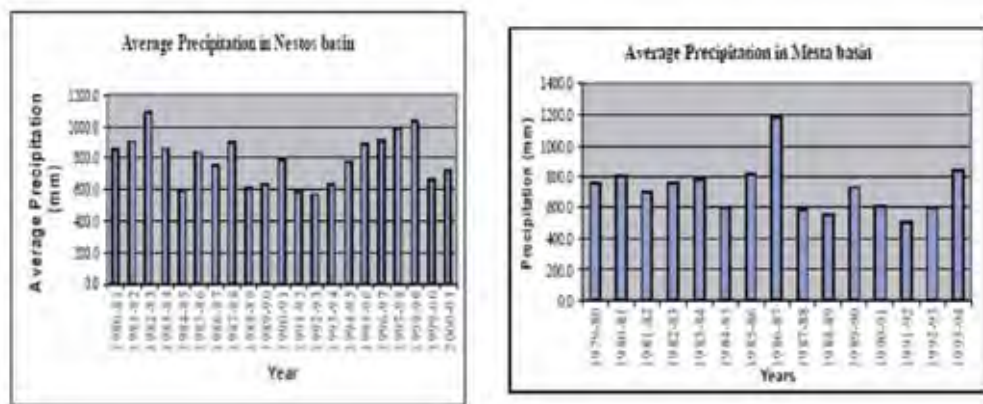
The Mesta River catchment area is a part of the region that experiences the influence of the European continental climate over the river flow. The southern-most part of the river valley serves as a corridor for the Mediterranean climate (Diadovski *et al.*, 2007). In the Bulgarian part, the Mesta River has 25 tributaries, 9 of them are considered as first order, as they supply large water quantities. The biggest is Dospatska or Dospat River, with a catchment area of 680 km<sup>2</sup>, which flows into Mesta in the Greek territory. In the Greek part, the Nestos River is supplied by 18 tributaries, with Arkoudorema, Diavolorema and Musdarema being the most important. The total catchment area of the above Nestos / Mesta tributaries is 1,350 km<sup>2</sup> (Darakas, 2002) (Fig. 5).



**Figure 5.** Hydrological network of  
a) the Bulgarian part and b) the Greek part of the Nestos / Mesta River basin.

The water quantity of the Mesta River is controlled at 22 hydrometric stations: five of them along the Mesta River and the rest 17 stations along the river tributaries (Ivanov *et al.*, 2004). From the above stations, only one gauging station (station code number 52800) recorded the longest data from hydrological years 1935-36 to 1994-95 and presently. For the other Bulgarian gauging stations, measurements have been made obtained for the period 1950-51 to 1994-95 and have been extrapolated to 60 years (Mimides *et al.*, 2007). In the Greek part, systematic rainfall data for the period 1964-1998 were collected by 16 stations, most of which were located at the northern mountainous part of the basin. Water discharge was measured at 6 stations from 1996 to presently (property of Public Electricity Corporation) and by 5 newly installed stations operating in the Stavroupolis to Delta area by various organizations (Ministry of Agriculture, Democritus University of Thrace, East Macedonia & Thrace, Regional Authority, etc.).

Two typical periods for the river flow formation are determined: a period of winter-spring (high water) and a period of summer-autumn (low water). In the Bulgarian part mean annual precipitation reached 810 mm/year, while in the Greek part 790 mm/year (Fig. 6). The past estimated mean runoff of the Mesta/Nestos



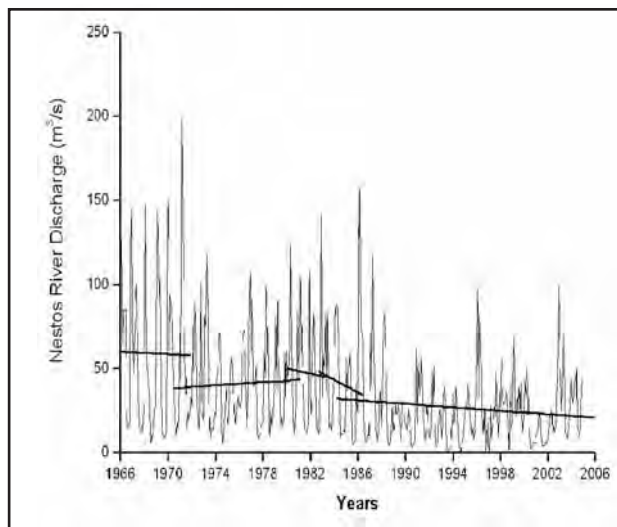
**Figure 6.** Mean annual precipitation at  
a) the Greek part and b) the Bulgarian part of the basin (Skoulidakis 2008).

River is 20 to 30 m<sup>3</sup>/s and the annual discharge 1,120 Mm<sup>3</sup> (Ganoulis *et al.*, 2008).

More specifically, the mean pre-damming annual discharge at the site Temenos during the period 1966-2006 was 39.7 m<sup>3</sup>/s, characterized by a strong seasonal and inter-decadal variability. The maximum mean annual discharge was observed in year 1996 as 75.48 m<sup>3</sup>/s (annual runoff 2,380 × 10<sup>6</sup> m<sup>3</sup>), while a minimum mean annual discharge of 15 m<sup>3</sup>/s (annual runoff 473.5 × 10<sup>6</sup> m<sup>3</sup>) was recorded in 1993. Analysis of the water discharge time-series recorded at the border station Delta shows that it may be divided into five parts (generations) due to changes in series trends (Koutroumanides *et al.*, 2009). The first period covers the period from January 1966 to May 1971, with a mean annual discharge of 36.4 m<sup>3</sup>/s and a total annual runoff of 1,132 × 10<sup>6</sup> m<sup>3</sup>/yr. During the second period (from June 1971 to April 1980) a 21.8% reduction in the total annual runoff was observed, but the generation trend is positive. Indeed, Nestos River discharge increases slightly during the third period (from May 1980 to December 1982) to the level of 29.6 m<sup>3</sup>/s. A significant reduction in Nestos River discharge was recorded during the last period from January 1983 to January 1986 to 22.3 m<sup>3</sup>/s, depicting a strongly negative trend. Finally, mean monthly discharge reached 17.7 m<sup>3</sup>/s corresponding to a total annual surface runoff of only 552 × 10<sup>6</sup> m<sup>3</sup>/yr, almost half compared to the first runoff period (Table 1, Fig. 7).

**Table 1.** Hydrologic characteristics of the five generations defined in the Nestos River discharge time-series.

| Generation | Time Period                   | Mean Annual Discharge (m <sup>3</sup> /s) | Total Annual Runoff (10 <sup>6</sup> m <sup>3</sup> /yr) | Mean Daily Runoff (10 <sup>3</sup> m <sup>3</sup> /d) | Annual Runoff Change from Generation 1 |
|------------|-------------------------------|-------------------------------------------|----------------------------------------------------------|-------------------------------------------------------|----------------------------------------|
| 1          | January 1966 - May 1971       | 36.41                                     | 1,132                                                    | 3,102.36                                              | 0.00%                                  |
| 2          | June 1971 - April 1980        | 28.47                                     | 886                                                      | 2,426.30                                              | -21.79%                                |
| 3          | May 1980 - December 1982      | 29.59                                     | 920                                                      | 2,521.34                                              | -18.73%                                |
| 4          | January 1983 - January 1986   | 22.31                                     | 694                                                      | 1,900.89                                              | -38.73%                                |
| 5          | February 1986 - December 2004 | 17.76                                     | 552                                                      | 1,513.50                                              | -51.21%                                |



**Figure 7.**  
Nestos River discharge time-series and trends defined for each generation.

## 6. Mesta/Nestos Water Uses

The water of Mesta River in Bulgaria is mainly used for irrigation, domestic use, fishery, tourism, waste disposal and slightly for energy production. On the other hand, the water of River Nestos in Greece is used for energy production, irrigation,

domestic use, fishery, waste disposal and tourism purposes.

The water use for energy production in Bulgaria is limited (Bournaski & Ivanov, 2003). Three small (less than 1.5 MW) hydro-power stations exist in Mesta basin (Yakoruda, Razlog and Toplika), and some new are under construction. Extensive water use for energy production takes place in Greece. During the last decade of the 20th century, the Public Electricity Corporation (DEH) constructed and operates since 1996 the multipurpose dams of Thessaurus and Platanovrysi. Their characteristics are presented in Table 2.

**Table 2.** Descriptive data of Thissavros and Platanovrysi reservoirs.

|                                                   | Thissavros | Platanovrysi |
|---------------------------------------------------|------------|--------------|
| Mean Width (m)                                    | 200        | 200          |
| Mean Depth (m)                                    | 40         | 15           |
| Highest Operational Stage from Mean Sea Level (m) | +380       | +227.5       |
| Lowest Operational Stage from Mean Sea Level (m)  | +320       | +195         |
| Volume in HOS ( $10^6 \text{ m}^3$ )              | 705        | 73           |
| Volume in LOS ( $10^6 \text{ m}^3$ )              | 135        | 16           |
| Reservoir Area in HOS ( $\text{km}^2$ )           | 18         | 3            |
| Maximum annual stage fluctuation (m)              | 30         | 2            |

On the Bulgarian drainage basin of Mesta, the dam of Despat constructed and operated well before the dams of the Hellenic side (Stoichev, 1989). This dam and other canals divert approximately  $164 \times 10^6 \text{ m}^3$  (by project data) towards the Maritsa basin (Ivanov *et al.*, 2004). All the above dams provide hydroelectric power, water for irrigation and anti-flooding protection of the basin lowlands and the deltaic plain.

In terms of irrigation, it occurs that along the Mesta/Nestos River four extensive irrigation networks have been developed (2 in Bulgaria and 2 in Greece), aiming to supply with water the adjacent cultivations. In the Bulgarian part, approximately  $50 \times 10^6 \text{ m}^3$  are abstracted from Mesta/Nestos river, to cover the irrigational needs for 18,600 ha of cultivated land (Ivanov *et al.*, 2004). In the Greek part the total arable land reaches  $142 \text{ km}^2$  of which  $131 \text{ km}^2$  are located at the deltaic area of the river and only 11



km<sup>2</sup> are situated at its central and northern part. Their total annual water demands exceed the level of 200 million m<sup>3</sup>.

In Bulgaria, in terms of domestic water use, approximately  $5.2 \times 10^6$  m<sup>3</sup> per year are abstracted to cover human consumption utilizing surface (56%) and groundwater resources (34%). In the Greek part of the basin, domestic water use of  $5 \times 10^6$  m<sup>3</sup> per year is supplied by the kartsic springs at the southern part of Lekani marbles, where the springs of Paradeisos and Stratones exist.

Industrial activities abstract water of the order of  $3.8 \times 10^6$  m<sup>3</sup> per year, especially at the towns of Razlog and Belitsa.

## **7. Pollution Sources and Water Quality**

Mesta River has been systematically monitored by the Bulgarian Authorities for the last 35 years, due to the organic pollution caused by yeast, cellulose and cardboard manufacturing in the town of Razlog. The industrial wastewater production exceeded 90,000 m<sup>3</sup> per day; the average daily levels of BOD<sub>5</sub> varied between 300-450 mg O<sub>2</sub>/dm<sup>3</sup>. Such an unfavourable ecological situation remained until 1990, when the operation of the plants – sources of great pollution, was banned by the respective authorities. Immediately, rapid improvements of the water quality and recovery of the affected ecosystem were registered. By this way, the developments of the ecological status of the Mesta River could be defined in two large periods: until 1990, the period of heavy loading with organic matter of industrial origin, and after 1990, the period of recovery and stabilization of the ecological situation.

In the Greek part of the hydrolithological basin the pollution phenomena are less intensive, as a result of the reduced agricultural activities in Bulgaria, especially after 1991 (Karakatsoulis *et al.*, 1998). In terms of point pollution sources, large towns of the area as Chrisoupolis, Stavroupoli and Paranesti lack of central sewerage systems followed by wastewater treatment plants (Darakas, 2002). Since there are no treatment plants, the Nestos River is the final receiver of untreated wastewater. The rest of the villages are served by private cesspools which are mainly drain tanks,



polluting the groundwater and consequently causing indirect pollution to the Nestos River.

The contribution of the non pointed pollutants, which form along the river from the Greek - Bulgarian border to Toxotes, is considered small. The only exception is the Delta area, where a big intensification of agriculture is taking place, with the simultaneous increase of nutrient, salts and eutrophication. The extensive drainage system of ditches and embankments associated with the re-arrangement of the riverbed, leads to the decline of the water quality and the recharge rate of the groundwater, rendering seawater's intrusion into the aquifers unavoidable.

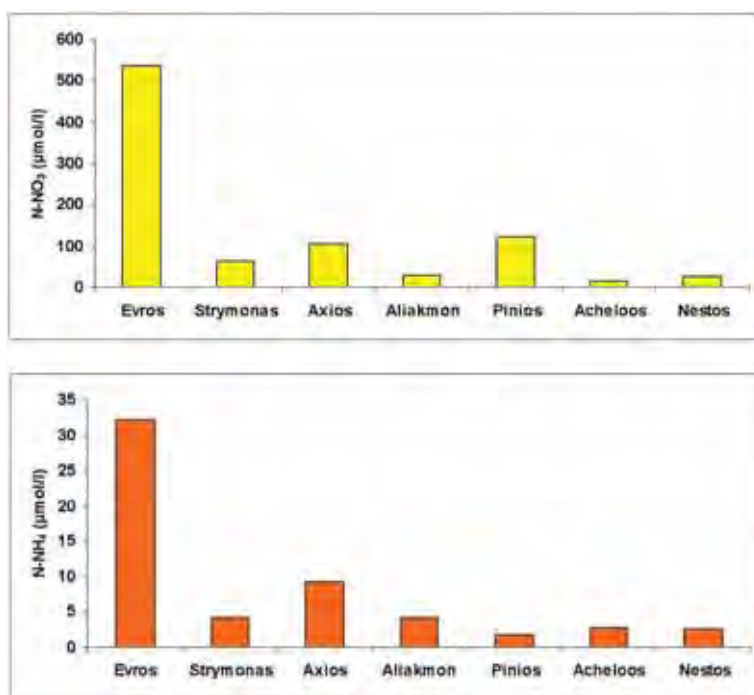
The point and non-point pollution sources located at the drainage basin of Mesta-Nestos River affecting its water quality are shown in Table 3 (Darakas, 2002).

**Table 3.** Pollution influence in Mesta/Nestos River basin.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Mesta River basin</p> <p>Mainly Wastewater (treateduntreated) from various activities such as:</p> <ul style="list-style-type: none"> <li>• small towns (Raslog, Bansko, Yakoruda, Belitza, Gotze Deltchev, Dospat),</li> <li>• villages (Banja, Eleshnitza, Hadjidimovo, Baroutin),</li> <li>• tourist bases (Vihren, Banderitza, Shiligarnitza, Damjanitza, Bezbog, Popina Laka),</li> <li>• resorts (Semkovo, Dospat Dam),</li> <li>• industrial areas (the towns and villages given above plus Uranium mining and the ore enrichment plant at the Eleshnitza village),</li> <li>• drainage ditches.</li> </ul> | <p>Nestos River basin</p> <p>Mainly sewage (treated-untreated) and wastewater from agricultural and industrial activities from:</p> <ul style="list-style-type: none"> <li>• small towns (Chrisoupolis, Paranesti &amp; Stavroupolis) and villages discharging into the Nestos River and its tributaries,</li> <li>• the few industries and small handicraft practices located in the catchment area.</li> <li>• The drainage ditches which receive, along with storm water, residues of pesticides and fertilizers.</li> </ul> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Overall, the Mesta River is regarded as one of the most natural streams found in Southern Europe, with minor disturbances of its hydro-morphology and moderate impacts from humans like water pollution, eutrophication, soil erosion, etc (NATURNET-REDIME, 2006). Water quality data indicated that Nestos River is characterised by low nutrient levels in comparison to other major Greek Rivers (Fig. 8). Some organophosphorous insecticides and herbicides were detected in Nestos River at low to moderate levels (Lekkas *et al.*, 2004).

Besides local pressures and impacts the river system is affected by, there are evidences of gradual decreasing of total water discharge following global changes and the aridity trend of the regions, especially in its southern sectors of the basin and watercourse.



**Figure 8.** Nestos river nutrients (A: nitrate and B: ammonium concentrations) in comparison to the water quality of other Greek Rivers (data for Nestos from the Fish Fauna Research Project of Nestos, Koutrakis *et al.*, 2009 and for the other rivers from Skoulikidis *et al.*, 1998).

# The Fishes

## An Introduction to the Study

by  
**Panos S. ECONOMIDIS,**  
**Milen VASSILEV & Manos KOUTRAKIS**

In this chapter some basic information on different aspects of fish systematics, biology, ecology and conservation for better use of the book are given. The identification and the recognition of a fish species is an essential action based to a set of characters, mainly morphological but also anatomical. The biology and the ecology of the fish contribute essentially to the better understanding of their life while the conservation emphasizes the importance for humans and for their own protection.

### **Definition and Nomenclature**

The Ichthyology is commonly defined as “the study of fish” or “that branch of zoology dealing with fish”. It has a long documented history, dating thousands of years back to the ancient times, mainly in China. In the Western Science, however, traditionally Aristotle (384-322 B.C.) is considered the "father" also of the Ichthyology, since he gave valid information about anatomy and behavior of fish and many common names as well (silouros, kolias, sparos, smariss, etc.). Before Aristotle for most of peoples fish was something which should be fished and eat (Balon & Noakes, 1980)

This long, sustained interest in fish is due to their double role as highly specious denizens of a fascinating, yet alien world, and as human food. It has generated, over

the centuries, highly heterogeneous information mainly taxonomic, but also referring to zoogeography, behavior, feeding, prey-predator relationships, environmental tolerance and adaptation, etc. The shape and the other morphological features of the body, as proportions and size relationships, are among the key characteristics used to date for classifying fishes, and hence understanding their basic overview and basic form requires.

It is well known that the notion of “species” is fundamental in Biology but it is also extremely difficult to be traced, in spite that people recognizes easy what exactly that means, when can separate easy a Carp from a Chub. Since species is the most essential rank of biological classification, naming any of them is a very important process for better comprehension of hierarchy. For technical point of view, after 1758 is followed the model proposed by Linnaeus in the 10<sup>th</sup> edition of his monumental book “Systema Naturae”. Wherein the species is defined by a so-called *binomen* consisting of a *unique* genus name, always starting with a capital letter, and a *species epithet*, which is *never* capitalized, for example, the Linnaean name *Salmo trutta* is the widely well known scientific name of Brown trout, a very popular fish in the upstream running freshwater. This scientific name has the great advantage to be the unique valid in all languages around world, a fact which facilitate science and social activity (commerce, education, etc.).

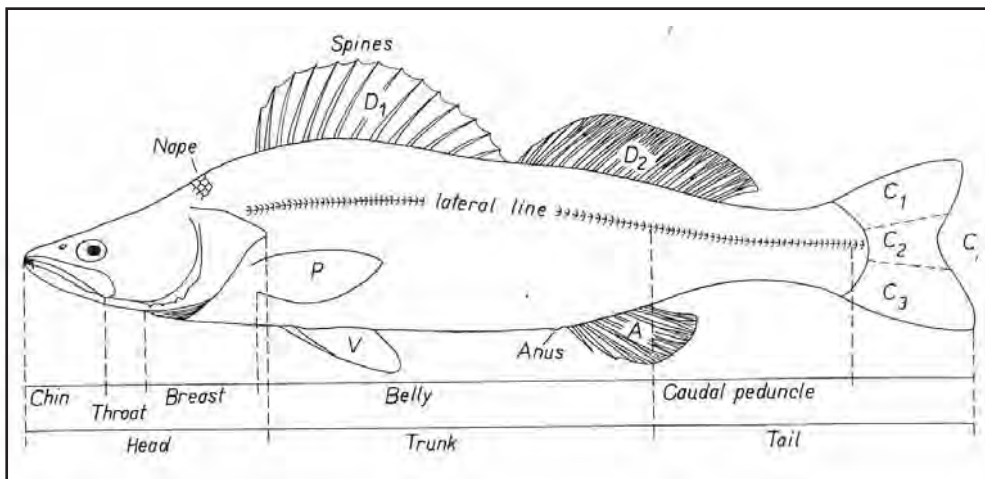
### **Diversity**

Fish are present as fossil records since the Devonian period, between 400-350 million years ago, but it is almost sure their first primitive forms appeared earlier in the ancient water of the Planet. Regarding their diversity, actually according to Nelson (2006) at present approximately 62 orders, 515 families, and just 27977 valid fish species are described. However, this number is growing fast and this is related to the fact that many habitats, where live fish, as in the deep of oceans and in the remote and/or isolated permanent fresh water species are still almost undiscovered. The latter estimates, however, will probably never be accurate because many species

are becoming extinct in some areas. Regarding the highest observed biodiversity actinopterygians, or ray-finned fishes, are the largest and the most specious group of contemporary fishes and make up almost half of all living vertebrates.

## Morphology

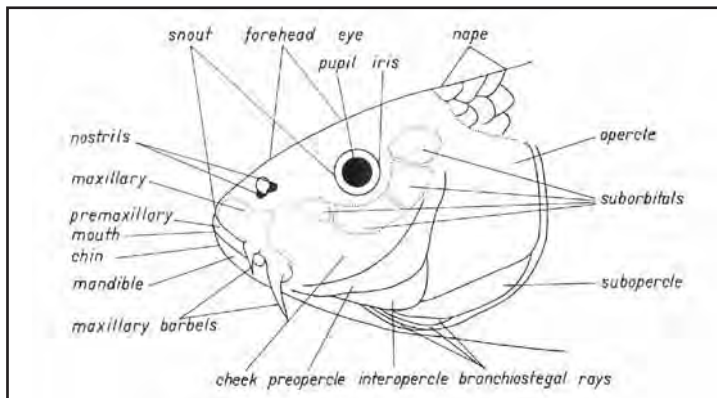
The external features of a fish are considered the shape and characteristics of the *body* and the *head*, the *fins*, the *scales* and the *color pattern*.



**Figure 9.** Diagram of fish morphology (Holcik *et al.* 1989).

**The body and the head.** In spite of the great variety of body shape in fishes, the most popular and well defined is the hydrodynamic *fusiform*, which is easily recognized as the "classical" fish body form. This is normally covered by *scales* and propel in the water by *fins* (**Fig. 9**). The body of a fish can be divided in three parts: the *head*, the *trunk* and the *tail*. In the head (**Fig. 10**) of a bony fish, from the tip of *snout* to the *gill slits*, is easy to observe the *mouth*, which could be *terminal*, *superior* or *inferior* bounded by the *maxilla* or *maxillary* and *premaxillary bones* (upper) and *mandibula* or *mandible* (lower) jaws, whom the shape and the proportional size are essential characters. Also, the *eyes* (with *iris* and *pupil*), the *nostrils*, and the *gill opening* or *gill slit*, backward to the

eyes. There is formed the *branchial cavity* covered by *operculum* or *opercle* (composed by *preopercle*, *interopercle*, *subopercle*). In the operculum very often are developed *spines*. In the head there are also some other areas or formations which are important for the recognition of the species and bearing special names as it is: the *cheeks*, in the sides of the head, the *chin* down the mouth, the *nape* the dorsal area behind the head, the *barbels* (if exist) and the *branchiostegal rays* behind and down; also there are the bones down and behind the eye which are calling *suborbitals* (**Fig. 10**).



**Figure 10.**  
The structure  
of the fish head  
(after Holcik *et al.* 1989)

**The fins.** In the trunk, ending in the *anus* opening, are laid the fins symbolized by the initial letter as: the *dorsal* (D), the *pectorals* (P) and the *ventrals* (V) - sometimes called *pelvics* -, while in the tail are located the *anal* (A) and the *caudal* (C) fins (**Fig. 9**). The free margin of this last appeared with various types as: *rounded*, *truncate*, *emarginated*, *forked*. Any fin is supported by *rays* which are qualified as *hard* or *spines* which are ossified and *smooth* or *serrated*, being furthermore *unbranched* and *branched* (**Fig. 11**). The number of fins rays is an important taxonomic character for any fish species and is presented as formula: D ii-iii/a-b, A i-ii/c-d, etc. which means: the dorsal fin has ii (=2) to iii (=3) unbranched or hard rays or spines and a to b branched. The same is valid also for the other fins. Except the number of the fin rays, the absolute and the related size and other characteristics of them are also used for recognition of fishes.

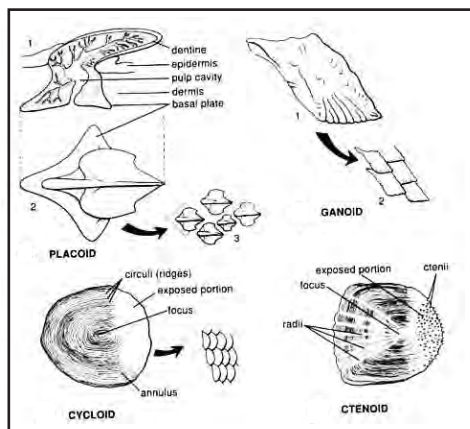
**The scales.** In the body and in the fleshy part of the tail and rarely in the upper part and the cheeks of the head, are observed the *scales*, which could be missing totally in





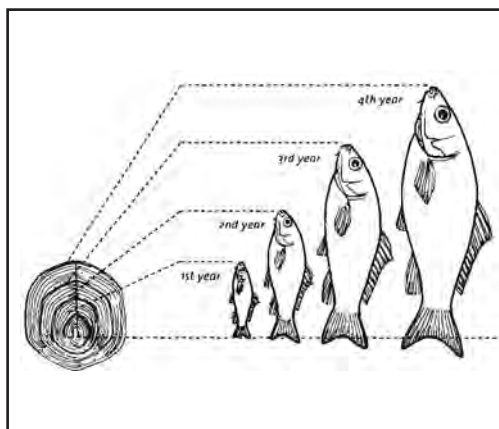
Furthermore, the *elasmoid* scales are presented in the modern fishes under two forms: the *ctenoid*, having small denticles, in the free margin, like a comb, and the *cycloid*, without these denticles (Fig. 13). The scales can be used successfully in the biology of fish for *determination of the age* because their yearly annuli are formed as the same annuli in a tree trunk (Fig. 14).

**The color.** The body of most fish is decorated and in several cases, as coral reefs, the colors are exceptionally brisk. In the biology of species this characteristic is very important for camouflage and as territoriality signs. Practically, colors also used for the identification of species, especially when they are stable in both sexes and are not affected seriously by the age and the habitat. However, there are also keys for the distinction of the color of juveniles or of male and/or female and those of various habitats, although the color identification depends on the personal estimation and the experience. For the different color patterns that appears in the males and in the females (sexual dimorphism), there are very important behavioral approaches, the reveal of which needs direct observations in the nature or in the aquarium. In general, colors are owed to the various migrating epithelial cells, the *chromatophores*



**Figure 13.**

Various types of scales  
(after Bond, 1996 )



**Figure 14.**

Scales and age  
(after Maitland, 2000)

(Fig. 15). There is a *color pattern* for each species, which should be analyzed if it is *homogenous* or not, if there are or not regular colored *spots* or *blotches* or *bands* or *zones* or *lines*, everywhere in the head, in the body and in the fins. Fortunately, the freshwater fishes of the temperate zone, where Nestos/Mesta belongs, are rather poor in colors having not special difficulties to be described. In any case, it is recommended to register in a notebook, eventually by the help of a colored key or to be photographed, the color pattern of a fish when is still alive or just dead, because colors alter quickly soon after. This is the ideal approach. However, the description or picturing of the colors must be given also for preserved (in the museum jars) specimens, just mentioning "colors in preserved specimen are...."

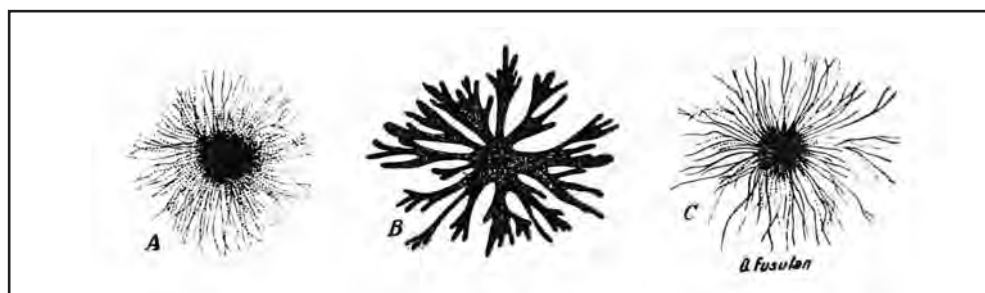
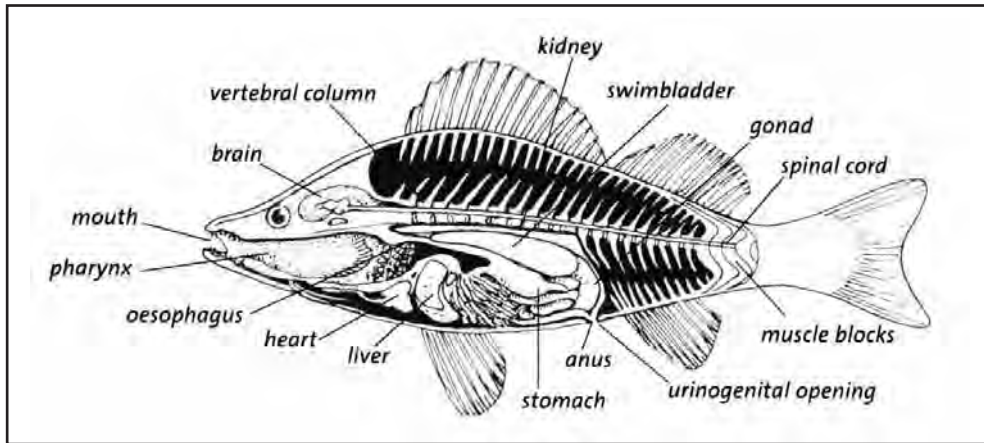


Figure 15. Chromatophores (after Banarescu, 1964)

### Anatomy

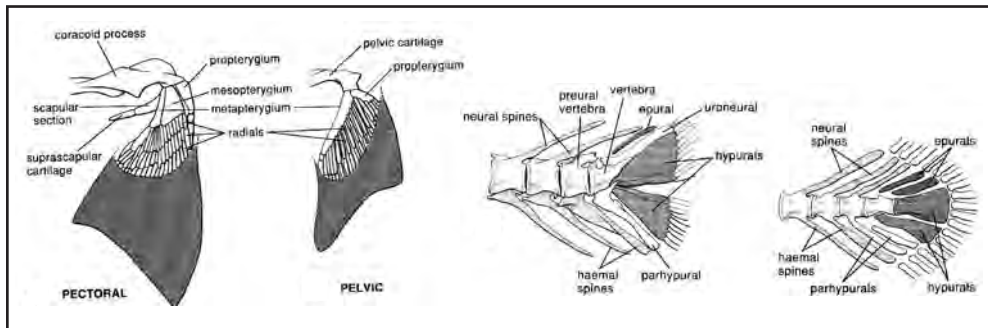
In the body of the fish are included all the fundamental internal organs, as in any other vertebrate (Fig. 16).

