

*The European Eel *Anguilla anguilla* (Pisces, Anguillidae). Native or Alien in the Black Sea?*

*Apostolos I. Apostolou**, *Boris K. Velkov*, *Milen V. Vassilev*

Institute of Biodiversity and Ecosystem Research
Bulgarian Academy of Sciences, 2 Gagarin Street, 1113 Sofia, BULGARIA

* Corresponding author: apostolosfish@abv.bg

Abstract. In 2006 the Scientific, Technical and Economic Committee for Fisheries (STEF) of EU suggested the Black Sea region should be excluded from the list of natural areas, where the European eel (*Anguilla anguilla*) is distributed. The basic conception of this idea was that the eels caught in the Black Sea region represent escaped specimens from fish farming in some Danubian countries. This article illustrates an effort to be given an indirect answer on the question if Black Sea is the end of natural distribution of European eel. The species is present but never been abundant in the region and do not represent an object of commercial fishing.

Key words: European eel, *Anguilla anguilla*, Black Sea Region

Introduction

The life cycle of the eel was a mystery for a very long period of scientific history - more than 6500 publications about the eel, but still much of its life history is enigmatic.

Until 1893, larval eels – transparent, leaf like 5 cm creatures of the open ocean – were considered a separate species – *Leptocephalus brevirostris*. Italian zoologist Giovanni Grassi observed the transformation of a *Leptocephalus* into a round glass eel in the Mediterranean Sea, and French zoologist Yves Delage proved in a laboratory that both *Leptocephalus* and eels were the same species. Despite this discovery, the name *Leptocephalus* is still used for larval eel. A Danish professor - Johannes Schmidt from 1904 onwards, directed many expeditions in the Mediterranean Sea and the North Atlantic, largely financed by the Carlsberg Foundation. Finally in 1922, he ended up

south of Bermuda in the Sargasso Sea, where he succeeded in catching the smallest eel-larvae ever seen. However, Schmidt was not able to observe the spawning directly, nor did he find ready-to-spawn adults. This area has not been confirmed by the presence of eggs, small larvae or spawning adults (BAKER, 1978). European eels are thought to spawn at ocean depths of 400-700 m in mid-water in late winter and early spring (BERTELSEN, 1967). The eggs are pelagic.

After hatchment the larval European eels travel by the aims of the Gulf Stream across the Atlantic Ocean and, after one to three years, reach European shores at a size of 45-75 mm. The common name for this stage is glass eel (based on the transparency of the body). Glass eels evolve into small eels before moving into freshwater basins. In fresh water they develop pigmentation, turn into elves (young eels) and feed on small crustaceans, worms and insects.

Young eels spend their growth period in freshwater, males for 6-12 years (a length of 30-40 cm), females for 9-20 years (55-65 cm), before ending their metamorphosis. They grow up in 10 or 14 years to a length of 60 to 80 cm. In this stage they are called yellow (green) eels because of their pigmentation.

At the end of their growth period, they become sexually mature and migrate towards the sea, crossing even wet grasslands at night to reach the proper rivers.

Whether the adults can ever make the 6,000 km open ocean journey back to their spawning grounds remains unknown. The body undergoes other changes as well: the eyes start to grow, for optimal vision, and the body sides become silvery, for optimal mobility. These migrating eels are often called silver eels. According to SCHMIDT (1912) a travel speed in the ocean of 15 km per day can be assumed, so a silver eel would need 140 to 175 days to reach the Sargasso Sea.

Today our knowledge on the fate of the eels once they leave the continental shelf is based on three eels found in the stomachs of deep sea fish, a whale caught off Ireland and off the Azores and some experiments on five eels.

The European eel (*Anguilla anguilla*) is representing a highly valuable stock in view to fisheries and aquaculture, with final consequence the severe decline of its stocks. According to estimates from the International Council for Exploration of the Seas (ICES), the recruitment level (the number of baby eel produced each year) is only 1 % of what it was before the 1980s, and total reported landings of European Eels (to FAO) dropped to 43.5% from 1984-2000.

