EUROPEAN PARLIAMENT

DIRECTORATE-GENERAL FOR INTERNAL POLICIES

POLICY DEPARTMENT B
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FISHERIES IN THE BLACK SEA

NOTE

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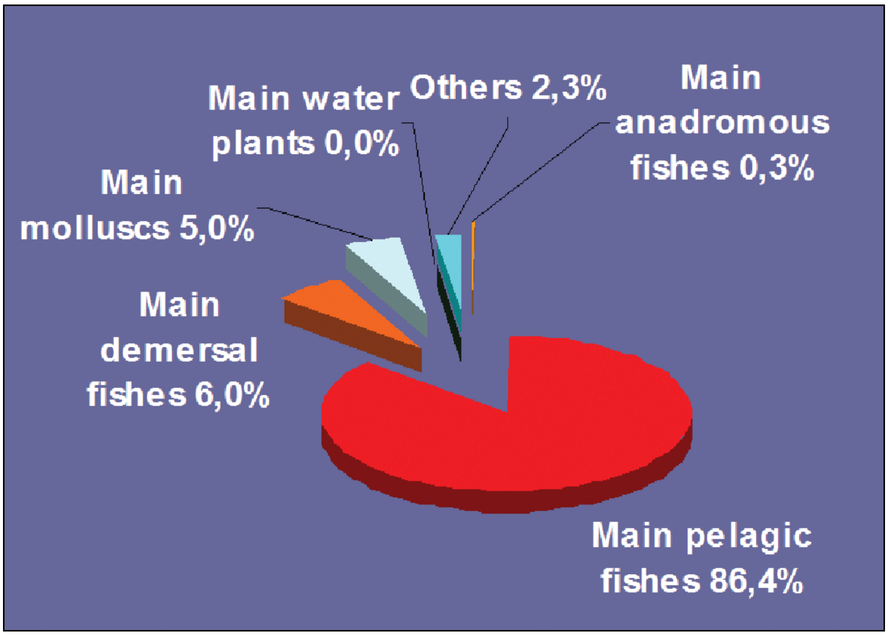
2. MARINE LIVING RESOURCES AND THEIR FISHERIES

Among the whole specific diversity of the Black Sea, the greatest economic value comes from about two dozen species that produced about 98% of catch in 1996-2005 (Figure 3). The remaining 2% included commercially less important fish, molluscs, crustaceans and other aquatic organisms. The main part of the catches falls into three groups: pelagic, demersal and anadromous fish. In each of these groups, more than 90% of the volume of the catches is represented by a few leading species (Shlyakhov and Daskalov, 2009)[3].

Figure 3: Commercial exploitation of marine living resources in the Black Sea (1996-2005)



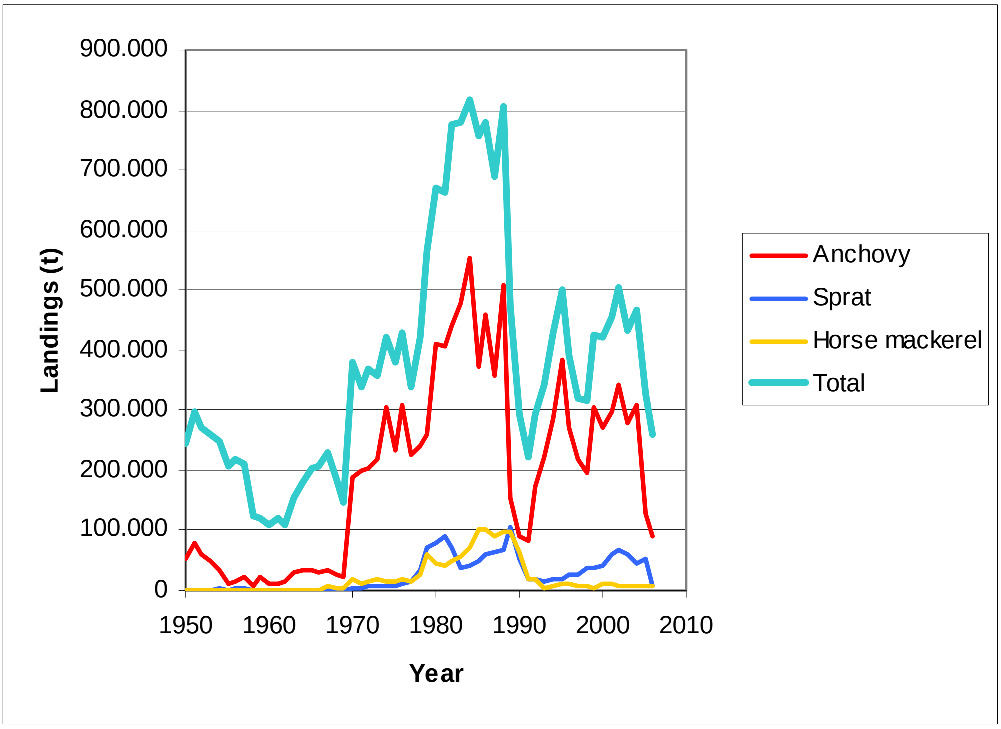
Source: Shlyakhov and Daskalov (2009)

2.1. Pelagic fish stocks

Pelagic fish, particularly the small-sized plankton-eating types, are the most abundant fish species in the Black Sea. The main target species of fisheries is European anchovy (*Engraulis encrasicolus*), which since 1970 constantly represented more than half of the total volume of the landings (up to 75% in 1995; Figure 4). European sprat (*Sprattus sprattus*, Mediterranean horse mackerel (*Trachurus mediterraneus*), Atlantic bonito (*Sarda sarda*) and bluefish (*Pomatomus saltatrix*) are the major pelagics in terms of fishing value. This latter species is a large-sized predator which enters the Black Sea from the Marmara and Aegean Seas for feeding and spawning in spring and leaves the Black Sea for wintering in late autumn. Evolution of the catches suggests partial recovery of major pelagic species after the fishery collapse in 1991 (Figure 5).