*The skeleton* which is divided in three part: the head, with *neurocranium* covering and lodging the *brain* (Fig. 16) and the *splachnocranium* supporting *jaws* and *brachial arches*, the *back bone* or *vertebral column* (Fig. 16) derivate from the primitive *notochord* and composing by *vertebrae* of various shape according to the place and to the species and the *skeleton of girdles* supporting paired fins (*pectorals* and *ventrals* or *pelvics*). Unpaired fins (*dorsal*, *anal* and *caudal*) are supported by *basal elements* to the back bone,



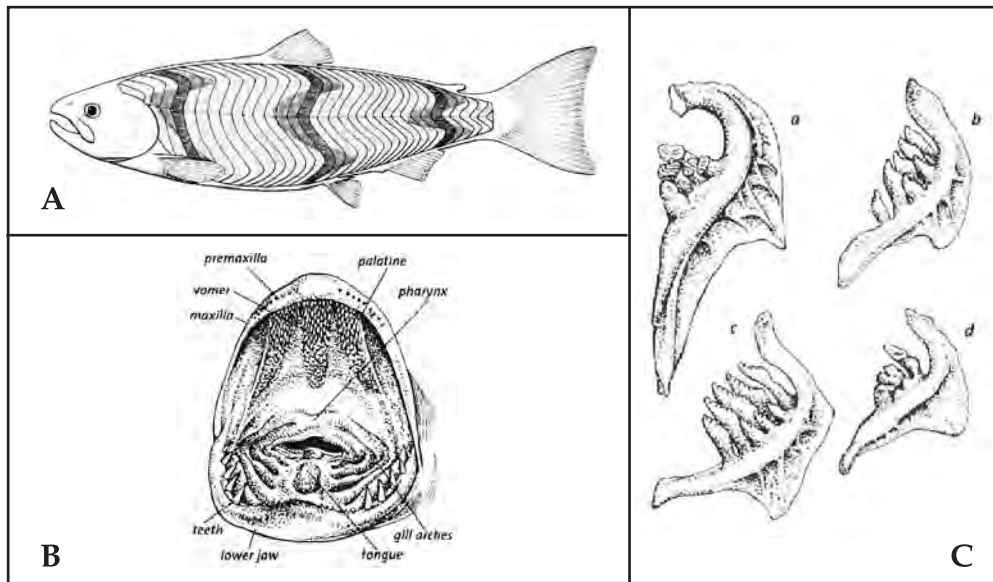
**Figure 16.** Anatomy of internal organic systems and organs of a spiny-rayed teleostean

which in the caudal are forming the *epurals* and *hypural* plates (**Fig. 17**). Initially the skeleton of the head is structured by special cartilages, which, later, are replaced after by numerous derivative bones, in which are also added many other structures, which are originated by ossification of various membranes.



**Figure 17.** The skeleton of girdles (left) and the skeleton of tail (right) (after Bond, 1996)

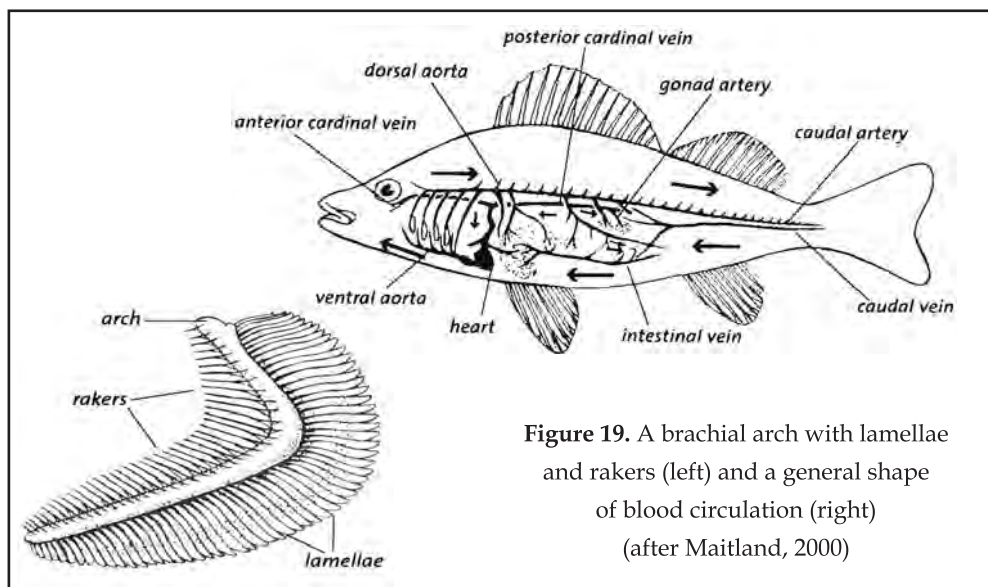
**The muscles.** Customary, a fish is promoting in the water by bending the second half of the body in parallel with caudal fin, while the other rest of the fins helping mainly to the stabilization. This movement is provided by the body *muscles blocks*, which are developed in the body and the tail, as a total of parallel *myotomes* (or *myomeres*) separating each other by *myosepta* (or *myocommata*). Myotomes have a very special structure (**Fig. 16, 18**).



**Figure 18.** The trunk fish muscles (A), the buccal cavity (B) and various pharyngeal teeth (C: a carp, b silver bream, c rudd, d tench) (after Bond, 1996 & Maitland, 2000)

**The digestive track.** In this are included: the *mouth* and the *buccal cavity* where are planted the *teeth* (**Fig. 16, 18**) which in several fish, as in cyprinids, could be absent. However, in the majority of the cases, the teeth are emerged regularly in the jaws or in the tongue and in other bones in the buccal cavity (*palatine, vomer*), or in the transformed fifth brachial arch (*pharyngeal*) (**Fig. 18**). Teeth could have various shape as *canine* like, *molar* like, etc. In the buccal cavity are also visible the *internal branchial* openings. The digestive track is continued by *esophagus* and the *stomach* which is normally present in fishes but sometimes is missing, while it follows the *intestine* being longer in the herbivorous fish. Special stomach appendices are the *pyloric caecae* which in mullets present remarkable variation. Other important annexes of the digestive track are the *swim-* or *gasbladder* (**Fig. 16**), which is formed as an evagination of the upper part of esophagus and play an essential role in the fish buoyancy and respiration, the *pancreas*, the *spleen* and the *liver* in which is incorporated the *gallbladder*.

*The respiratory system* which in the fish is the *gills*, lying in the special *branchial cavity* in the side of pharynx and supported by skeleton which is forming by the *branchial arches*. In the external side of these arches are developed the *gills filaments* or *lamellae* (**Fig. 19**), while in the internal are present the *gill rakers* - helping in the filtration of food items -, especially varied in the number and in the shape from one species to another. This classical respiratory organ, in several cases was evolved and there are fish species, which are adapted to the very low concentration of oxygen of the water, where a kind of *lungs* (dipnoid fish) is found and originates by the transformation of the swimming bladder, while other species can breath through the intestinal epithelium and some by special *epibranchial organs* which are transformed gills.

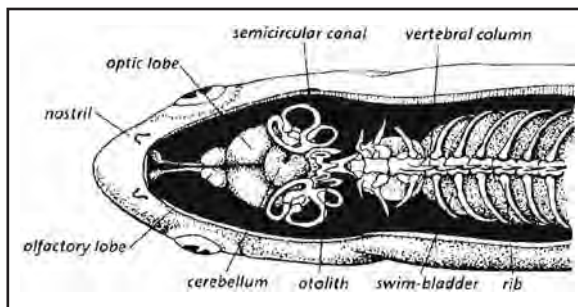


**Figure 19.** A brachial arch with lamellae and rakers (left) and a general shape of blood circulation (right) (after Maitland, 2000)

*The circulatory system* (**Fig. 11**) in fish, as in all vertebrates, is closed and composed by *veins*, *arteries* and a central pulsative organ, which is a two chambers *heart*. In this heart is circulating only veinal blood, which is going from front to back dorsally, just to bring the clean (arterial or oxygenate) blood to the tissues, and from back to front ventrally bearing the veinal blood to the heart and then to the gills .



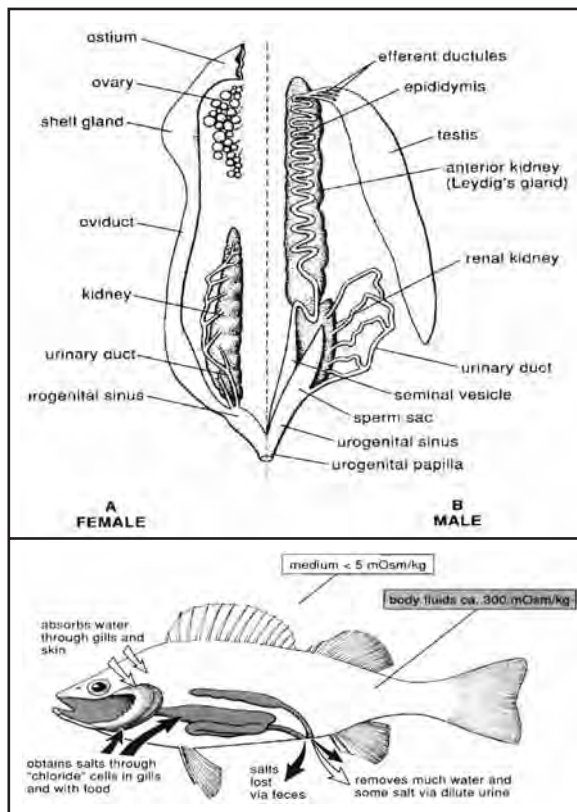
The *nervous system* and the *sense organs* (Fig. 20) allow the fish to explore and to check the environment and to respond accordingly to the any external irritant. Fundamentally it is derived by the primitive *neural* or *spinal cord*, which is lodged in a tube formed by the *neuro-apophyses* of vertebrae. In its



**Figure 20.** The central nervous system of a fish (after Maitland, 2000)

In its anterior part an inflation makes the *brain* divided in five parts, from which the more developed are the *cerebellum*, the *optic lobes* and the *olfactory lobes*. In the nervous system are related the *sense organs*, the most important of which are the *vision*, the *olfaction*, the *hearing* and the *taste*. Together with the organ of hearing is united and the *stability organ*, which is consisted by *semicircular canals*. However, the most important sense organ for fish is the *lateral organ*, lying under the perforated scales of lateral line, being responsible for the sense called as the "touch from distance" (see also Fig. 12).

**The excretory system and the osmotic regulation.** This system is responsible for removing from the body cavity all surplus of water, including various diluted salts which conduce *osmotic pressure*. Any fish in the water has to face this very serious problem because otherwise it cannot survive. The excretory organs or *kidneys*, which are lying in the roof of the posterior part of body cavity (Fig. 16) are responsible in the level of small nephric tubules or *nephridiums* (Fig. 21) to change, by *osmosis*, the diluted salt and to get them away to external as *urine*. The *osmotic regulation* is done either by an over function of kidneys for removing water (case of freshwater fishes which live in a hyposmotic environment) or by drinking water, just to replace the lost by osmosis from the fish body (hyposmotic) to the sea water (hyperosmotic) as in the case of the marine fish (Fig. 22). The diadromous species (sturgeons, mullets, eels, salmons, shads, many gobies, etc.) have more complicate problem to face when moving from marine to fresh water and vice versa, the inner osmotic pressure being regulated by more sophisticate anatomical structures and physiological procedures.



**Figure 21.** Diagram of the excretory organs in sharks A) Female, B) Male (up) and diagram of the osmotic regulation in freshwater teleosts (down) (after Bond, 1996)

**The reproductive system and the reproduction.** The system is related to the production of *gametes*, which after fertilization give the birth of a new *embryo*. The central organs or *gonads* (see Fig. 16, 21) are the *ovary* for female and the *testis* for male, and the *ducts* (*oviduct*, *sperm duct*), the *sperm vesicle* and the *urinogenital* or *urogenital opening* (Fig. 16).

**The sexuality.** The majority of fish are *bisexual* or *gonochoristic* creatures. Usually sexes are separated, but *sexual dimorphism* appeared only in few of cases by *anatomical* or *morphological variation* and/or *color pattern*. Nevertheless, there are also examples of *monosexual* or *unisexual* either

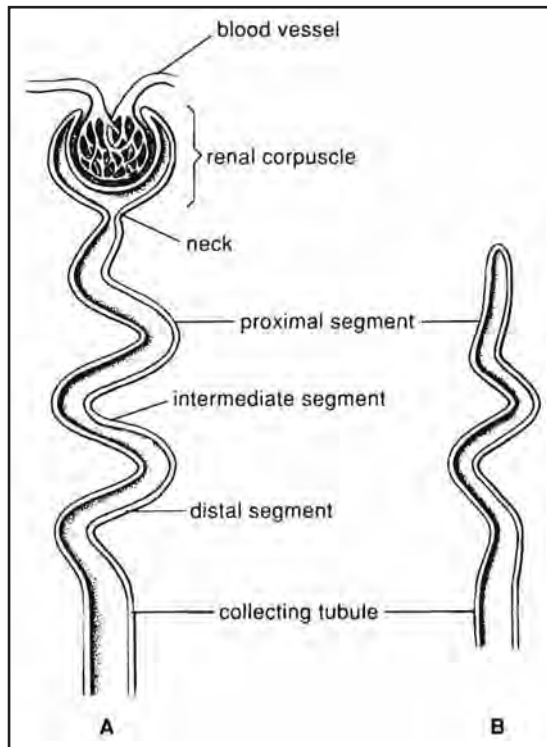
permanently (e.g. Black molly) or occasionally (e.g. Prussian carp). The *hermaphroditism* appeared when both sexes emerged in the same individual, although maturation is usually *asynchronous*, just to avoid the self-mating or *homogamy*. The most of the fish release free gametes in the environment where fertilization took place, e.g. is *external*, although there also are species or even major group having *internal* fertilization (as in sharks and rays, etc.). In these last cases species are real *livebearers* as eggs are fertilized internally by using a special copulatory organ which conduct the sperm (many cyprinodontids, poeciliids, rays, skates, dog fish, sharks, etc.). Initially the, the embryos are kept in the body of the mother and they are released after they grow enough inside.



The period of reproduction is an essential issue for fish biology. In fishes there are a great variety of *mating* and *reproductive strategies*, which are targeting that the embryos should have the highest chance to survive. These strategies include a number of cases going from high fertility without any care (e.g. *non guarders* as sardines) to the low fertility with parental caring (e.g. *guarders* as catfishes and the Nestos' Bitterling (*Rhodeus amarus*)), including all the intermediate combinations, ensuring the highest surviving.

Actually, it is believed that in temperate climates freshwater fishes reproduce once a year during the spring period of high water level or flood and abundant natural food. However, various modern studies shows that many fish are *partial spawners* releasing eggs and sperm in *batches*, several times from spring to the fall, a fact which ensure greater surviving.

The four major types, along with a few examples, are: *monogamy* i. e. maintaining the same partner for an extended period or spawns repeatedly with one partner (e.g. blennies); *polygyny* i. e. when a male has multiple female partners over each breeding season (e.g. sunfishes); *polyandry* i.e. when a female has multiple male partners over each breeding season (e.g. many European cyprinids, mullets, anemonefishes); *polygynandry* or *promiscuity* i.e. when both sexes, males and females, have multiple partners during the breeding season (e.g. herrings). Most fishes reproduce continually throughout their lifetime, although some other (e.g. Pacific salmon) spawn only

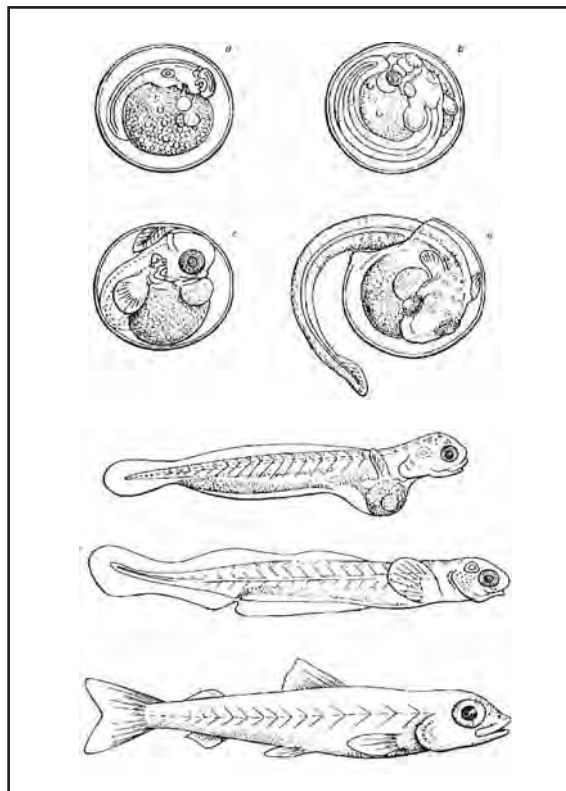


**Figure 22.** Schematic representation of two different types of nephridion A) with nephrons (renal corpuscle) and B) without nephrons (after Bond, 1996).

once and die shortly thereafter. Normally there is no any concern for eggs and larvae (non guarders) but an essential number of fish species (22%) exhibit parental care (guarders). Parental care is expressed by protecting of progeny, including the construction of nests. Males are responsible for carrying in 11% of cases as in the case of the Nestos' Bitterling, *Rhodeus amarus* and Greek Stickleback *Pungitius hellenicus* in Spercheios, while females for 7%, the rest carried out by both sexes.

### Development

In general, five major developmental periods are recognized in fish: *embryonic*, *larval*, *juvenile*, *adult* and *senescent*. Various stages from an embryo in an egg to a juvenile are pictured in the **Fig. 23**.



**Figure 23.** Early development in a fish (after Maitland, 2000)

Fishes are characterized by an *indeterminate growth* (growing throughout life). They also share with Amphibians a well defined larval stage. The fact that most fish are always growing means they constantly change in terms of anatomy and morphology, in the ecological requirements, and in the reproduction. The size is the most important attribute which is determined by heredity and by quantity and quality of available food, as well.

On the other hand, in the water trophic pyramid, fishes have the most important place either as consumers of various food items or as prey of other organisms. Therefore, size also determines natural mortality and how much food requires to eat, how fast it can swim and - to a large extent -, where it can live. The maximum size of fish can range from 7.9 mm in a Sumatra and Bintan living tiny fish named *Paedocypris progenetica* (see Kottelat *et al.*, 2006), to the 13-15 meters giant Whale shark, *Rhincodon typus* of tropical oceans. This large range of size and diversity of proper morphology allowed to colonized wide variation of different environments around world, ranging from temporary puddles to the central gyres of the open ocean. It is worth mentioning that the smallest European fish is a gobiid (*Economidichthys trichonis*) living in the Greek lake Trichonis, which is mature in the size of 18 mm (see Economidis & Miller, 1990).

### **Life-span and longevity**

The life-span of fishes varies widely. In general, smaller fish have shorter life and vice versa. For instance, many smaller species live for only a year or less. From the other side, some sturgeons can live between 80 to 150 years, and several species of rockfish live from 90 to 140 years. Tropical fish tend to be smaller and faster-growing than their cold-water counterparts and that their natural mortality tends to be higher. This is due to high temperature elevating the metabolic rates of tropical fish relative to their cold-water counterparts. However, usually fresh water fish live from 4 to 15 years, while the most common year classes are 4-7 years. In general species forming schools are short life and small size fish, while isolated

## Fish and environment

Globally, fish inhabit a variety of extreme environments including high altitude lakes and streams, desert springs, subterranean caves, ephemeral pools, polar seas, and the depths of the ocean. In Europe the distribution of freshwater fishes is limited exclusively to surface water bodies, namely rivers, streams and lakes. Even though occasional occurrence has been reported as in the Maara cave or cave of river Aggiti's origins (near Prosotsani of Drama) (see Koutrakis 2004), there are no exclusively cave dwelling fish families in Europe.

Based on their habitat, fish can be classified as *pelagic* and *benthic* or *demersal* species. Pelagic species prefer to live and feed in the water column up to the surface and usually they are rarely frequenting to the bottom, mainly when searching for food. Benthic species prefer to live on or near to the bottom, from where they take food. Usually they do not go to the surface for feeding purposes, except in several cases (e.g. *Silurus* in Polyfyto dam lake in Western Macedonia, Greece) when are looking for food in upper layers during the night (Papistas *et al.*, 2003).

The limiting environmental factors for the distribution of the fish species are the *temperature, oxygen, dissolved ions* and the *water movement*. As regards temperature, fish can be distinguished in cold (e.g. Nestos trout, *Salmo trutta*) or warm (e.g. Tilapia) water species. Cold water species are unable to live in waters with more than 20-22 °C, while warm water species prefer temperatures over 20 °C. Most fish are also depending on the concentration of the oxygen in the water. Upper courses of streams are usually saturated, while sluggish streams and stagnant waters have low oxygen concentration and the oxygen needed is produced mainly by photosynthesis. Freshwater fish may be classified in groups, such as *very high* O<sub>2</sub> (10-16 mg\*l<sup>-1</sup>) demanding species (e.g. Nestos trout, *Salmo trutta* and Strymon minnow, *Phoxinus phoxinus*), *high* O<sub>2</sub> (7-10 mg\*l<sup>-1</sup>) demanding species (e.g. Vardar nase, *Chondrostoma nasus* and Gudgeon, *Gobio gobio*), *moderate* O<sub>2</sub> (5-6 mg\*l<sup>-1</sup>) demanding species (e.g. European Perch, *Perca fluviatilis* and Roach, *Rutilus rutilus*), *low* O<sub>2</sub> (0.72-1.43 mg\*l<sup>-1</sup>)

demanding species (e.g. Common Carp, *Cyprinus carpio* and Prussian Carp, *Carassius carassius*). The influence of dissolved ions on fish is depending to the amounts of the diluted salts in the water. Species can be classified as *oligohaline* (salt content to 0.5‰), *mesohaline* or brackish (0.5- 30‰), *marine* (30-40‰) and *hypersaline* (40-300‰). Euryaline species can tolerate a vast range of salinities ranging from 0.5-90‰. A concentration of salts from 5-8‰ is considered to be a boundary between the fresh and brackish waters. Water movement is another factor having crucial effect on fish. The free surface waters are broadly classified as *lotic* or *running* and *lentic* or *stagnant*, determined essentially by the slope gradient. The swimming ability is the main factor in the capacity of fish to resist currents. Fish living close to the bottom (*benthic*) have low swimming ability, while those living to the column up to the surface (*pelagic*), have higher swimming ability.

### **Food and feeding**

Based on feeding habits fish could broadly classify as *herbivores*, *carnivores*, *omnivores*, *zoo- and phytoplanktivores* and *detrivores*. There is considerable nuance within each of these categories because many fish are opportunistic feeders, tending to consume whatever is around, especially when food is scarce. However, primary feeding habits are often associated with body form, mouth type and digestive apparatus, as well as teeth and gillrakers.

### **Movements, Migrations and Schoolin**

Many fish species exhibit migrations as a response for better feeding and protection or for reproduction; daily migrations from surface to the bottom are usually related to feeding or predator avoidance while longer migrations are usually for reproduction purposes. Some fishes stay within marine (*oceanodromous*) or fresh water (*potamodromous*) their entire lives, while others migrate between the marine and fresh water as part of their life cycle (*gamodromous*) or to feed (*agamodromous*). The

fishes that can pass from marine to freshwater environment or vice-versa are characterized as *diadromous*. They can be broken down into three types: those in which growth occurs primarily in saltwater but move into freshwater to spawn (*anadromous*), e.g. salmon; those in which growth occurs primarily in freshwater but move into saltwater to spawn (*catadromous*), e.g. eels; and those that moved between marine and fresh water for various purposes mainly for feeding (*amphidromous* or *agamodromous*), e.g. various gobies, mullets, sleepers and galaxiids. All these migrations can be done if the species has the ability to regulate properly its osmotic pressure.

When fishes group together, either for spawning migration, feeding or protection, they usually form *shoals*. In some other cases, however, fishes simply form aggregates (no social interaction but a mutual attraction to resources). Shoaling represents a continuum of fascinating social behavior. Schooling, in which individuals form a synchronized, polarized group, is actually an extreme form of shoaling and represents one of many types of shoal formation.

### **Communication and perception**

Furthermore to the nervous systems and sense organs exposed, it must be added that fish perceive the external environment in five major ways: *vision*, *mechanoreception*, *chemoreception*, *electroreception* and *magnetoreception*. Comparing to humans several of these sensory systems are entirely alien. Many types of perception are also used by ray-finned fishes to communicate with individuals of the same (conspecifics) or other species (heterospecifics). Clearly fishes display considerable complexity in their ability to perceive their environment and communicate with other individuals, yet until recently it was assumed that fish had negligible cognitive ability. Obviously, this is because the evolutionary history of fishes is very old as it dates almost 400 millions years.

### **Ecosystem and trophic pyramid**

Fish are an essential component of most aquatic ecosystems in which they occur. While many fishes prey on each other, they can also have significant impact on nearly all other animals in their habitat. In the various levels of the aquatic trophic pyramid, fishes produce a considerable biomass by consuming successfully other trophic levels. This biomass keeps pyramid stable and prevent collapses. On the other hand the output of this biomass is continued to various land animals (birds, mammals, etc.).

### **Importance for humans**

There was no specific information on negative impacts on humans. However, many fish are *poisonous* and *venomous*, and when disturbed, they can inflict serious wounds and death in some cases. This is also true of predatory fishes that are attracted to shiny objects or especially when can be assumed as pray, e.g. *shark attacks*. Humans willingly eat poisonous species considered delicacy, such as pufferfishes, but in some cases, people die from this habit. In the great majority, however, fishes are harmless for humans and their positive importance is huge. Fish are obviously of *enormous economic importance* as they are consumed through fishing and aquaculture, and fish are an essential source of proteins for millions of people around the world. Furthermore, fishes are quite popular in the aquarium trade. Sport fishing is also popular on rivers, lakes, coastal areas and reefs around the world. The fast-growing scuba industry relies heavily on thriving coral reefs with diverse and abundant communities of any kind of fish. Finally, of less direct (and severely underappreciated) economic importance are the ecological roles that fishes fill, like controlling insect populations (e.g. many still-water groups like gouramies, poecillids, etc.) and ensuring healthy-functioning aquatic systems, which helps to ensure the prevention of diseases spread.



## Conservation

The threat to aquatic habitats has grown steadily over the course of the twentieth century and continues today for a variety of reasons, most of which involve human intervention via *overexploitation*, *introduction of alien species*, *habitat alterations* mainly by constructing public works, pollution, and international trade. There are worrying even alarming signs, such as collapses in many of the world's fisheries and drastic declines in many large, mobile species (e.g. European sturgeon). Freshwater species account the vast majority of actual extinctions of ray-finned fishes. The most significant threats are to families with restricted distribution because localized threats can easily eliminate all individuals of a species. Introduced species, (such as the pumpkinseed) combined with pollution and habitat alteration, mainly spawning grounds and/or nurseries, migration prohibition by constructing dams, etc., have proven particularly disastrous for groups of other endemic species.

# Species Description



## How to use this edition

**Key to species:** Before the chapters with the description of each species, a section with the identification key for the River Nestos/Mesta fishfauna species, is included. An identification key is a set of questions that allow the user to establish the identity of an individual fish. A key is made of a series of couplets, numbered 1, 2, etc. Each couplet includes two alternative sentences, e.g. 1a, ab, 2a, 2b, etc. Each sentence includes one or several statements, and each sentence describes alternative conditions of the same character. In order to identify a fish, you must start from the beginning from couplet 1. Start by reading sentence 1a and 1b. Each sentence ends by an indication like “2” or a “name of a fish”. In case that you decide that the sentence that describes better the fish you want to identify ends in a number then you must go to the appropriate couplet, in this case couplet 2, and repeat the operation until you obtain a name for the fish you want to identify

**Fish name:** All the species names used in the headings are the official valid names used international that follow the nomenclature proposed by *International Code of Zoological Nomenclature*. Basically is used the nomenclature used by Kottelat & Freyhof (2007).

**Common name:** The vernacular or common names that are given after the scientific name of each species in this book are the official English common name and the official common names that are used in the two countries (Greece (Economidis, 1991) and Bulgaria).

**Authors:** For each fish species that is presented, two specialists, one for each country, worked together, gathering all the available information and data for the species.

**Photos & maps:** There was an attempt to gather original photos of the species, as much as possible representative of each species, presenting all the distinguishing characteristics. On the other hand, maps are giving to all the sampling stations both in Bulgaria and Greece where each one of the species was caught. Nestos is a Transboundary river, but in this book there are not included borders just to underline that fish can move freely. The separation point between the two countries is indicated by a small line.

**Nomenclature & synonyms:** In this section all the old names that were used in both countries in the past by various authors are presented. There was an effort to find classical references of nomenclature by taxonomist and mainly by local authors (Bulgarians or Greeks), just to help new scientists in both countries to reach the older sources.

**Diagnosis:** In this section there was an effort to present as simple as possible and with as more as possible all the characteristics that could be used in order to identify the fish species that are referred to, in the field without the need to use any special equipment.

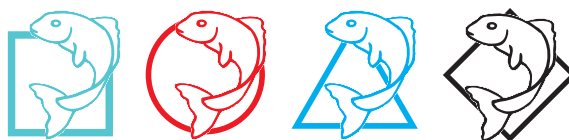
**Distribution:** The general distribution of the species in the world is given first followed by a more specific distribution of the species in the Bulgarian and the Greek part of the River.

**Ecology & biology:** All the available data on the habitats, feeding habits, behaviour, and reproduction of each species presented as simple as possible and summarized without giving too much information that could confuse the reader.

**Conservation:** The current status of the species population is presented along with the major threats that are responsible for eventual population decline. Also the legislation referred to each fish species in both countries and the EU legislation is included in this section. In the case of the translocated to the system species, even if they are protected in their native distribution area, they are not considered as being under protection for the Nestos/Mesta ecosystem.

|                                     |                                                                                                                                                                      |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Autochthonous or Alien/Translocated |   |
| Protected                           |                                                                                     |
| Freshwater or Euryhaline            |   |
| Marketable or not                   |   |

**Symbols:** In order to visualize the most important characteristics of each fish species, four categories of symbols were used. The first category of symbols (square shape) indicates whether a species is autochthonous or alien/translocated. Translocated species have been transferred from near by systems, while alien species have been introduced from other continents. The second one (circle shape) indicates that the fish species is protected by international or national legislation. The third category with a triangle shape shows that a fish is a freshwater one or euryhaline, while the last category indicates that the species is marketable or not. For each fish species three or four symbols are applied depending on their characteristics. For *Alosa fallax*, for example, four symbols are used:

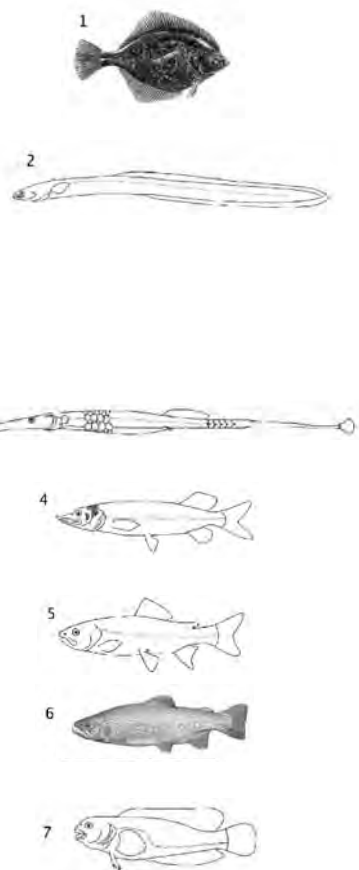


These symbols imply that the *A. fallax* is autochthonous (1<sup>st</sup> symbol), protected by international or national legislation (2<sup>nd</sup> symbol), euryhaline (3<sup>rd</sup> symbol) and finally that it is a marketable species.