The species is included in the IUCN Red list of threatened species as Critically Endangered (A2bd+4bd) (RedList IUCN, 2912). In 2007, it was included in CITES App. II (CITES, 2011) that deals with species not necessarily threatened with extinction, but in which trade must be controlled. Since 1985 it is included in the Bulgarian Red Book (2011) as a critically endangered species. The distribution and stocks accordingly of this species in the Bulgarian

water bodies during the last 50 - 60 years is decreased approximately more than 10 times (Fig. 1).

In the most relatively contemporary books, monographs, internet and others works concerning migrations and distribution of European eel we can find the next information concerning the species' distribution: Atlantic Ocean - Eastern Atlantic coast from Scandinavia to Morocco and rivers of North Atlantic, Baltic and Mediterranean Seas. There have been undertaken certain introductions to Asia, South and Central America, and Australia.

Development during life cycle with metamorphosis is typical for the representative species of order Anguilliformes (including the typical marine species). The unique biology of the species *Anguilla anguilla* is determined by the vast distances between places for spawn (Sargasso Sea) and the areas of distribution. In this case, according the strict sense (sensus stricto) of the term "native species", The European eel is not native for none of the European or other countries. These countries are part of the natural distribution areas for most of the species' developmental stages. To complete its life cycle the European eel should overcome distances between 10 000-12 000 km. Probably at first sight these enormous distances appear to be almost impossible for such a migration, but it should be considered, that this unique life cycle is a result of thousands of year's evolution.

In 2006 the Scientific, Technical and Economic Committee for Fisheries (STEF) of EU suggested the Black Sea region should be excluded from the list of natural areas, where the European eel *Anguilla anguilla* is distributed. The basic conception of this idea was that the eels caught in the Black Sea region represent escaped specimens from fish farming in some Danubian countries. This article illustrates an effort to be given an indirect answer on the question if Black Sea is the end of natural distribution of European eel.

