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6 DETAILED ASSESSMENTS

6.1 Sprat in the Black Sea

6.1.1 Biological features

6.1.1.1 *Stock Identification*

The Black Sea sprat (*Sprattus sprattus L.*) is a key species in the Black Sea ecosystem. Sprat is a marine pelagic schooling species sometimes entering in the estuaries (especially as juveniles) and the Azov Sea and tolerating salinities as low as 4‰. In the daytime it keeps to deeper water and in the night moves near the surface. It forms big schools and undertakes seasonal movements between foraging (inshore) and spawning (open sea) areas (Ivanov and Beverton 1985). Adults tend to remain under the seasonal thermocline, penetrating above its only during the spring and autumn homothermia. Juveniles are distributed in a larger area near the surface. Sexual maturity is attained at the age of 1 year and length of 7 cm. In Turkey it was found that males reached maturity at 7.5 cm and females at 7.8 cm at age 1 year (Avşar & Bingel, 1994).

Sprat is one of the most important fish species being fished and consumed traditionally in the Black Sea countries. It is most abundant small pelagic fish species in the region together with anchovy and horse mackerel and accounts for most of the landings in the north-western part of the Black Sea. Whiting is also taken as a by-catch in the sprat fishery although there is no targeted fishery beyond this (Raykov, 2006) except for Turkish waters.

Sprat fishing takes place on the continental shelf on 15-110 m of depth (Shlyakhov and Shlyakhova, 2011). The harvesting of the Black Sea sprat is conducted during the day time when its aggregations become denser and are successfully fished with trawls. The main fishing gears are mid-water otter trawl pelagic pair trawls and uncovered pound nets.

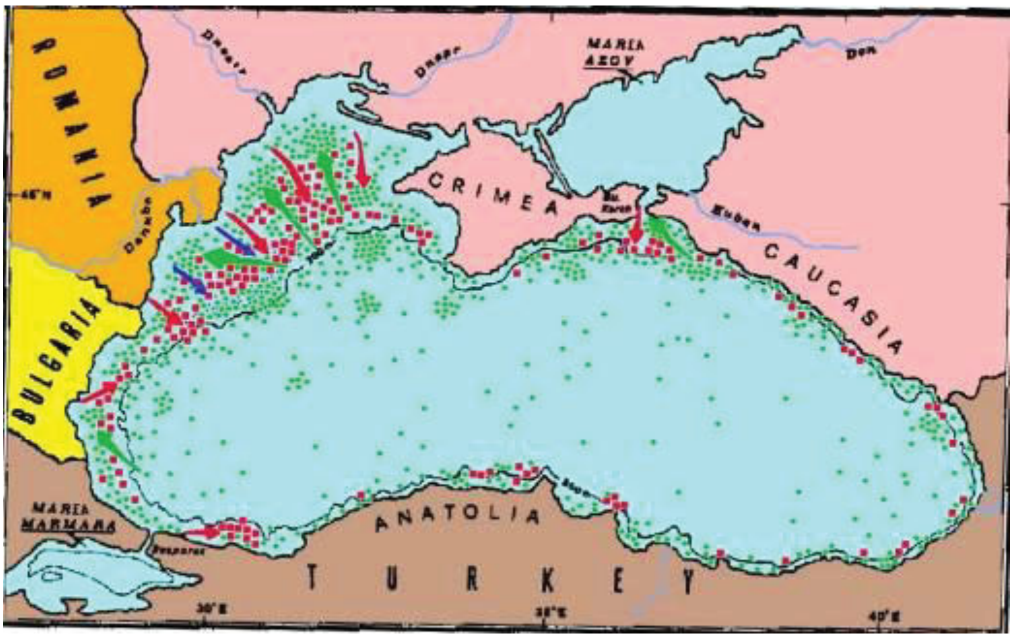

Fig. 6.1.1.1.1. Sprat distribution and migration in the Black Sea

Legend: Wintering areas and migration to | Spawning areas and migration to them | Feeding areas and migration to them