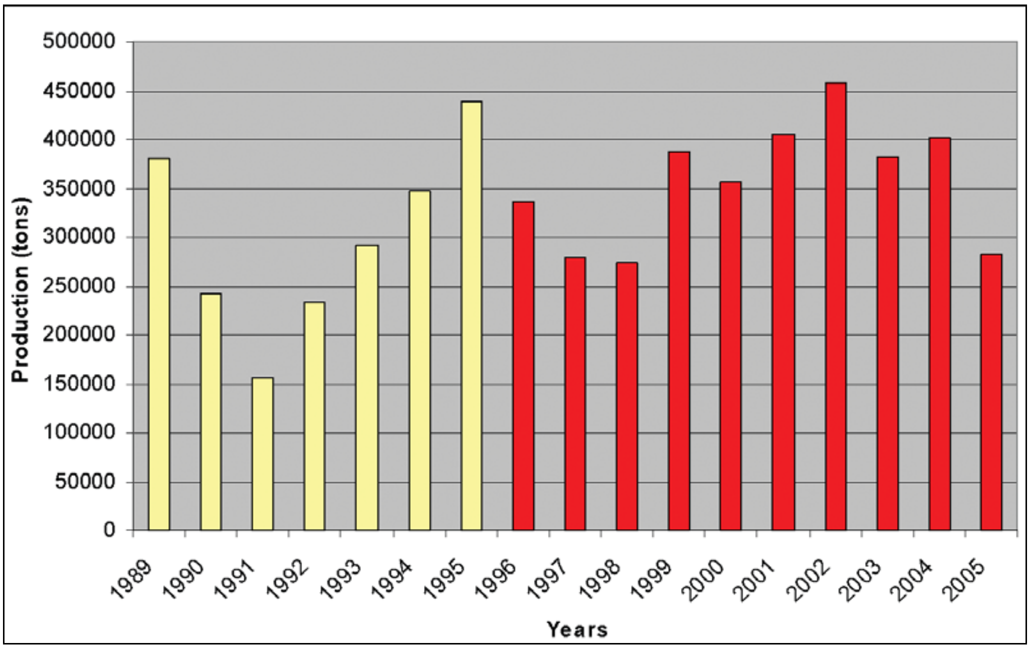
[3] This chapter is based on the recent review of Shlyakhov and Daskalov (2009).

Figure 4: Landings of anchovy, sprat and horse mackerel in the Black Sea (1950-2006). The total volume of the landings is indicated for comparison.



Data source: www.seaaroundus.org

Figure 5: Total catches of the main pelagic fish species in the Black Sea (1989-2005)



Source: Shlyakhov and Daskalov (2009)

2.1.1. Black Sea anchovy

Anchovy plays a crucial role in the Black Sea pelagic food web as a prey of many predators such as bonito, blue fish, horse mackerel, dolphins and others. It is also an important consumer of zooplankton, especially when the stock is large, and thus acts as a competitor of other planktivores (Daskalov *et al*., 2007).

The Black Sea anchovy is distributed over the whole Black Sea[4]. It migrates to the wintering grounds along the Anatolian and Caucasian coasts (October-November to March), forming dense concentrations targeted by intensive commercial fishery. During the rest of the year it occupies its usual spawning and feeding habitats across the sea, with the north-western shelf being the largest and most productive area (Fashchuk *et al*., 1991; Daskalov, 1999). Anchovy reaches maturity several months after spawning, which takes place during the summer.

Anchovy is subject to both artisanal fisheries (with coastal trap nets and beach seines) and commercial purse-seines fishery on their wintering grounds. Time-trajectories of abundance, catch and fishing mortality reveal pronounced decadal fluctuations (Figure 6). The increase in biomass and catch during the 1970s and 1980s was promoted by the expansion of powerful trawl and purse seine fishing fleets in Turkey and thus a steady increase in fishing effort (Gucu, 1997). After the 1981/1982 fishing season the limit of fishing mortality for safe stock exploitation has been systematically exceeded, however, the high catches were maintained by the relatively large reproductive stock.

The first signs of overfishing appeared after 1984, when anchovy shoals were difficult to be found and the fishery enterprises incurred losses (Shlyakhov *et al*., 1990). However, the real catastrophe occurred after 1986, when the stock shrunk from 1 200 000 to 500 000 tonnes in two subsequent years. Catches during the 1986/87 and 1987/88 fishing seasons remained high, but in 1988/1989, the catch suddenly dropped to 188 000 tonnes. Then, the stock experienced an abrupt decline to less than 300 000 tonnes in 1990, which was the lowest level over the period 1967-1993. The fishing effort and fishing mortality also dropped subsequently because of decreasing profitability of fishing. During the collapse phase, the size/age structure of the catch shifted toward a predominance of small, immature individuals (Prodanov *et al*., 1997; Gucu 1997). In 1995-2005, the stock partially recovered and catches increased to 300 000–400 000 tonnes, but because the fishing effort and the catches remained relatively high, the exploited biomass could not reach the 1980s levels.

Probably the strongest environmental effect on anchovy stock by the end of the 1980s was the food competition with the invasive ctenophore *Mnemiopsis leidyi*, but also predation by *Mnemiopsis* on anchovy larvae and eggs (Oguz *et al*., 2008). The major outbreak of *Mnemiopsis* in the Black Sea was reported in 1988-1989. It appears that the catastrophic reduction of the Black Sea anchovy stock in the late 1980s was due to the combined action of two factors: excessive fishing and the *Mnemiopsis leidyi* outburst (Grishin *et al*., 2007). The total loss from the anchovy catch over the years 1989-1992 due to the *Mnemiopsis* outbreak can be roughly estimated at about 1 million tonnes.

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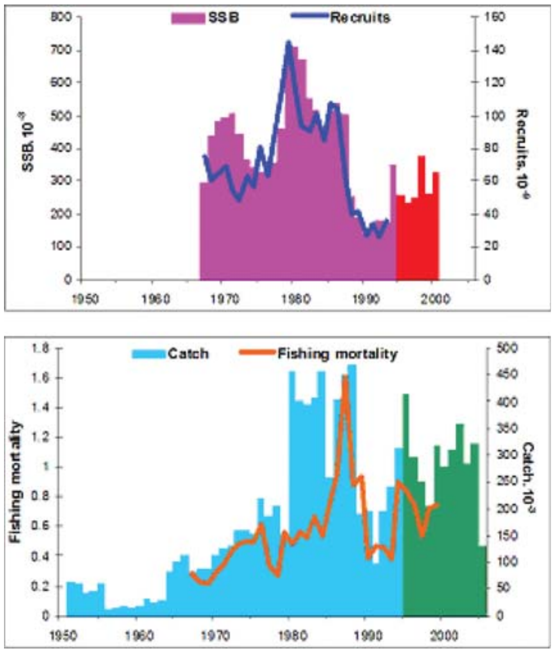
4 Two different anchovy populations exist in the Black Sea: the Black Sea anchovy and the Azov Sea anchovy. The latter reproduces and feeds in the Azov Sea and hibernates along the northern Caucasian and Crimean coasts. As this stock is of lower ecological and commercial importance it will not be considered here.