# Key to Species (Valid only for Nestos fish species)

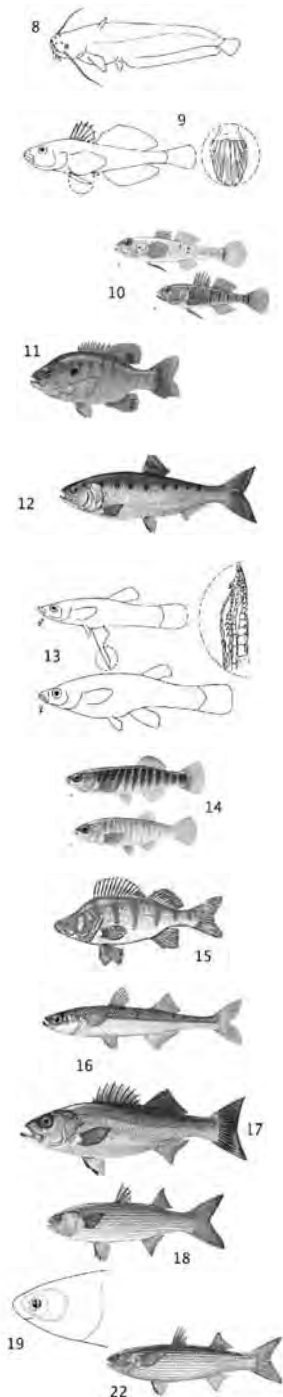
by  
Panos S. ECONOMIDIS & Apostolos APOSTOLOU

- 1a. Eyes place asymmetrical located both in the same side of the head (fig. 1)..... *Platichthys flesus*
- 1b. Eyes place symetrical located one in each side of the head.....2
- 2a. Body very elongated (snake form), with a rounded or angular section (fig. 2, 3) .....3
- 2b. Body normal, not very elongated (fish form), usual with an ellipsoid section.....4
- 3a. Body having a snake shape, impair fins (dorsal, caudal and anal) connected (fig. 2).....*Anguilla anguilla*
- 3b. Body with a angular section, covered with ossificated plates, impair fins not confused (fig. 3) .. *Syngnathus abaster*
- 4a. Body elongated ending forward in a snout like a duck beak. Dorsal and anal fins located backward in the tail have almost same size and opposite each other. Large fish (fig. 4) .....  
*Esox lucius*
- 4b. No such a combination of characters.....5
- 5a. Adipose fin present (fig. 5).....6
- 5b. Adipose fin absent .....7
- 6a. Black spots on the dorsal and caudal fins. A reddish strip in the sides of the body (fig. 6).....*Oncorhynchus mykiss*
- 6b. No spots in the dorsal and caudal fins. No reddish strip on the body .....*Salmo macedonicus*
- 7a. Body naked, without scales (fig. 7, 8).....8





- 7b. Body covered by scales, sometimes very small or hidden under the skin .....9
- 8a. Dorsal fin longer than the anal. Small size fish (fig. 7) .....*Salaria fluviatilis*
- 8a Anal fin longer than the dorsal. Large size fish (fig. 8) .....*Silurus glanis*
- 9a. Ventral fins connected and forming a kind of sucker (fig. 9). Small fish (fig. 10).....*Knipowitschia caucasica*
- 9b. Ventral fins free..... 10
- 10a. One dorsal fin..... 11
- 10b. Two dorsal fins .....15
- 11a. Anterior part of the dorsal fin spined (fig. 11). Body very brightly colored .....*Lepomis gibbosus*
- 11b. Anterior part of the dorsal fin with a maximum of 6 soft spines or unbranched rays .....12
- 12a. Lateral line invisible. A median scaled spined abdominal keel (fig. 12). Large migratory fish.....*Alosa fallax*
- 12b. No such a combination of characters.....13
- 13a. Fine teeth on the jaws. Small fish.....14
- 13b. No teeth on the jaws.....22
- 14a. Pre-orbital space greater than eye diameter. Males with gonopodium (fig. 13).....*Gambusia holdbrooki*
- 14b Pre-orbital space smaller than eye diameter. In lagoons (fig. 14).....*Aphanius fasciatus*
- 15a. A dark spot located in the posterior part of the first dorsal fin (fig. 15).....*Perca fluviatilis*
- 15b. No such a spot on the dorsal fin.....16
- 16a. A silver bright colored line along the body. Gregarius pelagic small fish (fig. 16).....*Atherina boyeri*
- 16b. No such a line along the body.....17
- 17a. More than 60 scale rows longwise the body. Operculum with spines (fig. 17).....*Dicentrarchus labrax*
- 17b. No more than 55 scale rows longwise the body. Operculum without spines..... 18
- 18a. Lower lip with sensitive papillae. Brackish watres and lagoons, also freshwater (fig. 18).....*Chelon labrosus*
- 18b. Lower lip smooth.....19
- 19a. Adults with an adipose eyelid, covering most of eye and reaching pupil (fig. 19) (fig. 22).....*Mugill cephalus*



- 19b. Adults with an adipose eyelid around eye (fig. 20).....20
- 20a. Predorsal scales with 2-5 longitudinal groves (fig. 21);  
48-40 lateral body scales (fig. 23)..... *Liza saliens*
- 20b. Predorsal scales without groves or only one; 40-46 lateral  
body scales.....21
- 21a. Around caudal peduncle 20 scale rows; pectoral fin reach  
eye when folded forward (fig. 24).....*Liza aurata*
- 21b. Around caudal peduncle there are 24 scale rows; pectoral fin  
does not reach eye (fig. 25).....*Liza ramada*
- 22a. With barbels. ....23
- 22b. Without barbels. ....27
- 23a. One pair of barbels. ....24
- 23b. Two or more pairs of barbels. ....25
- 24a. Lateral line with more than 100 scales. Mostly in muddy to  
silty bottoms.....*Tinca tinca*
- 24b. Lateral line with less than 45 scales. Mostly in sandy to  
muddy bottoms with clean water.....*Gobio bulgaricus*
- 25a. Two pairs of barbels. ....26
- 25b. More than two pairs of barbels. Small fish with small eyes  
(fig. 27) .....37
- 26a. Dorsal fin with more than 20 rays and 3-4 times longer than  
the anal. ....*Cyprinus carpio*
- 26b. Dorsal fin with less than 12-13 rays and up to 1,5 times  
longer than the anal fin.....*Barbus strumicae*
- 27a. Dorsal fin about 3 times longer than the anal and with more  
than 20 rays. ....*Carassius gibelio*
- 27b. Dorsal fin equal or shorter than the anal and with less than  
20 rays. ....28
- 28a. Mouth transversal with cusped thick lips  
.....*Chondrostoma vardareense*
- 28b. Mouth curved with normal lips.....29
- 29a. Scales small, more than 87 scales in a longitudinal line. Small  
fish.....*Phoxinus phoxinus*
- 29b. Scales less than 80 scales in a longitudinal line. ....30
- 30a. Lateral line invisible or incomplete with 3-5 scales (26)  
.....31
- 30b. Lateral line well developed and complete. ....32
- 31a. Ventral fin insertion by the of the dorsal. Body shape



|                                                                                                      |                                    |
|------------------------------------------------------------------------------------------------------|------------------------------------|
| elliptical. Small fish .....                                                                         | <i>Rhodeus amarus</i>              |
| 31b. Ventral fin insertion in front of the dorsal (fig. 26).....                                     |                                    |
| .....                                                                                                | <i>Leucaspis delineatus</i>        |
| 32a. Lateral bounded by a double dotted line of dark pigmentation. ....                              | <i>Alburnoides bipunctatus</i>     |
| 32b. Lateral line without the above character. ....                                                  | 33                                 |
| 33a. A black midlateral stripe from head to caudal base. Small fish. A 7.....                        | <i>Pseudorasbora parva</i>         |
| 33b. No such a stripe. A > 7.....                                                                    | 34                                 |
| 34a. Body high, its maximum depth 25% to 35% of SL. ....                                             | 35                                 |
| 34b. Body low, its maximum depth 10% to 15% of SL. ....                                              | 36                                 |
| 35a. Dorsal origin behind ventral (pelvic) base.....                                                 |                                    |
| .....                                                                                                | <i>Scardinius erythrophthalmus</i> |
| 35b. Dorsal origin above ventral (pelvic) base.....                                                  |                                    |
| .....                                                                                                | <i>Rutilus rutilus</i>             |
| 36a. Ventral (pelvic) origin before dorsal origin. Anal >15 soft rays, l.l. 45-48 Body silvery.....  | <i>Alburnus alburnus</i>           |
| 36a. Ventral (pelvic) origin just down dorsal origin. Anal <10 soft rays, l.l. 44-46. Body grey..... | <i>Squalius orpheus</i>            |
| 37a. Barbels around mouth of about the same length. Dark spots scattered on the body. ....           | 38                                 |
| 37b. One pair of barbel double in length. Dark spots on the body forming rows. ....                  | <i>Cobitis strumicae</i>           |
| 38a. The end of the caudal fin is almost vertical.....                                               |                                    |
| .....                                                                                                | <i>Barbatula barbatula</i>         |
| 38b. The end of the caudal fin is clearly forked.....                                                |                                    |
| .....                                                                                                | <i>Oxynoemacheilus bureshi</i>     |



## *Alburnoides strymonicus* Chichkoff, 1940

(EN) Strymon spirlin (BG) Strumska Govedarka, bleskavets  
(GR) Tsironaki Strymona

Luchezar PEHLIVANOV & Panos K. LEONTARAKIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Alburnoides bipunctatus*, Kovatchev, 1922; Drensky, 1930; Morov, 1931; Marinov, 1989; Vassilev & Pehlivanov, 2005.

*Alburnoides bipunctatus strymonicus* Chichkoff, 1940; Michajlova, 1965; Economidis, 1974.

**Diagnosis:** D iii/7-9, A iii/12-17, C 19; vertebrae 3840; L. 1. 4451, gill rakers: 1013. Lengthened laterally compressed body and deep. The ratio between maximum body length and maximum body depth (Hmax) varies from 3.7 to 4.6. The ratio between the Standard Length (SL) and the length of the head varies from 4 to 4.5. There are two rows of small black spots below lateral line along its entire length. The pre-dorsal distance is longer than the post-dorsal one. Eye diameter 13.5 to 16 times in the

standard body length. Mouth small.

**Distribution:** The species is endemic in the Aegean rivers Strymon/Struma and Nestos/Mesta in Bulgaria, being widely distributed in the upper and middle stretches of these rivers. However, is lacking from all drainage eastwards from to Nestos/Mesta up to the river Evros/Maritza basin. Its presence in the Mesta/Nestos, is mentioned by Economidis (1974) (Greek side) and by Apostolou (2005) (Bulgarian side). During Nestos project the species was



Autochthonus



Portected



Freshwater



Not Marketable



found upstream and downstream of the Nestos dams and in small numbers in the dam lake of Thisavros, but not in the dam lake of Platanovrisi. Also it was found in the tributary Arkoudorema. In Greece the species is also present in the Angitis, tributary of Strymon and in the small creek Marmaras draining in Pangaio valley (Maurakis & Economidis, 2003).

**Ecology & biology:** The species occurs in the middle and partially in the upper river courses, in sites with clean and well oxygenated water, sometimes fast running, of medium temperature, normally no less than 15° C. It feeds mainly on benthic insect larvae, crustaceans and diatoms. It spawns

from April to May, sometimes up to September. Maximum observed length from 14 to 15 cm.

**Conservation:** The species seems to be abundant in Mesta/Nestos and Struma/Strymon basin. However, during the Nestos/Mesta project only few specimens are caught in the Thisavros dam lake. The species is close depended from the water quality and quantity, especially in the mountain pools down the trout zone, where is its favorable habitat. According to IUCN norms it is qualified as Lower Risk/least concern, although the close similar species *Alburnoides bipunctatus* is included in the Annex III of Bern Convention.

## *Alburnus alburnus* (Linnaeus, 1758)

(EN) Bleak (BG) Uklei, Ukleyka, Bleskach (GR) Sirko

Luchezar PEHLIVANOV & Panos LEONTARAKIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Alburnus lucidus*, Kovachev, 1922; Morov, 1931; Drensky, 1930.

*Alburnus alburnus*, Chichkoff, 1940; Drensky, 1948, 1951; Michajlova, 1965; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D iii/8-9, A iii/14-20, C 19, vertebrae 41-44, L.l. 4656, gill rakers 1821. Lengthened, laterally compressed body, covered with large, shining, easy-falling scales. Unscaled abdominal keel from posterior base of pelvic fins to anal fin. Small upper mouth. The lower lip with small bulge and the upper lip concave. The ratio between the Standard Length (SL) and the length of the head is 4 to 5. The antheadorsal distance is much longer than the postdorsal one. The ratio between standard body length and maximum body depth (Hmax) is 10 to

11, between this last and to the minimum body depth (Hmin) 2.2 to 2.7 and the length of the head and the eye diameter 3 to 4.

**Distribution:** The species is a widely distributed fish in inland waters of Europe. In Bulgaria is distributed in rivers and reservoirs of the Danube basin (including the Danube itself) as well as in the watersheds of both the Black and the Aegean seas. For the Bulgarian part of the river Mesta/Nestos basin, is suggested as a translocated species. It is recorded only in the Dospat reservoir





Translocated



Freshwater



Not Marketable



(Zivkov, 1987; Apostolou, 2005); however no information about the origin of the initial stock are available. In the Greek part of the river there is not any previous historical record (see Economidis, 1974). Actually, however, during the Nestos project it was recorded also in the damlake of Thisavros. However, in spite it was accepted as native for the Mesta/Nestos basin (Drensky, 1930), however it is a translocated species in the Dospati reservoir (Zivkov, 1987; Apostolou, 2005), which never been recorded after in the Mesta/Nestos and its tributaries. Furthermore, the species is regularly presenting as native in many other waters as in the rivers Evros/Maritza, and Strymon/Struma, (see Maurakis & Economidis, 2003; Kottelat & Freyhof,

2007).

**Ecology & biology:** The species is frequenting in standing water basins (lakes, reservoirs), middle and lower river courses with slow current and clean water. It forms shoals moving in the water column especially near the water surface searching for food. Feeds mainly on zoo- and phytoplankton and aerial insects. The species appeared to be portion spawner releasing eggs from April to September. It also forms an important element of the food chain in a freshwater environment because it is the main feeding resource for various carnivorous fish and piscivorous bird. Maximum length about 15 cm.

**Conservation:** Not any consideration because it is an introduced species in the Mesta/ Nestos basin.



## *Alosa fallax* (La Cepède, 1803)

(EN) Twaite shad (BG) Sredizemnomorska finta (GR) Sardelomana

Manos KOUTRAKIS & Apostolos APOSTOLOU



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Alosa fallax nilotica*, Konsuloff & Drensky, 1943.

*Alosa (Alosa) fallax nilotica*, Economidis, 1974.

*Alosa fallax*, Kottelat, 1997; Kottelat & Freyhof, 2007.

**Diagnosis:** D iii-v/14-16, A ii-iii/20-21, P 15-16, V i/8, C 19, gill rakers 32-34, vertebrae: 55-56, abdominal scutes 36-37. No teeth at the palatine bones. Usually a series of 4-8 black blotches behind gill opening. Body laterally compressed of alosoid shape. Lower jaw longer than upper. Body scales large and detachable. The color of the body is bluish dorsally and upper laterally and whitish down and in the belly. Normally there are several black spots behind opercle cover.

**Distribution:** The species frequent coastal zone, mainly near estuaries, entering to large rivers because of its

anadromous habit of its breeding migration. The presence in the area is confirmed on the base of specimen caught in the river Evros and in the Vistonis lagoon (see Bobori *et al.*, 2001). In river Nestos/Mesta probably no longer migrates because of the low flow and the construction of a dam since 1966 near Toxotes.

**Ecology & biology:** It is an anadromous species migrating to rivers for spawning. Juveniles after hatching move to the sea where they remain close to shore and estuaries. In the sea the species has a trophic period where it has the life of a



Autochthonus



Portected



Euryhaline



Marketable



pelagic fish. Males migrate upstream after reaching 2-3 years age while females after 3-4 years. Adults congregate near estuaries in April and enter rivers when temperatures reach 10-12°C, mainly in May-June. Spawning starts when temperature reaches about 15°C or more, in May-June. Spawning take place in large near surface after midnight. Eggs sink to bottom or are pelagic. In the nearby river Evros/Maritza the species migrates from the end of March till the end of May each year reaching the tributary Ardas, proper ground in a distance more than 100 km from estuaries. Most juveniles migrate to river mouth during first summer and move to sea at end of the second year, where most of them remain until they mature.

Individual fish are thought to return to their natal spawning site. At sea, feeds predominantly on crustaceans and small fishes. In freshwater, adults do not feed. Juveniles prey on planktonic crustaceans (Kottelat & Freyhof, 2007).

**Conservation:** As all the anadromous species it is considering as threatened, because most populations have declined, although several of them have stabilised after. Main threats are from the pollution, impoundment of large rivers and the construction of dams or wires that prohibit the migration of the species to spawning grounds. In IUCN it is categorized as LC and it is being protected by the Directive 92/43/EEC (Annex II/V), Bern Convention (Annex III), Barcelona Convention (Annex III).

## *Anguilla anguilla* (Linnaeus, 1758)

(EN) Eel (BG) Речна змиорка (GR) Ηέλι

Teodora TRICHKOVA & Panos S. ECONOMIDIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Anguilla fluviatilis*, Kovatchev, 1921a.

*Anguilla vulgaris*, Kovatchev, 1923; Morov, 1931.

*Anguilla anguilla*, Kovatchev, 1921b; Drensky, 1930, 1948, 1951; Konsuloff & Drensky, 1943; Michajlova, 1965a; Michajlova, 1965b; Russev, 1966.

**Diagnosis:** In two specimens from Evros D 265-270, A 220-232, P 16-17, V missing, vertebrae 114-115, gill rakers 11-12 (Economidis, 1974). D and A fins elongated, confluent with C, forming one unique fin from the anus to the middle of the back. The lower jaw is slightly longer and projecting. The dorsal fin origin is far behind the pectoral fins; the anal fin origin is slightly behind the anus, well back from origin of dorsal fin; pelvic fins are absent and the scales are very small embedded in the skin (Froese & Pauly, 2008).

**Distribution:** The species is native in the river Mesta/Nestos where it was

mentioned by Drensky (1948, 1951), Penczak *et al.* (1985) and Dikov *et al.* (1921b). After the construction of the Nestos/Mesta reservoirs, the species disappeared from the Bulgarian section of the river. At present, it is found rarely in the Greek part from downstream the Toxotes dam to the estuary (Apostolou, 2005). In 2007-2008, several specimens were found near Paradeisos village and in Pontolivado channels (data from Nestos project). It was also reported in the lagoons of the river.

**Ecology & biology:** The species lives in brackish and freshwater areas with rich vegetation and muddy bottoms. It has



Autochthonus



Portected



Euryhaline



Marketable



rather nocturne habits, frequenting in all types of benthic habitats from small streams to large rivers and lakes. In fresh water appear mainly females, while in brackish mostly males. When reaching sexual maturity, they migrate downstream and head towards the sea. Being a catadromous species, their migration for spawning is ending in the Sargasso sea (Atlantic ocean), where the spawning occurs in late winter, early spring. Adults die after spawning. The newly hatched larvae undergo metamorphosis (from leptocephalus to glass-eel), and after about 2 years of drifting in the Atlantic to its NE, during which transformation to glass-eel is completed, they reach the European coasts. The feeding phase lasts for 5-8 years in males and up to 12 years and more in females (Kottelat & Freyhof,

2007). The species feeds on any kind of available food (molluscs, crustaceans, fish, etc.).

**Conservation:** The abundance of the species is very low all over Europe, due to anthropogenic impacts, such as river damming, overfishing and pollution. The species abundance is very low also in River Nestos/Mesta. The main threats are the river regulation by dams and weirs, draining of the wetlands and water pollution. In Bulgaria, the species is listed in the newly updated Red Data Book and characterized as Endangered (EN) according to IUCN criteria (Stefanov *et al.*, in press). In Greece, it is qualified as Near Threatened (NT) according to IUCN norms, but in a very large area, especially in the East slope drainage of Aegean Sea, as in Nestos, the species appear an essential decline (Economidis, unpubl.).

## *Aphanius fasciatus* (Valenciennes, 1821)

(EN) European Toothcarp (BG) Aphanius  
(GR) Zacharias, Zamparola

Manos KOUTRAKIS & Angel TSEKOV



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Aphanius fasciatus* Leonardos *et al.*, 1996; Leonardos & Sinis, 1998;

**Diagnosis:** D (8) 10-12 (13); A 9-12 (13), scales in a longitudinal series (23) 25-27 (30) (Whitehead *et al.*, 1986). This is a small size fish that is distinguished by the presence of teeth in the jaws, large scales and fins with slightly rounded margins. Also males by the pale yellow to yellow-orange color of the caudal fin and in some populations the wide dark submarginal bar (Kottelat & Freyhof, 2007). It exhibits sexual dimorphism particularly during reproductive period when males are brightly colored (Leonardos *et al.*, 1996), having 8-15 dark blue to grey bars on a silvery back-

ground, which usually are regularly shaped and set, while female has 11-17 short dark brown bars on sides (Wildekamp, 1993). The largest measured specimen had a size of about 62 mm SL in north Aegean sea (Porto Lagos lagoon) (Koutrakis *et al.*, 2005) and about 68 mm in coastal waters of western Greece (Mesolongi lagoon) (Leonardos & Sinis, 1999a).

**Distribution:** The species is distributed in the Mediterranean coastal habitats but also in several inland water bodies from Algeria to Egypt (Kottelat & Freyhof, 2007). In the Nestos/Mesta system it was



Autochthonus



Portected



Euryhaline



Not Marketable



found in the lagoons of the river delta.

**Ecology & biology:** This fish can support large fluctuations of salinity frequenting from the coastal hypersaline lagoons to the shallow still to slow-flowing fresh water, especially at river mouths. It spawns for the first time at the age of 7-12 months, during April-July (in western Greece), on bottom and in submerged vegetation (Leonardos & Sinis, 1998). The eggs are hatching in 10-14 days and juveniles form large schools. Its diet is dominated by various small invertebrates including, insects as mosquitoes (eggs, adults and larvae) and diatoms. The smaller size fish feed on planktonic prey (e.g. copepods, ostracods and nauplii of brine shrimp)

(Leonardos, 2008).

**Conservation:** The species is abundant in the lagoons of the river Nestos/Mesta delta, as in other similar habitats elsewhere in Greece. The lacking of any commercial value is an advantage for it but the accelerated destroying of coastal wetlands is always a perpetual threat. Furthermore, the species appeared to be in competition with the mosquito fish *Gambusia holbrooki* that is widely introduced and spread in all still waters and estuaries. In the frame of the international protection *Aphanius fasciatus* is included in the Annex II of the EC Directive 92/43/EEC, in the Bern Convention (Annex II) and in the Barcelona Convention (Annex II).



## *Atherina boyeri* Risso, 1810

(EN) Sand smelt (BG) Атерина (GR) Αθήρινα

Manos KOUTRAKIS & Apostolos APOSTOLOU



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Atherina boyeri*, Leonardos, 2001; Koutrakis *et al.*, 2004.

**Diagnosis:** D (vi) vii-viii (ix), I / (9) 10-13 (15); A i / (12) 13-15 (18), gill rakers 21-39, vertebrae 40-47, L.l. (39) 44-48 (49). Size up to about 85 mm SL, 120 mm in lake Trichonis and 145 mm in Caspian sea.

**Distribution:** Along coasts of Mediterranean, Black, Azov and Caspian seas. Sporadically it is also found in several coastal areas of NE Atlantic. Resident freshwater populations in Portugal, Greece (lake Trichonis) and Turkey. The species was introduced in Aral Sea, lakes Trasimeno (Italy) and Iznik (Turkey), and perhaps

in other lakes in Italy and Anatolia. In Nestos system it was found in the lagoons of the river delta.

**Ecology & biology:** The species is populating the lower parts of rivers, estuaries, coastal lakes and sea. The freshwater populations prefer still or slow-flowing waters. In lakes is frequenting from surface to bottom. It is a typical gregarious fish, which usually lives 1-2 years, rarely up to 4 (Miller, 2003). Overall male female sex ratio was 1:2.5, statistically different from unity. Total length up to 105 mm (Koutrakis *et al.*, 2005). Total mortality rate was  $\bar{A}E =$





Autochthonus



Euryhaline



Marketable



1.29 year<sup>-1</sup> and natural mortality  $\dot{I} = 0.95$  year<sup>-1</sup>. Males had a lower life span than females, the latter dominating length classes > 60 mm. (Koutrakis *et al.*, 2004). The Trichonis freshwater population spawn from March to October (Leonardos, 2001). Larger individuals appeared to be fractional spawner as they spawn for a longer period. The eggs bear long hairy appendages attaching them to filamentous algae, deposited at 2-6 m depth. Larvae are pelagic but often form schools close to the shores (Daoulas *et al.*, 1997, Economou *et al.*, 1994a). In

lakes and estuaries, the species is feeding mainly on small planktonic invertebrates, often from the benthos of the rivers. Locally the species is regarded as a valuable species for commercial fishing in European fisheries. It is quite abundant in the lagoons of the river Nestos delta.

**Conservation:** It is estimated that the species is threatened only by the overfishing. According to the Red Data Book of threatened Vertebrates of Greece is not a threatened species, therefore it can qualified as LC.

## *Barbatula barbatula* (Linnaeus, 1758)

(EN) Stone loach (BG) Gulesh, flastak (GR) Vinos

Teodora TRICHKOVA & Argyris SAPOUNIDIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Cobitis barbatulus*, Kovachev, 1923.

*Cobitis barbatula*, Morov, 1931.

*Nemachilus barbatulus*, Drensky, 1948;1951.

*Noemacheilus barbatulus*, Zivkov, 1987; Sivkov, 1991; Karapetkova & Zivkov, 1995.

**Diagnosis:** D iv/7 (rarely 3 or 5 unbranched and 7 branched rays), A iii-iv/5 (Sivkov, 1991). The species is mainly characterized by the posterior margin of the caudal fin which is truncate or slightly emarginated. The body is elongated, slightly depressed anteriorly and laterally compressed posteriorly. The body depth is 13.21-18.14% of SL and body width 11.39-16.93% of SL (Sivkov, 1991). The head is small and rounded with its width bigger than its depth. It has three pairs of

mouth barbels. The scales are very small and embedded in the skin. The body and head are covered with dark-brown blotches. Often, there are no dark blotches along the back between the nape and the dorsal fin (Kottelat & Freyhof, 2007).

**Distribution:** The species has a large distribution in Europe including the river Axios/Vardar. It has been introduced accidentally to the Dospat reservoir (Zivkov, 1987). Later, the species was found in the tributary



Alien



Freshwater



Not Marketable



Dospat/Despatis catchment downstream the reservoir (Apostolou *et al.* 2005). It was not yet found in the Greek part of the Nestos/Mesta.

**Biology:** It is a typical reophilic species inhabiting the upper and partly the middle reaches of a river in areas with sandy and/or gravel bottoms, and cold, fast-flowing water. It reaches sexual maturity after the age of 2-3 years. The spawning occurs in the period April-

June and eggs are laid among stones, where they develop for about 40 days. It feeds on benthic invertebrates (gammarids, chironomids, insect larvae), mainly during the night (Kottelat & Freyhof, 2007). The life span is up to 8 years (Maitland, 2000).

**Conservation:** Not any consideration because it is an introduced species in the Mesta/Nestos basin.

## *Barbus strumicae* Karaman, 1955

(EN) Strumica barbel (BG) Trakyska Mriana (GR) Virgiana

Apostolos APOSTOLOU & Manos KOUTRAKIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Barbus barbus cyclolepis*, Chichkoff, 1935.

*Barbus barbus plebejus*, Konsullov & Drensky, 1943.

*Barbus cyclolepis strumicae* Karaman, 1955; Economidis, 1991.

*Barbus cyclolepis*, Banarescu, 1960; Economidis, 1989; Economidis & Banarescu, 1991; Pehlivanov, 2000; Apostolou, 2002, 2005; Vassilev & Pehlivanov, 2002; Stefanov & Trichkova, 2004.

*Barbus plebejus strumicae* Karaman, 1971.

*Barbus plebejus cyclolepis* Economidis, 1974.

*Barbus* aff. *tauricus*, Drensky, 1926.

*Barbus tauricus*, Drensky, 1930.

*Barbus tauricus cyclolepis*, Berg, 1949; Marinov, 1964; Michajlova, 1965, 1970.

*Barbus meridionalis* (non Risso), Michajlova, 1965, 1970.

**Diagnosis:** D iii-iv/7-9, A iii/5, P i/15-18 (rarely 13), V ii/6-9, C 17-20, L.l. 12-20/58-75/ 8-14, vertebrae 40-44, gill rakers: 6-12, pharyngeal teeth: 5.3.2-2.3.5. The species is mostly characterized by the presence of fine denticles on the  $\frac{3}{4}$  of the biggest dorsal ray, and by the

almost straight margin of dorsal fin. In the body there are dark brown blotches scattered alongside and in the dorsal and anal fin there are small regular spots. Maximum observed total length about 32 cm.



Autochthonus



Freshwater



Marketable



**Distribution:** The species is native in the Aegean sea flowing systems from north, both in Bulgarian and Greek territories as Mesta/Nestos, Struma/Strymon, small creek Marmaras running in Pangaio valey and similar other in Chalkidiki peninsula up to lakes Koronia-Volvi and eastern tributaries of the river Axios/Vardar. Also in the spring Agia Varvara of Drama (Konsulof & Drensky, 1943). In Mesta/Nestos it is has a dense distribution from all along the river. A large population was found in the dam lakes, especially in Thisavros, in the river itself downstream of these dams near the village Paranesti and near the mouth of the river in the delta.

