J. Black Sea/Mediterranean Environment
Vol. 16(2): 195-210 (2010)

A review of fish fauna in the Turkish Black Sea

Karadeniz balık faunası

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Abstract

This review showed that a total of 161 fish species inhabit in the Turkish Black Sea according to previous studies. Atlanto-Mediterranean species consisted 62.73% of total fish fauna, 6.83% cosmopolitan, 28.57% endemics and 1.86% introduced species such as, *Liza haematocheila, Sphraena obtusata* and *Salmo salar*. For the protection of the fish diversity in the Black Sea needs to establish marine protected areas, get under control of illegal, unreported and unregulated fisheries, regional cooperation and concerted action.

Key words: Marine fishes, Black Sea, Turkey.

Introduction

The Black Sea is located between latitudes 40° 55'N to 46° 32'N and longitudes 27° 27'E to 41°42'E in the east-west depression between two alpine fold belts, the Pontic Mountains to the south and the Caucasus Mountains to the northeast (Degens and Ross 1974). It is connected with Atlantic Ocean via the Mediterranean Sea and Aegean seas and the "Turkish Strait System" (Istanbul Strait, Sea of Marmara, Çanakkale Strait). It is also connected with Azov Sea by Kerch Strait.

The surface area of the Black Sea is 436.400 km^2, water volume of 547.000 km^3, maximum depth of 2.206 m.

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The Black Sea is enclosed by Ukraine on the north, Russia on the northeast, Georgia on the east, Turkey on the south, and Bulgaria and Romania on the west.

The Black Sea has a positive water balance, and the outflow through the Istanbul Strait (612 km³/year) is twice as large as the inflow (312 km³/year) (Ünlüata et al. 1990). The surface circulation is consisting of two large cyclonic central gyres that define the eastern and western basins (Neuman 1942). These gyres are bounded by the wind-driven Rim Current, which flows along the abruptly varying continental slope all the way around the basin (Oguz et al. 1998). There are several anticyclonic eddies of the Rim Current (Oguz 2002). A thin upper layer with low salinity (~17-18 psu; 8 °C to 30 °C) is superimposed on the cold intermediate layer in the Black Sea. The greatest part of the water column is occupied by deep water mass. It is almost uniform in the vertical. The stable stratification is largely due to river runoff (mainly Danube, Dnestr, Bug and Dnepr) and high saline waters of Mediterranean origin through the Bosphorus. Restricted mixing between the brackish surface layers and the deeper, denser (~22-24 psu; 8.5 °C) waters is the prevailing anoxic conditions, which make the Black Sea the world's largest anoxic basin. The volume of anoxic deep water contaminated with hydrogen sulphide (H_2S), below the depth of 150-200 m, 423.000 km^3. Distribution of the hydrogen sulphide has been relatively stable over the last 7.500 years. But, there is a fluctuation according to physical oceanography of the region. Also, the hydrogen sulphide boundary is usually deepest in summer and shallowest in spring (Oguz et al. 1995).

The Black Sea became connected to the Mediterranean and the world ocean after the opening of the Çanakkale Strait (the first time since the formation of the Tethys Sea) in the Riss-Würm Interglacial Period (100.000-150.000 years ago). The Karangat Basin or Karangat Sea was formed with more saline waters than in the modern Black Sea. Marine flora and fauna were introduced together with ocean waters. They occupied a larger part of the basin, forcing the brackish water and Pontian species (into bays, harbours and river estuaries with reduced salinities). 18.000-20.000 years ago in the last Würm Glaciation, the