Figure 6: Black Sea anchovy: recruitment, spawning stock biomass (SSB), catches and fishing mortality



Source: Shlyakhov and Daskalov (2009)

The state of the anchovy stock has improved after the collapse in 1990s, and in 2000-2005 the catches reached ca. 300 000 tons. However, the anchovy catches dropped substantially in 2006 indicating a distressed stock condition. The other possible cause of the drop in anchovy stock include climatic effects (higher water temperature may cause a dispersal of fish schools making them less accessible to the fishing gears) and abundant predators (bonito). Given the strong natural variability, transboundary migratory behaviour and sensitivity to various environmental impacts, the protection and sustainable use of the anchovy resource can be achieved only by coordinated international management and regulation based on sound scientifically grounded stock assessment.

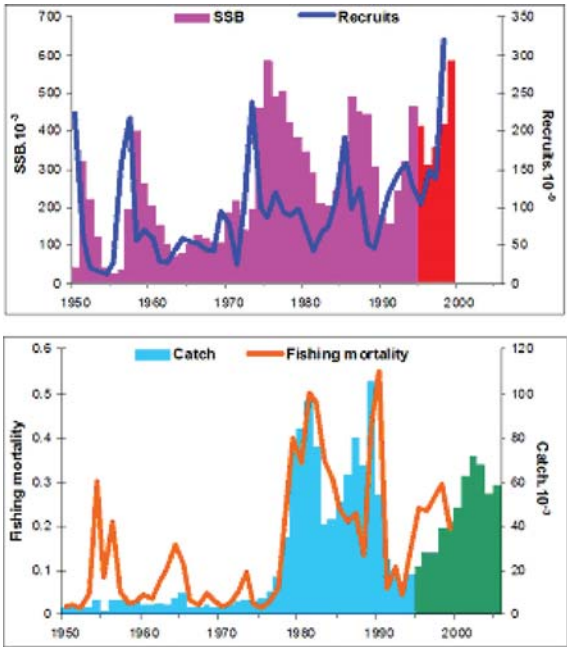
2.1.2. Sprat

Sprat is the second most abundant and commercially important pelagic fish species in the Black Sea after anchovy, and it serves as an important food source for larger fish. It is distributed over the whole Black Sea, but its maximum abundance occurs in the north-western region. In spring, schools migrate to coastal waters for feeding. In the summer, sprat stays under the seasonal thermocline forming dense aggregations near the bottom during the day and in the upper mixed layer during the night.

Sprat reaches maturity at 1 year and reproduces during the whole year, but its peak spawning takes place between November and March. Eggs and larvae are mostly concentrated near the shelf edge and within the central cyclonic gyres with relatively stable subsurface layer (20 - 50 m). Food competition with *Mnemiopsis leidyi* (mainly on the cold-water copepods *Calanus* and *Pseudocalanus*) can partly explain the reduction of the sprat stock in the early 1990s during the *Mnemiopsis* population outburst. As with the other commercial stocks, heavy overfishing took place before and during the *Mnemiopsis* outbreak, which could have aggravated the stock depletion. In addition to *Mnemiopsis leidyi*, the jellyfish *Aurelia aurita* distributed in deeper waters has a strong trophic interference with sprat. This may explain the coincidence between the declining phase of sprat recruitment and biomass and the peak abundance of *Aurelia aurita* during the 1980s (Daskalov, 2003).

Sprat has always been subject to both artisanal and commercial mid-water trawl fisheries. Time-series of the main stock parameters show that a quasi-decadal cyclic pattern dominates the recruitment abundance, as in the case of anchovy (Figure 7). Maxima of recruitment and biomass occurred in the mid-1970s and mid-1980s. Its maximum catch was recorded in 1989, leading to the highest fishing mortality prior to the stock collapse. The combination of low recruitment and excessive fishing as well as the *Mnemiopsis* outburst were the major causes of the 1990 stock collapse since the survey indices, age and size composition consistently showed a drop in recruitment, biomass, mean size and age (Daskalov, 1998).

Figure 7: Black Sea sprat: recruitment, spawning stock biomass (SSB), catches and fishing mortality



Source: Shlyakhov and Daskalov (2009)

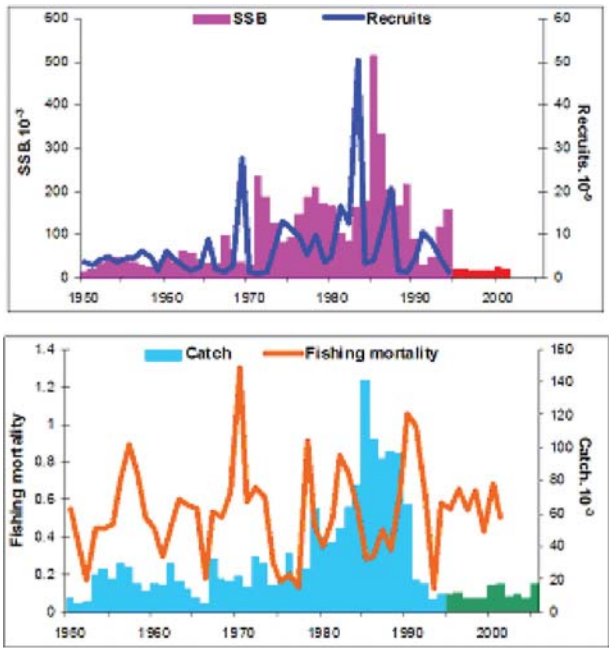
After the 1990 stock collapse, sprat recruitment, biomass and catches started to increase, and the stock reached the previous peak-level recorded in the 1980s by the mid-1990s and even higher stock size in 2005. The catch, however, remained at a relatively low level because of the stagnating economies of Bulgaria, Romania and Ukraine, although the fishing mortality increased between 1990 and 2000. Consequently, the catch attained its former 1980s level after 1995 and reached ca. 70 000 tonnes in 2001-2005. The decreasing catch per unit of fishing effort (CPUE) and mean catch size in Bulgarian and Romanian fisheries in 2006-2007 indicate that the current level of fishing pressure might be too strong for the size of exploited stock biomass and therefore further catch limitations may be needed.

2.1.3. Horse mackerel

The Black Sea horse mackerel is a subspecies of the Mediterranean horse mackerel *Trachurus mediterraneus*. It is a migratory species distributed all over the sea. In the spring, it migrates to the north for reproduction and feeding. In the summer, it is found mainly in shelf waters above the seasonal thermocline. In the autumn it migrates towards the wintering grounds along the Anatolian and Caucasian coasts. It matures at 1-2 years during the summer, which is also the main feeding and growth season. It spawns in the upper layers, both in the open sea and near the coast. Eggs and larvae are often found in areas with high productivity.