**Ecology & biology:** The species is a bottom dwelling fish typical rheophilic,

living in rivers, streams, and creeks with rocky, gravelly, sandy substrate and high, medium or low current velocity. Normally it is observed to move alone but it also forms schools. Reproduction is taking place around May, and eggs are laying scattereted to the open water or to the gravel substratum. It is feeding mostly on benthic invertebrates.

**Conservation:** The species is one of the most abundant in River Nestos/Mesta, even if it is the main target of recreational fishing activity. Consequently, in general it is characterized as Least Concern (LC) according to IUCN norms. Furthermore, conservation status according to Bulgarian Red Data Book and the Biological Diversity act is qualifying it as Data Deficient (DD).

## *Carassius gibelio* (Bloch, 1782)

(EN) Prussian carp (BG) Srebrista karakuda  
(GR) Petalouda, Agriochrysopsaro

Teodora TRICHKOVA & Panos S. ECONOMIDIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Carassius auratus gibelio*, Drensky, 1948, 1951; Economidis, 1974; Zivkov, 1987; Karapetkova & Zivkov, 1995; Sivkov, 2003; Apostolou, 2005; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D iv/17 rarely iii or v and 16 or 18, 19, A iii/5, gill rakers 46-50 (rarely 44, 45, and 51), vertebrae 31-33 (rarely 29 or 32), L.I. 30-31, rarely 29 or 32 (Sivkov, 2003). The dorsal fin is long and usually concave. The anal fin is short with 3 unbranched and 5 branched rays (3 and 6 rays, respectively, in the Mesta/Nestos River) (Apostolou, 2002; Sivkov, 2003). The last simple anal and dorsal rays are strongly serrated. The body is elongated, of moderate depth and laterally compressed. The body colour is silvery-brown and the peritoneum is black.

**Distribution:** The species has been

introduced to the Mesta/Nestos basin. Zivkov (1987) reported it as introduced accidentally together with common carp, which was used for aquaculture to the Dospat reservoir. Later, Stefanov & Trichkova (2006) confirmed its occurrence in the reservoir. First record in the river was reported by Economidis (1974). At present, it is found in the Dospat reservoir, in the slow-flowing sections of the river and adjacent backwaters. Two specimens were found in the Greek part of the Nestos/Mesta river, upstream of the Thisavros dam during Nestos project.





Translocated



Freshwater



Not Marketable



**Ecology & biology:** The species is frequenting in rivers, lakes and marshes, as well as in coastal fresh water lagoons. Populations appear to be unisexual composed by triploid females, or bisexual, including diploid females and males (Golovinskaya *et al.*, 1965). There were a very high percentage of unisexual populations reproducing gynogenetically by using the sperm of other species, mainly cyprinids, to activate their eggs (Berg, 1949a; Economidis, 1974; Penaz *et al.*, 1979). In Bulgaria, in the 1950-1980s, populations in the reservoirs and fishponds consisted mainly of gynogenetic females, while males occurred occasionally in an average varying from 0 to 1.5% (Paspalev & Pechev, 1955; Zivkov, 1980). However, recently, bisexual populations are found with

males ranging from 30 to 50% in the catches (Apostolou, 2002; Trichkova & Zivkov, 2007; Trichkova *et al.*, 2008). Spawning occurs in late May and June. The species is omnivorous feeding on plankton, benthic invertebrates, plant material and detritus. The body length reaches from 77 to 170 mm in the first year, from 132 to 273 mm in the second year, from 170 to 317 mm in the third, etc. (Trichkova & Zivkov, 2007).

**Conservation status:** The species is ecologically very plastic and very harmful, because of its strong competition with other native species. Maybe it is one of the main factors which caused the decline of native *C. carassius* populations in Bulgaria. No protection measures.



## *Chelon labrosus* (Risso, 1826)

(EN) Thicklip grey mullet (BG) Ostronos kefal (GR) Cheilonari

Apostolos APOSTOLOU & Manos KOUTRAKIS



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Chelon labrosus*, Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994; Koutrakis & Sinis, 1994; Koutrakis & Tsikliras, 2003; Koutrakis, 2004; Koutrakis *et al.*, 2005; Vassilev & Pehlivanov, 2005.

**Diagnosis:** The species is distinguished from other Mugilidae in having: lower 1/3 of upper lip with 2-3 rows of papillae with horny edges. Also it has 5-7 pyloric caeca around the stomach (Zismann, 1981) and a not especially thick adipose eyelid not which doesn't extend onto iris (Whitehead *et al.*, 1986). Maximum observed size in Vistonis Lake is up to 416 mm TL (Koutrakis & Sinis, 1994; Koutrakis & Tsikliras, 2003).

**Distribution:** The species is distributed in all coasts of Mediterranean, Black seas and of eastern Atlantic up to Norway,

southern Iceland and Faroe Islands (Kottelat & Freyhof, 2007). It practices trophic migration in freshwater and euryhaline waters of estuarine systems and lagoons, where it lives for long periods, through river mouth and channels. In Nestos/Mesta system it is frequenting in the lagoons of the river delta.

**Ecology & Biology:** The species has a pelagic life, living near shores, entering in lagoons and estuaries. Spawns at sea in coastal surface water (Froese & Pauly, 2008). Usually lives in schools and



Autochthonus



Euryhaline



Marketable



juveniles easily adapt to freshwater (Koutrakis, 1994) where they migrate 2-3 months after hatching. Males reproduce for the first time at 2 years, females at 3. Females are larger than males. Spawns pelagic eggs in February-April and juveniles of about 15 mm move towards coastal lagoons and estuaries (Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994). Main diet includes: phytoplankton (24%), detritus (20%), and unidentified insects (15%) for juveniles of the species *C. labrosus* (Salvarina & Koutrakis, 2008). The

highest recruitment rate of *C. labrosus* in North Greece was observed in June (Koutrakis, 2004). According to Koutrakis & Sinis (1994) the growth rate, recorded from lake Vistonis is the second higher among other Mugilidae found in this lake.

**Conservation:** The species, having a large range, is abundant in the lagoons of the river Nestos delta, constituting one of the main commercial fish species in these areas. Consequently it could be qualified as Lower Risk: least concern (LR/lc).

## *Chondrostoma vardarense* (Karaman, 1928)

(EN) Vardar nase (BG) Vardarski skobar, boinik  
(GR) Sirtis, Gourounomitis

Apostolos APOSTOLOU & Argyris SAPOUNIDIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Chondrostoma nasus vardarense* Karaman, 1928; Berg, 1932, 1949; Banarescu, 1964; Economidis, 1974, 1991.

*Chondrostoma nasus*, Drensky, 1930; Michajlova, 1965.

*Chondrostoma nasus vardarensis*, Chichkoff, 1939; Drensky, 1948, 1951; Michajlova, 1970; Karapetkova 1976; Pehlivanov, 2000.

*Chondrostoma vardarense*, Elvira, 1987; Vassilev & Pehlivanov, 2002; Stefanov & Trichkova, 2004.

*Chondrostoma vardarensis*, Economidis & Banarescu, 1991.

**Diagnosis:** D iii/8-9, A iii/9-10, P i/14-17, V ii/7-9, C 19, L.I. 9-10/59-67/5-6, vertebrae: 45-47, gill rakers: 29-33, pharyngeal teeth: 6-6 or 5-6. Maximum observed length about 42 cm. The species is characterized by its thick and fleshy lips, and the flat grey color of the body, which is typical fusiform as in the other rheophilic species.

**Distribution:** The species is confined in the aquatic systems flowing into the north Aegean, from the river Pinios in Thessaly up to the river Evros/Mariza in Thrace, including the river Aoos in Epirus (see Economidis, 1974, 1991). It is also found in the system of the drained lake Karla (Apostolou, unpublished data). First reference concerning the



Autochthonus



Portected



Freshwater



Marketable



occurrence of the species in Mesta/Nestos River is given by Drensky (1930). The more recent presence of the species in the downstream Greek part of the river is given by Economidis (1974) and in the upstream Bulgarian part by Apostolou (2002, 2005). The species is mainly distributed southern of the village Gospodintsi, upstream of the dam of Thisavros and the downstream of the Platanovrisi dam, especially in the area near the village of Paranesti. A dense population of *C. vardarensis* was found in the dam-lakes, especially in Thisavros.

**Ecology & biology:** The species inhabits lowland water courses in rivers, streams, and lakes (natural and

reservoirs). It is active in the water column better than in the bottom upper rocky, gravely and sandy substrate, with essential current velocity. Ascends tributaries to spawn in rapids and riffles among stones. It forms big schools and undertakes short migrations upstream in spawning period. Feeds on periphyton and benthic invertebrates.

**Conservation:** The species is quite abundant in the river Nestos/Mesta, even if it is one of the target fish of recreational fishing. However, in several habitats it is threatened because of the water pollution and water diversion. According to IUCN it is classified as Near Threatened (NT).

## *Cobitis strumicae* (Karaman, 1955)

(EN) Thracian Spined loach (BG) Strumski shtipok  
(GR) Thrakovelonitsa

Apostolos APOSTOLOU & Argyris SAPOUNIDIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Cobitis taenia*, Kovatchev, 1921a, 1921b; Michajlova, 1965a, 1965b; Russev, 1966; Economidis, 1974.

*Cobitis taenia taenia*, Drensky, 1928, 1929, 1930; Berg, 1932, 1949.

*Cobitis taenia vardarensis*, Taler, 1953.

*Cobitis taenia strumicae* Karaman, 1955.

*Cobitis peschevi* Sivkov & Dobrovolov, 1986

*Cobitis strumicae*, Economidis & Banarescu, 1991; Economidis, 1991; Economidis & Nalbant, 1996.

**Diagnosis:** D ii-iii/6-9, A ii-iii/4-6, P i/7-10, V ii/5-7, C 14-18, vertebrae: 40-44, gill rakers: 9-12, pharyngeal teeth: 10-11. Suborbital spine straight, with the longer thorn curved and three times longer than the shorter. The lateral line is reduced and does not exceed the length of pectoral fins. The species is characterized by the two *lamina circularis* (*Bicanestrinia*) of males lying on the base of the pectoral fins, and by the lacking of

round black spot in the upper part of caudal peduncle. In the place of this last, there are two lunate large brown spots, one in each corner, or 2-3 smaller. The lateral brown spots (Gambetta's zones) are well developed. Maximum observed size up to about 15 cm.

**Distribution:** The species is native and well distributed in the following aquatic systems in the north Aegean: rivers Struma/Strymon, Mesta/Nestos and



Autochthonus



Freshwater



Not Marketable



Maritza/Evros, and lakes Koronia and Volvi and almost all in-between smaller catchment (see Economidis, 1974, 1991; Apostolou, 2002, 2005; Vassilev & Pehlivanov, 2002; Stefanov & Trichkova, 2004). According to Bohlen *et al.* (2006), the species has a wider distribution, including also some Bulgarian tributaries of Danube system as Vit. First reference for river Mesta/Nestos is given by Drensky (1928). In the Bulgarian side of the river it has a scattered presence southern of the village Bukovo, while in Greece is distributed mainly upstream of the Thisavros dam and downstream of the Platanovrisi dam. Higher density was observed in the area near Stavroupolis.

**Ecology & biology:** The species is a typical benthic fish with cryptic

behaviour as it normally is hiding during day in the muddy or sandy bottoms, with or without macrophytes. It occurs in highland and lowland water with little current, in springs and associated wetlands and in lakes. It forms pairs during breeding and the eggs are lying scattered in open water substratum (Breder & Rosen, 1966). It feeds mainly on benthic invertebrates and detritus.

**Conservation:** In the large area of its distribution the species appeared locally abundant. But in several places obviously is threatened due to the pollution and the habitat destruction. According to IUCN qualification it should be considered as Data Deficient (DD).



## *Cyprinus carpio* Linnaeus, 1758

(EN) Common carp (BG) Sharan (GR) Grivadi

Teodora TRICHKOVA & Panos S. ECONOMIDIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Cyprinus carpio*, Athanassopoulos, 1917; Kovatchev, 1921a, 1921b; Konsuloff & Drensky, 1943; Drensky, 1948, 1951; Taler, 1953; Karaman, 1955; Michajlova, 1965b; Russev, 1966; Economidis, 1974; Tsigenopoulos & Berrebi, 2000.

**Diagnosis:** D iv / (17) 18-20 (22), A iii / 5, C 19, P i / 16-17, V ii / 8 (9), vertebrae 35-37; L. l. 6-7 / 35-38 / 6-7, gill rakers: 21-27 (Economidis, 1974; Karapetkova & Zivkov, 1995). The species is characterized by its dorsal fin which is nearly 4 times longer than the anal fin and by two pairs of barbels in its upper lip. The body is laterally compressed and covered by large scales. The body colour is uniform varying from grey to bronze (Froese & Pauly, 2008).

**Distribution:** The species has a rather unknown native distribution in Europe because of the large and perpetual stocking since the old time (see Balon, 1995). It seems that it has been

introduced also to the Mesta/Nestos basin, where it was firstly reported by Drensky, (1948) for the Bulgarian part of the river and later confirmed by Apostolou, (2005). The presence of the species in the Greek side of the river was recorded on the basis of specimen by Economidis, (1974). The species occurs in the Dospat reservoir, where it was introduced repeatedly (Zivkov, 1987, Stefanov & Trichkova, 2006). Recently, it has also been found in small numbers in artificial lakes formed by sand excavation near Eleshnitsa, Gotse Delchev and Hadzhidimovo (Bulgarian sector), as well as in the upstream of the Thisavros dam (Greek sector).





Translocated



Freshwater



Marketable



**Ecology & biology:** The species inhabits lower reaches of rivers, marshes, lakes and reservoirs, as well as coastal fresh water lagoons. In the Mesta/Nestos river drainage basin, it was signalled in almost all the above habitats. Sexual maturity in males appears at the age of 3-5 years, and in the females at 4-6 years (Kottelat & Freyhof, 2007). It takes place along shores or in the shallow backwaters among submerged plants and it is followed by a characteristic noise. The eggs are deposited on vegetation (phytofilous). The fecundity varies from 200000 to 1200000 eggs. Carp is an omnivorous species feeding on aquatic insects, crustaceans, annelids, molluscs, weed and tree seeds, aquatic plants and algae (Froese & Pauly, 2008), being most active during dusk and dawn (Kottelat & Freyhof,

2007). It is known from records of various European monasteries that it is a long lived species (Balon, 1995), reaching up to 30 and more years. In the period 1968-1983, in the Dospati reservoir, carp showed moderate growth rate attaining a body length of 119 mm in the first year, 238 mm in the second year and 489 mm in the 6<sup>th</sup> year (Zivkov, 1999).

**Conservation:** The native populations are threatened by the destruction of the spawning grounds. As a species which is widely used in fish farms and in various stocking programs, it is out of any control. On the Mesta/Nestos river basin, the carp population is in very low abundance and maintained mainly by stocking. In Bulgaria, only the wild form of *C. carpio* is protected, while in Greece, it is qualified as LC.

## *Dicentrarchus labrax* (Linnaeus, 1758)

(EN) European seabass (BG) Lavrak (GR) Lavraki

Panos S. ECONOMIDIS & Angel TSEKOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Dicentrarchus labrax*, Kottelat, 1997; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D1 viii-ix (x), D2 i + 12-13, A iii + 10-12, L. l. 52-80, gillrakers 8-10. The species is characterized in having two dorsal fins of almost equal size, the first with all rays spined and the second with one spined and 12-13 segmented soft rays. The body is rather elongate, ovoid, of a moderate to large size and covered by ctenoid scales which in the upper part of the head are cycloid. The posterior edge of the preopercle is finely serrated and the lower edge with strong forward-directed denticles. There are also two flat opercular spines while the vomerine teeth are present only

anteriorly in a crescentic band, without a backward extension on midline of roof of mouth. The colour of the body in adult fish is homogenous silver, greenish or slightly bluish on the back, but a diffuse black spot appeared on the edge of the opercle. The youngs have some dark spots on the upper part of the body. The species can reach a large size, up to 100 cm SL but usually rarely exceeds the 20-55 cm SL; max. reported weight: 12 kg and age 15 years.

**Distribution:** The species has a large distribution from eastern Atlantic to the Mediterranean and Black Sea (Froese &



Autochthonus



Euryhaline



Marketable



Pauly, 2008). In Nestos system it was found in the lagoons of the River Nestos delta.

**Ecology & biology:** *Dicentrarchus labrax* is a voracious predator looking for food mainly in the water column in all inshore waters, on various kinds of bottoms, including the slightly polluted in harbors. As an energetic hunter, this can support large variation of salinity, it also frequent in brackish waters entering in lagoons and even in rivers and jointed lakes. When it is young it is gregarious. The reproduction takes place in the sea and during this period it forms schools and spawns in groups

from January to March in the Mediterranean. The eggs are pelagic and the juveniles appeared in Porto Lagos lagoon in May (Koutrakis *et al.*, 2005) and in Strymonikos gulf in February (Koutrakis *et. al.*, 2000). The males mature at 2 years (23-30 cm SL) and the females at 3 years (31-40 cm SL). The food is composing by fish, crustaceans, mollusks, and occasionally by any available swimming or drowned item, including small mammals.

**Conservation:** The species is rather abundant in the lagoons of the Nestos delta as elsewhere. Therefore it can be qualified as Lower Risk/least concern.

## *Esox lucius* (Linnaeus, 1758)

(EN) Pike (BG) Shtuka (GR) Tournia

Lucho PEHLIVANOV & Panos LEONTARAKIS



Photo: T.C. Kline (fishbase)

**Nomenclature & synonyms:** *Esox lucius*, Kovatchev, 1921b, Drensky, 1951; Konsuloff & Drensky, 1943; Michajlova, 1965b; Russev, 1966.

**Diagnosis:** D vii-ix/13-16, A vi-vii/11-14, P i(ii), V i-ii/ 9-10, C 19, L.l. 15-16/115-135/14-17, vertebrae: 59. The species is distinguished by its long, flat and 'duck-bill' snout; its large mouth with many large and sharp teeth and the rearward position of its dorsal and anal fins. The gill rakers are present only as patches of sharp teeth on gill arches and the lateral line notched posteriorly. The dorsal fin is located far to the rear and the anal under dorsal is arising a little behind it; the pectorals and the ventrals fins are rounded, paddle-shaped and located low on the body (Morrow, 1980).

**Distribution:** The species presents a circumpolar distribution (America, Europe and Asia). It is recorded in Greece [lakes Koronia (now collapsed) and Volvi, rivers Vardar/Axios, Struma/Strymon and Evros/Maritsa. and in Thessaly] (Apostolidis, 1892, 1907; Athanassopoulos, 1921; Stephanidis, 1950). In the Bulgarian part of the river Mesta/Nestos it was first mentioned by Drensky (1951), although it is not clear if it is native for the system. At the moment it inhabits only the Ormanski Gyol sand pit near Gotse Delchev town. In the Greek sector



Translocated



Freshwater



Marketable



according to information given by local fishermen, the species exists in pools and irrigation channels in the lower part of the river.

**Ecology & biology:** The species occurs in clear vegetated lakes, quiet pools and backwaters of creeks and in small to large rivers. Usually it lives solitary and presents a high territoriality. Carnivorous fish, feeding mainly on fish, but at times feed heavily on frogs and crayfish. From time to time, juvenile presents cannibalistic habits, but usually it feeds on fishes, aquatic insect larvae,

birds, and aquatic mammals. Generally it does not undertake long migrations, but a few may move considerable distances (FishBase). It is an oviparous species, the eggs and the young are preyed upon by fishes, aquatic insect larvae, birds, and aquatic mammals (Fishbase). In spite of numerous attempts to culture this species, it was never entirely domesticated and does not accept artificial food (Billard, 1997).

**Conservation:** It is not evaluated because it seems to be an introduced species in the river Nestos/Mesta.

## *Gambusia holbrooki* (Girard, 1859)

(EN) Eastern mosquito fish (BG) Gambusia (GR) Kounoupofagos

Apostolos APOSTOLOU & Dimitris LACHOUVARIS



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Gambusia affinis holbrooki*, Economidis, 1974; Vassilev, 1988, 1999a, b; Polacik *et al.*, 2008; Apostolou, 2002, 2005.

**Diagnosis:** Di/7, Ai/9, L.l. 26-30. This is a small size warm-water fish characterized in having the ventral fins positioned abdominally, before the origin of the dorsal, and by a poorly developed lateral line. At presents a clear sexual dimorphism which is expressed in the male being smaller and having specified intromittent organ (copulatory organ or gonopodium) formed by the transformation of the anal fin. The species also has a body covered by large cycloid scales and a head which is characteristically flattened in its upper part. Total length about 4 cm.

**Distribution:** The species is originated from USA, but afterwards was introduced in almost all the world, including Europe, for the mosquito larvae control (malaria). The first reference for Struma/Strymon and Mesta/Nestos rivers was made by Apostolou (2002, 2005), in Mesta actually only in the former sandpit Ormanski Gjöl near Gotse Delchev town. In the Greek part of the river it was found, during the Nestos project, mainly in its lower catchment in the channels of the Hrysoupolis plain, where it observed to be locally abundant



**Alien**



**Freshwater**



**Not Marketable**



(marshes). It is also signaled elsewhere in Bulgaria as in the systems of the rivers Danube and Kamchia and the lakes Durankulak and Shabl (Vassilev, 1988, 1999a, b; Polacik *et al.*, 2008). For Greece see Economidis (1974).

**Ecology & biology:** The species inhabits rather warm, still and brackish water, in a pH ranging from 6.0 to 8.8 and a dH around 40, in a climate where the air temperature can vary from 15 to 35°C. Typically it can be seen shoaling at the edges of streams and lakes, but better stays in the shallow waters, hiding among vegetation. It has a high rate of fertility, as the populations being

doubling in a time less than 15 months. It feeds mainly on mosquito larvae but also various other items, including eggs and fries. It also presents a high aggressivity against other sympatric small size species and fry. The reproduction is internal (oviparous) and the spawning gives several decades of fry each time (batch spawning).

**Conservation:** As introduced species is not subjected in any conservation measure. Furthermore, it is very abundant in the lower part of Nestos/Mesta and a potentially pest fish, especially harmful for the native aquatic invertebrate fauna.



## *Gobio bulgaricus* Drensky, 1926

(EN) Aegean gudgeon (BG) Egeiska Krotushka (GR) Gyftopsaro

Panos S. ECONOMIDIS & Apostolos APOSTOLOU



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Gobio fluviatilis*, Kovatchev, 1921a.

*Gobio gobio*, Kovatchev, 1921b; Chichloff, 1937; Michajlova, 1965a, 1965b; Russev, 1966.

*Gobio gobio gobio*, Drensky, 1948, 1951; Michajlova, 1966; Marinov, 1973.

*Gobio gobio bulgarica* Drensky, 1926, 1930.

*Gobio gobio bulgaricus*, Berg, 1932, 1948; Banareccu, 1960; Economidis, 1974; Dobrovolov, 1994.

*Gobio bulgaricus*, Kottelat & Freyhof, 2007.

**Diagnosis:** D iii/7, A iii/5-7, P i/13-15, V ii/6-7, C 19, L. 1. 6-7/38-42/4-5, gill rakers 2-3, vertebrae 37-38, pharyngeal teeth 5.3-3.5 or 5.2-2.5. In the body there are 7-8 lateral spots. According to Kottelat & Freyhof (2007) the species is distinguished by a combination of characteristics such as: 4-6 scales between anus and insertion of anal fin (Á), head length 25-29 % of the Standard

Length (SL), thorax with scales near the ventral fins, which extend beyond the base of the ventral fins, often 35-38 + 3 scales in the lateral line, 14-16 lines of scales around the caudal peduncle and eye diameter 1.1-1.5 time of the interorbital space. Total observed length about 14 cm.

**Distribution:** The species is confined in the aquatic systems flowing into the



Alien



Freshwater



Not Marketable



north Aegean, from the river Aliakmon to the river Evros/Mariza, including all independent waters bodies in between (see Economidis, 1974). In the river Mesta/Nestos it is distributed southern of the confluence of the tributaries Razlozka and Glazna (under Razlog town), in Bulgarian side, and in Greek side downstream of Platanavrisi dam, near the village Paranesti and southern near to the town of Stavroupolis.

**Ecology & biology:** The species is frequenting in rather shallow areas of the river with clean and slow running water or in dead branches of the river with usually sandy bottoms. It also could be found in places with faster current. In general it is active during the day and it is observed to form schools,

but in case of disturbance, in particular by predators, it can switch its activity to periods when light intensity is weak. It is known as emitting squeaking sounds, probably of communication meaning, which vary with the degree of activity and the temperature and are independent of the season of reproduction. The diet is composed of insect larvae, molluscs, and crustaceans, while the reproduction take place in late spring to early summer.

**Conservation:** The species is locally abundant especially in low parts of the river confined in the Greek territory, in spite of the fact that the habitat destruction and the water pollution, which are the main reason of its decline. It is categorized as lower risk (LR).

## *Knipowitschia caucasica* (Berg, 1916)

(EN) Caucasian dwarf goby (BG) Kavkazko popche (GR) Pontogovios

Panos S. ECONOMIDIS & Angel TSEKOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Knipowitschia lenkoranica*, Georgiev, 1964.

*Knipowitschia caucasica*, Georgiev, 1966; Economidis, 1974; Economidis & Miller, 1990; Bianco *et al.*, 1996; Kottelat, 1997; Vassilev & Pehlivanov, 2005.

According to Kottelat & Freyhof (2007) the variability (morphological and ecological) reported for *Knipowitschia. caucasica* suggests that this is a complex of several species.

**Diagnosis:** The species is distinguished from the other species by: D1 vi (v-viii), D2 i + 8(7-10), A i + 8(7-10), P 15-17 (15-18), L.l. 33-35 (31-38); vertebrae 31-32 (30-33) (Economidis & Miller, 1990, Vasilieva & Kuga, 2001). In the body there are 4-8 dark stripes which are well visible in breeding males. In front of the origin of second dorsal fin there is a naked area. The anterior extremity of anterior oculoscapular canal in front of middle of eye (pore  $\ddot{e}$ ); the posterior

oculoscapular canal is present. The females have a yellow belly in life. Maximum observed size up to 50 mm SL.

**Distribution:** The species can be found in a variety of environments, from saline to fresh and estuarine waters along coasts of Black, Azov, Caspian and north eastern Mediterranean Sea. Existence of populations along the eastern shore of Adriatic is questionable. It has been recorded in freshwater lakes and



Autochthonus



Euryhaline



Not Marketable



lowland rivers more than 100 km from coast. It was introduced in Aral Sea, but now is extirpated (Ahnelt *et al.*, 1995). In Aegean sea is recorded in various brackish and freshwater bodies like rivers Evros, Filiouris, Nestos, Strymon, Axios and Aliakmon, and in lakes Vistonis, Volvi, Koronia (Economidis, 1991). In river Nestos/Mesta it was first mentioned by Economidis (1974) and during the Nestos project was found in the lagoons of the Delta.

**Ecology & biology:** The species can tolerate fresh to hypersaline waters (salinity up to 55 psu) of lakes, estuaries and lagoons. It is most abundant in shallow, well vegetated habitats. It lives less than 2 years and spawns from March to July after first winter, at a size of 20-23 mm SL. Each time it spawns up

to 4 portions of eggs which are attached to the roof of a cavity of dead braches of reed and other plant material or under stones or in empty shells and are guarded by the males (Daoulas, 1993; Miller, 2004). The hatched larvae are pelagic. It is a microphagus species feeding mainly on small invertebrates. In Lake Trichonis on mud to gravel bottom, at depths less than 2 m it feeds mainly on copepods and larvae of the zebra mussel *Dreissena polymorpha* (Economou *et al.*, 1994b).

**Conservation:** The species is locally abundant consequently it could be qualified as Lower Risk: least concern (LR/lc). However, due to the habitats destruction by wetlands drying and water pollution, its distribution is seriously restricted.

## *Lepomis gibbosus* (Linnaeus, 1758)

(EN) Pumpkinseed (BG) Slancheva riba (GR) Iliopsaro

Luchezar PEHLIVANOV & Panos LEONTARAKIS



Photo: FRI - A. Sapounidis

**Nomenclature & synonyms:** *Eupomotis gibbosus*, Drensky, 1920, 1948, 1951.  
*Lepomis gibbosus*, Vassilev & Pehlivanov, 2002; Apostolou, 2002, 2005.

**Diagnosis:** D x-xii/10-20, A iii/8-11, vertebrae: 2830. (Karapetkova & Zivkov, 1995; Maurakis & Economidis, 2003). The body is short, deep and laterally compressed, covered with small ctenoid scales. Anterior dorsal and anal fins with stout spines. The two parts of the dorsal fin being connected. The fish is colorful having in the posterior margin of the opercular flap in males a characteristic bright black red to orange spot.

**Distribution:** The species is native in America being introduced almost all over Europe since 1887. In Bulgaria it is

widely distributed in lower and partially middle river stretches, and in lakes, marshes and reservoirs of the Danube basin. Also, in the watersheds of both Black and Aegean seas. In Greece thriving populations occur in river systems of Evros (Ardas), Strymon (Kerkini), Axios, Loudias, and in the lower part of Aliakmon, lakes Prespa, and dam lake of Tavropou (Maurakis & Economidis, 2003) and recently in Ladonas (Peloponnesus). Its distribution in the Mesta/Nestos basin is related to the water bodies artificially stocked with carp and other species. It



Alien



Freshwater



Not Marketable



has been firstly mentioned in the Mesta/Nestos by Apostolou (2002, 2005), and also reported in the Bulgarian part of the Struma /Strymon by Vassilev & Pehlivanov (2002). In the Greek part of the river was mainly found, during the research project on the river Nestos/Mesta fishfauna, in the damlake of Thisavros and downstream of Platanovrisi dam, near the village Paranesti.

**Ecology & biology:** The species can be characterizing as a termophilous and slowly moving fish, occurring mostly in still or slow-flowing waters such as ponds, pools, lakes, marshes, creeks, small rivers often among dense vegetation, with weed and mud bottom.

It also inhabits the lowest stretches of the rivers and standing water basins, tolerating extremely low oxygen saturations. It is an omnivorous fish, adults' diet consists of bottom invertebrates and aquatic insect larvae, young are fed on algae. The breeding period is mainly May to June and it is taking place in shallow water among dense vegetation. The maximum observed length is about 50 to 60 cm.

**Conservation:** As an introduced species is not subjected in any conservation measure. Furthermore, it is quite abundant in the low part of Nestos River and potentially a pest fish, especially harmful for the native aquatic fauna.



## *Leucaspheus delineatus* (Heckel, 1843)

(EN) Sun bleak (BG) Belitsa, Varlovka (GR) Mikrosirko

Panos LEONTARAKIS & Teodora TRICHKOVA



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Phoxinellus thracicus* Battalgi, 1942.

*Leucaspheus delineatus*, Michailova, 1967; Economidis, 1974; Kottelat, 1997.