Karangat Sea was replaced by the Neoeuxinian Lake-Sea. It lost its connection to the ocean, and salinity was greatly reduced. The halophilic oceanic biota disappeared, while the Pontian relics had survived in harbours and river estuaries came out of hiding and yet again occupied the entire sea. The modern Black Sea was formed with current phase after nearly 10.000 years. A connection between the Mediterranean and the world ocean was established through the Istanbul Strait and the Çanakkale Strait nearly 5.000-7.000 years ago. The Mediterranean Sea was colder than today. The moderately cold water species (Arctic relics), such as *Squalus acanthias, Sprattus sprattus, Merlangius merlangus* and *Platichthys luscus,* were introduced to the Black Sea. A gradual salinisation of the Black Sea followed within 1.000-1.500 years, and the salinity became sufficient to support a large number of Mediterranean species (Mediterranean immigrants). The Pontian relics have again moved to the bays and harbours with low salinities as happened during the time of the Karangat basin (Zaitsev and Mamaev 1997). The warm water fish, which account for the largest number of species, originated in the Mediterranean and moved through the Istanbul Strait during the post-glacial period. This group includes *Engraulis encrasicolus, Mugil cephalus, Mullus barbatus, Dasyatis pastinaca* and all the members of Sparidae and Sciaenidae families. Other member of this group, such as *Sarda sarda, Scober colias, Scomber scombrus* and *Pomatomus saltatrix,* are migratory, spending the warmer months in the Black Sea and wintering in the Marmara Sea and the northern Aegean (Öztürk 1999).

Diversity of fish fauna

First scientific study related with fish fauna characteristics in the Black Sea (Pallas, 1811 in Slastenenko, 1955-1956). Wachner (1953) gave some information dealing with the distribution of marine species on the different habitat in the Black Sea. According to this author, 74 of the 350 fish species in the Mediterranean Sea presented in the Black Sea. Marine and fresh water fishes were summarised in "the fishes of the Black Sea Basin" by Slastenenko (1955-1956), recorded 184 fish species in the Black Sea and adjacent estuaries. Marine fish species in the Black Sea were given by Whitehead et al. (1984-1986) and Fischer et al. (1987). In

the Turkish Black Sea: Sözer (1941) studied on the Gobiidae. Some other studies on the distribution of fish species in the Black Sea were carried out by Kutaygil and Bilecik (1977, $1979_{a,b}$, 1998). Demirhan et al. (2005) studied demersal fish species.

Erazi (1942) was recorded 128 fish species from the Turkish Black Sea. Kocataş et al. (1987) reported 150 fish species, Mater and Meriç (1996) reported 138 fish species. Öztürk (1999) reviewed to the general biodiversity in the Turkish Black Sea, and stated that the presence of 140 fish species in the area. Bilecenoğlu et al. (2002) reported 151 fish species. Bat et al. (2005) identified 94 species, and investigated their distribution by habitat along the central Black Sea coast. Fricke et al. (2007) recorded 157 species in the Black Sea along the Turkish coast, adjacent estuaries and lower watersheds. In these species, *Salmo salar* and *Liza haematocheila* introduced to the Black Sea for aquaculture. *Acipenser persicus*, *Apletodon dentatus bacescui*, *Gobius cruentatus* and *Zebrus zebrus* were new recorded from the Turkish Black Sea (Bat et al. 2005, Bat et al. 2006, Engin et al. 2007, Kovačić and Engin 2009). *Sphraena obtusata*, Indo-Pacific species was observed in Şile coast in the western Black Sea (Öztürk 2006 in Shiganova and Öztürk 2009).

Considering to the last records and observation, a total of 161 species present in the Turkish Black Sea: 62.73% of which is Atlanto-Mediterranean species, 6.83% cosmopolitans, 28.57% endemics (18.01% Black Sea endemics, 10.56% Mediterranean endemics) and 1.86% introduced species (Indo-Pacific and Atlantic origins). In Table 1, fish species in the Turkish Black Sea is listed according to origin. The Black Sea ecosystem varies in the Mediterranean Sea as a result of anoxic deeper waters. Hydrological condition changes from subtropical and saline water in the Mediterranean Basin to arcto-boreal and brackish water in the Black Sea. Fish Fauna characterizes with endemic species (Pontian relics and Mediterranean endemics), Mediterranean immigrant, and cosmopolitan species. High endemism of Pontian relics in the Black Sea relates to complex geological history of the Black Sea. Species composition in the Black Sea was highly dissimilar to the Sea of Marmara and in the Aegean Sea (Bilecenoglu 2002, Keskin 2010).