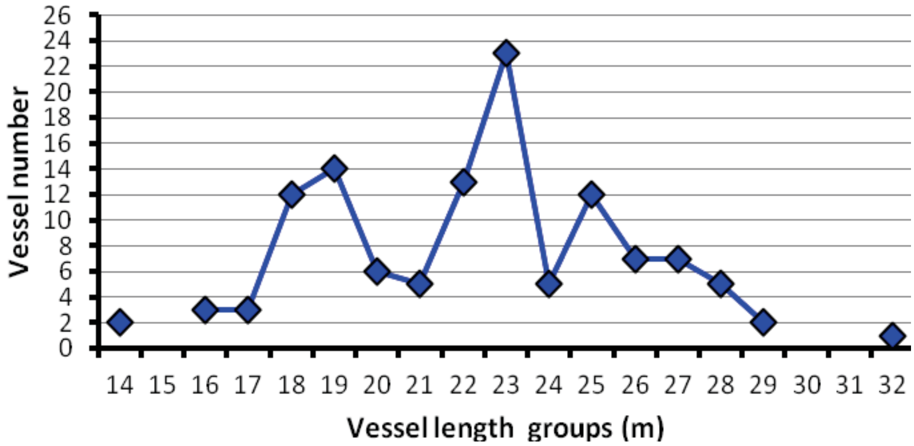

Figure 6.1.1.2.5.4. The frequency distribution of pelagic fishery vessels in size.

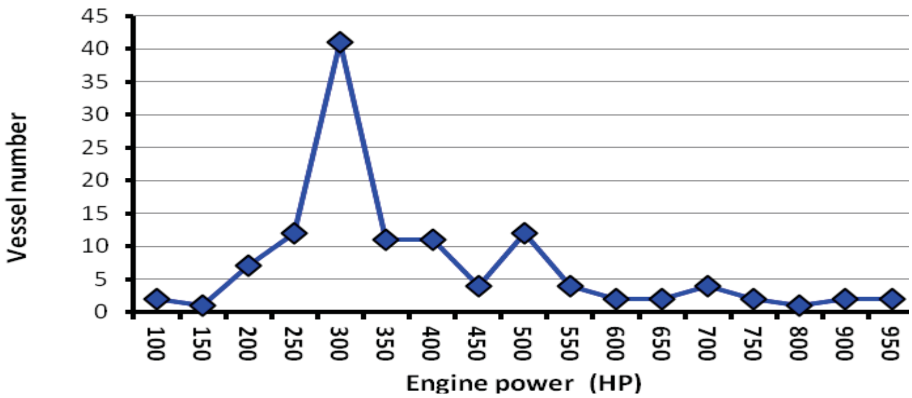

Figure 6.1.1.2.5.5. The frequency distribution of engine power in pelagic fishery fleet.

Actually, the fleet is dynamic and the number of vessels operating on sprat changes in years.

The smallest of these licensed vessels was 14.9 m and the biggest is 32.2 m. Mean length was estimated as 22.7 cm. 71.1% of vessels are over 20m length and the rest percent 28.3 are 19 m and below. The size distribution has a mode around 22 and 23 m lengths. Engine power ranges between 140 HP and 970 HP. The mean engine power of this fleet is approximated as 415.7 HP and the mode appears around 300 HP.

Composition of CPUE

The monthly composition of sprat total landing and CPUE values for 2011 estimated for Samsun shelf area is presented in Table 6.1.1.2.5.3. The mean landing is nearly 10 tons/day per vessel (Table 6.1.1.2.5.3.). The individual experience of fisherman and the quality of technical equipment of the vessel are determinative in the amount of daily catch. Sprat catch reaches its maximum especially in spring months; especially between March-May.

Table 6.1.1.2.5.3. The monthly composition and CPUE values of sprat landing from Samsun shelf area in 2011.

Months	Landing (kg)	Catch composition(%)	CPUE (kg/vessel/day)	CPUE *(kg/vessel/hour)
January	8578.3	9.8	7975.9	997.0
February	6414.7	7.4	8672.5	1084.1
March	37409.7	42.9	17369.5	2171.2
April	26733.1	30.7	11556.9	1444.6
May	5615.7	6.4	14683.9	1835.5
November	456.6	0.5	6683.1	835.4
December	1932.9	2.2	8891.4	1111.4

* The active operation duration of a vessel is generally 8 hours.