**Diagnosis:** D ii/7-8, A iii/10-12, P i/12-14, V ii/7, C 18-19, L.I. (2) 4-7 (9), Squamation 40-46, vertebrae 38-40, gill rakers 14-16 (17). This is a small fish with elongated body of low depth and laterally compressed, covered with large loosely attached silvery scales. The lower edge of the body between the pelvic and anal fins forms a sharp keel. The mouth is terminal. The colour of the body is homogenous grey to silver without any spot or speckle except an inconspicuous intense dark grey to green band along each side. The maximum body depth ranges from 18.1

to 21.6% of SL, and the maximum body width from 9.9 to 14.1% of SL (Manolov & Sivkov, 1977).

**Distribution:** The species has a large distribution in Europe and Asia, spreading out into northern Europe through the canal systems (Froese & Pauly, 2008). In river Nestos/Mesta it was found firstly in the Paradeisos carstic spring (Economidis, 1974) and recently during the Nestos project in several channels in Chrysoupolis plain. Elsewhere, it was also recorded in river Evros/Maritsa (Economidis, 1974) and in several independent water bodies





Autochthonus



Protected



Freshwater



Not Marketable



near Constantinople (Battalgil, 1942).

**Ecology & biology:** The species is frequenting in the lower reaches of permanent rivers and coastal lakes. It is living between weeds in shallow pools and creeks, shallow lakes, peat and clay excavations and canals. This is a shoaling fish reaching sexual maturity usually in the second year at body length of 40-50 mm (Manolov & Sivkov, 1977). The spawning takes place in shallow waters, among weeds, in the period from April to June (Maitland, 2000). With the help of elongated urogenital papillae -in the same manner as ovipositor- the female lays 80 to 2300 eggs (Holcik, 1998) which are guarded by the male. It feeds on invertebrates

(especially crustaceans and insect larvae) and fine plant material. It reaches a maximum body length of 90 to 120 mm and has life span of about 5 years (Maitland, 2000).

**Conservation:** In the Nestos/Mesta drainage the species seems to have small abundance probably affected by changes in the hydrological regime of the river which resulted in a loss of the species habitats mainly in the lowland catchment. The IUCN norms consider the species as Least Concern (LC), although it is registered in Bern Convention in Annex III. The species is included in the Bulgarian Red Data Book as vulnerable, but not in the Greek Red Data Book.

## *Liza aurata* (Risso, 1810)

(EN) Golden grey mullet (BG) Platerina (GR) Miksinari

Manos KOUTRAKIS & Luchezar PEHLIVANOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Liza aurata*, Koutrakis, 1994, 1999, 2004; Koutrakis *et al.*, 1994, 2005; Vassilev & Pehlivanov, 2005; Kottelat, 1997.

**Diagnosis:** The species is distinguished from other species of the *Liza* family in Europe by: a golden blotch on opercle, predorsal scales with a single or no longitudinal groove, 20 circumpeduncular scale rows, posterior angle of preorbital bone pointed, 40-41 scales in a longitudinal line (not including scales on caudal base) (Kottelat & Freyhof, 2007). Also the tip of the pectoral fin when is folded forward, almost reaches the pupil of the eye. Juveniles are identified by pyloric caeca, which are placed in one group of 8-9 (Zismann, 1981). Maximum observed

size in Lake Vistonis is up to 311 mm TL (Koutrakis & Sinis, 1994).

**Distribution:** The species is distributed in Mediterranean and Black Sea and eastern Atlantic up to southern Norway, British Isles and northern Red sea (Kottelat & Freyhof, 2007). In Nestos/Mesta system it was found in the lagoons of the river delta.

**Ecology & biology:** It is a pelagic fish frequenting in coastal areas, sometimes in lagoons and estuaries, rarely into freshwaters. Among Mugilidae recorded from European freshwaters, this is the least tolerant to freshwater. It



Autochthonus



Euryhaline



Marketable



spawns at sea (Froese & Pauly, 2008) and usually lives in schools. The reproduction in North Greece takes place, from October to December (Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994). The eggs are pelagic and non-adhesive. Juveniles of about 15 mm move to coastal lagoons and estuaries in winter and especially in spring (Koutrakis, 1994; Koutrakis *et al.*, 1994). They feed on copepods (17%), insects (17%), amphipods (13%), and mysids (12%) (Salvarina & Koutrakis, 2008) while larger individuals feed on small

benthic organisms, detritus, and occasionally on insects and plankton.

**Conservation:** The species is abundant in the lagoons of the Nestos delta, constituting one of the main commercial fish species, with high value. Consequently, is out of any obvious direct threat, although extended habitat destruction in wetlands suggesting a progressive threat. Today, it could be qualified as Lower Risk: least concern (LR/lc).

## *Liza haematocheilus* (Temminck & Schlegel, 1845)

(EN) Soiyu mullet (BG) Pelengas (GR) Sazanokefalos

Panos S. ECONOMIDIS & Milen VASSILIEV



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Mugil soiyu*, Koutrakis & Economidis, 2000.

*Liza lauvergnii*, Koutrakis & Economidis, 2000.

*Liza haematocheila*, Corsini-Foka & Economidis, 2007.

*Liza haematocheilus*, Harrison, 2004; Minos *et al.*, 2009.

**Diagnosis:**  $D_1$  iv  $D_2$  i/8,  $A$  iii/8-9. The species is distinguished from other members of the Mugilidae family in having a rather emarginated to slight forked caudal fin and large scales. According to Koutrakis & Economidis (2000) it also has: an elongate and slender body; a pointed head flattened on top and in a length which is the 23-24% of SL; ctenoid scales without denticulation, 40-43 scales in a lateral series; 6 pyloric caeca; thin adipose eyelid (25-30% of the head length). Pectoral fin short and is not reaching first dorsal fin origin.

**Distribution:** The species is native in the

brackish waters of Japan Sea, from Peter the Great bay to Macao in the south (see Minos *et al.*, 2009). It is introduced in Azov and Black seas during 70s from artificial propagation and it escaped to the nearby free waters (Starushenko & Kazansky, 1996). At present it becomes one of the most important commercial fish in these areas (Pianova, 2005). Alive fish crossed Bosphorus, Marmara Sea and Dardanelles and appeared in the Gulf of Smyrna in Turkey (Kaya *et al.*, 1998) and in the Thracian Sea in Greece (Koutrakis & Economidis, 2000). Last years it is progressively spreading around and



Alien



Euryhaline



Marketable



signaled in several other localities (mainly in the Strymon/Struma and Nestos/Mesta estuaries).

**Ecology & biology:** The species occurs near shores, estuaries and river mouths entering easy in lagoons, coastal lakes and rivers (see Minos *et al.*, 2009). In the fall, it migrates into rivers and settles down into pits for wintering (Serkov, 2003). Individuals are observed to wandering in the Vistonis lagoon, too. In the Amour bay the spawning period is proceeding from June to the middle of July (Mizyurkina, 1984). In the Azov sea, however, observed some remarkable differences (Abrosimova & Abrosimov, 2002) and during evening and night (Chesalina, 2000). Eggs may be fertilized in salinity ranging from 3 to 45 psu and larvae can be adapted to fresh and salt

water (Bulli & Kulikova, 2006). Free eggs in the Black sea are pertained since 1996 (Chesalina, 1997; Kideys *et al.*, 2000). According to Matishov & Luzhnyak (2007) the species after acclimatization in the Azov Sea, switched its spawning standards and reproduces into rivers and streams with low salinity, a fact which has not been previously recorded (Luzhnyak, 2007). The growth of the species in the environment of Azov and Black seas seems to be good, as larger size (up to 80 cm) specimens are not rare.

**Conservation:** This is an alien species which presents a very successful adaptation in Black sea, becoming very soon a harmful fish for other mullets species because of its strong competition upon them. Not any conservation care.

## *Liza ramada* (Risso, 1826)

(EN) Thinlip mullet (BG) Tankoust kefal (GR) Mavraki

Manos KOUTRAKIS & Luchevar PEHLIVANOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Liza ramada*, Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994; Kottelat, 1997; Koutrakis, 2004; Koutrakis *et al.*, 2005; Vassilev & Pehlivanov, 2005; Kottelat, 1997; Kottelat & Freyhof, 2007.

*Liza ramado*, Fricke, 1999; Fricke *et al.*, 2007.

**Diagnosis:** The species is distinguished from other species of *Liza* in Europe by: the predorsal scales which have a single or no longitudinal groove, the 24 circumpeduncular scale rows, a black spot at pectoral base, 41-46 lateral scales (not including scales on caudal base) (Kottelat & Freyhof, 2007). Furthermore, the tip of pectoral fin does not reach or barely reach posterior rim of eye, when it is folded forward. The adipose eyelid is poorly developed. The species has one group of 6-9 caeca (Zismann, 1981).

Maximum observed size in Lake Vistonis is up to 488 mm TL (Koutrakis & Sinis, 1994, Koutrakis, 1994, Koutrakis & Tsikliras, 2003).

**Distribution:** The species belongs to the Mediterranean group of mullets and it is also distributed in Black and Azov seas, and the eastern Atlantic from Cape Verde and Senegal to southern Baltic and British Isles (Kottelat & Freyhof, 2007). In Nestos/Mesta system it was found in the lagoons of the river delta.

**Ecology & biology:** The species follows





Autochthonus



Euryhaline



Marketable



a pelagic mode of life staying near shore, entering lagoons and lower reaches of rivers. It has the highest stamina in freshwater (Koutrakis, 1994) and often it is observed in polluted waters. In general it spawns offshore at sea (Froese & Pauly, 2008) and usually lives in schools. The males reproduce for the first time at the age of 3 years or later, while females at 4 or later. It spawns several million pelagic eggs from November to January (Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994). The juveniles of around 15 mm SL move to coastal lagoons and estuaries in autumn and especially winter (Koutrakis, 1994). Juveniles feed on unidentified insects (33%), copepods (18%), and

phytoplankton (17%) (Salvarina & Koutrakis, 2008). When they reach a size of about 30 mm SL, they switch their feeding habits and start feeding on benthic animals and plants. Adults filter algae and vegetal detritus (Kottelat & Freyhof, 2007). The growth rate in lake Vistonis is probably the highest among the members of the Mugilidae family (Koutrakis & Sinis, 1994).

**Conservation:** Actually the species is abundant in the lagoons of the Nestos Delta. It can be qualified as Lower Risk: least concern (LR/lc). However, as the main habitat of the species is the lowland wetlands, the future of the species is close related to their quality, and their existence.



## *Liza saliens* (Risso, 1810)

(EN) Leaping mullet (BG) Ilariya (GR) Gastros

Manos KOUTRAKIS & Luchevar PEHLIVANOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Liza saliens*, Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994; Kottelat, 1997; Vassilev & Pehlivanov, 2005; Koutrakis *et al.*, 2005; Fricke, 2000; Fricke *et al.*, 2007; Kottelat & Freyhof, 2007.

**Diagnosis:** The species is distinguished from the other species of *Liza* by: the predorsal scales with 2-5 longitudinal grooves, the 48-49 lateral scales (not including scales on caudal base), the 20 circumpeduncular scale rows, the pectoral fin which when folded forward, it reaches the eye (Kottelat & Freyhof, 2007). Furthermore, the adipose eyelid is poorly developed. The upper lip is thin, less than the diameter of the eye and pyloric caeca are forming two groups of 7-8 caeca in total (Zismann, 1981). Maximum observed size in the nearby

lake of Vistonis is up to 341 mm TL (Koutrakis & Sinis, 1994; Koutrakis, 1994; Koutrakis & Tsikliras, 2003).

**Distribution:** The species is distributed in Mediterranean and Black seas, and eastern Atlantic from Angola to Bay of Biscay (Kottelat & Freyhof, 2007). In the Nestos/Mesta system is found in the lagoons of the river delta.

**Ecology & biology:** The species have a pelagic mode of life; however, specimen have observed to stay close to the shore, sometimes in lagoons and estuaries living in schools. The males are repro-



Autochthonus



Euryhaline



Marketable



ducing for the first time at 2 years (Koutrakis, 1994, 1999) while females spawn pelagic eggs at sea (Froese & Pauly, 2008) during the period from June to December (Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994). The juveniles of around 10 mm SL move to coastal lagoons and estuaries in summer and autumn (Koutrakis, 1994) feeding on phytoplankton (22%), amphipods (18%), copepods (15%) and other arthropods (14%) (Salvarina & Koutrakis, 2008). Adults feed on algae and vegetal detritus (Kottelat & Freyhof, 2007). The growth rate was found to be higher than reported in literature for the species in the west Mediterranean and the Atlantic

coasts of Europe but slightly lower than in the south Mediterranean area (Koutrakis & Sinis, 1994).

**Conservation:** The species is abundant in the lagoons of the Nestos delta, constituting one of the main commercial fish species in these lagoons, even if its value is lower than the other mugilidae species. Consequently, following the IUCN norms it can be qualified as Lower Risk: least concern (LR/lc). However, as the other mullet species which use the trofic stocks of the lagoons, its future is close related to the environmental quality of these habitats, which actually are under high pressure.

## *Mugil cephalus* (Linnaeus, 1758)

(EN) Flathead mullet (BG) Morski kefal (GR) Kefalos

Manos KOUTRAKIS & Angel TSEKOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Mugil cephalus*, Koutrakis, 1994, 1999; Koutrakis *et al.*, 1994; Koutrakis, 2004; Koutrakis *et al.*, 2005; Vassilev & Pehlivanov, 2005; Harrison *et al.*, 2007; Kottelat & Freyhof, 2007.

**Diagnosis:** The species is distinguished from other species of Mugilidae in Europe by: the adipose tissue covering the greatest part of eye, reaching pupil in adults (Kottelat & Freyhof, 2007). The lateral scales are 36-45, while the anal fin has 8 soft rays. The juveniles can be recognized by the position of the pyloric caeca around the stomach, which are only two (Zismann, 1981). Maximum observed size in Lake Vistonis is up to 411 mm TL (Koutrakis & Sinis, 1994, Koutrakis, 1994; Koutrakis & Tsikliras, 2003).

**Distribution:** The species has a very large range of habitats covering all tropical and subtropical seas; also in Mediterranean, Black sea and Atlantic, reaching northward to Bay of Biscay (Kottelat & Freyhof, 2007). In the Nestos/Mesta system it was found in the lagoons of the river Delta.

**Ecology & biology:** The species has a rather pelagic mode of life and it is keeping close to the shores and the bottom, foraging in lagoons, estuaries and lower courses of rivers, and ports, as well, searching for food in any solid



Autochthonus



Euryhaline



Marketable



substratum. Usually it lives in schools. The males are reproducing for the first time at 2 years and females, which are larger, at 3. It spawns at sea in coastal surface water (Froese & Pauly, 2008). During spawning it is releasing several million of pelagic eggs in September-November (Koutrakis, 1994, 1999 and Koutrakis *et al.*, 1994). The eggs are developing optimally at marine environment. In north Greece juveniles around 15-20 mm SL move to coastal lagoons and estuaries in October-December (Koutrakis *et al.*, 2005). They feed on phytoplankton (73%) and detritus (14%) (Salvarina & Koutrakis, 2008) until about 30 mm SL; larger

individuals filter algae, vegetal detritus and small invertebrates (Kottelat & Freyhof, 2007).

**Conservation:** The species is abundant in the lagoons of the Nestos delta, constituting one of the main commercial fish species in these lagoons as meat and mainly as salted and cired eggs (avgotaracho). Given that dense exploitation and the very large distribution of the species can qualified as Lower Risk: least concern (LR/lc). However, as other mullet species frequenting estuaries its future is close related from the future of these fragile wetlands.

## *Oncorhynchus mykiss* (Walbaum, 1792)

(EN) Rainbow trout (BG) Dagova pastarva (GR) Iridizousa Pestrofa

Milen VASSILEV & Manos KOUTRAKIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Salmo* (*Trutta*) *irideus*, Morov, 1931.

*Trutta* (*Salmo*) *iridea*, Drensky, 1948, 1951.

*Salmo irideus*: Michajlova, 1965.

*Salmo gairdneri irideus*, Karapetkova, 1972, 1974; Karapetkova *et al.*, 1998.

*Oncorhynchus mykiss*, Economidis, 1974; Smith & Stearley, 1989; Karapetkova *et al.*, 1995; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D iii-iv/10-12, A iii-iv/8-12, Pi/11-17, V ii/8-10, C: 19, L.I. 22-26/135-150/23-30, gill rakers 15-22, vertebrae 60-66. The species is characterized by its reddish to pink large middle lateral band from opercl to the base of caudal fin, and by the presence of small spots in the caudal fin. The body is elongated, somewhat compressed especially in larger fish. The colouration varies with the habitat, the size and the sexual condition. Stream residents specimen and spawners have darker and more

intense colors, while lake residents are lighter, brighter, and more silvery.

**Distribution:** The species is native to the north-western America in the Rocky Mountains drainage, introduced widely elsewhere in the world, including Bulgaria and Greece. In Greek side of the river various unregistered stocking made in some tributaries and fishfarms were developed near Sidironeron and Paradeisos. Actually in the Greek part of the river, the species was found upstream of the Thisavros dam in small



Alien



Freshwater



Marketable



tributaries and also downstream of the Platanovrisi dam near the village of Paranesti. The species is permanently occurred in the Dospat Reservoir as an aquaculture object.

**Ecology & biology:** In the original distribution the species presents an exclusively freshwater form and a migratory (anadromous) one. Fishes of this last form, practice trophic migration to the north Pacific and return to the upstream of the native river for spawning. From fishes of non migratory form seems to originate all introduced stocks around world. The optimum water temperature for fish in summer is 12 to 18°C. In lakes, adult fish present a pelagic mode of life foraging for food in the upper layers as predator, but also in the water column up the bottom. In

rivers they require moderate to fast flowing, well oxygenated waters for breeding, although natural reproduction in River Nestos is not confirmed (Vassilev & Pehlivanov, 2005). Young feed predominantly on zooplankton, while for the adults the food is composed by fish, including other trout, frogs and tadpoles, various amphibians and their larvae, fish eggs, molluscs, crustacean, but also aquatic and terrestrial insects, etc. The species is also considering as one of the most important game fish, consequently, apart of farming, it is also the object of sport fishing.

**Conservation:** As alien species there is not any conservation measure and evaluation according to IUCN.



## *Oxynoemacheilus bureschi* (Drensky, 1928)

(EN) Strymon stone loach

(BG) Strumski gulesh, Kamenarka (GR) Petrocheili

Teodora TRICHKOVA & Argyris SAPOUNIDIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Nemachilus bureschi* Drensky, 1928, 1948, 1951.

*Nemachilus angorae bureschi*, Chichkoff, 1939.

*Noemacheilus angorae bureschi*, Economidis, 1974; Karapetkova & Zivkov, 1995.

*Noemacheilus bureschi*, Penczak *et al.*, 1985; Sivkov, 1992; Dikov *et al.*, 1988, 1994.

*Barbatula bureschi*, Apostolou, 2005; Stefanov & Trichkova, 2006.

**Diagnosis:** D iii/8, rarely 7 or 9, A iii/5, rarely 6. The body is elongated and slim, its depth being the 15.37 to 21.15% of SL, and its width 13.49 to 19.08% of SL (Sivkov, 1992). The head is rounded with three pairs of barbels around mouth. The caudal fin is deeply emarginated or forked. The depth of caudal peduncle is 1.9-2.3 times in its length (Kottelat & Freyhof, 2007). The body is covered with very small scales. The lateral line reaches the caudal base.

**Distribution:** The species is native in the systems of rivers Struma/Strymon (type locality, Drensky, 1928) and Mesta/

Nestos and the Vistonis catchment (tributary Kompsatos). In the Bulgarian part of the Struma/Strymon river, the species is found downstream the Lobosh Reservoir and in some of its biggest tributaries (Stefanov & Trichkova, in press). In the Greek part, it is recorded in the tributary Aggitis (Economidis, 1974). In the Bulgarian part of Mesta/Nestos, it was first recorded near Nevrokop and in its tributary Topolitza (Chichkoff, 1939). Later, it was reported by Drensky (1948, 1951), Penczak *et al.* (1985), Dikov *et al.* (1994), Karapetkova & Zivkov (1995), Apostolou (2005). At present, the species





Autochthonus



Protected



Freshwater



Not Marketable



is recorded downstream the Momina Klisura Site and in the tributaries Dospat and Bistritsa (Stefanov & Trichkova, 2006; Stefanov & Trichkova, in press). In the Greek part of the river Nestos/Mesta, nowadays the species is appearing only in the area of the village Paranesti and in the tributary Arkoudorema.

**Ecology & biology:** This is a typical reophilic species having a nocturnal activity. It is frequenting in the upper and middle reaches of the rivers and creeks, with sandy or mostly gravels bottom and fast current (usually in riffles and rapids). It reaches sexual maturity at a body length of about 50 mm. The spawning takes place in shallow water from May to July. Eggs are laid over stones and gravel, in a fast current. The species is feeding on worms and insect larvae. It reaches a maximum body length of 90 mm

(Maitland, 2000).

**Conservation:** The species nowadays can be found in a quite big abundance upstream of the dams and in a very small number downstream the dams. Recent and potential threats of the species are any kind of damming prohibiting free movement. Another potential threat is the planned mini-hydro power construction in the upper and middle reaches of the river. Additionally, it could be added the deforestation (altering upstream habitats) and water pollution (degrading water quality downstream). The species is qualified as Least Concern (LC) and included in the Greek Red Book (1992). In Bulgaria, it is listed in the newly updated Red Data Book as Vulnerable (VU) (Stefanov & Trichkova, in press) and protected by the Biological Diversity Act (2002).

## *Perca fluviatilis* Linnaeus, 1758

(EN) European perch (BG) Rechen kostur (GR) Perki

Milen VASSILEV & Panos LEONTARAKIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Perca fluviatilis*, Kovachev, 1921b; Drensky, 1923, 1930, 1931, 1948, 1951; Morov, 1931; Chichkoff, 1939; Karapetkova, 1972; Karapetkova & Zhivkov, 1995; Karapetkova *et al.*, 1998; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D1 xiii-xvii, D2 i-iii/12-16, A ii/7-10, L.I. 7-10/57-77/12-17, vertebrae 39-42. The species is recognised easily by: its ctenoid scales, two dorsal fins (D1 with spined rays and higher than the second, D2 with ii spined and 7-10 soft rays) and the well developed black spot in the end of D1. The color of the body is greenish-yellow, having 5-9 transverse black bands on the sides; D1 is gray and D2 greenish-yellow, P yellow and other fins red.

**Distribution:** The species has a very large native distribution throughout

Europe from northernmost extremity of Scandinavia, except Iberian Peninsula, central Italy and Adriatic basin and south Greece up to Thessaly. It is living in most rivers, lakes and reservoirs of the Aegean Sea basins. In Nestos/Mesta system is not native and it was found in the tributary Dospat and in the dam lakes, especially in Thisavros.

**Ecology & biology:** The species can be found in a wide range of habitats. Adults occur in slow-flowing rivers, lakes, reservoirs and ponds, and in some cases in brackish waters (Black Sea). It prefers



Translocated



Freshwater



Marketable



places where there is abundant aquatic vegetation. The span of life sometimes exceeds 21 years, but usually it is about 6 years. The males reproduce for the first time at 1-2 years while females at 2-4 years, and spawning occurs in spring. The eggs are released in a spiral clockwise movement and fertilised soon after. They hatched in 1-3 weeks and the young form schools. Larvae live in open water, preying mainly at sunrise and sunset, on any available organism in the pelagic zone, showing a positive phototactic behaviour, and may be

widely distributed by currents. Juveniles feed on zooplankton, bottom invertebrates, while adults feed on both invertebrates and fish. During first summer, many juveniles come near shores to feed on benthic prey.

**Conservation:** The species is quite abundant in the dam lakes of Thisavros and Platanovrysi, especially in the first one. It is one of the main target species of commercial and recreational fishing activity.

As alien in the system is not evaluated according to IUCN.

## *Phoxinus strymonicus* Kottelat 2007

(EN) Strymon minnow (BG) Strumska leshanka  
(GR) Kokkinogastros Strymona

Milen VASSILEV & Panos S. ECONOMIDIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Phoxinus laevis*, Kovatchev, 1921a, 1921b; Drensky, 1930.

*Phoxinus phoxinus*, Berg, 1932, 1949; Chichkoff, 1940; Drensky, 1948, 1951; Michajlova, 1965a, 1965b, 1970; Russev, 1966; Economidis, 1974; Pehlivanov, 2000; Apostolou, 2002, 2005; Vassilev & Pehlivanov, 2002; Stefanov & Trichkova, 2004.

*Phoxinus phoxinus phoxinus*, Konsuloff & Drensky, 1948.

*Phoxinus strymonicus* Kottelat, 2007.

**Diagnosis:** D iii/7 (last double), A iii/7, P i/14-16, V ii/6-7, C 19, lateral line incomplete reaching beyond anal fin base, squamation 87-93, gill rakers 6-8, vertebrae 38-39, pharyngeal teeth: 4.1-1.4 or 4.2-1.4 or 5.2-1.4 or 5.2-2.4 (Economidis, 1974). The species is distinguished from the other of the genus by the patches of breast scales absent or reduced to very few scales (Kottelat, 2007). Most specimens have a dark brown midlateral stripe from the eye to about the middle of the base of C. The colour of the body is brown with fine small darker marks, while the belly is brownish yellow (Kottelat, 2007). Size up to 60 mm TL.

**Distribution:** The species is endemic in the area, confined at the moment in the aquatic system of Struma/Strymon, tributary Aggitis (type locality). However, apparently it could also be distributed in the Mesta/Nestos system (new material from Bulgaria but not from Greece), and in the various other in



Autochthonus



Freshwater



Not Marketable



close vicinity water, as in the streams Marmaras and Filiouris. All old records (see Economidis, 1974) from Strymon/Struma to Evros/Maritsa need taxonomical revision and the population from Evros/Maritsa itself and the other Aegean sea catchment (Axios, Loudias), as well.

**Ecology & biology:** The species is a typical cold water dwelling fish, frequenting mainly in springs, where is most abundant, in small streams having characteristics of the trout zone. Often it is observed to swim in small schools in the upper layer, but normally it is keeping hidden among aquatic plants. It is feeding by small food particles as various invertebrates and plant material. There is not any relate information about its reproduction in the area, but according to observation in the nature it seems that it

take place in spring, as in this season the males bear nuptial tubercles, brightly coloured during spawning. In the close related species *Phoxinus phoxinus* eggs are lying over stones and gravels, where they adhere, in running water (Maitland, 2000).

**Conservation:** In the IUCN norms it is considered as a species of Lower Risk: least concern (LR/lc). Also, it is not included in the Greek Red Data Book, as a very recent and after taxonomical arrangement. Regarding the Greek populations, however, given the extended alteration in the springs of the lowland Strymon catchment, mainly in tributary Aggitis (Kefalari, Mylopotamos in Drama, and Aigiannis of Serres, as well), it is better to be putted in the category of EN, as proposed by Kottelat & Freyhof (2007).

## *Platichthys flesus* (Linnaeus, 1758)

(EN) European flounder (BG) Pisia (GR) Chamatída

Panos S. ECONOMIDIS & Luchezar PEHLIVANOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Platichthys flesus flesus* Belloc, 1948; Bini, 1960, 1965.

*Platichthys flesus luscus* Konsuloff & Drensky, 1943; Stankovic, 1960, Economidis & Bauchot, 1976; Economidis, 1973.

**Diagnosis:** D 51-67, A 35-46, L.l. almost straight with about 80 scales. The body is flattened, deep and asymmetrical (abnormal) with eyes on the right side and covered by cycloid scales. The species is characterized by the presence of bony tubercles along the lateral line. The body colour in the upper side (eyed side) is brownish, greyish or olivaceous, uniform or variously blotched and mottled with darker marks and/or faint red spots (Nielsen, 1986). Maximum observed size up to about 52 cm. The population of eastern Mediterranean

and Black seas (formerly named *Platichthys flesus luscus*) is distinguishing from the population of western Mediterranean and eastern Atlantic by its lower part of anterior gill arch with 8 rakers, and by post-ocular ridge ending in a sharp prominence.

**Distribution:** The species is distributed in all coastal waters of Europe, entering in the rivers. In the Thracian Sea in which flow the rivers Evros/Mariza, Nestos/Mesta and Strymon/Struma the species is frequent in regular abundance subjected to normal fishing.





Autochthonus



Euryhaline



Marketable



**Ecology & biology:** The species is practicing a benthic mode of life being mainly nocturnal and burrowing, at shallow depths with soft bottoms (to 55 m); often found in brackish water. It feeds on small fish and invertebrates. It spawns at the sea in February-June. Eggs and larvae are pelagic.

**Conservation:** The species is subjected to commercial fishing. The total catches being reported to the FAO annuals. Therefore it is out of any meaning to be covered by conservation measures. Obviously there is not such legislation for the species.



## *Pseudorasbora parva* (Temminck & Schlegel, 1846)

(EN) Stone moroko (BG) Pseudorasbora, kubinka (GR) Pseudorasbora

Apostolos APOSTOLOU & Panos LEONTARAKIS



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Leuciscus parvus* Temminck & Schlegel, 1846.  
*Pseudorasbora parva*, Nichols, 1929.

**Diagnosis:** D iii/7-8, A iii/6-7, P i/11-14, V i/7, L. I. 5-6/34-37/4-5, gill rakers 6-10, pharyngeal teeth: 5-5. The species is characterized by: the small size of no more than 11 cm, the complete lateral line, the transverse and superior mouth, the uniserial pharyngeal teeth and the dark band longwise the middle side ending in a black spot in the base of caudal fin. It is observed sexual dimorphism in large adults having different coloration.

**Distribution:** The species seems to be hazardedly introduced to Europe from Asia where it is native. Currently it occurs in the rivers Dnieper, Dniester,

Danube basins and the lake Skadar. In Greece it was first mentioned by Bianco (1988) in Prespa lakes and the river Aliakmon (see also Economidis *et al.*, 2000). In Bulgaria it was firstly discovered by Manolov & Sivkov (1977) and now it inhabits the systems of the rivers Danube, Kamchia, Struma/Strymon, Mesta/Nestos and Maritza/Evros (Marinov, 1979; Boyadjiev & Basamakov, 1988; Vassilev & Pehlivanov, 2002; Uzunova & Zlatanova, 2007; Polacik, *et al.*, 2008). In the river Mesta/Nestos it was firstly recorded in former sandpit Ormanski Gyor near Gotse Delchev town by Apostolou



Alien



Euryhaline



Not Marketable



(2002). Moreover, the species is also frequenting in the Greek part of the river Nestos/Mesta where some specimens have been caught during the research project on Nestos/Mesta fish fauna in the lower part, not far from its mouth.

**Ecology & biology:** The species is ecologically tolerant, as it is able to tolerate a variation of climate parameters. Adults occur in cool running water but also inhabit lowland water courses and estuaries. It makes nests under stones where the male cleans the cavity with its pearl organs.

The eggs adhere to the ceiling of the cavity. The male leaves the nest before the eggs hatch. The population presents low vulnerability (24.02), based on Lmax and K as it is estimated by Cheung *et al.* (2005). Feed on small insects, fish fry and fish eggs. The species has adverse ecological impact and it is regarded as a pest species which competes with success other small fish and fry due to its high reproductive rate.