Table 1. Fish species in the Turkish Black Sea and *new record species. A: Atlantic species, A-M: Atlanto-Mediterranean species, C: cosmopolitans, M: Mediterranean endemic, B: Black Sea endemic, IP: Indo-Pacific species. The table was updated according to Bilecenoglu et al. (2002) and Fricke et al. (2007).

Families	**Species**	**Origin**
Alopiidae	*Alopias vulpinus* (Bonnaterre, 1788)	C
Scyliorhinidae	*Scyliorhinus canicula* (Linnaeus, 1758)	A-M
Squalidae	*Squalus acanthias* Linnaeus, 1758	C
	Squalus blainvillei (Risso, 1821)	C
Squatinidae	*Squatina squatina* (Linnaeus, 1758)	A-M
Rajidae	*Raja clavata* Linnaeus, 1758	C
Dasyatidae	*Dasyatis pastinaca* (Linnaeus, 1758)	A-M
Gymnuridae	*Gymnura altavela* (Linnaeus, 1758)	A-M
Acipenseridae	*Acipenser gueldenstaedtii* Brandt & Ratzeberg, 1833	B
	Acipenser nudiventris Lovetzky, 1828	B
	*Acipenser persicus Borodin, 1897**	B
	Acipenser stellatus Palas, 1770	B
	Acipenser sturio Linnaeus, 1758	A-M
	Huso huso (Linnaeus, 1758)	B
Anguilidae	*Anguilla anguilla* (Linnaeus, 1758)	A-M
Congridae	*Conger conger* (Linnaeus, 1758)	A-M
Engraulidae	*Engraulis encrasicolus* (Linnaeus, 1758)	A-M
Clupeidae	*Alosa agone* (Scopoli, 1786)	M
	Alosa immaculata (Bennett, 1835)	B

	Alosa maeotica (Grimm, 1901)	B
	Alosa tanaica (Grimm, 1901)	B
	Clupeonella cultriventris (Nordmann, 1840)	B
	Sardina pilchardus (Walbaum, 1792)	A-M
	Sardinella aurita Valenciennes, 1847	C
	Sprattus sprattus (Linnaeus, 1758)	A-M
Salmonidae	*Salmo labrax* Pallas, 1814	B
	Salmo salar Linnaeus, 1758	A
Merluccidae	*Merluccius merluccius* (Linnaeus, 1758)	A-M
Gadidae	*Merlangius merlangius* (Linnaeus, 1758)	A-M
Lotidae	*Gaidropsarus mediterraneus* (Linnaeus, 1758)	A-M
Ophidiidae	*Ophidion barbatum* Linnaeus, 1758	A-M
	Ophidon rochei Müller, 1845	M
Lophiidae	*Lophius budegassa* Spinola, 1807	A-M
	Lophius piscatorius Linnaeus, 1758	A-M
Mugilidae	*Chelon labrosus* (Risso, 1827)	A-M
	Liza aurata (Risso, 1810)	A-M
	Liza haematocheila (Temminck and Schlegel, 1845)	IP
	Liza ramada (Risso, 1810)	A-M
Families	**Species**	**Origin**
	Liza saliens (Risso, 1810)	A-M
	Mugil cephalus Linnaeus, 1758	A-M
Atherinidae	*Atherina boyeri* Risso, 1810	A-M
	Atherina hepsetus Linnaeus, 1758	A-M
Belonidae	*Belone euxini* Günter, 1866	B
Zeidae	*Zeus faber* Linnaeus, 1758	C

