BLACK SEA HORSE MACKEREL, *TRACHURUS MEDITERRANEUS PONTICUS* ALEEV

The Black Sea horse mackerel is a subspecies of the Mediterranean horse mackerel, *Trachurus mediterraneus*. Aleev (1957, 1959) considers that in the Black Sea the species is represented by four local subpopulations: the south-western (Bosporic), the northern (Crimean), the eastern (Caucasian), and the southern (Anatolian), each one with its own biological characteristics like wintering grounds, fat content, spawning patterns, age composition, growth rate, feeding patterns, etc. On the basis of investigations carried out by Georgiev and Kolarov (1959, 1962) on size composition, and also tagging experiments of horse mackerel caught off the Bulgarian coast, they concluded that in the Black Sea two subpopulations occur that belong to the small size - type of *Trachurus mediterraneus ponticus*, the eastern and western ones, respectively. Although the two subpopulations are mixing at the edge of their distribution areas, they have the same behaviour and biology.

According to the Romanian meristic analyses (Cautis, 1966; Cautis and Jonescu, 1961, 1979) in the western and north-western part of the Black Sea there exists a single "group" of horse mackerel. For the eastern part Cosswig (1955) and Numann (1956) suggest that the small and large types are in fact different age groups from the same stock. Shaverdashvily (1976) asserts that the large horse mackerel can be found in period of strong year classes of anchovy and they belong to the same species and stock. On the other hand the existence of two different subspecies of *Trachurus mediterraneus* in the Black Sea is supported by Altukhov and Apekin (1963) from serological analyses, by Altukhov and Michalev (1962) by means of the characteristics of the cellular thermal stability, and also by Schulman (1972) who used yearly rings on different hard structures. Dobrovolov and Dobrovolova (1983), using electrophoretic methods, assumed that no difference at species level can be found between *Trachurus mediterraneus ponticus* and *Trachurus mediterraneus mediterraneus*. For this reason according to Dobrovolov (1985) the large-sized type occurrence can be explained as a result of a heterosis effect between the above-mentioned subspecies. This type being sterile does not produce further offspring, and became extinct after completing its life span.

In our opinion the Black Sea horse mackerel represents 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.

Table 49 shows Black Sea horse mackerel catches by countries during the period 1950-1994 (small type only).

TABLE 49. Black Sea horse mackerel landings (in tonnes) during the period 1950-1994

Years	Bulgaria	Romania	former USSR	Turkey	Total
1950	644.4	217.0	6230.0	1200.0	8291.4
1951	736.2	293.0	1870.0	2500.0	5399.2
1952	564.9	260.0	3050.0	2600.0	6474.9
1953	294.7	140.6	1650.0	9200.0	22094.7
1954	593.2	617.8	1600.0	12200.0	25511.2
1955	662.4	297.4	500.0	7200.0?	19950.4
1956	131.5	63.5	200.0	14200.0?	29734.5
1957	69.4	119.7	200.0	14000.0?	26919.4
1958	233.0	587.4	220.0	4900.0	17370.0
1959	687.4	839.8	2110.0	700.0	12687.4
1960	1017.7	674.6	6240.0	4800.0	17691.7
1961	1240.6	2200.0	5720.0	3600.0	16345.6
1962	805.2	1166.0	13700.0	13500.0	29271.2
1963	231.4	532.0	13900.0	3500.0	18163.4
1964	242.0	248.4	10200.0	3100.0	13790.0
1965	301.6	1364.7	5240.0	1200.0	8106.3
1966	556.7	1770.0	2350.0	600.0	5276.7
1967	245.7	762.0	6489.0	24615.0	32111.7
1968	37.4	175.0	4750.0	15162.0	20124.4
1969	95.9	156.0	1280.0	16762.0	18293.9
1970	689.1	1342.0	630.0	19380.0	22041.1
1971	630.9	1218.0	4350.0	8722.0	14920.9
1972	534.0	500.0	21820.0	10855.2	33709.2
1973	849.0	606.0	10780.0	16593.7	28828.7
1974	2168.8	608.0	2883.0	10244.8	15904.6
1975	1972.8	1003.0	4335.0	11897.8	19208.6
1976	1808.7	1514.0	18345.0	14077.9	35745.6
1977	791.0	404.0	4707.0	14674.3	20576.3
1978	565.0	729.0	685.0	23529.0	25508.0
1979	934.5	1179.0	734.0	59772.0	62619.5
1980	813.0	1536.0	609.0	42339.0	45297.0
1981	476.2	588.0	344.0	40543.0	41951.2
1982	366.8	291.0	1875.0	48918.0	51450.8
1983	496.7	1510.0	7157.0	54548.0	63711.7
1984	1015.8	872.0	5502.0	69980.0	77369.8
1985	755.8	1035.0	38870.0	100417.0	141077.8
1986	850.9	945.0	2370.0	100943.0	105108.9
1987	826.4	997.0	543.0	90850.0	93216.4
1988	1676.8	2660.0	398.0	93006.0	977408
1989	1100.9	1459.0	305.0	94023.0	96887.9
1990	164.1	165.0	56.0	65163.0	65548.1
1991	122.9	48.0	3.0	19781.0	19954.9
1992	54.0	22.0	0.0	17524.0	17600.0
1993	31.0	22.0	0.0	5000.0	5053.0
1994				15000.0	15500.0*