**Conservation:** Not evaluated because it is alien.

## *Rhodeus amarus* (Bloch, 1782)

(EN) Bitterling (BG) Gorchivka, Violetka (GR) Mourmouritsa

Panos LEONTARAKIS & Teodora TRICHKOVA



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Rhodeus amarus*, Kovatchev, 1921a, 1921b; Drensky, 1930, Koutrakis *et al.*, 2003.

*Rhodeus sericeus*, Berg, 1932; Drensky, 1948.

*Rhodeus sericeus amarus*, Berg, 1949a; Banarescu, 1964; Drensky, 1951; Economidis, 1974; Karapetkova & Zivkov, 1995; Vassilev & Pehlivanov, 2005.

*Rhodeus sericeus amarus* forma *strumica* Karaman, 1955.

**Diagnosis:** D iii/9, rarely 8 or 10, A iii/8-9, P i/10-11, V ii/6-7, C 19, L.I. 5-8, rarely less than 5 or more than 8, squamation 35-37, branchiospines 11-17, pharyngeal teeth 5-5 and vertebrae 34-36 (Economidis, 1974). The species is characterized by its incomplete lateral line composed of 5-8 scales with tubes, and its small size rarely exceeding 70-80 mm, most frequently between 40 and 60 mm (Holcik, 1999). Measurements in Bulgarian specimens by Sivkov (2004) and in river Mesta/Nestos, (by Apostolou (2002), show that the scales are large and oval, 35 to 37 in a longitudinal line longwise sides (squamation). The back is greyish-green, the sides silvery,

and the belly being yellowish (Holcik, 1999).

**Distribution:** The species has a very large distribution in Europe, covering all drainages in south Baltic and North seas, in north Aegean and in western Black seas. It is native in the river Nestos/Mesta, where it was firstly discovered by Drensky (1930). Later, it was recorded by Apostolou (2005) and by Stefanov & Trichkova (2006). At present, it is found in the region of Gotse Delchev and downstream. In the Greek part of the river it was reported by Economidis (1974) and during the Nestos project it was found upstream and downstream the dams, with higher abundance in the area near



Autochthonus



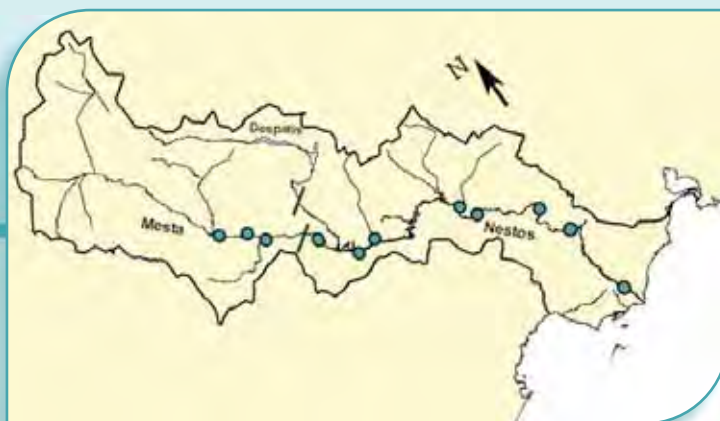
Protected



Freshwater



Not Marketable



the Greek-Bulgarian border and close to the mouth of the river.

**Ecology & biology:** It is a limnophilic species occurring preferably in slow-flowing and shallow water. It achieves sexual maturity at age 1 and at about 30-35 mm SL (Reichard & Jurajda, 1999). In river Rihios the spawning period last from April to June (Koutrakis *et al.*, 2003) and it is close related with freshwater mussels (*Unio* and/or *Anodonta*) (Smith *et al.*, 2004). During the spawning season, males develop bright nuptial coloration and defend area around mussels, while females develop long ovipositors used to deposit eggs onto the mussel gills through the exhalation siphon. Males fertilize the eggs by releasing sperm into the inhalation siphon of the mussel which carries the sperm to the eggs (Smith *et al.*, 2004). Embryos reside inside the mussel for approximately 1 month up to active swimming capacity (Aldridge, 1999). The

species feeds mainly on algae insect larvae, crustaceans, diatoms and plant detritus, and rarely on crustaceans and organic and inorganic material insect larvae (Koutrakis *et al.*, 2003). It has a short life span; maximum reported age is 5 years (Koutrakis *et al.*, 2003). In the population, males usually predominate over females, especially on the spawning grounds (Holcik, 1999). In the Mesta/Nestos, a sexual ratio of 2.3 females to 1 male was reported (Apostolou, 2002).

**Conservation:** The species is vulnerable to water pollution and ambient temperature changes, as well as to alteration in its proper habitat. By IUCN norms it is qualified as Least Concern (LC). It is included in the Appendix III of the Bern Convention and Annex II of the EC Directive 92/43/EEC. In Bulgaria it is protected by the Biological Diversity Act (2002).

## *Rutilus rutilus* (Linnaeus, 1758)

(EN) Roach (BG) Babushka (GR) Tsironi

Argyrios SAPOUNIDIS & Milen VASSILEV



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Leuciscus rutilus*, Kovatchev, 1921b.

*Rutilus rutilus mariza* Drensky, 1926, 1930, 1948, 1951; Berg, 1932, 1949; Michajlova, 1965a, 1967.

*Rutilus rutilus*, Chichkoff 1942; Holcik & Skorepa, 1970; Kottelat, 1997; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D (iii) iv/9-11, A iii/9-11, rarely 8 or 12, P i/15-16, rarely 14 or 17, V ii/7-8, L. 1. 8-9/40-44/4, rarely 7/38, 39 or 45, 46/5, gill rakers 11-16, pharyngeal teeth 6-6, vertebrae 38-40. The species is recognised by a combination of characteristics as it is the uniserial pharyngeal teeth, the yellow to orange color of fins and the insertion of ventral fins in the same vertical line with the insertion of dorsal fin. Furthermore, the mouth is terminal, the snout pointed; the iris is yellow in juveniles and deep

red in adults. The maximum recorded size is up to 50 cm SL, while in river Nestos the observed length reaches up to 35 cm SL.

**Distribution:** The species has a very large range in Europe extending from north of Pyrenees and Alps, eastward to Ural and Eya drainage (Caspian basin) to Aegean basin in south from Pinios of Thessaly up to Evros/Mariza, including almost all meanwhile drainage (rivers Axios/Vardar, Strymon/Struma, lakes Doirani, Volvi). Populations from lakes



Translocated



Freshwater



Not Marketable



Vegorit, *Orestias* (Kastoria) maybe belong to another species. Economidis (1974) mentioned the possible native presence of the species in river Nestos/Mesta, which however never confirmed. It remains as very probable the fact that the species is introduced in this ecosystem. During the research project on Nestos/Mesta fish fauna, the species was found upstream of the dams Thisavros and Platanovrysi.

**Ecology & biology:** The species has a wide variety of habitats, mainly in lowland areas. Most abundant is in rich lakes and large to medium sized rivers and backwaters. It also takes advantage of canalisation, damming and slight organic pollution, also in small lowland

streams and brackish coastal lagoons. It spawns among dense submerged vegetation in backwaters or lakes, flooded meadows or in shallow, fast-flowing river habitats on plant or gravel bottom. Males reproduce for the first time at 2-3 years, females one year later, usually at about 100 mm SL. Eggs are sticky and hatch in about 12 days. The larvae and the juveniles inhabit a wide variety of shallow habitats. It feeds mainly on benthic invertebrates, plant material and detritus, zooplankton or chironomids, molluscs as *Dreissena* mussels.

**Conservation:** As an alien species is not placed into any frame of protection.



## *Salaria fluviatilis* (Asso, 1801)

(EN) Freshwater blenny (BG) Sladkovodna kuchka (GR) Potamosaliara

Argyris SAPOUNIDIS & Milen VASSILEV

Female

Male



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Blennius vulgaris*, Karaman, 1924.

*Blennius fluviatilis*, Berg, 1932; Stephanidis, 1971; Economidis, 1974.

*Salaria fluviatilis*, Bianco *et al.*, 1996; Kottelat, 1997; Perdices *et al.*, 2000; Bath, 2003; Almada *et al.*, 2005.

**Diagnosis:** D xii-xiii/16-17 rarely 15, A 18-20, P 13-14 rarely 15, V i-ii/3 rarely 4, C 13-14 rarely 12, vertebrae 35, male bearing a crest in the head (Economidis, 1974). Furthermore, the species is distinguished by: a broad diagonal band of tiny dots from lower edge of eye downward and backward, cirrus above eye branched, head length 25-31 % of SL, 16-24 teeth in upper jaw, 16-20 in lower jaw. Size up to 130 mm (SL).

**Distribution:** The species has a peri-Mediterranean distribution from Spain,

Morocco and Algeria to Israel and Turkey. Also in France, including Corsica, and Italy, including Sicily and Sardinia, in Croatia, in Montenegro and in Albania. In Greece the species has a very broad distribution (Corfu rivulets, rivers Kalamas, Acheron, Acheloos, most drainage of Peloponnese, Spercheios, Aliakmon and lakes Kurna in Crete, Doirani, Volvi and Vistonis. In Nestos the species was discovered during the Nestos project, downstream to the Delta and the irrigation channels.





Autochthonus



Euryhaline



Not Marketable



**Ecology & biology:** The species is found in lakes and streams with moderate current and stony bottom; in streams, it prefers deepest and lotic microhabitats; sometimes in coastal lagoons with low salinity (Freeman *et al.*, 1990). It spawns for first time at the end of first year and up to 3 years, but most females die at the end of first spawning (Vinyoles & de Sostoa, 2007). In general reproduction takes place from April to August at temperatures above 18°C. Female spawns up to 1200 eggs usually in portions during a spawning season. Male cleans, aeriate and defends eggs

until hatching. Feeds on insects, crustaceans and fry.

**Conservation:** Most riverine populations have declined in recent years because of habitat alteration (especially siltation and alteration of stream morphology) and predation by exotic species. The presence of habitat suitable for the larval pelagic stage downstream of spawning sites is a limiting factor. The abundance of the species in river Nestos is low. It is qualified as Lower Risk: least concern (LR/lc).

## *Salmo macedonicus* (Karaman, 1924)

(EN) Nestos Trout (BG) Makedonska (Rechna) pastarva  
(GR) Pestrofa Nestou

Milen VASSILEV & Panos S. ECONOMIDIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Salmo trutta fario*. Kovatchev, 1921a; Drensky, 1948, 1951; Michajlova, 1965a.

*Trutta fario macedonica* Karaman, 1924; Drensky, 1926, 1930.

*Salmo trutta macrostigma*, Berg, 1932; Economidis, 1974

*Trutta fario macroptera*, Chichkoff, 1939.

*Salmo trutta macedonicus*, Economidis, 1991.

*Salmo macedonicus*, Naumovski, 1995; Kottelat, 1997; Simonovich, 2001, 2005; Maric *et al.*, 2004; Kottelat & Freyhof, 2007.

**Diagnosis:** D iv/10-11 rarely 9, A iii-iv/8-9, P i/12-13, V ii/8 rarely 7, C 18-19, L.l. 116-122, branchiospines 16-21, vertebrae 56-59, pyloric caeca 41-44 rarely 47, palatine teeth in two lines 12-17 in each bone, vomerian teeth in two or three lines 4 or 5 + 10-20. There is always a dark spot behind the eye and 1-10 smaller in the cheek and the opercle (Economidis, 1974). The coloration varies by many pink-red-violet-brown of different size spots often rounded with white rings. In some specimen there are also black spots on the back. The

belly and the head are golden-yellowish. The caudal fin is red-orange and missing spots. There are red, brown and black spots on dorsal and adipose fin. The upper jaw bone in females reach the end of the eye while in males overtakes it.

**Distribution:** The species has been described using specimen from Treska and Kadina which are tributaries of the river Vardar/Axios (Karaman, 1924). Drensky (1926, 1930) has reported the presence of the same species from in the basins of the rivers Mesta/Nestos and Struma/Strymon. Later this point was



Autochthonus



Protected



Freshwater



Marketable



enlarged for all Bulgarian rivers of the Aegean Sea watershed (Drensky, 1951; Vassiliev, unpubl.). Naumovski (1995) reported the presence of this species in rivers Vardar/Axios, Struma/Strymon (tributary Strumitsa) and Mesta/Nestos. Simonovitch (2004, 2005) is sharing this opinion for the catchment of the river Struma/Strymon. However, the systematic position of the populations in Strymon/Struma, Evros/Maritza and Nestos/Mesta and their relations with the populations of the Black Sea (*Salmo labrax*) remains obscure.

**Ecology & biology:** As all *Salmo* species this also is found in cold streams, rivers and alpine or mountain dam lakes. It spawns in rivers and streams with swift water from October to January. The feeding of the species is as usual various invertebrates (insect larvae, worms,

millusks, crustaceans), and vertebrates (adult amphibians and tadpoles and fish fry and adults, including small trout).

**Conservation:** The species has a very low abundance in the Greek part of the river and is locally very restricted, except some tributaries where there was found isolated population with rather higher abundance. The main reason is the uncontrolled and illegal fishing (including poisoning), especially during spawning season. Furthermore, wild population of Nestos tributaries seems to have already genetically “polluted” by unfair stocking with fry from river Acheloos (Ionian Sea catchment) (see Apostolidis et al., 1996, 1997, 1999). According to the Greek Red Book (1992), the species is characterized as a Rare, Vulnerable, and Endangered. It also is included in the Annex II of the EC Directive 92/43/EEC.

## *Scardinius erythrophthalmus* (Linnaeus, 1758)

(EN) Rudd (BG) Chervenoperka (GR) Kokkinoftera

Luchezar PEHLIVANOV & Argyris SAPOUNIDIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Leuciscus erythrophthalmus*, Morov, 1931.

*Scardinius erythrophthalmus*, Kovachev, 1921; Drensky, 1930, 1948, 1951; Berg, 1932; Konsuloff & Drensky, 1943; Michajlova, 1965b; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D iii/8-9, A iii/9-12, P i/14-15, V ii/7-8, C 18-19, L. l. 8/37 42/4-5, pharyngeal teeth biserial 5.3-3.5 (5.2-2.5), gill rakers 11-13, vertebrae-36-39 (Drensky, 1951; Berg, 1949; Economidis, 1974; Maurakis & Economidis, 2003). The species is recognized by the insertion of the dorsal fin, which is clearly behind the vertical line passing through origin of ventral fins, and by the biserial pharyngeal teeth. Furthermore, the body is laterally compressed having a moderate high profile and being almost ellipsoidal. Among the posterior

base of the ventral fins and the anal fin there is a scaled abdominal keel. The depth of the body is greater than the length of the head. There are no spots on the body which is homogenous grey more light in the belly, while the dorsal and the anal fins are characteristically red.

**Distribution:** The species has a wide distribution in Europe and middle Asia spreading in numerous basins of the North, Baltic, Black, Caspian and Aral seas; it is absent in Siberia. It is also translocated to several catchments



Translocated



Freshwater



Not Marketable



where it is unknown as native. In Greece occurs in large river systems from the Evros/Maritza to Thessaly, except in western Macedonia (Maurakis & Economidis, 2003). In Bulgaria is widely distributed in the lower courses of all rivers of the Danube basin and in the watersheds of both the Black and the Aegean seas, in almost all marshes, coastal lakes, and many reservoirs. It is reported long ago in the Bulgarian part of the river Mesta/Nestos basin by Drensky (1948) and confirmed by Apostolou (2005), but not from the Greek sector of the river (Economidis, 1974). The species can be assumed as native for the Mesta/Nestos but actually it is presented only scarcely in several places of the Bulgarian sector of the river.

**Ecology & biology:** The species inhabits lakes, rivers, marshes, ponds and canals with very low flow. However, it selects better places with sub-merged plants, among which is searching for food. In general, it is an omnivorous species but it presents a preference for macrophyte food component when adult. It can also feed on plankton (phyto- and zooplankton), insect adults and larvae. These items are the main food of juveniles and younger. The spawning period is usually prolonged from spring to summer. The eggs are attached to vegetation in shallow water.

**Conservation:** Due to the fact that the species is introduced in the ecosystem of the river Nestos/Mesta, there is not any conservation care.

## *Silurus glanis* Linnaeus, 1758

(EN) Wells catfish (BG) Som (GR) Goulianos

Luchezar PEHLIVANOV & Panos LEONTARAKIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Silurus glanis*, Kovachev, 1921a, 1921b, 1922; Karaman, 1924; Drensky, 1930, 1948, 1951; Berg, 1932, 1949; Konsuloff & Drensky, 1943; Michailova, 1965a, 1965b; Vassilev & Pehlivanov, 2002; Apostolou, 2002; 2005.

**Diagnosis:** D i/35, A i/77-95, C 17. The species is characterized by a very small dorsal fin and by a very large anal, almost ten times greater; also by the very small eyes and the lacking of scales. The body is elongated and compressed laterally and the head is large and flat, compressed dorso-ventrally. The upper jaw bears one pair of long barbels and the lower jaw has two pairs of short barbels. The anal fin is connected with the small caudal fin.

**Distribution:** *Silurus glanis* is widely distributed in Europe and Asia. In Bulgaria occurs in the Danube river

basin as well as in the watersheds of both the Black and the Aegean seas. In Greece is occurring natively in Thessaly (River Pineios), in Macedonia, (Aliakmon, Axios, Strymon rivers, and lakes Doirani and Volvi) and in Thrace (River Evros) (Maurakis & Economidis, 2003), while by supposed but unregistered stocking in lakes Kastoria and Vegoritis and in many reservoirs, in Bulgaria and Greece, as well. For the River Mesta/Nestos River it is suggested to be a native species (Apostolou, 2002; 2005), but this fact never was verified. The recent population is supported by occasional





Translocated



Freshwater



Marketable



stocking of the oxbow water bodies, from which are originated the recent Bulgarian records for Mesta/Nestos River. The species was not found in the Greek part of the river.

**Ecology & biology:** The species is occurring in fresh and brackish waters especially in places with still or slow flowing deep water (in standing water basins, lakes and rivers). It is a predatory fish, but as it has small eyes and large barbels it is known to feed by lying in ambush at night, usually be hidden in submerged caves or among plants. Regular food items are fish, crayfish, amphibians and water mammals as

voles and sometimes birds as ducks or any swimming or drowned vertebrate of a proper size. Large individuals can reach during night upper layers searching for pelagic food (Papistas *et al.*, 2003). It breeds in June to July in shallow water where it is making nests. This is a species with high economical value for commercial and recreational (gamefish) fisheries and aquaculture. It can reach large size, up to about 5 m length and 300 kg weight.

**Conservation status:** In the IUCN norms it qualified as Lower Risk/least concern, but it is included in the Bern Convention, Annex III.

## *Squalius orpheus* Kottelat & Economidis, 2006

(EN) Orpheus chub (BG) Egeiski kefal (GR) Thrakotilinari

Milen VASSILEV & Panos S. ECONOMIDIS



Photo: FRI - M. Koutrakis

**Nomenclature & synonyms:** *Squalius cephalus*, Kovachev, 1921a, 1921b.

*Leuciscus cephalus orientalis*, Drensky, 1926, 1930.

*Leuciscus cephalus*, Drensky, 1930, 1948, 1951; Chichkoff, 1943; Michajlova, 1964, 1965a, 1965b, 1970; Russev, 1966; Marinov, 1989; Imsiridou *et al.* 1997; Imsiridou *et al.* 1998; Tsigenopoulos & Karakousis, 1996; Durant *et al.* 1999; Vassilev & Pehlivanov, 2005.

*Leuciscus cephalus macedonicus* Karaman, 1955; Banarescu, 1960, 1964; Economidis, 1974.

*Leuciscus macedonicus*, Apostolou & Dobrovolov, 1999; Apostolou, 2002, 2005.

*Squalius orpheus*; Kottelat & Economidis, 2006; Kottelat & Freyhof, 2007.

**Diagnosis:** D iii/7-9, A iii /7-9, P i/14-18, V ii/7-9, C 17-19, lateral line 8(9)/43-47/3-4, gill rakers 7-13, vertebrae 41-45, pharyngeal teeth 5.2-2.5 (Economidis, 1974). According to Kottelat & Economidis (2006) the species is distinguished from the other close related mainly by the origin of the dorsal fin which is above the base of the anal fin, and by a combination of other characters among which the upper lip which is

clearly projecting beyond the tip of the lower jaw, the subterminal mouth, the free margin of scales faintly marked, the dark spot on scale pocket poorly contrasted, the dorsal fin with dense black pigments and the anal fin with dense black pigments on most membranes in both sexes. The color of the head and the body is yellowish brown, darker on back and yellowish to whitish in the belly. Sometimes there is a narrow black bar



Autochthonus



Freshwater



Marketable



from top of gill opening to pectoral fin base.

**Distribution:** The species is confined in the aquatic systems flowing into the north Aegean, from the river Evros/Mariza to the river Strymon/Struma (Kottelat & Freyhof, 2007). Especially, in the Nestos/Mesta system the species was found along the whole length from the down stream in the Greek part up to up stream in Bulgaria, including tributaries. A dense population of the species was found in the dam lakes, especially in Thisavros.

**Ecology & biology:** The species is a typical course fish populated the column of the water. It also can found in natural and dam lakes, pools and channels. This is an omnivorous fish that feed mainly in the water column but also in the upper layers. The food is composed by various items including fallen and drowned

terrestrial insects and aquatic invertebrates. It can reach an age up to 6 years, a length up to about 50 cm length and a weight more than 2 kg. The spawning period is long, starting from the end of April and going till the beginning of August (fragmental spawner). The eggs are lying on rocky substrate in areas with a moderate to fast water current (Michajlova, 1964). The species is targeted by local and recreational fishermen.

**Conservation:** The species is one of the most abundant species in the river Nestos/Mesta, as they do the other chub species in Europe. It can populate a wide range of habitats, where it usually forms exploited populations, which are out of serious environmental pressure. Consequently, it can be qualified as Lower Risk/least concern. Not evaluated according to IUCN.

## *Syngnathus abaster* Risso, 1826

(EN) Black-striped pipefish (BG) Черноивичеста игла  
(GR) Rigoti Sakorafa

Argyris SAPOUNIDIS & Angel TSEKOV



Photo: FRI - A. Christidis

**Nomenclature & synonyms:** *Syngnathus abaster*, Dawson in Whitehead *et al.*, 1986; Kottelat, 1997; Bogutskaya *et al.*, 2001; Bogutskaya & Naseka, 2004; Vassilev & Pehlivanov, 2005.

**Diagnosis:** D 24-40, P 10-14. The species is distinguished by: a caudal fin with rounded margin, a cylindrical snout having a length, which is the half or less than half of head length, a body depth which enters 2-4 times in the body length, snout depth about 2-4 in snout length, a predorsal length of 40-42% of SL, the 14-18 + 32-41 rings and the total subdorsal rings 6-11 (Whitehead *et al.*, 1986). Also by the non elongated bump on top of head behind eye. Size up to 190 mm SL (Silva *et al.*, 2006a, 2006b; Kottelat & Freyhof, 2007).

**Distribution:** The species is living in

coastal and lower reaches of rivers in Caspian, Black and Mediterranean seas basins; in the Atlantic coast from Gibraltar to southern Biscay; it enters in the Danube reaching Romanian-Hungarian border; in Dniepr reaching Kiev. It is introduced in reservoirs of middle and lower Volga with mysids brought from Don Estuary, spreading and up to south of Moscow (Svetovidov, 1964). In Nestos/Mesta system it was found in the lagoons of the river delta.

**Ecology & biology:** The species can live in a wide range of marine, brackish- and fresh-water habitats, mostly associated



Autochthonus



Euryhaline



Not Marketable



with dense submerged vegetation. It also can be found on muddy bottom. It spawns at its first year, from April to October. Females lay 10-60 eggs into a brood pouch on ventral surface of tail of males, which fertilise them as they enter the pouch. Eggs incubate in the male's brood pouch for about 20-32 days, depending of temperature. Feeds on small

invertebrates (Kottelat & Freyhof, 2007).

**Conservation:** The species is close related with the ecological quality of the coastal environments. Therefore, the recovery of these areas would help the species to increase its abundance to normal levels. At present it qualified as Lower Risk: least concern (LR/lc).

## *Tinca tinca* (Linnaeus, 1758)

(EN) Tench (BG) Лин (GR) Glini

Luchezar PEHLIVANOV & Panos LEONTARAKIS



Photo: A. Sediva

**Nomenclature & synonyms:** *Tinca vulgaris*, Kovachev, 1921a; Athanassopoulos, 1934; Athanassopoulos & Pellegrin, 1934.

*Tinca tinca*, Kovachev, 1921b, 1922; Drensky, 1930, 1948, 1951; Berg, 1932, 1949; Konsuloff & Drensky, 1943; Karaman, 1955; Michailova, 1965a, 1965b; Economidis, 1974; Vassilev & Pehlivanov, 2002.

**Diagnosis:** D iii-iv/8-9, A iii-iv/7-8, P i/17-18, V ii/8-9, C 19, vertebrae 39-41, L.l. 29-30/94-100/20-22, gill rakers 11-14, pharyngeal teeth 5-4 or 4-5 (Drensky, 1951; Berg, 1949; Economidis, 1974; Karapetkova & Zivkov, 1995; Maurakis & Economidis, 2003). The species is characterized by a massive, deep and rounded body, the ratio between the SL and Hmax being about 3. The caudal peduncle is short and deep. The body is covered with very small scales fixed deeply into the skin. The mouth is small

with one barbel at the upper lip. The margin of the dorsal and the anal fins are rounded (convex), while the margin of the caudal fin is straight or slightly concave. The sexual dimorphism is expressed in the adult males by having the second ray of the pelvic fin extremely thick.

**Distribution:** The species is widely distributed in almost all of Europe, from France at the West until the Siberian Rivers at the East, including British Isles. In Bulgaria is recorded from rivers and





Alien



Freshwater



Not Marketable



reservoirs of the Danube basin and from the watersheds of both the Black and the Aegean seas. In Greece the species occurs in all of the permanent river systems from Thessaly to River Evros in Thrace (Maurakis & Economidis, 2003), including Nestos (Economidis, 1974). However, actually the Mesta/Nestos river population suggested as introduced appearing only in the basin of a small reservoir near the town of Gotse Delchev.

**Ecology & biology:** The species prefers the still or slow flowing water. It is often frequenting among dense vegetation, in warm lakes, pools and marshes with weed and mud bottom. It can qualified as a thermophilous, slowly moving fish, inhabiting in the lowest stretches of the rivers and standing water basins, where

it tolerates extremely low oxygen saturation. Tench is an omnivorous species feeding on bottom invertebrates and aquatic insect larvae, and the young on algae. The breeding takes place in May-June in shallow water among dense vegetation. The maximum length reaches 50-60 cm (TL) and the maximum weight the 7.5 kg. It is a commercially valuable fish.

**Conservation:** There is not an absolute agreement that all recorded populations are native or not, because many, repeated and uncontrolled stocking were made since old time with doubtful success, which might be the reason that many of the populations are actually declining. According to the IUCN norms it is qualified as Lower Risk/least concern.



## B i b l i o g r a p h y

- Abrosimova N. A. & S. S. Abrosimov, 2002. *Mugil so-iuy* Basilewsky as a new object of aquaculture. *European Aquaculture Society, Special Publication*, 32: 105-106.
- Ahnelt H., P.G. Bianco & H. Schwammer, 1995. Systematics and zoogeography of *Knipowitschia caucasica* (Teleostei: Gobiidae) based on new records from the Aegean Anatolian area. *Ichthyological Exploration of Freshwaters*, 6: 49-60.
- Aldridge D.C., 1999. Development of European bitterling in the gills of freshwater mussels. *Journal of Fish Biology*, 54: 138-151.
- Almada F., V.C. Almada, T. Gullemaud & P. Wirtz, 2005. Phylogenetic relationships of the north-eastern Atlantic and Mediterranean blenniids. *Biological Journal of the Linnean Society*, 86: 283-295.
- Apostolidis A.P., Y. Karakousis & C. Triantaphyllidis, 1996. Genetic differentiation and phylogenetic relationships among Greek *Salmo trutta* L. (brown trout) populations as revealed by RFLP analysis of PCR amplified mitochondrial DNA segments. *Heredity*, 77: 608-618.
- Apostolidis A.P., C. Triantaphyllidis, A. Kouvatsi & P.S. Economidis, 1997. Mitochondrial DNA sequence variation and phylogeography among *Salmo trutta* L. (Greek brown trout) populations. *Molecular Ecology*, 6: 531-542.

- Apostolidis A., K. Triantaphyllidis, A. Kouvatsi, P. S. Economidis, & S. Tsakalidis, 1999. Use of molecular indices in the genetical study and management of fish populations with special emphasis in trout populations (*Salmo trutta* L.) of Greece. *Geotechnika Epistimonika Themata*, 10: 350-359 (in Greek).
- Apostolidis N., 1883. La pêche en Grèce. *Faune Ichthyolog. de Grèce*. Athènes, 35 pp.
- Apostolidis N., 1892. Freshwater fishes of Thessaly. *Contribution to the natural history of Greece*. Athens, printed by Perri Brothers, 31 pp.
- Apostolidis N., 1907. La pêche en Grèce. *Faune Ichthyolog. de Grèce*. Athènes, 68 pp.
- Apostolou A., 2002. The ichthyofauna (morphologic, electrophoretic, taxonomic and faunistic research) from the middle and lower course of the rivers Mesta and Strouma in Bulgarian and Greek territory. Sofia university, Thesis (In Bulgarian).
- Apostolou A. 2005. The ichthyofauna from the Bulgarian Sector of the Mesta River. *Acta zoologica bulgarica*, 57 (2): 191-196.
- Apostolou, A., T. Stefanov, M. Vassilev, A. Sediva & L. Pehlivanov, 2008. Distribution of the stone loaches (Pisces: Balitoridae) in Bulgaria past and present status. *Acta zoologica bulgarica*, 60 (2): 29-33.
- Asso I. de, 1801. Introduccion á la ichthyologia oriental de España. *Anales de Ciencias Naturales*, 4 (10): 28-52.
- Athanassopoulos G., 1917. Quelques elements de recherché hydrobiologiques en Grèce. 3. Désignation de certaines espèces de poissons. *Bull. Stat. Hydrobiol. Marine Grèce*, 1: 19-25.
- Athanassopoulos G., 1921. Addition aux tableau faunistiques. *Bull. Stat. Hydrobiol. Marine Grèce*, 3(2): 9-13 (in Greek).
- Athanassopoulos G., 1934. Un caractere essentiel de l' ichthyofaune d' eau douce de la peninsule balcanique. Paris, *Bull. Mus.Hist. Nat.*, 6: 346-347.
- Athanassopoulos G. & J. Pellegrin, 1934, Sur une race naine de Tanche des eaux grecques. *Bull. Soc. Centr. Aquic. Peche*, 41: 68-70.
- Balon E.K., 1995. Origin and domestication of the wild carp, *Cyprinus carpio*: from

- Roman gourmets to the swimming flowers. *Aquaculture*, 129: 3-48.
- Balon E.K. & D.L.G. Noakes, 1980. *Principles of Ichthyology*. University of Guelph, Canada, 285 p.
- Banarescu P., 1960. Einige Fragen zur Herkunft und Verbeitung der Süßwasserfischfauna der europäisch-mediterranean Unterregion. *Arch. Hydrobiol.*, 57, 16-134.
- Banarescu P., 1964. *Pisces Osteichthyes*. Fauna Republicii Populare Romine. Bucuresti, 962 pp. (In Romanian).
- Bath H., 2003. Suborder *Blennioidei*. pp. 91-121. In: *The Freshwater Fishes of Europe*. Volume 8/1 Mugilidae, Atherinidae, Atherinopsida, Blennidae, Odontobutidae, Gobiidae I. Aula, Wiebelsheim.
- Battalgil F. 1942. Contribution à la connaissance des poissons des eaux douces de la Turquie. *Rev. Fac. Sci. Univ. Istanbul*, 7B: 287-306.
- Belloc G., 1948. *Inventory of the fishery resources of the Greek waters*. Mimeo Appendix B': Catalogue of the resources of Greek waters. *Pisces*, pp 4-64.
- Berg L. S., 1916. *Les Poissons des eaux douces de la Russie*. Moscow. *Poiss. Eaux Douces Russie*: i-xxvii + 1-563. [In Russian.]
- Berg L. S., 1932: Übersicht der Verbreitung des Süßwasserfische Europas. *Zoogeographica* 1, 107-208.
- Berg L. S., 1948. *Fresh-water fishes of Soviet Union and adjacent countries*. I. Freshwater Fish. USSR, Guide Fauna USSR No. 27: 1-466. English translation, 1964, by IPST, Jerusalem.]
- Berg L. S., 1949. *Fresh-water fishes of Soviet Union and adjacent countries*. II. Freshw. Fish. USSR, Guide Fauna USSR No. 29: 467-925. [English translation, 1964 by IPST, Jerusalem.]
- Bianco P. G., 1988. Occurence of the Asiatic gobionid *Pseudorasbora parva* (Temminck and Schlegel) in south-eastern Europe. *Journal of Fish Biology*, 32: 973-974.
- Bianco P. G., H. Ahnelt & P. S. Economidis, 1996. The freshwater fishes from eastern, and large Mediterranean islands with comments on their safety status. *Acta*

*Univ. Carol. Biol.*, 40: 45-60.