The maximum CPUE has been recorded in June-July (Tab. 6.1.2.5.7).

Table 6.1.1.2.5.4. CPUE *kg/h* *1000 of Ukrainian fishing vessels. 1996-2011 (Shlyakhov *et al*., 2012)

Ukrainian commercial fleet CPUE kg*h^{-1} by years and quarters					
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	average
1996	0.41	0.96	1.27	0.64	0.82
1997	0.36	0.84	1.11	0.56	0.72
1998	0.46	1.08	1.42	0.72	0.92
1999	0.50	1.20	1.58	0.80	1.02
2000	0.85	2.22	2.80	1.41	1.82
2001	0.65	1.55	2.00	1.03	1.31
2002	0.85	2.12	2.75	1.39	1.78
2003	0.45	1.10	1.45	0.65	0.91
2004	0.40	1.20	1.50	0.75	0.96
2005	0.48	1.10	1.55	0.75	0.97
2006	0.50	1.25	1.67	0.85	1.07
2007	0.45	1.20	1.55	0.80	1.00
2008	0.83	2.00	2.60	1.30	1.68
2009	0.85	2.10	2.75	1.40	1.78
2010	0.80	2.15	2.80	1.40	1.79
2011	0.55	1.77	2.17	1.15	1.44

6.1.3 Scientific Surveys

6.1.3.1 *Method 1: International (Bulgarian and Romanian) hydroacoustic survey (Nov-Dec, 2011)*

Stratified sampling methodology was applied in Bulgarian (for the period of 2007-2010 by Raykov *et al.* 2007; Raykov, 2008; Raykov *et al*., 2008;Raykov *et al*., 2009; Raykov *et al*., 2010; Raykov *et al*.,2011). and Romanian waters (Radu *et al*., 2010a; Radu *et al*., 2010b;Radu *et al.,* 2010c).Taking into account exact depths (isobaths), the whole area was divided to sub areas,. "strata", depending on depth: first stratum 15-35 – second 35- 50 m., third 50-75m, and fourth 75-100m. The examined area was divided into equal sized fields - with total number 55; each sector equal to about 63 кm^2 (5' Lat. × 5' Long.). The trawling activities were carried out in meridian direction. The duration of each haul was 60 min; average velocity 2.8 knots (5.19 km* h^{-1}). Biological data collection using mid-water trawl supply scientists with valuable information of population parameters such as size, age, sex composition, condition (Fulton's coefficient) and relative indices of abundance used in tunning later in the analysis. The CPUE derived from pelagic surveys was used for tunning series in the ICA for sprat.

The acoustic survey was accomplished under National Data Collection Programs of Bulgaria and Romania for 2011 during the period 15th November – 6th December 2011 with duration of 20 working days (Panayotova et.al, 2012). The survey covers partially the territorial waters and EEZ of Bulgaria and Romania in FAO GSA 29 – Black Sea. The study area includes continental shelf and slope up to 2000 m in front of Bulgarian and Romanian coasts. The design for the acoustic sampling was adapted to the characteristics of the spatial structures of small pelagic fish in the Black Sea as well as the peculiarities in the topography. The survey design includes parallel transects, perpendicular to bathymetry with inter-transect distance of 5 nm – Fig. 6.1.3.1.1, to achieve the minimization of the coefficient of variation of the acoustic estimates for the target species (Panayotova *et.al*, 2012).

6.2 Turbot in the Black Sea

6.2.1 Biological features

6.2.1.1 Stock Identification

Turbot (*Scophthalmus maximus*) is demesal species and occurs all over the shelf area of all Black Sea coastal states at depths up to 100 m -140 m, grouped in local shoals. Species inhabits sandy or silt bottoms, mussel beds or mixed types. The spawning process is taking place in spring season – between April and June. Turbot in the Black Sea is represented by several local populations, which migrate and mixing in the adjacent zones. Local populations are independent units of the stock, and have to be covered in order to ensure an accurate assessment of the stock at regional level. Due to existing gaps of information in terms of accurate fisheries statistics and availability of biological data, the present assessment is based on the analysis of the best available information, obtained from combined data of all Black Sea countries.