The horse mackerel fishery operates mainly on its wintering grounds in the southern Black Sea using purse seine and mid-water trawls. Over the last 40 years, highest horse mackerel catches were reported in the years preceding the *Mnemiopsis* outbreak. The maximum catch of 141 000 tonnes was recorded in 1985, from which ca. 100 000 tonnes were taken by Turkey (Prodanov *et al*., 1997). In the period 1971-1989, the stock increased, although years of high abundance alternated with years of low abundance due to year class fluctuations, typical for this fish (Figure 8). According to Bryantsev *et al.* (1994) and Chashchin (1998), intensive fishing in Turkish waters in 1985-1989 led to overfishing of horse mackerel population and to reduction of the stock and catches in the subsequent years. A drastic decline in stock abundance occurred after 1990 when the stock was diminished by 56%. In 1991, the horse mackerel stock dropped to a minimum of 75 000 tonnes and the catch dropped to 4700 tonnes, which was a twenty fold reduction compared to the average annual catch in 1985-1989.

Figure 8: Black Sea horse mackerel: recruitment, spawning stock biomass (SSB), catches and fishing mortality



Source: Shlyakhov and Daskalov (2009)

Moreover, since the first *Mnemiopsis* outburst in the autumn of 1988, its strong feeding pressure on zooplankton directly affected larval and juvenile horse mackerel, especially through the sharp decline of the copepods *Oithona nana* and *Oithona similis*, which constitute the main food of larval horse mackerel.

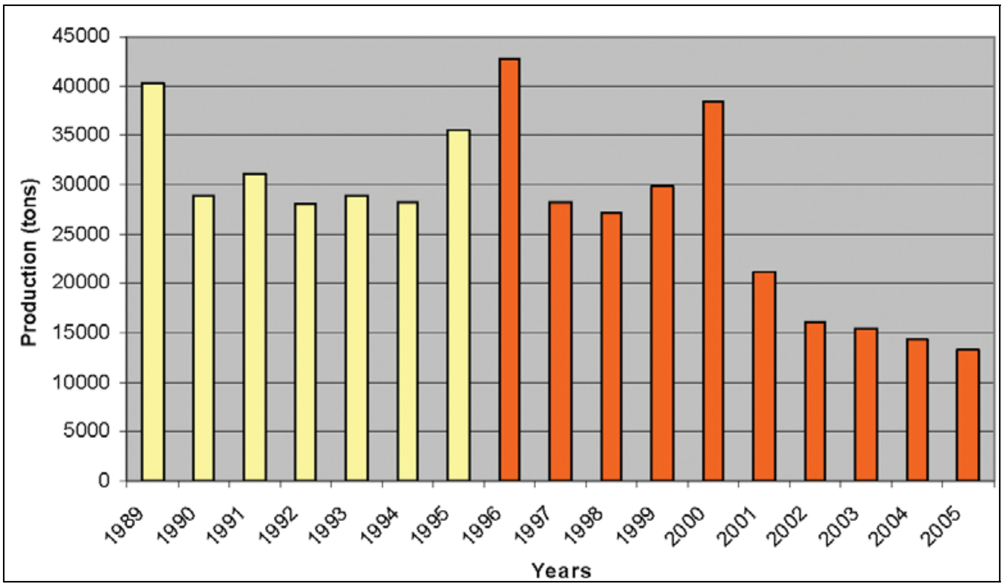
In contrast to anchovy and sprat, the horse mackerel stock still remains in a depressed state. The horse mackerel fishery was extremely limited in the former USSR countries during 1992-1998 because of the lack of fishable aggregations on the wintering grounds. Small quantities of horse mackerel were caught with trap-nets in the coastal areas of

Crimea and Caucasus. In Turkish waters, horse mackerel catches in 1994-2006 were 9000-11 000 tonnes, i.e. at the level of the years 1950-1975 before the start of industrial fishing.

2.2. Demersal fish stocks

From the Black Sea fisheries perspective, the most important demersal fish species are turbot (*Psetta maxima*), whiting (*Merlangius merlangus*), picked dogfish (*Squalus acanthias*), striped and red mullets (*Mullus barbatus, M. surmuletus*), and four species of the family *Mugilidae*. The total mean catches of these demersal fish species in 1996-2005 were lower than the total 1989-2005 average, and clearly decreased after 2000 (Figure 9).

Figure 9: Total catches of the main demersal fish species in the Black Sea (1989-2005)



Source: Shlyakhov and Daskalov (2009)

2.2.1. Turbot

Turbot occurs all over the Black Sea shelf. It is a large-sized fish with long life cycle: it reaches 85 cm in length, 12 kg in weight and can live more than 17 years. Larvae and fries in the first two months inhabit the pelagic zone, feeding on zooplankton. Adults feed mainly on fish, both on demersal (whiting, red mullet and gobies), and pelagic species (anchovy, sprat, horse mackerel, shad). The diet of turbot also includes crustaceans (shrimps, crabs), molluscs and Polychaeta worms. Turbot does not undertake distant transboundary migrations. Local migrations for spawning, feeding and wintering occur between the coast and the offshore areas (Map 6). It matures in majority at the age of 3-6 years. It spawns in spring, from late March until late June, at water temperatures of 8-12ºC. The spawning peak occurs in May at depths from 20-40 to 60 m. After spawning turbot moves downwards to 50-90 m depth and maintains low-activity life with limited feeding until the early autumn. In autumn, turbot returns to coastal waters again, where it feeds intensively. For wintering it migrates to depths from 60 m to 140 m.

In all the Black Sea countries, turbot is one of the most valuable fish species. The fishery targeting turbot was conducted with bottom (turbot) gill nets with a minimum mesh size of 180 mm in the waters of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine

(Prodanov *et al.*, 1997) and with 160-200 mm minimum mesh size as well as with bottom trawls with 40 mm minimum mesh in the waters of Turkey (Tonay and Öztürk, 2003). Since 2007, Romania and Bulgaria apply a 400 mm minimum legal mesh size for bottom-set nets. Turbot as a by-catch is harvested with trawls, long-lines and purse seines. Turbot fishing in Turkish waters of the Black Sea used 72% bottom gill nets and 26% trawls, while 2% came from purse seines by-catch (Zengin, 2003). More than 80% of the Ukrainian turbot catches were performed by target fisheries using nets with mesh size 180-200 mm, the remainder mainly corresponding to by-catches. In 1996-2005, the mean annual turbot catches were 1235 tons for Turkey, and 177 tons for the other Black Sea countries. The turbot fishery was completely banned or largely limited by the Total Permitted Catch in all countries except Turkey in the early 1990s and therefore was at a negligible level.