- Billard R., 1997. *Les poissons d'eau douce des rivières de France. Identification, inventaire et répartition des 83 espèces*. Lausanne, Delachaux & Niestle, 192 pp.
- Bini G., 1960. *Catalogue of the names of fishes of commercial importance in the Mediterranean*. FAO, Rome, 250 pp.
- Bini G., 1965. *Pesci, molluschi, crostacei del Mediterraneo*. Ed. Vito Bianco, Rome, 407pp.
- Biological Diversity Act, Republic of Bulgaria. State Gazette No. 77/ 09.08.2002. Available at: <http://www.internationalwildlifelaw.org/BiodiversityActBulgaria.pdf>
- Bobori D.C., E.T. Koutrakis & P.S. Economidis 2001. Shad species in Greek waters - an historical overview and present status. *Bull. Fr. Peche Piscic.*, 362/363: 1101-1108-
- Bogutskaya N.G., A.M. Naseka & A.M. Komlev, 2001. Freshwater fishes of Russia: preliminary results of the fauna revision. *Proceedings of the Zoological Institute, Russian Academy of Sciences*, 289: 39-50.
- Bogutskaya N.G. & A.M. Naseka, 2002. An overview of nonindigenous fishes in inland waters of Russia. *Proc. Zool. Inst. Russ. Acad. Sci.* 296:21-30.
- Bogutskaya N.G. & A.M. Naseka, 2004. Catalogue of agnathans and fishes of fresh and brackish waters of Russia with comments on nomenclature and taxonomy. Russian Academy of Sciences, Moscow. *Fishes Russia*, 1-389. [In Russian.]
- Bohlen J., A. Perdices, I. Doadrio & P.S. Economidis, 2006. Vicariance, colonization, and fast local speciation in Asia Minor and the Balkans as revealed from the phylogeny of spined loaches (Osteichthyes, Cobitidae). *Molecular Phylogenetics and Evolution* 39: 552-561.
- Bournaski E. & I. Ivanov, 2003. Bulgarian-Greek Cooperation for the Integrated Water Management of the Mesta/Nestos Transboundary River Basin: the Bulgarian Case Study. Proceedings of the 2<sup>nd</sup> International Conference on Ecological Protection of the Planet Earth, Sofia, Bulgaria, 5-8 June, pp.439-453.



- Boyadjiev A. & I. Basamakov, 1988. Sur la dissémination de la *Pseudorasbora parva* (Schlegel, 1842) en Bulgarie. Université de Plovdiv 'Paissii Hilendarski'. Travauxscientifiques, 26 (6): Biologie: 67-73. (In Bulgarian)
- Breder C.M. & D.E. Rosen, 1966. *Modes of reproduction in fishes*. T.F.H. Publications, Neptune City, New Jersey. 941 p.
- Bulli L.I. & N.I. Kulikova, 2006. Adaptive capability of larvae of the haarder *Liza haematocheila* (Mugilidae, Mugiliformes) under decreasing salinity of the environment. *Journal of Ichthyology*, 46(7): 534-544
- Chereshnev I.A. & A.V. Shestakov, 2001. First appearance in abundance of the grey mullet *Mugil cephalus* (Mugilidae) in the Tauy Estuary (north part of the Okhotsk Sea). *Voprosy Ikhtiologii* 41 (3): 382-386. [In Russian. English translation in *Journal of Ichthyology*, 41 (4): 308-312.]
- Chesalina T.L., 1997. On the spawning of pilengas (*Mugil so-iuy*) in the Black Sea. *Journal of Ichthyology*, 37 (5): 717-718 (In Russian).
- Cheung W.W.L., T.J. Pitcher & D. Pauly, 2005. A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing. *Biol. Conserv.*, 124: 97-111.
- Chichkoff G., 1933. On the new spiralin *Alburnoides bipunctatus*. *Tzanevi* ssp. nova. *Proceedings of the Bulgarian Geographic Society*, No 1.
- Chichkoff G., 1935. Sur in Barbeau peu connu. *Annu. Univ. Sofia, Sci Nat.*, 33: 227-289. (In Bulgarian with large French summary)
- Chichkoff G., 1937. Sur les Goujons habitant les eaux douces de la Bulgarie. *Annu. Univ. Sofia. Sci. Nat.*, 33(3): 227-289 (in Bulg. with large French summary).
- Chichkoff G., 1939. Poissons nouveaux et peu connus des eaux douces de la Bulgarie. *Annuaire de l'Université de Sofia, Faculte de Sciences*, 35 (3): 91-199. (In Bulgarian with large French summary)
- Chichkoff G., 1939/40. Morphological studies on the species of the genus *Alburnoides* presented in our fresh waters. *Ann. of the Sofia University*, 36 (3): 73-164 (In Bulgarian with large French summary).

- Chichkoff G., 1940. Etudes morphologiques sur le Vairon habitant les eaux douces de la Bulgarie. *Annu. Univ. Sofia, Sci. Nat.*, 36: 21-72.
- Chichkoff G., 1940/41. Morphological studies on the *Alburnus alburnus* presented in our fresh waters. *Ann. of the Sofia University*, 37(3): 31-90 (In Bulgarian with large French summary).
- Chichkoff G., 1943. Etudes morphologiques sur *Leuciscus cephalus* et *Rutilus rutilus* répandus dans nos eaux douches. *Annu. Univ. Sofia, Sci. Nat.*, 38: 1-67.
- Choleev I. & G. Baltakov, 1989. Basic features of the late Cenozoic evolution of the Mesta valley system on Bulgarian territory. In: *Proceedings of International Conference 'Geographica Rhodopica'*, Sofia, 1: 1417.
- Corsini-Foka M. & P.S. Economidis, 2007. Allochthonous and vagrant ichthyofauna in Hellenic marine and estuarine waters. *Mediterranean Marine Science*, 8 (1): 67-89.
- Council of Europe. *Convention on the Conservation of European Wildlife and Natural Habitats*. Bern, 19.09.1979.
- Daoulas C., A.N. Economou, T. Psarras & R. Barbieri-Tseliki, 1993. Reproductive strategies and early development of three freshwater gobies. *Journal of Fish Biology*, 42: 749-776.
- Daoulas C., A.N. Economou, M.T. Stoumboudi, T. Psarras & R. Barbieri-Tseliki, 1997. Larvae development in a landlocked population of *Atherina boyeri* in Lake Trichonis, Greece. *Israel Journal of Zoology*, 43: 159-166.
- Darakas E., 2002. The transboundary River Nestos and its water quality assessment: cross-border cooperation between Greece and Bulgaria. *Environmentalist*, 22: 367-375.
- Diadovski I.K., M.P. Atanassova & I.S. Ivanov, 2007. Integral assessment of climate impact on the transboundary Mesta River flow formation in Bulgaria. *Environmental Monitoring & Assessment*, 127: 383-388.
- Dikov T., J. Jankov & S. Jocev, 1988. Ichthyofauna composition, number and biomass of different species in the River Palakarija, a tributary to the River Iskar.

- Hydrobiology*, Sofia, 33: 59-67. (In Bulg.).
- Dikov T., J. Jankov & S. Jocev 1994. Fish stocks in rivers of Bulgaria. *Polskie Archiwum Hydrobiologii*, 41 (3): 377-391.
- Dobrovolov I., 1994. Electrophoretic investigation of protein from gudgeons (Genus *Gobio*, Pisces) in Bulgaria with regard to their taxonomy. *Proceedings of the Institute of Fisheries*, Varna, 12: 117-138. (In Bulgarian).
- Drensky P., 1920. A new fish species from the Svishtov Marsh. *Records of agriculture*, Sofia, 9 (5): 11 (In Bulgarian)
- Drensky P., 1926. New and rare fishes in Bulgaria. *Proceedings of the Bulgarian Natural-Historian Society*, 12: 121-150 (In Bulgarian).
- Drensky P., 1928. Die Fische der Familie Cobitidae in Bulgarien. *Bull. de l'Inst. Royales d'Histoire Naturelle a Sofia*, 1: 156-181. (In Bulgarian)
- Drensky P., 1929. Über die Verbreitung der Familie Cobitidea (Pisces) besonders im Hinblick auf die Balkanhalbinsel. *SB. Ges. Naturf. Fr. Berlin*, 229-232.
- Drensky P., 1930. Zur Kenntnis der Süßwasserfischfauna Bulgariens. *Zool. Jahrb., Syst.*, 59: 663-680.
- Drensky P., 1948. Synopsis and distribution of fishes in Bulgaria. *Annuaire de l'Universite de Sofia, Faculte de Sciences*, 44 (3): 11-71. (In Bulgarian)
- Drensky P., 1951. *Fishes in Bulgaria. Fauna of Bulgaria*. 2. Bulgarian Academy of Sciences, 270 p. (In Bulgarian).
- Economidis P.S., 1973. Checklist of the Greek fishes. *Hellenic Oceanol. Limnol*, 11: 1-598
- Economidis P.S., 1974. *Etude morphologique, systematique, et zoogeographique des poissons d'eau douce de la Macedoine Orientale et de la Thrace Occidentale (regions Greques)*. Publ. Universite de Thessaloniki, 179 p. (In Greek)
- Economidis P.S., 1989. Distribution pattern of the genus *Barbus* (Pisces, Cyprinidae) in the freshwaters of Greece. *Travaux du museum d'Histoire naturelle Grigore Antipa*, 30: 223-229.
- Economidis P.S., 1991. Check list of freshwater fishes of Greece (recent status of threats and protection). *Hellenic Society for the Protection of Nature*, Special

publication, 48 pp.

- Economidis P.S. & M.L. Bauchot, 1976. Sur une collection de poissons des mers helléniques (mers Egée et Ionienne) déposée au Muséum national d'histoire naturelle. *Bull. Mus. Natn. Hist. Nat.*, Paris, 3e ser., No 392, Zool., 274: 871-903.
- Economidis P.S. & P. J. Miller, 1990. Systematics of freshwater gobies from Greece (Teleostei: Gobiidae). *Journal of Zoology*, 221: 125-170.
- Economidis P.S. & P. Banareescu, 1991. The distribution and origin of freshwater fishes in the Balcan Peninsula, Especially in Greece. *Int. Revue ges. Hydrobiol.*, 76: 257-283.
- Economidis P.S. & T. Nalbant, 1996. A study of the genera *Cobitis* and *Sabanejewia* (Pisces, Cobitidae) of Greece, with description of six new taxa. *Trav. Mus. Hist. Nat. "Grigore Antipa"*, 36: 295-347.
- Economidis P.S., E. Dimitriou, R. Pagoni, E. Michaloudi & L. Natsis., 2000. Introduced and translocated fish species in the inland waters of Greece. *Fish. Manage. Ecol.*, 7: 239-250.
- Economou A.N., C. Daoulas, T. Psarras & R. Barbieri-Tseliki, 1994a. Freshwater larval fish from Lake Trichonis (Greece). *Journal of Fish Biology*, 45: 17-35.
- Economou A.N., C. Daoulas, T. Psarras & R. Barbieri-Tseliki, 1994b. Further data on the reproduction and larval development of *Knipowitschia caucasica* (Gobiidae). *Journal of Fish Biology*, 45: 360-362.
- Economou A.N., S. Giakoumi, L. Vardakas, R. Barbieri, M. Stoumboudi, & S. Zogaris, 2007. The freshwater ichthyofauna of Greece - an update based on a hydrographic basin survey. *Mediterranean Marine Science*, 8(1): 91-166.
- Elvira B., 1997. Taxonomic revision of the genus *Chondrostoma* Agassiz 1835 (Pisces, Cyprinidae). *Cybium*, 11(2): 111-140.
- European Communities, 1992. *Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora*. 21 May 1992
- Freeman M.C., D. Vinolas, G.D. Grossman & A. de Sostoa, 1990. Microhabitat use by *Blennius fluviatilis* in the Rio Matarrana, Spain. *Freshwater Biology*, 24: 335-345.

- Fricke R., 1999. *Annotated checklist of the marine and estuarine fishes of Germany, with remarks of their taxonomic identity*. Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie), 587: 1-67.
- Fricke R., 2000. Invalid neotypes. *Copeia*, 2000 (2): 639-640.
- Fricke R., M. Bilecenoglu & H. Musa Sari, 2007. *Annotated checklist of fish and lamprey species (Gnathostomata and Petromyzontomorphi) of Turkey, including a Red List of threatened and declining species*. Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie), 706: 1-174.
- Froese R. & D. Pauly (Eds.) 2008. *FishBase*. World Wide Web Electronic Publication, [www.fishbase.org](http://www.fishbase.org) Version (02/2008).
- Ganoulis J., H. Skoulikaris & J.M. Monget, 2008. Involving stakeholders in transboundary water resource management: The Mesta/Nestos 'HELP' basin. *International Symposium 'HELP in Action: Local Solutions to Global Water Problems Lessons from the South'*, Emperor's Palace, Johannesburg, South Africa, 4-9 November 2007.
- Georgiev J.M., 1964. Some new and little known bullheads (Gobiidae, Pisces) to Bulgarian ichthyofauna. *Izvestia Inst. Rib.*, Varna, 4: 189-206. (in Bulg.).
- Georgiev J.M., 1966. Composition d'espèces et caractéristiques des Gobiidés (Pisces) en Bulgarie. *Izvestia Inst. Rib.*, Varna, 7: 159-228. (in Bulg.).
- Gerakis A. & K. Kalburtzi, 1998. Agricultural activities affecting the functions and values of Ramsar wetland sites of Greece. *Agricultural Ecosystems Environment*, 70 (23): 119-128.
- Golovinskaya K.A., D.D. Romashov & N.B. Cherfas, 1965. Monosexual and bisexual forms of *Carassius auratus gibelio* Bloch. *Voprosy Ichtiologii*, 5 (4): 614-629. (In Russian)
- Harrison I.J., 2003. Mugilidae Günther, 1861. pp. 1-42. In *The Freshwater Fishes of Europe*. P.J. Miller (ed.) AULA-Verlag, Wiebelsheim, Germany.
- Harrison I.J., 2004. Mugilidae. Addendum to Volume 8. Part 1. In: P.J. Miller (ed.) *The Freshwater Fishes of Europe*. Vol. 8 (2). pp. 469-471. AULA-Verlag,

Wiebelsheim, Germany.

- Harrison I.J., M. Nirchio, C. Oliveira, E. Ron & J. Gaviria, 2007. A new species of mullet (Teleostei: Mugilidae) from Venezuela, with a discussion on the taxonomy of *Mugil gaimardianus*. *Journal of Fish Biology*, 71 (A): 76-97.
- Heckel J.J., 1843. *Ichthyologie* [von Syrien]. In: J. von Russegger. Reisen in Europa, Asien und Africa, mit besonderer Rücksicht auf die naturwissenschaftlichen Verhältnisse der betreffenden Länder unternommen in den Jahren 1835 bis 1841, etc. Stuttgart. *Ichthyol. von Syrien* v. 1 (pt 2): 990-1099.
- Holcik J., 1998. *Ichthyologia. Bratislava. Priroda*, 310 p. (In Slovakian).
- Holcik J., 1999. *Rhodeus sericeus* (Pallas, 1776). In Banarescu, P. M. (Ed.), *The Freshwater Fishes of Europe*, Vol. 5/1, Cyprinidae 2/1. AULA-Verlag, Wiebelsheim, 1-32.
- Holcik J. & V., Skorepa, 1971. Revision of the roach, *Rutilus rutilus* (Linnaeus, 1758), with regard to its subspecies. *Annotationes Zoologicae et Botanicae*, 64: 1-60.
- Imsiridou A., A. Apostolidis, Durant J.-D., J. Briolay, Y., Bouvet & C. Triantaphyllidis, 1998. Genetic differentiation and phylogenetic relationships among Greek Chub *Leuciscus cephalus* L. (Pisces, Cyprinidae) populations as revealed by RFLP analysis of mitochondrial DNA. *Biochemical Systematics and Ecology*, 26: 415-429.
- Imsiridou A., Y. Karakousis & C. Triantaphyllidis, 1997. Genetic polymorphism and differentiation among chub *Leuciscus cephalus* L. (Pisces, Cyprinidae) populations of Greece. *Biochemical Systematics and Ecology*, 25 (6): 537-546.
- IUCN, 2008, *Red List of Threatened Species*. <http://www.iucnredlist.org/>
- Ivanov I., I. Diadovski, E. Bournaski & R. Tetkov, 2004. The transboundary Mesta river water use and preservation in according to the requirements of the EU Water Framework Directive. *Proceedings*, Sofia, 250.
- Ivanov, I., E. Bournaski & R. Petkov, 2004. The transboundary Mesta River water use and preservation in according to the requirements of the EU Water Framework Directive. *Seminar Proceedings*, Sofia, 250 (in Bulgarian).
- Ivanova V., 2001. Mechanisms of Planning and Monitoring Structures for Co-



- ordination at Regional and National Level in Bulgaria. In: *THE INTEREG MODEL. Practical Experience in Cross-Border Co-Operation*. Friedrich Ebert Stiftung, Zagreb Office, Zagreb, November, pp. 718.
- Kallioras A., F. Pliakas & I. Diamantis, 2006. The legislative framework and policy for the water resources management of transboundary rivers in Europe: the case of Nestos/Mesta River, between Greece and Bulgaria. *Environmental Science & Policy*, 9: 291-301.
- Karakatsoulis P., Th. Mimides & Mendadjiev D., 1998. *A preliminary research for an integrated management of the Nestos/Mesta river basin waters. Existing regime General Specifications. FINAL REPORT*. Greek Ministry of National Economy. INTERREG IIA. AUA, December. In two Volumes.
- Karaman M., 1971. Süßwasserfische der Türkei. Teil 8. Revision der Barben Europas, Vorderasiens und Nordafrikas. *Mitt. Hamburg Zool. Mus. Inst.*, 67: 175-254.
- Karaman S.L., 1924. *Pisces Macedoniae*, Split, 90 p.
- Karaman S.L., 1928 Beiträge zur Ichthyologie von Jugoslawien I. *Bull. Soc. Sci. Skopje*, 6: 147-176. (In Russian, German summ.)
- Karaman S.L., 1955. Die Fische der Strumica (Struma-System). *Acta Mus. Macedonici Sci. Nat.*, 3 (7): 181-208. (Russian Summary)
- Karapetkova M.S., M. Zivkov & K. Alexandrova-Kolemanova, 1998. The freshwater fishes of Bulgaria. In: *Bulgaria's Biological Diversity: Conservation Status and Needs Assessment*, Vol. 1 and 2 (C. Meine, ed.), Pensoft Publishers, 375-393.
- Karapetkova M.S. & M. Zivkov, 1995. *Fishes of Bulgaria*. Gea-Libris Publ., Sofia, 247 p. (In Bulgarian)
- Karapetkova M.S., 1972. Ichthyofauna of the Yantra River. *Proceedings of the Zoological Institute with Museum*, 39: 85-98 (In Bulgarian, Russian and French summaries).
- Karapetkova M.S., 1974. Ichthyofauna of the Kamchia River. *Proceedings of the Zoological Institute with Museum*, 36: 149-182. (In Bulgarian, Russian and French summaries).

- Karapetkova M.S., 1976. Caractéristique biométrique de sous-espèces de *Chondrostoma nasus* (L.) en Bulgarie. *Hydrobiologia*, Sofia, 3: 78-86.
- Karapetkova M.S., 1998. Class Pisces (Fishes). In: *Biodiversity of the Srebarna Biosphere Reserve, Checklist and Bibliography* (Eds. T. Michev, B. Georgiev, A. Petrova & M. Karapetkova).
- Kaya M., S. Mater & A.Y. Korkut, 1998. A new grey mullet species "*Mugil so-iuy* Basilewsky" (Teleostei: Mugilidae) from the Aegean Coast of Turkey. *Turkish Journal of Zoology*, 22: 303-306.
- Kideys A.E., A.V. Kovalev, G. Shulman, A. Gordina & F. Bingel, 2000. A review of zooplankton investigations of the Black Sea over the last decade. *Journal of Marine Systems*, 24: 355-371.
- Konsuloff S. & P. Drensky, 1943. Die Fischfauna der Aegais. *Annu. Univ. Sofia, Sci. Nat.*, 39: 293-308 (In Bulgarian with German summary).
- Kottelat M. & P.S. Economidis, 2006. *Squalius orpheus*, a new species of cyprinid fish from Evros drainage, Greece (Teleostei: Cyprinidae). *Ichthyol. Explor. Freshwat.*, 17 (2): 181-186.
- Kottelat M., R. Britz, H.H. Tan Heok & K.E. Witte, 2006. *Paedocypris*, a new genus of Southeast Asian cyprinid fish with a remarkable sexual dimorphism, comprises the world's smallest vertebrate. *Proceedings of the Royal Society London B*, 273: 895-899.
- Kottelat M. & J. Freyhof, 2007. *Handbook of European freshwater fishes*. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany, pp. 646.
- Kottelat M., 1997. European freshwater fishes. An heuristic checklist of the freshwater fishes of Europe (exclusive of former USSR), with an introduction for non-systematists and comments on nomenclature and conservation. *Biologia, Bratislava, Section Zoology*, 52 (5): 1-271.
- Kottelat M., 2004. *Salaria economidisi*, a new species of freshwater fish from Lake Trichonis, Greece, with comments on variation in *S. fluviatilis* (Teleostei: Blenniidae). *Revue Suisse de Zoologie*, 111 (1): 121-137.

- Kottelat M., 2007. Three new species of *Phoxinus* from Greece and Southern France (Teleostei, Cyprinidae). *Ichthyological Exploration of Freshwaters*, 18: 145-162.
- Koutrakis E.T., 1994. Biology and population dynamics of grey mullets (Pisces: Mugilidae) in the Lake Vistonis and the Lagoon of Porto-Lagos. Aristotle University of Thessaloniki, 233pp. (in Greek with English summary).
- Koutrakis E.T., 1999. Review of the history and the systematics of the Mediterranean grey mullets (Mugilidae). *Geotechnical Scientific Issues*, 10, 6 (4): 365-374.
- Koutrakis E.T., 2004. Temporal occurrence and size distribution of grey mullet juveniles (Pisces, Mugilidae) in the estuarine systems of the Strymonikos Gulf (Greece). *Journal of Applied Ichthyology*, 20: 7678.
- Koutrakis E.T. & A.I. Sinis, 1994. Growth analysis of grey mullets (Pisces, Mugilidae) as related to age and site. *Israel Journal of Zoology*, 40: 31-53.
- Koutrakis E.T., A.I. Sinis & P.S. Economidis, 1994. Seasonal occurrence, abundance and size distribution of gray mullet fry (Pisces, Mugilidae) in the Porto-Lagos Lagoon and Lake Vistonis (Aegean Sea, Greece). *The Israeli Journal of Aquaculture* Bamidgheh, 46 (4): 182-196.
- Koutrakis E.T. & P.S. Economidis, 2000. First record in the Mediterranean (North Aegean Sea) of the Pacific *Mugil soiyuy* Basilewsky, 1855 (Pisces, Mugilidae). *Cybium*, 24 (3): 299-302.
- Koutrakis E.T., A.K. Kokkinakis, E.A. Eleftheriadis & M.D. Argyropoulou, 2000. Seasonal changes in distribution and abundance of the fish fauna in the two estuarine systems of Strymonikos gulf (Macedonia, Greece). *Belg. J. Zool.*, 130 (1): 43-50.
- Koutrakis E.T. & A.C. Tsikliras, 2003. Lengthweight relationships of fishes from three northern Aegean estuarine systems (Greece). *Journal of Applied Ichthyology*, 19: 258260.
- Koutrakis E.T., Kokkinakis A.K., Tsikliras A.C. & Eleftheriadis E.A., 2003. Characteristics of the European bitterling *Rhodeus amarus* in the Rihios River, Greece. *J. Freshwater Ecology*, 18 (4): 615-624.

- Koutrakis E.T., N.I. Kamidis & I. Leonardos, 2004. Age, growth and mortality of the sand smelt *Atherina boyeri* (Risso, 1810), (Pisces: Atherinidae) in an estuarine system of Northern Greece. *Journal of Applied Ichthyology*, 20: 382-388.
- Koutrakis E.T., A.C. Tsikliras & A.I. Sinis, 2005. Temporal variability of the ichthyofauna in a Northern Aegean coastal lagoon (Greece). Influence of environmental factors. *Hydrobiologia*, 543: 245-257.
- Koutrakis M., G. Sylaios, N. Kamidis, D. Markou, A. Sapounidis, P. Leontarakis & P.S. Economidis, 2008. Actions of monitoring, protection and enhancement of river Nestos fishfauna. *Final Report: "Management actions, protection and promotion of the Nestos River fish-fauna" in the framework of the 3.2 measure "Protection, promotion and management of natural environment" of the Operational Program "Interreg IIIa / Phare CBC Grece - Boulgaria"*. NAGREF Fisheries Research Institute, Kavala, Greece, 168 pp.
- Koutroumanidis Th., G. Sylaios, E. Zafeiriou & V.A. Tsihrintzis, 2009. Genetic modeling for the optimal forecasting of hydrologic time-series: Application in Nestos River. *Journal of Hydrology*, 368: 156-164.
- Kovatchev V., 1921a. Fish populations of the Struma River. *Travaux de la Societe Bulgare des sciences naturelles*, 9: 87-89. (In Bulgarian)
- Kovatchev V., 1921b. Zur Kenntnis der Ichthyologischen Fauna der Maritza. *Travaux de la Societe Bulgare des sciences naturelles*, 9: 90-94. (In Bulgarian)
- Kovatchev V., 1922. Faune des poissons d'eau douce en Bulgarie. *Archives du Ministere de l'Agriculture*, 3: 163 pp. (In Bulgarian)
- Kovatchev V., 1923. Faune des poissons d'eau douce en Bulgarie. *Archives du Ministere de l'Agriculture et des Domaines du Royaume de Bulgarie*, 3: 1-164. (In Bulgarian)
- Lekkas Th., G. Kolokythas, A. Nikolaou, M. Kostopoulou, A. Kotrikla, G. Gatidou, N. Thomaidis, S. Goulinopoulos, C. Makri, D. Babos, M. Vagi, A. Stasinakis, A. Petsas & D. Lekkas, 2004. Evaluation of the pollution of the surface waters of Greece from the priority compounds of List II, 76/464/EEC Directive, and

- other toxic compounds. *Environment International*, 30: 995-1007.
- Leonardos I., 2001. Ecology and exploitation pattern of a landlocked population of sand smelt, *Atherina boyeri* (Risso 1810), in Trichonis Lake (western Greece). *Journal of Applied Ichthyology*, 17: 1-5.
- Leonardos I., 2008. The feeding ecology of *Aphanius fasciatus* (Valenciennes, 1821) in the lagoonal system of Messolongi (western Greece). *Scientia Marina*, 72 (2): 393-401.
- Leonardos I., A.I. Sinis & D. Petridis, 1996. Influence of environmental factors on the population dynamics of *Aphanius fasciatus* (Nardo, 1827) (Pisces: Cyprinodontidae) in the Lagoons Mesolongi and Etolikon. *Israel Journal of Zoology*, 42: 231-249.
- Leonardos I. & A.I. Sinis, 1998. Reproductive strategy of *Aphanius fasciatus* Nardo, 1827 (Pisces: Cyprinodontidae) in the Mesolongi and Etolikon lagoons (W. Greece). *Fisheries Research*, 35: 171-181.
- Leonardos I. & A.I. Sinis, 1999. Age growth and mortality of *Aphanius fasciatus* (Nardo, 1827) (Pisces: Cyprinodontidae) in the Mesolongi and Etolikon lagoons (Western Greece). *Contributions to the Zoogeography and Ecology of the Eastern Mediterranean Region*, 1: 327-335.
- Linnaeus C., 1758. *Systema Naturae*, ed. 10 v. 1: i-ii + 1-824. Nantes and Pisces in Tom. 1, pp. 230-338.
- Luzhnyak V.A., 2007. New data on specific features of the ecology of reproduction of haarder *Liza haematocheilus* (Mugilidae) in the Azov-Black Sea basin. *Journal of Ichthyology*, 47(8): 676-679.
- Maitland P.S., 2000. *Guide to freshwater fish of Britain and Europe*. Octopus Publishing Group Limited, London, 256 p.
- Manolov Z. & J. Sivkov, 1977. Morphometrische Charakteristik des Varlovka-Fisches *Leucaspis delineatus* (Heckel) im Fluss Kamcjia. *Bulletin du Musee National de Varna*, 13 (28): 215-218. (In Bulgarian, German summary)
- Maric S., V. Hegedis, V. Nikolic & P. Simonovic, 2004. Conservation status of two

eastern Balkan endemic fish species in Serbia and proposal for their protection. *Acta zool. bulg.*, 56: 213-222.