Gasterosteidae	*Gasterosteus aculeatus* Linnaeus, 1758	A-M
	Pungitius platygaster (Kessler, 1859)	B
Syngnathidae	*Hippocampus hippocampus* (Linnaeus, 1758)	A-M
	Hippocampus guttulatus Cuvier, 1829	A-M
	Nerophis ophidion (Linnaeus, 1758)	A-M
	Syngnathus abaster Risso, 1827	A-M
	Syngnathus acus Linnaeus, 1758	A-M
	Syngnathus schmidti Popov, 1927	B
	Syngnathus tenuirostris Rathke, 1837	M
	Syngnathus typhle Linnaeus, 1758	A-M
	Syngnathus variegatus Pallas, 1811	B
Scorpaenidae	*Scorpaena notata* Rafinesque-Schmaltz, 1810	A-M
	Scorpaena porcus Linnaeus, 1758	A-M
Triglidae	*Chelidonichthys cuculus* (Linnaeus, 1758)	A-M
	Chelidonichthys gurnardus (Linnaeus, 1758)	A-M
	Chelidonichthys lucernus (Linnaeus, 1758)	A-M
Moronidae	*Dicentrarchus labrax* (Linnaeus, 1758)	A-M
Serranidae	*Serranus cabrilla* (Linnaeus, 1758)	A-M
	Serranus scriba (Linnaeus, 1758)	A-M
Pomotomidae	*Pomatomus saltatrix* (Linné, 1766)	A-M
Carangidae	*Lichia amia* (Linnaeus, 1758)	A-M
	Naucrates ductor (Linnaeus, 1758)	C
	Trachurus mediterraneus (Steindachner, 1868)	A-M
	Trachurus trachurus (Linnaeus, 1758)	A-M
Sparidae	*Boops boops* (Linnaeus, 1758)	A-M
	Dentex dentex (Linnaeus, 1758)	A-M

	Diplodus annularis (Linnaeus, 1758)	A-M
	Diplodus puntazzo (Cetti, 1777)	A-M
	Diplodus sargus (Linnaeus, 1758)	M
	Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	A-M
	Oblada melanura (Linnaeus, 1758)	A-M
	Pagellus erythrinus (Linnaeus, 1758)	A-M
	Sarpa salpa (Linnaeus, 1758)	A-M
	Sparus aurata (Linnaeus, 1758)	A-M
	Spondyliosoma cantharus (Linnaeus, 1758)	A-M
Centracanthidae	*Spicara maena* (Linnaeus, 1758)	A-M
	Spicara smaris (Linnaeus, 1758)	A-M
Families	**Species**	**Origin**
Sciaenidae	*Argyrosomus regius* (Asso, 1801)	A-M
	Sciaena umbra Linnaeus, 1758	A-M
	Umbrina cirrosa (Linnaeus, 1758)	A-M
Mullidae	*Mullus barbatus* Linnaeus, 1758	A-M
	Mullus surmuletus Linnaeus, 1758	A-M
Pomacentridae	*Chromis chromis* (Linnaeus, 1758)	A-M
Labridae	*Coris julis* (Linneaus, 1758)	A-M
	Ctenolabrus rupestris (Linneaus, 1758)	A-M
	Labrus viridis Linneaus,1758	A-M
	S*ymphodus cinereus* (Bonnaterre,1788)	A-M
	Symphodus ocellatus (Linneaus, 1758)	M
	Symphodus roissali (Risso, 1810)	A-M
	Symphodus rostratus (Bloch, 1797)	M
	Symphodus tinca (Linneaus, 1758)	A-M

Ammodytidae	*Gymnammodytes cicerelus* (Rafinesque-Schmaltz, 1810)	M
Trachinidae	*Trachinus draco* Linneaus,1758	A-M
Uranoscopidae	*Uranoscopus scaber* Linneaus,1758	A-M
Tripterygiidae	*Tripterygion tripteronotum* (Risso, 1810)	M
Blenniidae	*Aidablennius sphynx* (Valenciennes, 1836)	M
	Blennius ocellaris Linnaeus, 1758	A-M
	Coryphoblennius galerita (Linneaus, 1758)	A-M
	Microlipophrys adriaticus (Steindachner&Kolombatović,1883)	A-M
	Parablennius gattorugine (Linneaus, 1758)	A-M
	Parablennius incognitus (Bath, 1968)	A-M
	Parablennius sanguinolentus (Pallas,1814)	A-M
	Parablennius tentacularis (Brünnich,1768)	A-M
	Parablennius zvonimiri (Kolombatović,1892)	M
	Salaria pavo (Risso, 1810)	A-M
Gobiesocidae	*Apletodon dentatus bacescui* (Murgoci, 1940)*	B
	Diplecogaster bimaculata (Bonnaterre, 1788)	A-M
	Lepadogaster candolii Risso, 1810	A-M
	Lepadogaster lepadogaster (Bonnaterre, 1788)	A-M
Callinonymidae	*Callinonymus fasciatus* Valenciennes,1837	M
	Callinonymus lyra Linneaus,1758	A-M
	Callinonymus pusillus Delaroche, 1809	M
	Callinonymus risso LeSueur,1814	M
Gobidae	*Aphia minuta* (Risso, 1810)	A-M
	Babka gymnotrachelus (Kessler, 1857)	B
	Gobius bucchichi Steindachner, 1870	A-M
	Gobius cobitis Pallas, 1814	A-M