Map 6: Turbot distribution in the Black Sea

Source: UNEP/GRID-Arendal (2001)

As with many demersal fish species, a serious problem for estimating the state of the turbot population and for justifying efficient fisheries regulation measures is the considerable difference between the recorded statistics and the real catches. According to the expert assessments (Shlyakhov and Charova, 2003), the unregistered annual yield of turbot for Ukrainian waters was in the range of 200-800 tonnes in 1992-2002. These incomplete assessments (including only unregistered turbot by-catch during sprat fisheries and poaching (illegal) catches of Turkish vessels) show that unregistered annual yield was even higher than official turbot statistics.

In the base period (1967-1988), Turkish landings made up 82% of total catches of all the countries. In 1967-1971 and 1985-1992 the Turkish fishery was conducted mainly on local turbot stocks in its own waters, but in 1972-1984 it extended into the western and north-western stocks within international waters (Acara, 1985). By 1985, the western and north-western stocks appeared to be overfished. For this reason, in 1986 the former USSR imposed banning of turbot fisheries in its waters to which Bulgaria and Romania joined soon. Turkey refused to join this ban. Turbot stocks which decreased prior to 1989 had a partial recovery of turbot in waters of all countries except Turkey, as a result of banning and limiting the fisheries by the early 1990s.

2.2.2. Whiting

In the Black Sea, whiting is one of the most abundant demersal species. Like turbot, it does not undertake distant migrations, and spawns mainly in the cold season all across the basin. Whiting produces pelagic juveniles, which inhabit the upper 10 m water layer for one year. The adult whiting lives in cold waters (6-10ºC) and forms dense concentrations at depths up to 150 m (most often at 60-120 m depth; Shlyakhov and Charova, 2003). The main whiting diet consists of zooplankton, small pelagic fish and benthos organisms (crustaceans and Polychaeta worms). In turn, whiting is an important prey species for large predators, dolphins and fish-consuming birds.

In Bulgaria, Georgia, Romania, the Russian Federation and Ukraine, whiting was rarely a target species, and was collected mainly as by-catch by trawl fisheries or non-selective fisheries with fixed nets in the coastal areas. This fishery was most developed in Romanian waters. In 1996-2005, the total mean annual catch of whiting by Black Sea countries (except Turkey) was less than 600 tonnes. Whiting landings by-caught in larger quantities during target trawl fisheries for sprat and other fish in Bulgaria, Georgia, Romania and the Russian Federation were specified in the official reports of these countries. Thus, the whiting by-catch in the waters of Ukraine in 1996-2002 was assessed in the range of 650-1800 tonnes (Shlyakhov and Charova, 2003). On the other hand, by-catches of small-sized whiting populations were often not graded and merely discarded (although it is prohibited by the Regulations of Fisheries) or recorded in statistics as sprat.

On the southern coast whiting concentrations are more stable. Turkey is the only country in the region to conduct target trawling fisheries for whiting, which is allowed between September and April within offshore areas outside the 3 mile zone from the coast. Among the Turkish by-catches, whiting is usually ranked third or fourth. Along the eastern coast of Turkey in 1990-2000, more than 80% of landings of whiting were caught by trawl (Zengin, 2003). The research on trawl fisheries in the vicinity of Samsun indicated that as much as 75% of whiting trawl catches were discarded in 2005 due to their small size average length (Knudsen and Zengin, 2006). Whiting stock in Turkish waters may be characterised as excessively exploited. The main reason for whiting overfishing in Turkey may be the lack of any limitation for annual catch sizes and/or fishing efforts.

The tendency of increasing whiting biomass along the Bulgarian and Romanian coasts was associated with improved ecological conditions of the Black Sea environment after 1993 (Prodanov and Bradova, 2003; Radu *et al*., 2006). Rehabilitation of small-sized pelagic fish stocks reduced the pressure on whiting populations, thus leading to a slight recovery of their stock. Another likely cause of rehabilitation of the whiting stocks may be natural variations in their reproduction, length-weight and age parameters (Shlyakhov, 1983), whereas intensity of whiting fisheries along the coasts of Bulgaria and Romania has been too low to exert major effect on its abundance and biomass.

2.2.3. Picked dogfish

Picked dogfish inhabits the whole Black Sea shelf at water temperatures 6-15ºC. In autumn, they migrate in the form of large schools to the Crimean, Caucasus and Anatolian coasts, for overwintering and feeding on anchovy and horse mackerel. In the Ukrainian and Romanian grounds of whiting and sprat concentrations, abundant wintering concentrations of picked dogfish are also observed at depths from 70-80 m to 100-120 m (Kirnosova and Lushnicova, 1990). Reproductive migrations of picked dogfish take place in spring and autumn in coastal waters at 10-30 m depth. The major grounds for reproduction are the Crimean coastal waters such as the Karkinitsky Bay, the vicinity of Kerch Strait, and the

Feodosia Bay. Picked dogfish belongs to long-living viviparous fish. Two peaks of birth of juveniles can be distinguished in April-May and in August-September, at water temperatures of 12-18°C (Serobaba *et al*., 1988). The picked dogfish population includes 19 year-classes, and is inferior only to sturgeons in duration of life cycle among commercial fish species of the Black Sea.

The picked dogfish is mostly caught as by-catch in trawl and purse seine operations, mainly during their wintering period. The largest catches are along the coasts of Turkey. In the Ukrainian waters, picked dogfish is mainly harvested in spring and autumn by target fishing with nets of 100 mm in mesh and with long-lines. It is also taken as by-catch during sprat trawl fisheries.

In 1989-2005, the picked dogfish stock on the Ukrainian shelf reduced gradually. The stock increased until 1981 due to high abundance of their main dietary species (whiting, sprat, anchovy and horse mackerel), and then started to decrease due to intensification of the dogfish fishery (according to Prodanov *et al*., 1997). However, other authors consider that the role of fisheries in reduction of picked dogfish stock was overestimated, as the mean annual capture from the stock in the Black Sea made up 8254 tonnes or about 4% of the initial stock in 1979-1984, and was reduced to 3.5% in 1989-1992 (Kirnosova, 1990). Even taking into account unreported catches, real capture was not excessive. The mean length of picked dogfish in the north-western Black Sea in trawl catches in 1989-2005 did not reduce and even increased, which does not indicate overexploitation of this species. The causes of reduction of picked dogfish stock could therefore be related to changes in the Black Sea ecosystem due to pollution and subsequent progressive deterioration of reproductive ability of females (Shlyakhov and Charova, 2003).

2.2.4. Striped mullet

Striped mullet[5] is distributed all over the Black Sea shelf. It prefers waters with temperatures over 8º C and with salinity higher than 17‰. Striped mullet reaches maturity at 1-2 years, and usually lives 4-5 years reaching a length of more than 20 cm. Striped mullet spawns in warm periods with a maximum in mid-summer. Eggs and juveniles (up to the age of 1.5 months) are pelagic; adults live near the bottom, feeding on Polychaetes, crustaceans and molluscs. Near the Crimean and Caucasian coasts, two distinct forms occur (one of which is settled while the other one is migratory). The migratory form has a greater commercial value. It moves to the Kerch Strait and the Sea of Azov for fattening and spawning in spring and returns to the coasts of Crimea for wintering.