* - the total catch is enlarged by 500 tonnes for 1994 since the fishery statistics for all Black Sea countries, except Turkey, are underestimated.

Generally, the horse mackerel fishery is carried out by active (bathypelagic trawls and surrounding nets), and by passive (trap nets) gears. The Bulgarian and Romanian catches are taken primarily by passive, while the Turkish and former USSR entities by active gears.

Table 50 presents the age composition of horse mackerel catches during the period 1950-1994.

TABLE 50. Age composition (x 10^{-6} specimens) of total horse mackerel catches in the Black Sea during 1950-1954 (W = mean weight fish in catches, g)

Years	0+	1,1+	2,2+	3,3+	4,4+	5,5+	6,6+	Total	W
1950	523.3	198.9	62.4	35.3	3.1	0.4	0.0	823.4	10.07
1951	1.4	214.8	54.4	87.5	3.9	0.3	0.1	362.4	14.9
1952	0.1	130.8	104.4	39.3	11.3	2.7	0.2	288.8	22.43
1953	812.4	517.5	247.8	109.5	86.4	8.4	51.3	1833.3	12.05
1954	901.3	623.3	305.4	156.5	81.1	11.7	4.8	2084.1	12.24
1955	703.6	483.7	302.6	164.6	63.8	28.5	2.3	1749.1	11.41
1956	994.1	866.2	288.8	179.2	86.7	29.6	1.8	2446.4	12.15
1957	1083.9	935.4	317.9	106.4	78.6	32.6	4.4	2559.2	10.52
1958	424.6	765.2	214.6	117.3	18.8	15.4	0.1	1556	11.16
1959	77.3	415.4	404.3	70.1	18.5	4.4	0.5	990.5	12.81
1960	146.5	114.2	300.6	141.1	31.4	7.2	1.6	742.6	23.82
1961	10.1	566.8	81.5	132.4	51.4	4.7	1.1	848	19.28
1962	182.6	403.9	572.9	66.3	98.1	26.4	2.4	1352.6	21.57
1963	89.9	93.9	417.4	295.1	35.5	41.3	12	985.1	18.44
1964	4.9	42.1	164.3	222.3	96.2	10.4	8.2	548.4	25.14
1965	63.3	97.4	111.8	76.5	91.6	17.6	3.3	461.5	17.56
1966	0.1	89.3	58.3	52.7	11.5	2.7	6.4	221.0	23.88
1967	0.2	149.9	948.7	192.2	36.3	38.6	2.9	1368.8	23.46
1968	0.1	188.6	207.3	496.7	59.0	12.4	0.1	964.2	20.87
1969	135.0	491.3	88.2	141.4	217.5	21.8	0.3	1095.5	16.70
1970	0.2	604.5	352.8	73.3	63.2	104.2	0.4	1198.6	18.39
1971	0.3	0.7	486.6	100.3	11.1	1.5	0.7	601.2	24.82
1972	62.6	132.7	173.1	771.4	27.2	2.5	1.2	1170.7	28.79
1973	0.5	130.0	100.9	89.2	445.3	2.2	0.3	768.4	37.52
1974	27.6	45.8	33.7	18.7	5.1	343.5	3.3	477.7	32.29
1976	0.3	30.9	1050.9	100.2	12.1	2.4	4.1	1200.9	29.77
1977	0.2	29.0	102.3	411.6	57.2	6.4	7.5	614.2	33.50
1978	38.4	790.8	102.0	89.8	227.9	14.0	1.1	1264.0	20.18