Materials and Methods

In order to register the species' presence in the Bulgarian Black Sea sector and

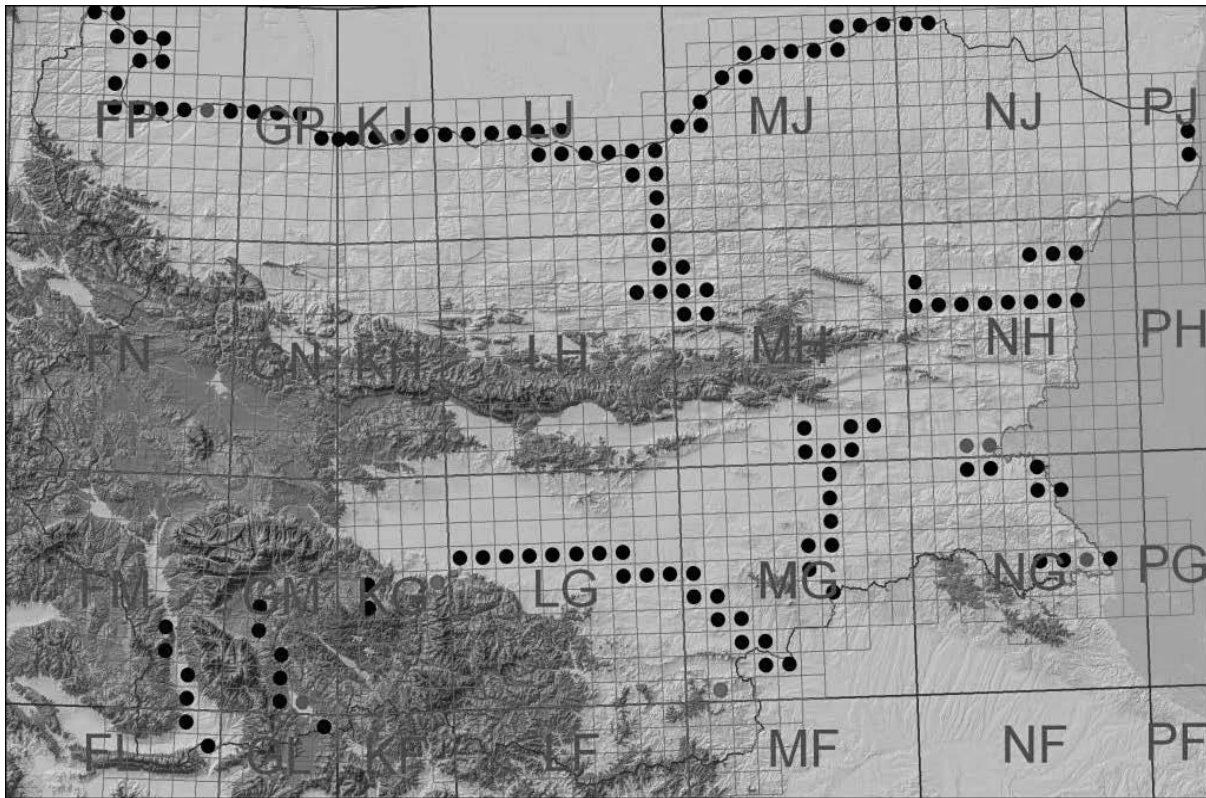


Fig. 1. Past and present distribution of the European eel in Bulgaria according to the Red Data Book of the Republic of Bulgaria, 2011, (Digital edition).

adjacent freshwater bodies during the period 2009-2012 the following methods have been applied: baited and unbaited net traps, underwater transects in both marine/brackish and fresh waters (the last when visibility permitted) – both during day and night, inquiries of local professional fishermen and fish markets. The survey covered almost the entire Bulgarian Black Sea sector, and adjacent sea shore lakes, lagoons, estuaries and rivers.

Results and Discussion

The results obtained from the questionnaires showed, that the European eel is present in most of the main freshwater bodies, connected directly with Black Sea, from north to south: Durankulak and Shabla/Ezerets coastal lakes, Varna lake complex, Kamchia River, Bourgas/Mandra coastal lakes system, Ropotamo and Veleka Rivers. It is not clear if inhabits rivers Karaagach, Diavolska and Rezovska, such information is lacking. From the other side the fishermen's statements have to be

accepted as truly without doubt. Single specimens are also irregularly caught by professional pound nets along the entirely Bulgarian Black Sea coast.

Keeping in mind the cryptic and nocturnal life mode of the species, it is extremely difficult to be registered. In September 2010 a single European eel specimen has been captured by the authors, between Primorsko and Kiten towns ($42^{\circ} 14' 32.84''$, $E 27^{\circ} 45' 59.04''$) (Fig 2). The captured in Black Sea specimen occurred to be a yellow eel 92 cm long. It was discovered on rocky substrate hiding between rocks at a depth of about 2.5 m and represents the most recently documented registration along the Bulgarian Black Sea sector.

Native or alien?

In order to replay to the question "Is the Black Sea water basin part of the native area of distribution for European eel (*Anguilla anguilla*)", we should accept or reject the following two conceptions:

1. Black Sea water basin was artificially settled with eels from the humans – in this

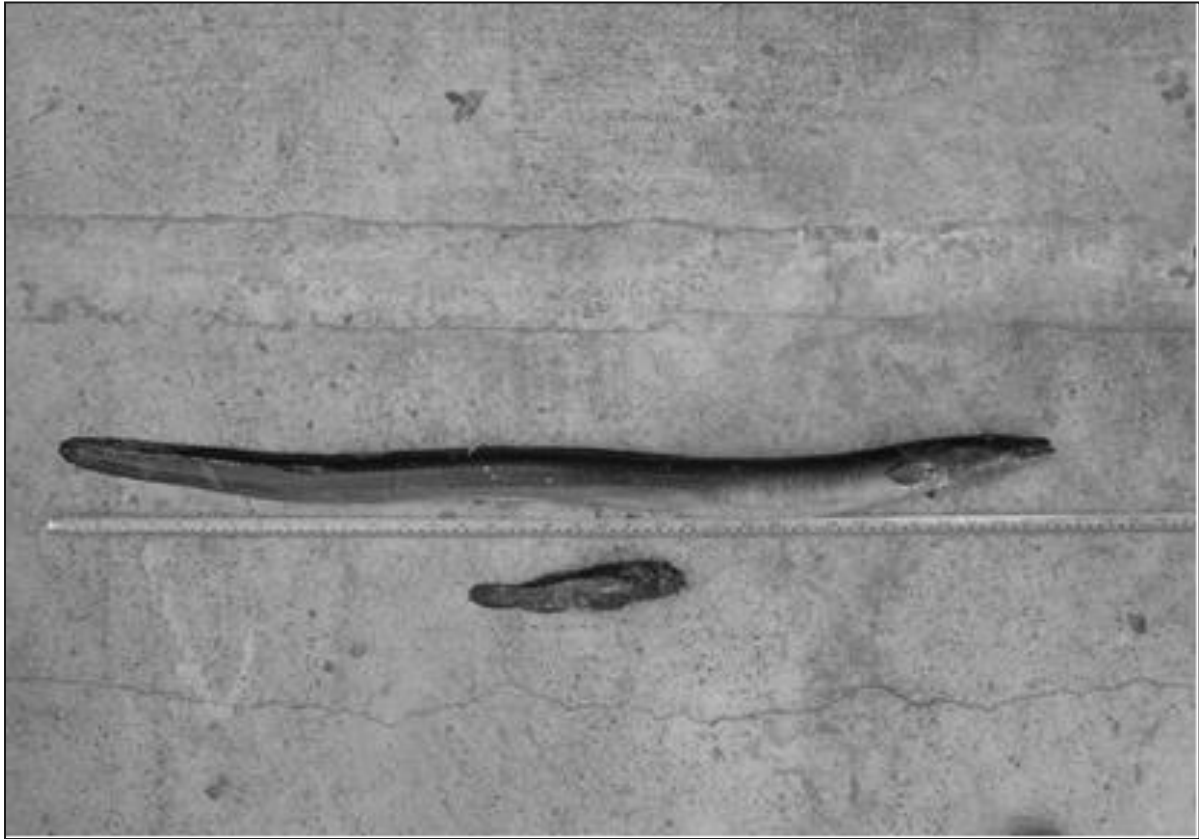


Fig. 2. The most recently documented European eel capture in Black Sea near Kiten town (N 42° 14' 32.84'', E 27° 45' 59.04'') in September 2009. Yellow eel, 92 cm, 806 gr.

case the Black sea water basin is not a native area of distribution.

2. The presence of eel in the Black Sea water basin is consequence of the natural distribution of the species through Aegean Sea, Sea of Marmara and Bosphorus.

In the first case the entrance of eel in the Black sea could happen only through the Danube river, as a result of aquaculture farming in the upper reaches of the river – in Germany, Austria and Hungary. Indeed the eel is farmed artificially in aquaculture (fatten to market size) in these countries from the beginning of the XXth century, in the beginning extensively and later intensively. The statement that aquaculture eel escapes in Danube river reaches could lead to settlement in Black sea water basin cannot be taken as a serious view. Pioneers in the eel aquaculture and artificial settlement of animal and plant species are considered to be the Romans, but still from those old times it is well known that to settle a certain species in new area and to ensure

its survival it is necessary to perform successful acclimatization, in other words to establish spawning in the new area. Concerning the European eel, similar speculation is impossible, taking in mind what it is known about the biology of the species – after the entrance in the rivers and approaching maturity, the eel turns back to the sea, where undergoes migratory changes (coloration, behavior etc). The next stage is the long way to the Sea of Sargasso. In this way of thinking it should be considered, that except in the Danube River, Northern and North-Western part of Black Sea, the eel should not be found in the North, East and South parts of the Sea, in The Sea of Azov and in the other rivers of this particular water basin. This concept seems to be incorrect. The presence of the species in Black Sea and The Sea of Azov basins is proved by many scientific researches accomplished in the region and dated before the development of any aquaculture activities and building of artificial water

channels, connecting the basins of Black Sea and Baltic Sea.