6.2.1.1. Growth

Turbot is a long living species with a slow growth rate. The parameters reported here by countries are considered appropriate for the description of an average growth performance of the species in GSA 29 – Tab. 6.2.1.2.1.

Table 6.2.1.2.1. Growth parameters of turbot by countries and periods.

COUNTRY	AREA	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	A	B
ROM	29	2003-2005	TUR	C	80.98	0.15	-1.37	0.000018	3.01
ROM	29	2006-2008	TUR	C	72.5	0.212	-1.15	0.00806	3.22
ROM	29	2009-2011	TUR	C	86.3	0.19	-2.1	0.030088	2.87
BGR	29	2007-2008	TUR	C	77.81	0.242	0.152	0.000431	2.21
BGR	29	2008-2009	TUR	C	120.40	0.076	-2.811	0.000011	3.13
BGR	29	2008-2009	TUR	F	129.81	0.065	-3.351	0.000013	3.11
BGR	29	2008-2009	TUR	M	67.38	0.246	-1.217	0.000041	2.78
BGR	29	2007-2008	TUR	M	57.60	0.507	0.458	0.000918	1.96
BGR	29	2007-2008	TUR	F	80.31	0.213	-0.136	0.000424	2.22
BGR	29	2006-2007	TUR	M	77.49	0.158	-1.975	0.000022	2.92
BGR	29	2006-2007	TUR	F	124.27	0.080	-2.136	0.000021	2.94
BGR	29	2006-2007	TUR	C	79.26	0.173	-1.561	0.000008	3.17
UKR (NE)	29	2000 - 2006	TUR	C				0.000216	2.48
UKR (NW)	29	2008 - 2009	TUR	C	74	0.106	-1.73	0.001437	1.94
TR	29	1990 - 1991	TUR	C	82.57	0.17	-0.93	0.0085	3.18
TR	29	1990 - 1996	TUR	C	96.24	0.119	-0.01	0.0112	3.12
TR	29	1998 - 2000	TUR	C	95.9	0.104	-1.55	0.0106	3.14
BGR-RO	29	2010	TUR	C	79.578	0.237	-0.104	0.000242	2.361
TR	29	2010	TUR	C	60.57	0.218	0.25	0.12	3.081
BGR	29	2011	TUR	C	69.98	0.395	1.043	0.0000339	2.837
TR(west)	29	2011	TUR	C	96.376	0.112	-1.304	0.014	3.059
TR(east)	29	2011	TUR	C	101.12	0.11	-1.24	0.01	3.17
ROM	29	2011	TUR	C	86.32	0.242	-1.971	0.06254606	2.660

6.2.1.2. Maturity

The species reaches sexual maturity at ages between 3 and 5. The maturity ogive for 2011 was prepared based on data from Bulgaria, Romania and Turkey, averaged by age groups. In Turkish waters, earlier maturation at age of 2 yers was observed. The proportions of mature individuals by age groups for the period 1970 – 2011 are given in Table 6.2.1.3.1.

6.4 Horse mackerel in the Black Sea

6.4.1 Biological features

6.4.1.1 Stock Identification

The Black sea horse mackerel is a subspecies of the Mediterranean horse mackerel *Trachurus mediterraneus.* Although in the past the Black sea horse mackerel has been attributed to various subpopulations, in a more recent study Prodanov *et al.* (1997) brought evidence that the horse mackerel rather exists as a single population in the Black sea, and thus all Black sea horse mackerel fished across the region should be treated as a unit stock.