Due to its taste, the striped mullet is a valuable target species for fisheries. Most of all striped mullet is harvested in Turkish waters, where it is the second most important target species in the bottom trawling fisheries after whiting. In 1990-2000, around 75% of the landings of striped mullet were caught by trawl along the eastern Black Sea coast of Turkey (Zengin, 2003). Mean annual catches made up 2590 tonnes and, as compared with the previous 7-year period, decreased by 46% in 1996-2005 due mainly to decreased catches in the eastern part of the sea. Since 1999, more than half of the striped mullet landings came from the western Turkish waters, where the proportion of trawl fisheries is much lower. To some extent this is evidence of excessive pressure of trawl fisheries on striped mullet stocks near the Turkish coasts.

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[5] Two physiologically similar species *Mullus barbatus* and *Mullus surmuletus* (striped and red mullets) belong to the family *Mullidae*. Hereafter the name striped mullet is used for both species.

In Bulgarian and Romanian waters the striped mullet is not a target species for fisheries. It is harvested as by-catch during trawl fisheries or together with other species during non-selective fisheries with trap nets. In 1996-2005, catches of striped mullet in Bulgarian waters increased slightly. In the waters of Georgia in 1989-1996, catches of striped mullet were absent or included in the "other fish" group, while in 1997-2005 mean annual catches reached 28 tonnes. Along the coasts of the Russian Federation, fisheries targeting striped mullet are performed mainly with passive fishing gear. In Ukrainian waters target fishing of striped mullet was permitted only with beach seines and scrapers. However, the main part of the catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The amount of nonregistered catches of striped mullet is undefined.

2.2.5. Mullets (*Mugilidae*)

Among the six species of mullets from the *Mugilidae* family inhabiting the Black Sea, three aboriginal species (*Liza aurata*, *Mugil cephalus* and *Liza saliens*) and one acclimatized species *Mugil so-iuy* (*Liza haematocheilus*) are of commercial value. Mullets are distributed all over the coastal waters and in the estuaries adjacent to the sea. Their migration routes run along the whole coast and via the Kerch Strait (to the Sea of Azov and back). Wintering migrations of mullets are the most intensive in November. Wintering of warm-loving aboriginal mullets takes place in the narrow coastal zone and in bays at less than 25 m depth. Spawning migrations of aboriginal mullets from feeding grounds to the Black Sea take place in late August-September. The most abundant stock occurs in the northern Black Sea in the waters of the Russian Federation and Ukraine.

All coastal countries are engaged in mullet fisheries. Due to its geographical position and wide application of active fishing gears for mullets capture, Turkey has the largest landings. So-iuy mullet fisheries along the coasts of Anatolia are mainly based on fishing off pre-spawning and spawning concentrations. In other countries, the mullet fisheries are carried out with passive fishing gears with traps of different design.

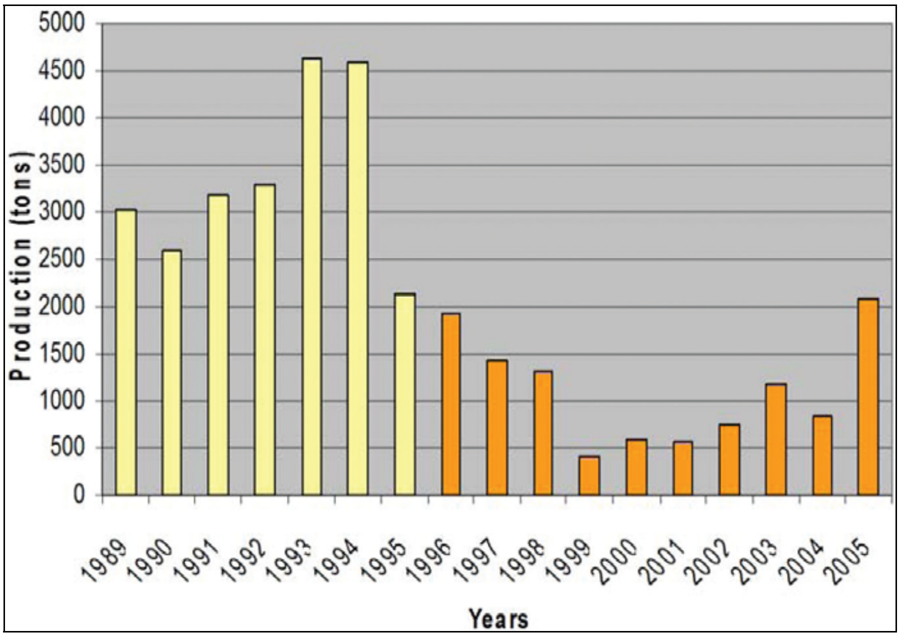
The 1980s and early 1990s marked a period of very low mullet stocks in the Crimean-Caucasus coasts and thus their fisheries were prohibited. Populations of mullets started to recover only in the late 1990s. However, their renewed fisheries became less intensive.

2.3. Anadromous fish stocks

Anadromous fish is characterised by a life cycle consisting of marine periods (for wintering and fattening) and river periods (for spawning). The anadromous species in the Black Sea include the pontic shad (*Alosa pontica*) and three sturgeon species (*Acipenser gueldenstaedtii*, *Acipenser stellatus* and *Huso huso*). As regards the volume of the catches, anadromous fish ranks last (Figure 3), but their high consuming and economical value determines their specific role in the structure of the marine resources.

The stocks of anadromous fish consist mainly of the Danube populations. Annual catches of anadromous fish significantly decreased in 1996-2005 as compared with the previous period (Figure 10). Following the minimal catches occurred in 1999, however, an increasing trend of annual catches was observed due particularly to the recovery of Pontic shad.

Figure 10: Total catches of the main anadromous fish species in the Black Sea (1989-2005)



Source: Shlyakhov and Daskalov (2009)

2.3.1. Sturgeons

Out of the six sturgeon species of family *Acipenseridae* occurring in the Black Sea and inflowing rivers, the most common are the Russian sturgeon (*Acipenser gueldenstaedtii*), the starred sturgeon (*Acipenser stellatus*) and the beluga (*Huso huso*). They are large-sized fish with a long life cycle: beluga lives up to 100 years, reaching weights of more than 1 tonne and 490 cm in length; for Russian sturgeon the maximum recorded age is 37 years, the length is 236 cm and the weight is 115 kg; starred sturgeon reaches the length of 218 cm, weight 54 kg and age 23 years. Russian sturgeon and starred sturgeon feed mainly on benthic organisms, namely molluscs and Polychaeta worms. Beluga is a typical predator, feeding exclusively on fish.