During the 17th century the traveler scientist Marsilius (in BERG, 1961) announced presence of eel in the upper and middle reaches of Danube River. In 1774, the famous Russian ichthyologist GULDENSTADT (1791) described European eel in Dnieper River basin. Other Russian ichthyologist - KESSLER (1857) reported that this species is not rare in lower reaches in Dniester River. In the beginning of 20th century the eel is caught in most of the coastal lakes in Russia, Romania and Bulgaria. (ANTIPA, 1909; CHICHKOFF, 1912; MAKSIMOV, 1914; DRENSKY, 1923; BERG, 1949 etc.). For particular specimens capture in Black sea, Sea of Azov and the flowing nearby rivers is mentioned in the references of RYABKOV (1896); TROITSKYI (in BERG, 1949); BERG (1949, 1961); DRENSKY (1951); BANARESCU (1964); SVETOVIDOV (1964); MARTI (1980) etc.

Another evidence for the entrance of eel in Black sea trough Bosphorus is the size of the discovered specimens - between 20 cm and 100 cm, i.e. that are eels (20-25 cm) which reached Black Sea and are ready to enter the rivers and others (over 50 cm) which are migrated from the rivers to the sea (fishermen's communications and recent capture). The case seems similar as another locality, where different sized specimens are caught altogether: the Baltic Sea, which is assumed as part of the eels natural areal. The species presence in Volga drainage (KOTTELAT & FREYHOFF, 2007) is also a pro argument for the second conception - it does not seem possible to travel in Black Sea via Danube from Baltic Sea, enter Caspian Sea drainage and then return to Black Sea for reproductive migration to the Sargasso Sea.

As an evidence for the ancient presence of European eel in Black Sea basin can also be indicated the original names of this species in some of the languages in the region, especially Bulgarian local name "Zmiorka", which does not have analogy among the other eel names as well Russian and Ukrainian name "Ugor". The usual practice during the introduction of alien

(exotic) species is to take the origin name used in the country, from which the species is imported and not to be given a new one.

Actually, the Black Sea basin which is connected by Bosphorus and Sea of Marmara with Aegean Sea (Mediterranean) Basin - is the end constituent of natural area of distribution of European eel (ANTIPA, 1909; KOVACHEV, 1922; Berg, 1949; DRENSKY, 1951; BANARESCU, 1964; SVETOVIDOV, 1964; MARTI, 1980. In this part of the area the European eel was never been abundant and respectively an object of commercial fishery. Probably because of this reason, it has not been an object of any careful studies and statistical data in the region.

Bulgarian rivers belong to both Black Sea and Aegean Sea watershed. In Bulgaria until 1940s - 1950s there were caught dozens of specimens by fishermen in the lakes and the rivers flown directly in the Black Sea (Kamchiya, Ropotamo, Veleka, Rezovska); in some marshes and rivers from the Aegean catchment (Struma / Strymon, Mesta / Nestos, Maritsa / Evros, Tundzha, Arda / Ardas); in the Danube River and marshes along the river (CHICHKOFF, 1912; KOVACHEV, 1922; DRENSKY, 1948, 1951).

During the last years the European eel is considerably rare caught in the lower parts of the rivers: Arda, Maritsa, Tundzha, Kamchiya, Veleka and in the Bulgarian stretch of Danube River (MIHAILOVA, 1965; KARAPETKOVA, 1974, 1975, 1976; KARAPETKOVA & ZIVKOV, 1995; MARINOV, 1978; VASSILEV & PEHLIVANOV, 2005 etc.).

Conclusion

Black Sea is the end of natural distribution of European eel. The species is not abundant in the region and do not represent an object of commercial fishing. At the present time, besides a natural penetration of eels through Bosphorus, replenishment by fish farming is possible.

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