1980	0.8	139.1	687.2	130.8	315.8	165.8	64.3	1503.8	30.12
1981	200.0	228.9	335.8	715.9	64.8	116.3	22.0	1683.7	24.92
1982	696.3	600.3	602.5	283.9	337.5	48.6	65.0	2634.1	19.53
1983	15.5	17.2	1991.2	219.4	92.5	36.7	2.9	2375.4	26.82
1984	84.9	609.2	419.2	1640.7	62.1	7.0	2.1	2825.2	27.39
1985	47.7	218.3	4438.2	383.4	85.9	22.1	3.4	5199.0	27.14
1986	0.8	61.4	69.9	2664.2	403.6	25.0	22.3	3247.2	32.37
1987	34.3	51.4	256.5	51.7	2063	116.2	16.9	2590.0	35.99
1988	481.9	3864.5	1189.4	127.9	81.4	197.9	19.8	5962.8	16.39
1989	59.7	86.3	1878.1	958.8	101.4	68.3	243.6	3396.2	28.53
1990	6.5	41.1	73.1	1362.7	392.2	52.3	15.3	1943.2	33.73
1991	0.3	190.0	249.2	77.0	159.0	44.0	3.6	723.1	27.60
1992	0.4	25.5	511.8	46.3	23.2	14.6	2.3	624.1	28.20
1993	0.2	19.1	45.1	124.9	4.6	1.0	0.3	195.2	25.89
1994	11.6	45.4	183.6	295.2	47.1	1.7	0.2	584.8	26.50
Average	176.8	362.4	473.4	319.6	147.8	41.5	15.2	1536.7	22.80

On the basis of these data VPA was F_{st} and these values were calculated as the difference between the mean values of Z and M. The coefficient Z was estimated by regression of the age composition. The usual iterative procedure was next to minimize the errors arising on determining the values of F_{st}. As it was pointed out, 10 iterations of F values were performed by age group.

The mean value of M was obtained by Kutty and Quasim's method (1965). For this purpose the parameters of the von Bertalanffy's equation were estimated as follows:

$$L_\infty = 19.25 \quad t_o = -0.59142 \quad k = 0.34806$$
$$W_\infty = 73.65 \quad t_o = -2.26408 \quad k = 0.15663$$
$$n = 1.7170 \quad a = 0.3220$$

Using these data it was established that the mean value of M was 0.40. This value lies in the middle of the interval determined by Ivanov and Beverton (1985) - 0.35-0.45. We applied the value of 0.45 in the VPA analysis mainly for two reasons: the first one assumes that using Pauly's method, based also on the parameters of von Bertalanffy's function, the value of M is considerably higher, around 0.70; the second considers that Black Sea horse mackerel has a shorter life span than other representatives of genus *Trachurus* for which M values ranging around 0.40 have been estimated.

Tables 51 and 52 and **Figure 19** show the results of VPA.