Marinov B.T., 1964. Über den Geschlechtsdimorphismus dei *Barbus tauricus cyclolepis* Heckel. *Izv. Zool. Inst. Sofiya*, 17: 167-170. (In Bulgarian with Russian summary)

Marinov B.T., 1973. Über die systematische lage der unterarten von *Gobio gobio* (L.), 1758, aus Bulgarien. *Annuaire de l' Université de Sofia, Faculté de Biologie*, 65 (I): 104-115. (In Bulgarian with German summary).

Marinov B.T., 1979. *Pseudorasbora parva*, (Schlegel 1842) (Pices, Cyprinidae)-new representative for the Bulgarian ichthyofauna. *Hydrobiology, Sofia*, 8: 75-77.

Marinov B.T., 1989. *Systematic, faunistic and bionomic research of some genera from the families Cyprinidae and Cottidae*. Thesis, Sofia Universty, Faculty of Biology, 209 pp. (In Bulgarian).

Matishov G.G. & V.A. Luzhnyak, 2007. Extension of the spawning area of the Far Eastern mullet *Liza haematocheilus* (Temminck et Schlegel, 1845) acclimated in the Sea of Azov and Black Sea basin: Recent data on reproduction ecology. *Doklady Biological Sciences*, 414: 221-222

Maurakis E.G. & P.S. Economidis, 2003. Identification Key to Fishes in Fresh Waters of Greece. *Virginia Journal of Science*, 54 (3 4): 169 204.

Michajlova L., 1964. Über die Biologie des Döbels (*Leuciscus cephalus* L.) in der Struma. *Izv. Zool. Inst. Sofiya*, 17: 125-156. (In Bulgarian with German summary).

Michajlova L., 1965a. Untersuchungen über die Fischfauna des Struma Flusses. *Izv. Zool. Inst. Sofiya*, 19: 55-71. (In Bulgarian with Russian summary)

Michajlova L., 1965b. Über die ichthyofauna Trakiens. *Fauna Trakiya, Sofia*, 2: 265-289. (In Bulgarian)

Michajlova L., 1966. Beitrag zu der systematischen Lage der Art *Gobio gobio* L. in Bulgarien. *Fragm. Balcan.*, 6: 17-29.

Michajlova L., 1967. Seltene Fisharten aus der Süßwasserfauna Bulgariens. *Z. Fisch. Hilfswissensch.*, 15: 153-160.

- Michajlova L., 1970. The ichthyofauna in the rivers of the Aegean Sea catchment area. *Priroda*, 4: 62-65. (In Bulgarian, English summary)
- Miller P.J., 2003. (Ed.) *The freshwater fishes of Europe*. 8/1. Mugilidae, Atherinidae, Atherinopsidae, Blenniidae, Odontobutidae, Gobiidae I. Aula, Wiebelsheim.
- Miller P.J., 2004. (Ed.) *The freshwater fishes of Europe*. Gobiidae 2. Freshw. Fishes Europe 8 (2): i-x + 1-477.
- Mimides Th., N. Kotsovinos, S. Rizos, C. Soulis, P. Karakatsoulis & D. Stavropoulos, 2007. Integrated runoff and balance analysis concerning Greek-Bulgarian transboundary hydrological basin of River Nestos/Mesta. *Desalination*, 213: 174-181.
- Minos G., A. Imsiridou & P. S. Economidis, 2009. *Liza haematocheilus* (Pisces, Mugilidae) in Northern Aegean Sea. *Fish Invasions of the Mediterranean Sea*.
- Mizyurkina A.V., 1984. Spawning of haarder in Amur Bay. *Rybn. Khoz.*, 5: 31.
- Morov T., 1931. *The freshwater fishes of Bulgaria*. Union of Bulgarian Fishermen, Sofia, 93 p. (In Bulgarian)
- Morrow J., E., 1980. *The freshwater fishes of Alaska*. University of B. C. Animal Resources Ecology Library, 248 pp.
- Mylopoulos Y., E. Kolokytha, E. Kampragou & D. Vagiona, 2007. A Combined Methodology for Transboundary River Basin Management in Europe. Application in The NestosMesta Catchment Area. *Water Resources Management*, 22 (8): 1101-1112.
- NATURNET-REDIME, 2006. *Textual description of river Mesta case study*. Technical Report, 28 p.
- Naumovski M., 1995. *Fishes of Macedonia*, Skopje, 162 p.
- Nelson J. S., 2006. *Fishes of the World*. 3rd Edition, John Wiley & Sons, New York. 601 p.
- Nichols J.T., 1929 (15 Oct.) An Analysis of minnows of the genus *Pseudorasbora* from Shantung. *Am. Mus. Novit.*, 377: 1-11.
- Nielsen J., 1986. Pleuronectidae. In: P.J.P. Whitehead *et al.*, (eds.). *Fishes of the North-eastern Atlantic and the Mediterranean (FNAM)*. Unesco, Paris, vol. III: 1299-



- Papistas A., R. Giannopoulos & P.S. Economidis, 2003. An extremely large size specimen of *Silurus glanis*, wels, caught in the dam lake Polyfyto Kozani (Greece). *Proceedings of the 11th Panhellenic Congress of Ichthyologists*, 117-120 (in Greek).
- Paspalev G. & T. Peshev, 1955. Contribution to the study of the ichthyofauna in the Iskar River. *Annuaire de L'Universite de Sofia, Faculte de Biologie, Geologie et Geographie*, 48 (1): 1-39. (In Bulgarian)
- Pehlivanov L., 2000. Ichthyofauna of the East Rhodopes (South Bulgaria): Composition and Distribution: *Acta Zoologica Bulgarica*, 52 (3): 45-53.
- Penaz M., P. Rab & M. Prokes, 1979. Cytological analysis, gynogenesis and early development of *Carassius auratus gibelio*. *Acta Scientiarum Naturalium Brno*, 13 (7): 3-33.
- Penczak T., J. Jankov, T. Dikov & M. Zalewski, 1985. Fish production in the Mesta River, Rila Mountain, Bulgaria. *Fisheries Research*, 3: 201-221.
- Perdices A., I. Doadrio, I.M. Côté, A. Machordom, P. S. Economidis & J.D. Reynolds, 2000. Genetic divergence and origin of Mediterranean populations of the river blenny *Salaria fluviatilis* (Teleostei: Blenniidae). *Copeia* 2000 (3): 723-731.
- Petalas C., E. Pliakas, I. Diamantis & A. Kallioras, 2005. Development of an integrated conceptual model for the rational management of the transboundary Nestos River, Greece. *Environmental Geology*, 48: 941-954.
- Pianova S., 2005. Reproductive adaptations of harder (*Liza haematocheila*) to the new environment of the Russian South Seas. *Reports and Meeting Documents, Annual Science Conference, ICES CIEM/Q*: 06.
- Polacik M., T. Trichkova, M. Janac, M. Vassilev & P. Jurajda, 2008. The ichthyofauna of the shoreline zone in the longitudinal profile of the Danube River, Bulgaria. *Acta zoologica Bulgarica*, 60 (1): 77-88.
- Reichard M. & P. Jurajda, 1999. Patterns of ontogenetic changes in relative growth in the precocial cyprinid, bitterling (*Rhodeus sericeus*). *Netherlands Journal of*

*Zoology*, 49: 111-124.

- Risso A., 1810. Ichthyologie de Nice, ou histoire naturelle des poissons du département des Alpes Maritimes. F. Schoell, Paris. *Ichthyol. Nice*: i-xxxvi + 1-388.
- Risso A., 1826. Histoire naturelle des principales productions de l'Europe méridionale, et particulièrement de celles des environs de Nice et des Alpes maritimes. F. G. Levrault, Paris & Strasbourg. *Hist. Nat. Europe Mérid.*, 3: i-xvi + 1-480.
- Russev B., 1966. *Hydrobiologische Untersuchungen der Marica*. Fauna Trakiya, Sofiya, 3: 231-291.
- Salvarina I. & Koutrakis E.T., 2008. Feeding habits of the juveniles of five species of the Mugilidae family in two estuarine systems of the Strymonikos Gulf. *30th Scientific Conference, Hellenic Society of Biological Sciences*, Thessaloniki, May 22-24.
- Serkov V.M., 2003. Salinity tolerance of some teleost fishes of Peter the Great Bay, Sea of Japan. *Russian Journal of Marine Biology*, 29 (6): 368-371.
- Silva K., N.M. Monteiro, M.N. Vieira & V.C. Almada., 2006b. Reproductive behaviour of the black-striped pipefish *Syngnathus abaster* (Pisces; Syngnathidae). *Journal of Fish Biology*, 69: 1860-1869.
- Silva K., N.M. Monteiro, V.C. Almada & M.N. Vieira, 2006a. Early life history of *Syngnathus abaster*. *Journal of Fish Biology*, 68: 80-86.
- Simonovic P., S. Maric & V. Nikolic, 2005. Morphological differentiation of Salmonines (Subfamily Salmoninae) with emphasis on Trout *Salmo* spp. stocks in Serbia and adjacent regions. *Acta zool. bulg.*, 57 (3): 341-362.
- Simonovic, P., 2001. *Fishes of Serbia*, Beograd, 247 p. (In Serbian).
- Sivkov J., 1991. Morphological characterization of the stone loach *Noemacheilus barbatulus* (L.) (Pisces, Cobitidae) from Bulgaria. *Acta zoologica bulgarica*, 42: 27-33.
- Sivkov J., 1992. Morphological characteristics of the loach *Noemacheilus bureschi*

- Drensky, 1928 (Pisces, Cobitidae). *Bulletin du Musee National de Varna*, 28 (43): 357-360.
- Sivkov J., 2003. Morphological characteristics of the goldfish *Carassius auratus gibelio* (Bloch, 1783) (Pisces, Cyprinidae) from Bulgaria. *Bulletin du Musee National de Varna*, 34-35 (49-50): 421-428. (In Bulgarian, English summary)
- Sivkov J., 2004. Biometrical studies of the Amur bitterling *Rhodeus amarus* Bloch, 1782 (Pisces, Cyprinidae) from the Bulgarian waters. *Bulletin du Musee National de Varna*, 40 (55): 366-376. (In Bulgarian, English summary)
- Sivkov Y. & I. Dobrovolov, 1986. *Cobitis (Bicanestrinia) peshevi*, sp. n. (Pisces, Cobitidae) from Bulgaria. *Acta Zoologica Bulgarica*, 31: 3-17.
- Skoulikaris Ch., 2008. *Numerical simulation for the sustainable management of water resources works at the drainage basin scale: The case of Nestos River*. Thesis, Aristotle University of Thessaloniki, 333 p.
- Skoulikidis N.T., I. Bertahas & T. Koussouris, 1998. The environmental state of freshwater resources in Greece (river and lakes). *Environmental Geology*, 36 (1/2): 1-17.
- Smith C. L., 1990. *Moronidae* (pp. 692-694), *Serranidae* (pp. 695-706). In: Quéro *et al.* 1990 [ref. 15946]. Clófeta v. 2.
- Smith C., M. Reichard, P. Jurajda & M. Przybylski, 2004. The reproductive ecology of the European bitterling (*Rhodeus sericeus*). *Journal of Zoology*, 262: 107-124.
- Smith G.R. & R.F. Stearley, 1989. The classification and scientific names of rainbow and cutthroat trouts. *Fisheries*, 14 (1): 4-10.
- Stankovic S., 1960. *The Balkan lake Ohrid and its living world*. Ed. Uitgeverij Dr. W. Junk-Den Haag, 357 pp.
- Starushenco L.I. & A.B. Kazansky, 1996. Introduction of mullet harder (*Mugil so-iuy* Basilewsky) into the Black Sea and the Sea of Azov. *Studies and Reviews, General Fisheries Council for the Mediterranean*, 67: 29 pp.
- Stefanov T. & T. Trichkova, 2004. Fish species diversity in the Eastern Rhodope Mountains. In: Beron, P., & A. Popov (eds.), *Biodiversity of Bulgaria*. II.

- Biodiversity of the Eastern Rhodopes (Bulgaria). *Nat. Mus. Natur. Hist.*, Pensoft Publ., Sofia, 849-861.
- Stefanov T. & T. Trichkova, 2006. The Ichthyofauna of the West Rhodope Mountains (Bulgaria). In: Beron P. (Ed.). *Biodiversity of Bulgaria*. ЁЁЁ. Biodiversity of Western Rhodopes (Bulgaria and Greece) I. Pensoft & Nat. Mus. Natur. Hist., Sofia. 843-861.
- Stefanov T. & T. Trichkova. (In press). Struma Loach, *Barbatula bureschi* (Drensky, 1928). In: Golemansky V. (Ed.), *Red Data Book of Bulgaria*. Vol. 2. Animals.
- Stefanov T., T. Trichkova & J. Sivkov, (In press). European Eel *Anguilla anguilla* (Linnaeus, 1758). In: Golemansky, V. (Ed.), *Red Data Book of Bulgaria*. Vol. 2. Animals.
- Stephanidis A., 1950. Contribution à l'étude des poissons d'eau douce de la Grèce. *Prakt. Akad. Athen*, 18: 200-210. [In Greek, French summ.]
- Stephanidis A., 1971. Poisson d'eau douce du Peloponnese. *Biologia Gallo-Hellenica*, 3 (2): 163-212
- Stoichev K., 1989. Fluctuations concerning the annual stream flow in the Rhodope massif. *Geografica Rhodopica*, 2: 158-169.
- Svetovidov A.N., 1964. *Fishes of the Black Sea*. Nauka, Moskva [in Russian].
- Svetovidov A.N., 1973. *Clupeidae* (pp. 99-109), in Hureau & Monod 1973 *Clofnam* v. 1.
- Taler Z., 1953. Rasprostranjenje i popis slatkovodnix riba Jugoslavije. *Bull. Muz. Hist. Nat. Pays Serbe*, serie B, 5-6: 425-455.
- Temminck C.J. and H. Schlegel, 1846. *Pisces*, Fauna Japonica Parts, 10-14: 173-269.
- Thomson J.M., 1986. *Mugilidae* (pp. 344-349). In: Daget *et al.* 1986
- Thomson J.M., 1990. *Mugilidae* (pp. 855-859). In: Quéro *et al.* 1990
- Thomson J.M., 1997. *The Mugilidae of the World*. Memoirs of the Queensland Museum, 41 (3): 457-562.
- Trichkova A., M. Zivkov & A. Apostolou, 2008. Some biological characteristics of gibel carp (*Carassius gibelio*) from three localities in the Bulgarian stretch of the Danube River. In: Genov, I. (Ed.). *The 17th International Symposium*

"Ecology & Safety 2008", 9-13 June, Sunny Beach, Bulgaria, Scientific Articles.  
(In Bulgarian, English summary)

- Trichkova T. & M. Zivkov, 2007. Structure, maturity and growth rate of *Carassius gibelio* population in the Drenovets Reservoir, North-West Bulgaria. In: Genov, I. (Ed.), *The 16th International Symposium "Ecology 2007"*, 4-8 June, Bulgaria, Scientific Articles, 247-256. (In Bulgarian, English summary)
- Tsigenopoulos C.S. & P. Berrebi, 2000. Molecular phylogeny of north Mediterranean freshwater barbs (genus *Barbus*: Cyprinidae) inferred from cytochrome b sequences: biogeographic and systematic implications. *Molecular Phylogenetics and Evolution*, 14 (2): 165-179.
- Tsigenopoulos C.S. & Y. Karakousis, 1996. Phylogenetic relationships of *Leuciscus keadicus*, an endemic cyprinid species from Greece, with other Greek species in the genus *Leuciscus*. *Folia Zoologica*, 45 (1): 87-93.
- Uzunova E. & S. Zlatanova, 2007. A review of the fish introductions in Bulgarian freshwaters. *Acta Ichthyologica et Piscatoria*, 37 (1): 55-61
- Vasilieva E.D. & T.I. Kuga, 2001. Cranial differences between Caucasian goby *Knipowitschia caucasica* and marbled goby *Pomatoschistus marmoratus* and the taxonomic problems of "sand gobies" (Gobiidae). *Voprosy Ikhtiologii*, 41: 159-166 [in Russian, translated in *Journal of Ichthyology*, 41: 135-142].
- Vassilev M., 1988. Alteration of the ichthyofauna in the Shabla and Ezerets Lakes. In: *Biodiversity of Shabla Lake System. Sofia, "Prof. Marin Drinov"*, Academic publishing house: 101-106.
- Vassilev M., 1989a. Changes of ichthyofauna in the Lesenski and the Mazen Marshes (Kamchia reserve, Bulgaria). *Acta Zoologica Bulgarica*, 51 (1): 57-60.
- Vassilev M., 1989b. Changes of ichthyofauna in the Durankulak Lake. *Acta Zoologica Bulgarica*, 51 (1): 61-68.
- Vassilev M.V. & L.P. Pehlivanov, 2002. The ichthyofauna of the Bulgarian part of the Struma River. *Historia naturalis bulgarica*, Sofia, 14: 103-108 (In Bulgarian with English summary).

- Vassilev M.V. & L. P. Pehlivanov, 2005 *Checklist of Bulgarian freshwater fishes*. *Acta Zoologica Bulgarica*, 57 (2): 161-190.
- Vinyoles D. & A. de Sostoa, 2007. Life-history traits of the endangered river blenny *Salarias fluviatilis* (Asso) and their implications for conservation. *Journal of Fish Biology*, 70: 1088-1108.
- Whitehead P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, 1986. *Fishes of the North-eastern Atlantic and the Mediterranean*. Vol. I. UNESCO. Fish. N-e. Atl. and Mediterranean: 1-510.
- Whitehead P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, 1986. *Fishes of the North-eastern Atlantic and the Mediterranean*. Vol. II. UNESCO. Fish. N-e. Atl. and Mediterranean: 517-1007.
- Whitehead P.J.P., M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, 1986. *Fishes of the North-eastern Atlantic and the Mediterranean*. Vol. III. UNESCO. Fish. N-e. Atl. and Mediterranean: 1015-1473.
- Wildekamp R.H., 1993. *A world of killers. Atlas of the oviparous cyprinodontiform fishes of the world*. Volume 1. The genera *Adamas*, *Adinia*, *Aphanius*, *Aphyoplatys* and *Aphyosemion*. American Killifish Association, Mishawaka.
- Wolf A., J. Natharius, J. Danielson, B. Ward & J. Pender, 1999. International river basins of the 21 world. *International Journal Water Resources Development*, 15 (4): 387-427.
- Xeidakis G.S. & P. Delimani, 2002. Coastal erosion problems in northern Aegean coastline: the case of the Nestos River delta and the adjacent coastline. *Coastal Environment, Environmental Problems in Coastal Regions IV*, Wit Press, pp. 151-159.
- Zagorchev I., 2007. Late Cenozoic development of the Strouma and Mesta fluviolacustrine systems, SW Bulgaria and northern Greece. *Quaternary Science Reviews* 26: 2783-2800.
- Zismann L., 1981. Means of identification of grey mullet fry for culture. In *Aquaculture of grey mullets*, Oren, O.H. (Eds).

- Zivkov M., 1980. Numerical dynamics of fish populations in the Batak Dam. V. Maturity and sex ratio. *Hydrobiology*, BAS, Sofia, 12: 49-62. (In Bulgarian)
- Zivkov M., 1987. Ichthyofauna and fish-farming in the Dospat Reservoir. *Hydrobiology*, 30: 15-22. (In Bulgarian, English summary).
- Zivkov M., 1999. *Population-biological variability of fresh water fish species regularities and methodology*. Institute of Zoology, Bulgarian Academy of Sciences, DSc Thesis, Sofia, 406 p. (In Bulgarian).



## INDEX

(fish common names, synonyms, biological terms)

|                  |        |                        |                 |
|------------------|--------|------------------------|-----------------|
| <b>A</b>         |        | Basal element          | 47              |
| Adult            | 54     | Belitsa                | 108             |
| Aegean gudgeon   | 102    | Benthic                | 56, 57          |
| Agamodromous     | 58     | Bisexual               | 52              |
| Agriochrysopsaro | 86     | Bitterling             | 24, 53, 54, 132 |
| Amphidromous     | 58     | Black-striped pipefish | 146             |
| Anadromous       | 58, 74 | Bleak                  | 25, 72          |
| Anal             | 44, 47 | Bleskach               | 72              |
| Anatomy          | 47     | Bleskavets             | 70              |
| Aphanius         | 78     | Body                   | 43              |
| Aristotle        | 41     | Boinik                 | 90              |
| Aterina          | 80     | Brackish               | 57              |
| Atherina         | 80     | Brain                  | 47, 51          |
|                  |        | Branchial arches       | 47, 50          |
|                  |        | Branchial cavity       | 44, 50          |
| <b>B</b>         |        | Branchiostegal rays    | 44              |
| Babushka         | 134    | Buccal cavity          | 49              |
| Back bone        | 47     |                        |                 |
| Barbels          | 44, 82 |                        |                 |

|                      |            |                       |             |
|----------------------|------------|-----------------------|-------------|
| <b>C</b>             |            | Diversity             | 42          |
| Caduceus             | 45         | Dorsal                | 44, 47      |
| Carnivores           | 57, 98     | Dospat dam            | 23, 86      |
| Catadromous          | 58         | Drainage basin        | 28, 37, 39  |
| Catchment            | 18, 27     |                       |             |
| Catchment area       | 20, 22     | <b>E</b>              |             |
| Caucasian dwarf goby | 104        | Eastern mosquito fish | 25, 79, 100 |
| Caudal               | 44, 47     | Eel                   | 25, 76      |
| Chamatída            | 128        | Egeiska Krotushka     | 102         |
| Cheilonari           | 88         | Egeiski kefál         | 144         |
| Chemoreception       | 58         | Elasmoid scales       | 45, 46      |
| Chernoivichesta igla | 146        | Electroreception      | 58          |
| Chervenoperka        | 140        | Emarginated           | 44, 82      |
| Chromatophores       | 47         | Embryonic             | 54          |
| Circulatory system   | 50         | Environment           | 56          |
| Color                | 43, 46     | Epibranchial          | 50          |
| Common carp          | 25, 56, 94 | Epurals               | 48          |
| Communication        | 58         | European flounder     | 128         |
| Cosmpoid             | 45         | European perch        | 25, 56, 124 |
| Ctenoid scales       | 46         | European seabass      | 96          |
| Cycloid scales       | 46         | European Toothcarp    | 77          |
|                      |            | Excretory system      | 51          |
| <b>D</b>             |            | Eyes                  | 43          |
| Dagova pastarva      | 120        |                       |             |
| Detrivores           | 57         | <b>F</b>              |             |
| Development          | 54         | Families              | 42, 56, 60  |
| Diadromous           | 57         | Fins                  | 43          |
| Digestive track      | 49         | Flathead mullet       | 118         |

|                    |     |                         |        |
|--------------------|-----|-------------------------|--------|
| Forked             | 44  | Heli                    | 76     |
| Freshwater blenny  | 136 | Herbivores              | 57     |
| Fusiform           | 43  | Hermaphroditism         | 52     |
|                    |     | Hydrology               | 33     |
| <b>G</b>           |     | Hydro-power stations    | 37     |
| Gallbladder        | 49  | Hypersaline             | 57, 79 |
| Gambusia           | 100 | Hypurals                | 48     |
| Gamodromous        | 58  |                         |        |
| Ganoid             | 45  | <b>I</b>                |        |
| Gastros            | 116 | Ichthyology             | 22, 41 |
| Geological         | 29  | Ilariya                 | 116    |
| Gill opening       | 43  | Iliopsaro               | 106    |
| Gill slits         | 43  | Inferior                | 43     |
| Glini              | 148 | Interopercle            | 44     |
| Gneisses           | 29  | Iridizousa Pestrofa     | 120    |
| Golden grey mullet | 110 | Iris                    | 43     |
| Gonochoristic      | 52  |                         |        |
| Gorchivka          | 132 | <b>J</b>                |        |
| Goulianos          | 142 | Jaws                    | 47     |
| Gourounomitis      | 90  | Juvenile                | 54     |
| Granite            | 29  |                         |        |
| Grivadi            | 94  | <b>K</b>                |        |
| Gudgeon            | 50  | Kamenarka               | 122    |
| Gulesh             | 82  | Kavkazko popche         | 104    |
| Gyftopsaro         | 102 | Kefalos                 | 118    |
|                    |     | Kokkinoftera            | 140    |
| <b>H</b>           |     | Kokkinogastros Strymona | 126    |
| Hard rays          | 44  | Kounoupofagos           | 100    |
| Head               | 43  | Kubinka                 | 130    |

|                              |     |                    |             |
|------------------------------|-----|--------------------|-------------|
| <b>L</b>                     |     | Mouth              | 43, 49      |
| Lamellae                     | 50  | Muscles            | 48          |
| Larval                       | 54  | Myocommata         | 48          |
| Lateral line                 | 45  | Myomeres           | 48          |
| Lavrak                       | 96  | Myosepta           | 48          |
| Lavraki                      | 96  | Myotomes           | 48          |
| Leaping mullet               | 116 |                    |             |
| Lentic                       | 57  | <b>N</b>           |             |
| Lin                          | 143 | Nape               | 44          |
| Lotic                        | 57  | Nervous system     | 50          |
|                              |     | Nestos Trout       | 24, 56, 138 |
| <b>M</b>                     |     | Neural cord        | 51          |
| Magnetoreception             | 58  | Neurocranium       | 47          |
| Makedonska (Rechna) pastarva | 138 | Nomenclature       | 41, 63, 64  |
| Mandible                     | 43  | Nostrils           | 43          |
| Mandibula                    | 43  | Notochord          | 47          |
| Marine                       | 57  |                    |             |
| Mavraki                      | 114 | <b>O</b>           |             |
| Maxilla                      | 43  | Oceanodromous      | 57          |
| Maxillary                    | 43  | Oligohaline        | 57          |
| Mechanoreception             | 58  | Omnivores          | 57          |
| Mesohaline                   | 57  | Opercle            | 44          |
| Mikrosirko                   | 108 | Operculum          | 44          |
| Miksinari                    | 110 | Orders             | 42          |
| Monosexual                   | 51  | Orpheus chub       | 144         |
| Morphology                   | 43  | Osmotic regulation | 50          |
| Morski kefal                 | 118 | Ostronos kefal     | 88          |
| Mourmouritsa                 | 132 |                    |             |

|                    |             |                         |                            |
|--------------------|-------------|-------------------------|----------------------------|
| <b>P</b>           |             | Pupil                   | 43                         |
| Palatine           | 49          | Pyloric caeca           | 49, 88, 110, 114, 116, 118 |
| Paleozoic          | 29          |                         |                            |
| Pectorals          | 44, 47      | <b>Q</b>                |                            |
| Pelagic            | 56, 57      |                         |                            |
| Pelengas           | 112         | <b>R</b>                |                            |
| Pelvics            | 44, 47      | Rainbow trout           | 25, 120                    |
| Perforated scales  | 45          | Ramsar                  | 31                         |
| Perki              | 124         | Rechen kostur           | 124                        |
| Pestrofa Nestou    | 138         | Rechna zmiorka          | 76                         |
| Petalouda          | 86          | Reproduction            | 52                         |
| Petrocheili        | 122         | Reproductive strategies | 52                         |
| Phytoplanktivores  | 57, 73      | Reproductive system     | 52                         |
| Pike               | 98          | Respiratory system      | 50                         |
| Pisia              | 128         | Rigoti Sakorafa         | 146                        |
| Placoid scales     | 45          | Rila mountains          | 27                         |
| Platanovrysi dam   | 23, 71, 107 | River hydrology         | 33                         |
| Platerina          | 110         | Roach                   | 25, 56, 134                |
| Pollution          | 38, 60      | Rounded                 | 44                         |
| Pollution sources  | 38          | Rudd                    | 140                        |
| Pontogovios        | 104         |                         |                            |
| Potamodromous      | 57          | <b>S</b>                |                            |
| Potamosaliara      | 136         | Sand smelt              | 80                         |
| Premaxillary bones | 43          | Sardelomana             | 74                         |
| Preopercle         | 44          | Sazanokefalos           | 112                        |
| Prussian carp      | 56, 86      | Scales                  | 43                         |
| Pseudorasbora      | 25, 130     | Schists                 | 29                         |
| Pumpkinseed        | 25, 60, 106 | Senescent               | 54                         |

|                        |         |                       |                |
|------------------------|---------|-----------------------|----------------|
| Sense organs           | 51      | Sthuka                | 98             |
| Sexual dimorphism      | 52      | Suborbitals           | 44             |
| Sexuality              | 52      | Subopercle            | 44             |
| Sharan                 | 94      | Sun bleak             | 25, 108        |
| Sirko                  | 72      | Superior mouth        | 43             |
| Sirtis                 | 90      | Systema naturae       | 42             |
| Skeleton               | 47      |                       |                |
| Skeleton of girdles    | 47      | <b>T</b>              |                |
| Sladkovodna kuchka     | 136     | Tail                  | 43             |
| Slancheva riba         | 106     | Tankoust kefal        | 114            |
| Snout                  | 43      | Taxonomic             | 42, 44         |
| Soiyu mullet           | 112     | Tench                 | 148            |
| Som                    | 142     | Terminal              | 43             |
| Spines                 | 44      | Thicklip grey mullet  | 88             |
| Spines rays            | 44      | Thinlip mullet        | 114            |
| Splachnocranium        | 47      | Thisavros dam         | 23, 71, 84, 93 |
| Srebrista karakuda     | 86      | Thracian Spined loach | 24, 92         |
| Sredizemnomorska finta | 74      | Thrakovelonitsa       | 92             |
| Stagnant               | 57      | Throkotilinari        | 144            |
| Stone loach            | 82      | Tlastak               | 82             |
| Stone moroko           | 130     | Tourna                | 98             |
| Strumica barbel        | 84      | Toxotes dam           | 23, 74         |
| Strumska govedarka     | 70      | Trakyiska Mriana      | 84             |
| Strumska leshanka      | 126     | Transboundary         | 27, 29         |
| Strumski gulesh        | 122     | Truncate              | 44, 82         |
| Strumski stipok        | 92      | Tsironaki Strymona    | 70             |
| Strymon minnow         | 56, 126 | Tsironi               | 134            |
| Strymon spirlin        | 24, 70  | Twaite shad           | 74             |
| Strymon stone loach    | 24, 122 |                       |                |

## U

|           |    |
|-----------|----|
| Uklei     | 72 |
| Ukleyka   | 72 |
| UNESCO    | 30 |
| Unisexual | 52 |

## Z

|                 |        |
|-----------------|--------|
| Zacharias       | 78     |
| Zamparola       | 78     |
| Zoogeography    | 42     |
| Zooplanktivores | 57, 73 |

## V

|                  |                |
|------------------|----------------|
| Vardar nase      | 24, 25, 56, 90 |
| Vardarski skobar | 90             |
| Varlovka         | 108            |
| Ventrals         | 44, 47         |
| Vertebrae        | 47             |
| Vertebral column | 47             |
| Vinos            | 82             |
| Violetka         | 132            |
| Virgiana         | 84             |
| Vision           | 58             |
| Vomer            | 49             |

## W

|                           |     |
|---------------------------|-----|
| Water Framework Directive | 27  |
| Wells catfish             | 142 |

## X

## Y