The horse mackerel is a migratory species distributed in the whole Black Sea (Ivanov and Beverton, 1985; Figure 6.4.1.1.1). In the spring it migrates to the north for reproduction and feeding. In summer the horse mackerel is distributed preferably in the shelf waters above the seasonal thermocline. In the autumn it migrates towards the withering grounds along the Anatolian and Caucasian coasts migration (Ivanov and Beverton, 1985). The horse mackerel population in the Black Sea mainly winters along the Crimean, Caucasian and Anatolian coasts and warm sections of the Marmara Sea. They winter at a depth ranging between 20 and 90 meters off Crimea and between 20 and 60 meters off the Caucasian coasts. The horse mackerel population continuously remains in the eastern Black Sea winters in an area north-east of Trabzon. The population migrating between Marmara and the eastern Black Sea spend the winter in the Bosphorus area and off the Marmara Sea at optimal depths ranging between 30 and 50 meters. Depending on water temperature, feeding migration starts in mid-April or towards the end of that month (Demir, 1958). Horse mackerel groups migrate from the Bosphorus to the Bulgarian and Romanian coasts in the north. They are also believed to migrate from Crimea to the north-west and from the Caucasian and north-eastern Anatolian coasts to the Crimean coasts. Autumn migration starts in September and reaches a peak in October and November (Ivanov and Beverton, 1985).

The family Carangidae is represented by two species in the Black Sea: *Trachurus trachurus* and *T. mediterraneus* (Drenski, 1948, 1951; Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.,* 1963; Svetovidov, 1964; Valkanov *et al.,* 1978; Sivkov, 2004; Zhivkov *et al.,* 2005; Kapapetkova and Zhivkov, 2006; Raykov and Yankova, 2008; Yankova *et al.,* 2010a). The systematic position of the Black Sea horse mackerel was examined by Nümann (1956) and Aleev (1952, 1957). These authors stated that in the Black Sea the species is represented by four local subpopulations: a south western (Bosporic), a northern (Crimean), an eastern (Caucasian) and a southern (Anatolian). Each subpopulation has its own biological characteristics such as wintering grounds, fat content, spawning patterns, age composition, growth rate, feeding patterns.

According to some authors (Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.,* 1963; Kapapetkova and Zhivkov, 2006) the Black Sea horse mackerel is represented into two size-forms: ”large” and “small”. The presence of the large form has been reported for a first time in 1913 by S. A. Zernov (Aleev, 1956). However, after that time this form disappeared, but it is registered again in the territorial waters of Georgia in 1947 and is being intensively fished for 10 years. Draughts of the large form for the eastern part of the Black Sea reached up to 8601,7 t in 1954 (Tikhonov *et al.,* 1955). Since 1958, only single specimens are found in the nets (Dobrovolov, 2000). There are several hypotheses about the presence of the large horse mackerel in the Black Sea: a) it is a new immigrant from the Mediterranean (Aleev, 1956); b) it is the same small horse mackerel with accelerated growth under extremely favorable conditions (Tikhonov *et al.,* 1955; Shaverdov, 1964); c) it is an ecological breed that hibernates in the warmest areas (Aleev, 1957), or it is an ecotype (Shaverdov, 1964); d) it belongs to another species present in the Mediterranean or even in the Atlantic Ocean and in case of extremely high species numbers some shoals enter the Black Sea enlarging their nutritive territory (Altukhov and Salmenkova, 1981); e) it is a polyploid form of the small horse mackerel originating in the Black Sea (Georgiev and Kolarov, 1962); f) it is a "giant" horse mackerel as a new species *Trachurus gigas*, n.sp (Banarescu and Nalbant, 1979).

According to Shaverdov (1964), the "large" and "small" forms of the Black Sea horse mackerel belongs to one and the same subspecies as described by Aleev (1957). After the study of Golovko (1964) about the electrophoretic spectra of serum proteins from these two forms, Shulman and Kulikova (1966) reconsidered their own earlier assumption about the belonging of both forms to a taxonomically close but different species. Tkacheva (1957) performs crosses between small and large horse mackerel under field conditions on board a research motor boat, which showed the possibility to obtain hybrids. Until now, there does not exist any information confirming the polyploidity of the large form of horse mackerel. On the other hand, the existence of two different subspecies of *T. mediterraneus* in the Black Sea: *T. m.* ssp. *ponticus* and *T. m.* ssp. *mediterraneus* is described by Altukhov and Apekin (1963) based on serological analyses and also by Altukhov and Michalev

(1964) by means of the characteristics of the cellular thermal (Prodanov *et al.,* 1997). According to (Dobrovolov & Dobrovolova 1983; Dobrovolov and Manolov 1983; Dobrovolov, 1988) no difference at species level can be found between *T. mediterraneus* ssp. *ponticus* and *T. mediterraneus* ssp. *mediterraneus* by electrophoretical method. Dobrovolov (1986) revealed that the occurrence of large form can be explained as a result of heterosis effect between the above-mentioned subspecies.