TABLE 51. Number of horse mackerel (by age groups x 10^{-6} sp.)in the Black Sea during the period 1950-1995

Years	0+	1,1+	2,2+	3.3+	4,4+	5,5+	6,6+
1950	3411.86	1103.63	424.85	106.96	5.49	1.64	0.00
1951	2881.00	1764.34	554.65	221.85	40.78	1.14	0.38
1952	3967.95	1835.90	995.94	310.79	73.81	22.93	1.70
1953	4859.88	2530.00	1067.41	527.31	167.25	38.19	233.21
1954	3643.34	2460.98	1207.74	486.74	250.45	40.59	16.65
1955	4409.54	1618.50	1082.06	531.40	188.70	96.66	7.80
1956	4418.39	2259.02	655.39	454.04	210.78	70.79	4.30
1957	5891.19	2039.27	770.17	195.40	150.97	67.46	9.10
1958	4663.80	2906.20	580.49	245.66	43.49	36.20	0.24
1959	1420.27	2636.06	1255.32	203.91	66.62	13.24	1.50
1960	5885.72	844.56	1356.43	486.15	75.61	28.05	6.23
1961	3894.94	3637.04	448.70	629.60	200.05	23.97	5.61
1962	2435.39	2475.53	1873.80	222.17	297.75	87.40	7.95
1963	1424.73	1408.81	1261.29	748.94	90.04	113.63	33.02
1964	2230.18	837.48	824.18	479.98	249.39	29.96	23.63
1965	8871.59	1418.15	500.75	396.76	135.22	84.59	15.86
1966	2044.34	5606.66	827.38	231.78	193.01	17.64	41.81
1967	1119.09	1303.45	3504.25	481.56	106.55	113.99	8.56
1968	2668.53	713.40	713.10	1494.34	158.52	39.76	0.32
1969	27443.86	1707.72	314.18	293.68	572.54	55.73	0.77
1970	1102.80	17392.08	706.07	131.57	78.78	196.73	0.76
1971	833.12	703.02	10611.81	180.04	28.08	4.16	1.94
1972	1163.38	530.98	447.71	6381.93	38.43	9.32	4.48
1973	6285.72	692.36	234.84	151.57	3462.15	4.25	0.58
1974	12927.11	4007.56	339.52	71.95	29.01	1857.23	17.84
1975	11121.72	8220.83	2519.07	189.93	31.27	14.29	714.11
1976	9449.52	7067.61	4679.26	1407.51	105.27	15.78	26.95
1977	5063.50	6025.04	4482.04	2161.13	818.40	57.60	67.50
1978	9460.44	3228.47	3818.77	2776.96	1055.26	476.70	37.45
1979	3388.16	6001.84	1440.28	2354.29	1699.67	494.42	8.51
1980	4879.30	2160.15	3634.98	558.90	924.17	783.32	303.78
1981	16731.11	3110.55	1267.57	1778.89	254.05	344.14	65.10
1982	12445.08	10509.86	1802.77	545.94	581.14	111.35	148.92
1983	50195.58	7385.47	6227.35	681.56	131.15	114.41	9.04
1984	3194.44	31993.84	4695.56	2422.64	264.03	14.70	4.41
1985	3870.28	1969.72	19918.23	2663.54	316.35	119.78	18.43
1986	11795.12	2430.03	1084.04	9226.52	1396.96	134.71	120.16
1987	20783.40	7520.27	1500.89	636.04	3807.29	576.28	83.81
1988	1609.90	13224.92	4754.44	601.71	364.78	854.61	85.50
1989	1333.96	651.32	5422.28	2101.87	283.50	168.88	602.34
1990	4913.88	803.40	347.42	2000.06	602.29	102.15	29.88
1991	10641.33	3128.08	479.81	164.27	255.72	89.19	7.30
1992	8024.10	6784.97	1844.54	115.49	45.60	42.99	6.77
1993	4153.80	5116.08	4306.10	777.06	37.86	11.33	3.40
1994	1106.30	2648.42	3247.03	2709.98	397.38	20.52	2.41
1995		696.23	1652.79	1925.41	1495.47	216.31	13.13

TABLE 52. Horse mackerel fishing mortality rate (by age groups) during the period 1950-1994