Map 7: Sturgeon distribution in the Black Sea

Source: UNEP/GRID-Arendal (2001)

Anadromous sturgeons undertake long migrations during their life from the sea into the rivers, and back into the sea after completion of spawning (Map 7). The coastal waters of Ukraine are the main fattening and wintering grounds for the Danube and Dnieper populations of Russian sturgeon and starred sturgeon, as well as juveniles of beluga. The Danube, the Dnieper and the Rioni Rivers offer most important habitats for their reproduction. Most adult sturgeon comes from the Danube and Dnieper populations. The Danube populations of Russian sturgeon, starred sturgeon and beluga are all abundant. Among Dnieper populations, the Russian sturgeon is the most abundant, and artificial reproduction (restocking) plays an important role in keeping its abundance above a certain level.

In 1998, all sturgeon species were included in the Convention of International Trade of Endangered Species (CITES Appendix II/Notification to the Parties No. 1998/13 Conservation of Sturgeons), due to the unfavourable state of sturgeon populations. In the opinion of the IUCN experts, stocks of migratory sturgeons in the lower Danube River have been overexploited and a collapse of the stocks was inevitable if the rate of exploitation was maintained.

Statistics on targeted and non-targeted fisheries comprise only officially documented catch or by-catch. Unreported catch due to its hidden part during legal fisheries and from poachers' catch, as well as dead fish which is not landed by some reasons (fish died in nets, discarded illegal catch etc.) were not usually included in statistics, but their proportion may be much higher than the officially reported catch size. Therefore, any reliable assessment for the state of sturgeons has to include the contribution of unreported catches (Prodanov *et al*., 1997; Navodaru *et al*., 1999; Shlyakhov *et al*., 2005).

After the USSR disintegration, the unreported catches increased up to 280 tonnes in 1994, due to illegal fishing of sturgeon aggregations wintering in the Karkinitsky Bay (Zolotarev *et al*., 1996). About 60-70% of these poaching catches consisted of Russian sturgeon. The unreported catch of sturgeons was estimated at ca. 600 tonnes for 1995, which was 12 times more than the officially reported catch by all the Black Sea countries. This number is expected to be even higher since the calculations did not cover all areas of the sturgeon fishery and no correction was made for fish death at sea. In the Sea of Azov, mean annual unreported catch of the Russian sturgeon was estimated at 2000-4800 tons for 1988-1997. Overfishing led to the collapse of the sturgeon stock in the Sea of Azov in less than 10 years, and there has been no recovery so far, in spite of the complete banning of commercial fisheries of Azov sturgeons after 2000 by the Russian Federation and Ukrainian authorities.

Banning of commercial sturgeon fisheries by Turkey in 1997, Ukraine in 2000 and Romania in 2006 was an important step towards conservation of sturgeon stocks. However, such measures, as well as insufficiently developed restocking and inefficient control of poaching, cannot solve this transboundary problem. Concerted actions of all Black Sea countries are necessary.

2.3.2. Pontic shad

The Pontic shad (*Alosa pontica*) is an anadromous pelagic fish up to 45 cm long, maturing at the age of 3-4 years. It is not found in the catches at an age older than 6-8 years. Mature Pontic shad feeds mainly on fish (anchovy, sprat) and, to a lesser extent, on crustaceans. It is considered that two populations of Pontic shad (Don and Danube) inhabit the Azov and Black Seas. The Don populations winter in the eastern part of the sea from the Crimean coasts to Batumi, and the Danube populations in the western part of the sea.

Other studies suggested wintering along the Turkish coasts. The Danube population migrates into the Danube, Dnieper and Dniester Rivers for spawning in spring. The Pontic shad fishery is conducted both at sea (during the spring migration period in Bulgaria and Romania, and during the wintering phase in Turkey) and in the western rivers (by Bulgaria, Romania and Ukraine). This fishery is almost absent in the territorial waters of Georgia and Russian Federation.

After the peak in 1974-1975 till the early 1990s, the stock and catches of Pontic shad tended to reduce even excluding the Turkish catch. After 1989, the catch statistics also included the Turkish catches that accounted for 2000-4000 tonnes from 1989 to 1995. Intensification of fishing in Turkish waters was most likely due to the yearning of fishermen to compensate their losses as a result of collapses in anchovy and horse mackerel fisheries. The extensive harvesting caused a sharp drop in shad catches after 1994 to less than 500 tonnes in 1999-2001. The Turkish catches increased again in 2005, exceeding 1000 tonnes. In 1989-1998 the catches of Bulgaria, Romania and Ukraine were approximately at the same level of 1000 tonnes. They declined sharply in 1999 and acquired a slight recovery afterwards.

The present state of the Danube population of Pontic shad should be regarded as unfavourable. Even taking into account unfortunate ecological changes due to natural factors such as lower water level, water temperature and pollution that could affect the success of the Danube shad reproduction, the most important cause of the stock decrease appears to be overfishing, mainly in the Danube Delta area (Radu, 2006). Indeed, poaching fishery for shad in the lower Danube during the last decade has become wide-scale, although it has not been assessed properly so far. Marine fisheries of Turkey possibly made a comparable contribution to the overexploitation of the Danube stock of shad.

2.4. Molluscs

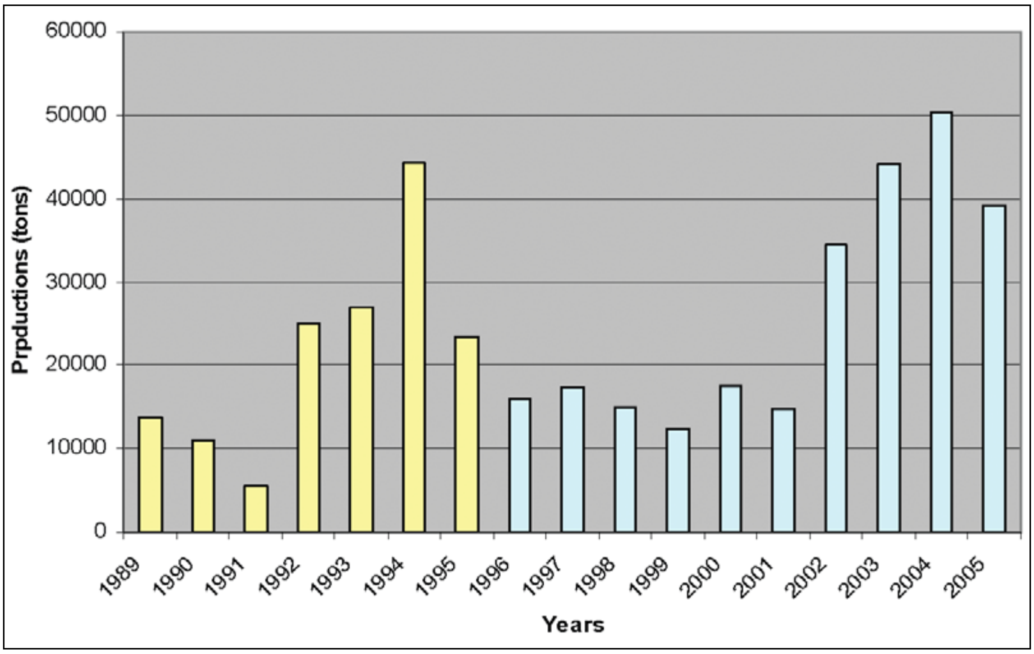
Among molluscs, the Mediterranean mussel (*Mytilus galloprovincialis*), the clams (*Chamelea gallina*, *Tapes* spp.) and the sea snail (*Rapana*) have the greatest commercial value. The former two species are harvested mainly in Turkey, while the latter species is targeted in all the Black Sea countries. The catches of molluscs in 1996-2005 show an increasing trend (Figure 11).