Turan (2004) analysed the population structure of *T. mediterraneus* in Turkish coastal waters using morphometric and meristic traits and reported on population structuring in three areas: the Black Sea, Marmara Sea and the north-east Mediterranean Sea. The samples from the Black Sea were similar to each other for both morphometric and meristic charactrers. Biometric indices were insufficient to distinguish two horse mackerel subpopulations in the Bulgarian and Turkish Black Sea waters (Yankova and Raykov, 2006a). The same authors concluded that all of the morphological differences are possible due to variability of the habitat and sample size of the study. Acording to Prodanov *et al.,* (1997) the Black Sea horse mackerel represent a single population, as the environmental conditions are almost one and the same in the whole area inhabited, and there exists no positive evidence for the occurrence of two distinct subpopulations differing substantially in their biological parameters. The present mtDNA analysis also indicated that there were no subspecies of *T. mediterraneus* from the Turkish Black Sea waters (Bektas and Belduz, 2008).

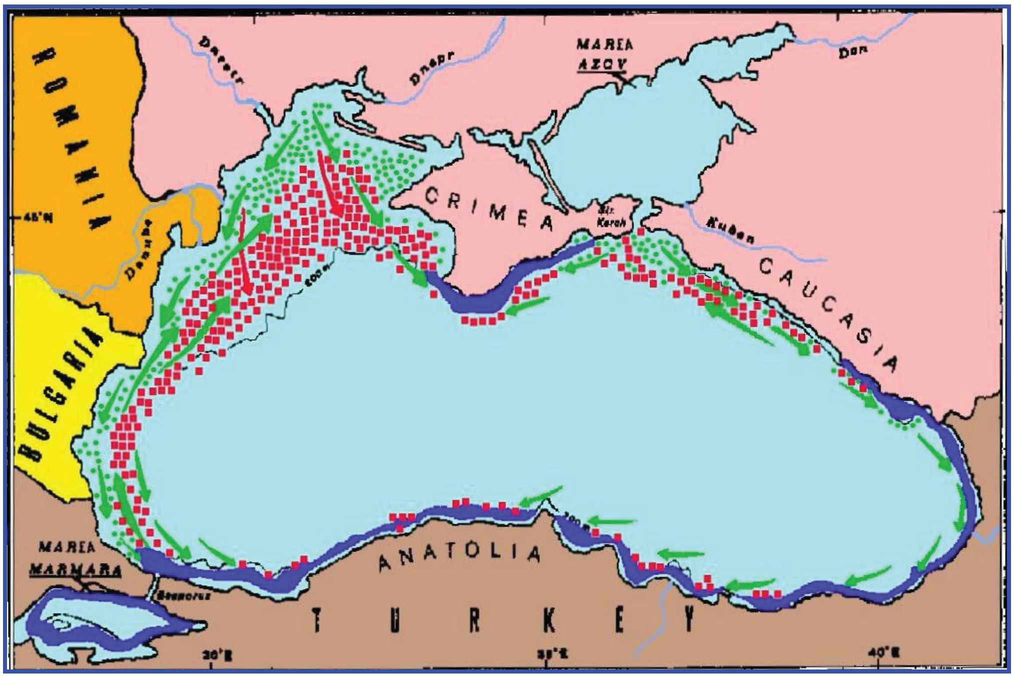

Fig.6.4.1.1.1 Distribution and migration routes of horse mackerel in the Black Sea.