	Gobius cruentatus Gmelin 1789	A-M
	Gobius niger Linneaus,1758	A-M
	Gobius paganellus Linneaus,1758*	A-M
Families	**Species**	**Origin**
	Knipowitschia caucasica (Berg,1916)	B
	Knipowitschia longecaudata (Kessler, 1877)	B
	Mesogobius batrachocephalus (Pallas, 1814)	B
	Neogobius fluviatilis (Pallas, 1814)	B
	Neogobius melanostomus (Pallas,1814)	B
	Pomatoschistus marmoratus (Risso,1810)	M
	Pomatoschistus minitus (Pallas, 1770)	A-M
	Ponticola eurycephalus (Kessle,1874)	B
	Ponticola kessleri (Günther, 1861)	B
	Ponticola platyrostris (Pallas, 1814)	B
	Ponticola ratan (Nordmann 1840)	B
	Ponticola syrman (Nordmann 1840)	B
	Proterorhinus marmoratus (Pallas, 1814)	B
	Zebrus zebrus (Risso 1827)*	M
	Zosterisessor ophiocephalus (Pallas,1814)	M
Sphyraenidae	*Sphyraena obtusata* Cuvier, 1829*	IP
	Sphyraena sphyraena (Linnaeus, 1758)	A-M
Scombridae	*Auxis rochei* (Risso, 1810)	C
	Euthynnus alletteratus (Rafinesque-Schmaltz,1810)	A-M
	Sarda sarda (Blonch, 1793)	A-M
	Scomber colias Gmelin, 1789	C
	Scomber scombrus Linneaus,1758	A-M

	Thunnus alalunga (Bonnaterre, 1788)	C
	Thunnus thynnus (Linneaus,1758)	A-M
Xiphiidae	*Xiphias gladius* Linneaus,1758	C
Scophthalmidae	*Psetta maxima* (Linneaus,1758)	A-M
	Psetta maeotica (Pallas, 1814)	B
	Scopthalmus rhombus (Linnaeus, 1758)	A-M
Pleuronectidae	*Platichthys luscus* (Pallas, 1814)	B
Bothidae	*Arnoglossus kessleri* Schmidt,1915	M
	Arnoglossus laterna (Walbaum, 1792)	A-M
	Arnoglossus thori Kyle,1913.	A-M
Soleidae	*Buglossidium luteum* (Risso, 1810)	A-M
	Microchirus variegatus (Donovan, 1808)	A-M
	Pegusa lascaris (Risso,1810)	A-M
	Solea solea (Linneaus, 1758)	A-M
Balistidae	*Balistes carolinensis* Gmelin, 1789.	A-M

Pontian relics such as *Mezogobius batrachocephalus* and *Noegobius melanostomus* occurred less saline and temperate waters in the Black Sea, while Atlantic-Mediterranean species such as *Citharus linguatula, Serranus hepatus, Scyliorhinus canicula* and *Merluccius merluccius* were among the common species in the Aegean Sea and in the Sea of Marmara, in which salinity and temperature were more close to the Mediterranean Sea (Keskin 2010).

Last decades, new findings on the introduce and rare species in the Black Sea shows that fish diversity in the Black Sea is changed by the natural process of "mediterranization" (such as penetration of *Micromesistius poutassou*), extension of ranges of invading species (such as *Sphyraena obtusata, Sphyraena pinguis*), and the accidental introducing of exotic species (such as *Tridentiger trigonocephalus*) with ballast waters of vessels (Boltachev et al. 2009).