2.4.1. Mediterranean mussel

The Mediterranean mussel *Mytilus galloprovincialis* has the highest commercial value among the Black Sea molluscs. It is one of the most abundant macrozoobenthos species in the Black Sea, and forms communities all along the coast from the shoreline to 55-60 m depth.

In 1989-2005, mussel fisheries were developed in Turkey and Ukraine, while harvesting in the waters of Bulgaria and of the Russian Federation was less significant. At that time, Georgia and Romania did not harvest this mollusc at all. As compared with the previous period 1989-1995, mussel harvesting in 1996-2005 shows a major reduction in the volume of catches in the waters of Turkey and Ukraine.

Figure 11: Total catches of the main molluscs in the Black Sea (1989-2005)



Source: Shlyakhov and Daskalov (2009)

Mediterranean mussel banks have been seriously affected and production rates have decreased. In the Ukrainian waters, degradation of the mussel settlements occurred mainly due to the deterioration of the environmental conditions and anthropogenic impacts, in particular bottom trawling (Fashchuk *et al*., 1991; Gubanov, 2005). The most abundant settlements of this mollusc were concentrated in the north-western basin. Up to the mid-1970s, mussel biomass in the north-western Black Sea varied between 8 and 12 million tonnes. In subsequent years, massive death of bottom organisms occurred almost every year due to the oxygen deficiency in the near-bottom water layer. This resulted in rejuvenation of the mussel population as compared with the preceding period. In the 1980s, the total mussel stock on the Ukrainian north-western shelf reduced to 4-6 million tonnes (Zaitsev, 1992). The juveniles made up the basic population at the age of fingerlings and yearlings. In some years the juvenile proportion became as high as 75% of the total population.

2.4.2. Sea snail Rapana

This species of mollusc is *Rapana venosa*, but the name *Rapana thomasiana* is also used (Figure 12). It supposedly came to the Black Sea in ballast waters from its home places of the Indian-Pacific oceans (Sorokin, 1982). Near the Ukrainian coast, the sea snail becomes mature at the age of 2-3 years; it lives up to 8-9 years and reproduces during the warm period (July-September). Pelagic larvae of sea snail feed on nanoplankton algae. Adults feed mainly on bivalves of families *Cardiidae*, *Mytilidae*, *Veneridae* and *Arcidae*, and travel over large distances for feeding. In some periods of the year it buries itself into the ground.

Introduction of this predatory mollusc into the Black Sea ecosystem turned out to be a catastrophe for oyster biocenoses. In the Ukrainian waters sea snail destroyed the oyster banks in the Kerch Strait zone and in the Karkinitsky Bay, and biocenoses of other molluscs up to 30 m depth suffered as well. Distribution of sea snail is associated with reduction in area and density of mussel settlements, in particular near the coasts of Anatolia and Caucasus.

Turkey has been conducting large-scale harvesting of sea snail since the mid-1990s, and the other Black Sea countries have also joined in this fishery. The Turkish catches remained, however, much higher than the catches of the other countries and increased noticeably during the 2000s. Analysis of fisheries along the eastern coast of Turkey (Samsun Province) showed that the number of vessels using drags for sea snail harvesting in 2000-2005 increased considerably, typically with boats that combine sea snail dredging, bottom trawling and net fishing (Knudsen and Zengin, 2006). Although resources of this mollusc are still withstanding these activities, such high intensity of fisheries and the large-scale implementation of dragging have a destructive effect on the sea floor ecosystem as a whole.

Sea snail also became a commercially important resource in Bulgaria after 1994. Bottom trawling and dredging were officially forbidden, although these fishing gears were still used for the sea snail fishery. According to the assessments of the Private Bourgas Fishery Association, sea snail landings were almost 17 times higher than the official report (8557 tonnes in 2005; Raykov, 2006). Until the early 1990s, sea snail was harvested along the Ukrainian coast in an amateurish way for a fine shell used as souvenirs. Between the initial commercial exploitation in 1990 and the period of intensive fishing, sea snail stocks decreased from 1500-2800 tonnes (virgin population) to 1300 tonnes (exploited population), which provides evidence of the drag fisheries impact. The use of knife-edge drags adversely affected the bottom ecosystem.

Figure 12: *Rapana venosa* eating a mussel

Source: http://blacksea-education.ru

2.4.3. Clams - Striped venus

Striped venus (*Chamelea gallina*) is a small-sized bivalve mollusc, inhabiting sandy ground down to 35 m depth. It maturates in the second year of life and reproduces during the warm period of the year (July-September). Its larvae are pelagic. Adult mollusc is a filtrator and seston-eater. Biocenoses of striped venus are characterised by abundant biomass. In the north-western Black Sea, the largest abundance of clam is observed at 7-8 m depth on sands (up to 600 - 800 individuals/m^2 and even higher in the southern areas).

Turkey is the only country to conduct regular striped venus harvesting in the Black Sea. Dynamics of its harvesting show a rapid growth for the first three years after the beginning of harvesting and a subsequent five-year period of decline. In 1996-2005, an increase in landings was observed, with mean annual catches making up 9459 tonnes. The hydraulic dredge boats operating in clam fishing are mainly concentrated along the south-western coast of the Black Sea. Pressure on different sites of the coast is regulated by means of opening or closure from season to season. Its sustainable production requires standardising the sieves, freezing the fishing license of striped venus, applying quotas and sharing out the fishing grounds between the boats. Due to the lack of a market in Turkey, striped venus is exported to EU countries as frozen or canned food.