6.4.1.2 Growth

Horse mackerel growth parameters from VBGF and length-weight relationship, provided by different countries are presented in Table 6.4.1.2.1.

The exponent *b* ranged between 3.3029 for females and 3.3123 for males, exhibiting positive allometric growth (Yankova *et al.,* 2010). There was not a significant difference when the length-weight relationships of the sexes were compared using covariance ($P > 0.05$). The slope (*b* value) of the length-weight relationship was similar for males (3.3123) and females (3.3029), indicating that weight increased allometrically with length (Yankova *et al.,* 2010).

6.5 Anchovy in the Black Sea

6.5.1 Biological features

6.5.1.1 Stock Identification

Achovy *Engraulis encrasicolus* populations has been represented by two stocks in the Black Sea: the Black Sea and the Azov Sea stocks (Ivanov and Beverton 1985). The later reproduces and feeds in the Azov Sea and hibernates along the northern Caucasian and Crimean coast of the Black Sea.

The Black Sea stock has higher ecological and commercial importance and the information bellow concerns only this stock which will be further called Black sea anchovy.

Black sea anchovy is distributed in the whole Black Sea – Fig. 6.5.1.1.1. In October-November it migrates to the wintering grounds along the Anatolian and Caucasian coasts in southern Black Sea. In these areas it forms dense wintering concentrations in November-March which are subject to intensive commercial fishery. In the rest of the year it occupies its usual spawning and feeding habitats across the sea with some preference to the shelf areas and the northwestern part of the sea– characterized by the largest shelf area and high productivity due to abundant river run-off (Faschuk *et al*. 1995, Daskalov, 1999). But according to the studies carried out in the southern Black Sea (Turkey's EEZ) anchovy has also spawn in that area (Fig. 6.5.1.1.2) (Niermann et al. 1994). It also may be affected from the climatic changes and other ecological impacts in the last 3 decades.

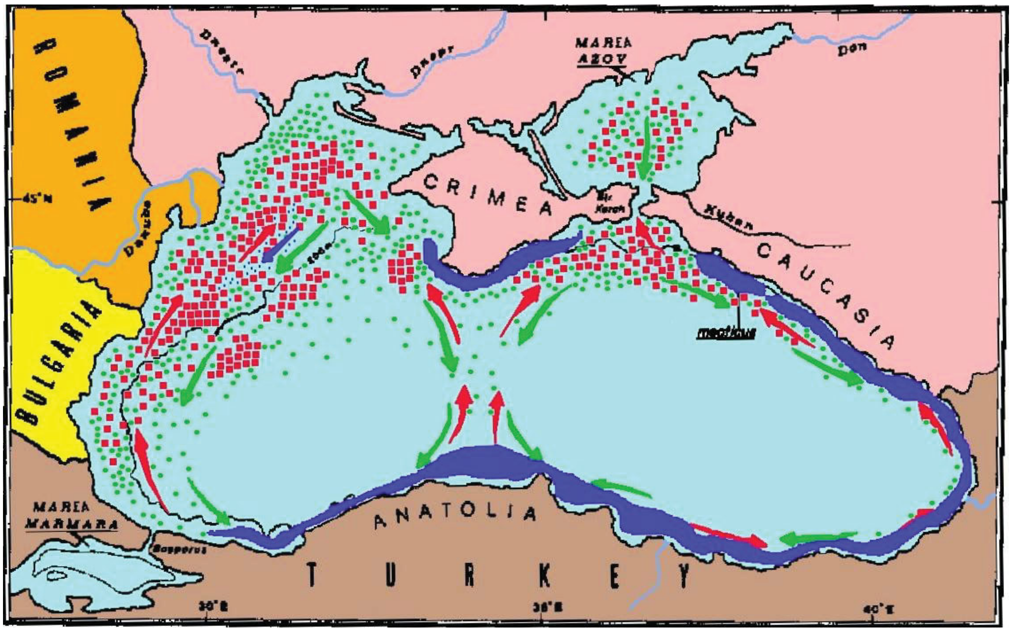

Fig. 6.5.1.1.1 Distribution of the anchovy at the Romanian littoral and in the whole Black Sea.