Threats

This unique and almost land-locked sea has been become one of the most polluted seas in the world, especially, using for discharges and disposal of waste from many kinds of human activities and releases from ships (Göktepe 2002). Eutrophication has risen as a result of increasing level of the nutrient load, and leading to hypoxia and occasional anoxia. This anoxia leads to the formation of the hydrogen sulphide in the shelf zone. As the upper layer waters of the Black Sea supported to the very rich marine resources only four decades ago, pelagic and demersal resources were decreased by overexploitation. Alien species (*Minemiopsis leidyi*), coastal degradation, eutrophication and hypoxia are negative factors affected to this fragile marine ecosystem and species diversity. For example; the populations of Acipenseridae, *Thunnus thynnus, Xiphias gladius, Scomber colias* and *Scomber scombrus* disappeared or their populations dramatically declined (Öztürk 1999). Acipenseridae are threaten by overfishing, marine pollution and reservoir-building on the spawning rivers, blocking the traditional migration routes and destroying spawning grounds or preventing access to them. *Acipenser güldenstaedtii* and *A. stellatus* have been under protection in Turkey since 1997 (Dumont 1999). Fishery of *Huso huso* is forbidden in the

Turkish Black Sea. Chemical pollution, intensive navigation in Istanbul Strait negatively affected to migration of *Thunnus thynnus*, *Pomatomus saltatrix*, *Scomber scombrus*, *Sarda sarda* in the Black Sea since the 1970s (Zaitsev 2003). The spiny dogfish *(Squalus acanthias)* have been fished for their meat and liver oil, is now included on vulnerable species in the IUCN *Red List of Threatened Species* due to serious overfishing from intense, poorly regulated fisheries (Anonymus 2010). Thornback Skate (*Raja clavata*), now included on near threatened in the IUCN *Red List of Threatened Species* is a very important component of demersal fisheries in most European waters and is taken by trawl and gillnet, particularly as by-catch (Anonymus 2010).

Aidablennius sphynx, *Belone euxine*, *Mullus barbatus*, *Knipowitschia longicaudata*, *Solea nasuta*, *Conger conger*, *Gobius bucchichi*, *Hippocampus guttulatus* and *Clupaenella cultriventris* are threaten by habitat degradation, such as reduction of *Cystoseria* belts and *Zostera* sp. meadows, sand dredging, pollution of the surface micro layer of water, chemical pollution, algal bloom followed by hypoxia, over fishing, illegal fishing (Dumont 1999). *Cystoseria* belts and *Zostera* sp. meadows are important as nursery area for many fish, crabs and molluscs. Over-urbanization, tourism and fish farms seem to be potential sources of pollution and habitat degradation. Two different points are important for conservation of biodiversity in the Turkish Black Sea: conservation policies of critical areas, habitats and species, and environmental administrative policies (Öztürk 1999).

Establishing marine protected areas can be one of the solution recovery of the fisheries stocks, which is gravely depleted, and another solution enforcement of the national legislations for mostly demersal fishes such as turbot and sturgeons due to illegal, unreported and unregulated fisheries. Long term monitoring study is needed in the Istanbul and Kerch straits introduce of alien, and penetration of Mediterranean originated species. Finally, for the protection of the Black Sea fish biodiversity regional cooperation and concerted action is needed.

Özet

Yapılan çalışmalar Karadeniz'in Türkiye kıyılarında toplam 161 balık türünün barındığını göstermiştir. Balık faunasının %62.73'ü Atlantik-Akdeniz kökenli türler, %6.83'i kozmopolitanlar, %28.57'si endemikler ve %1.86'i yabancı türlerden oluşmaktadır. Karadeniz'de balık çeşitliliğinin korunması için koruma alanları oluşturmak, yasadışı ve kaçak balıkçılığı önlemek, uluslararası işbirliği ve ortak eylem gerekmektedir.

Acknowledgement

The author thanks Dr. Bayram Öztürk for his pre-review of the manuscript and valuable contributions. Also, thanks to Semih Ergin for his helps and advice.

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Received: 23.07.2010
Accepted: 10.08.2010