Years	0+	1,1+	2,2+	3,3+	4,4+	5,5+	6,6+
1950	0.2095	0.2380	0.1997	0.5143	1.1219	0.3564	0.0000
1951	0.0006	0.1628	0.1292	0.6505	0.1258	0.3891	0.3891
1952	0.0000	0.0923	0.1449	0.1697	0.2091	0.1571	0.1571
1953	0.2305	0.2895	0.3353	0.2945	0.9659	0.3147	0.3147
1954	0.3614	0.3717	0.3710	0.4976	0.5021	0.4342	0.4342
1955	0.2188	0.4540	0.4184	0.4747	0.5305	0.4465	0.4465
1956	0.3232	0.6261	0.7602	0.6511	0.6893	0.7052	0.7052
1957	0.2566	0.8065	0.6927	1.0526	0.9780	0.8707	0.8707
1958	0.1194	0.3895	0.5962	0.8550	0.7395	0.7225	0.7225
1959	0.0698	0.2156	0.4986	0.5421	0.4149	0.5191	0.5191
1960	0.0314	0.1825	0.3175	0.4379	0.6986	0.3773	0.3773
1961	0.0032	0.2132	0.2529	0.2988	0.3781	0.2757	0.2757
1962	0.0974	0.2243	0.4671	0.4532	0.5133	0.4601	0.4601
1963	0.0813	0.0861	0.5161	0.6496	0.6502	0.5829	0.5829
1964	0.0027	0.0643	0.2811	0.8169	0.6312	0.5488	0.5488
1965	0.0089	0.0888	0.3203	0.2706	1.5867	0.2951	0.2951
1966	0.0001	0.0200	0.0912	0.3272	0.0766	0.2090	0.2090
1967	0.0002	0.1532	0.4023	0.6612	0.5357	0.5316	0.5316
1968	0.0000	0.3914	0.4388	0.5191	0.6016	0.4788	0.4788
1969	0.0061	0.4332	0.4204	0.8658	0.6183	0.6432	0.6432
1970	0.0002	0.0440	0.9165	1.0944	2.4905	1.0055	1.0055
1971	0.0004	0.0012	0.0585	1.0944	0.6525	0.5763	0.5763
1972	0.0690	0.3658	0.6331	0.1616	1.7528	0.3976	0.3976
1973	0.0001	0.2626	0.7330	0.2034	0.1728	0.9704	0.9704
1974	0.0027	0.0143	0.1309	0.3834	0.2438	0.2581	0.2581
1975	0.0034	0.1135	0.1321	0.1401	0.2341	0.1368	0.1368
1976	0.0000	0.0054	0.3225	0.0922	0.1531	0.2076	0.2076
1977	0.0000	0.0060	0.0287	0.2668	0.0905	0.1476	0.1476
1978	0.0051	0.3572	0.0337	0.0409	0.3082	0.0371	0.0371
1979	0.0001	0.0515	0.4966	0.4851	0.3247	0.4894	0.4894
1980	0.0002	0.0831	0.2646	0.3384	0.5378	0.3010	0.3010
1981	0.0150	0.0955	0.3924	0.6687	0.3749	0.5302	0.5302
1982	0.0718	0.0734	0.5227	0.9762	1.1752	0.7493	0.7493
1983	0.0004	0.0029	0.4941	0.4983	1.7383	0.4961	0.4961
1984	0.0335	0.0239	0.1170	0.5858	0.3404	0.8512	0.8512
1985	0.0154	0.1472	0.3196	0.1954	0.4037	0.2574	0.2574
1986	0.0001	0.0318	0.0832	0.4352	0.4355	0.2591	0.2591
1987	0.0021	0.0085	0.4640	0.1060	1.0440	0.2847	0.2847
1988	0.4549	0.4416	0.3663	0.3026	0.3201	0.3341	0.3341
1989	0.0571	0.1785	0.5473	0.7998	0.5708	0.6732	0.6732
1990	0.0016	0.0655	0.2990	1.6068	1.4599	0.9522	0.9522
1991	0.0000	0.0782	0.9742	0.8316	1.3332	0.8985	0.8985
1992	0.0001	0.0047	0.4145	0.6652	0.9428	0.5336	0.5336
1993	0.0001	0.0046	0.0131	0.2206	0.1625	0.1156	0.1156
1994	0.0131	0.0215	0.0726	0.1445	0.1582	0.1081	0.1081

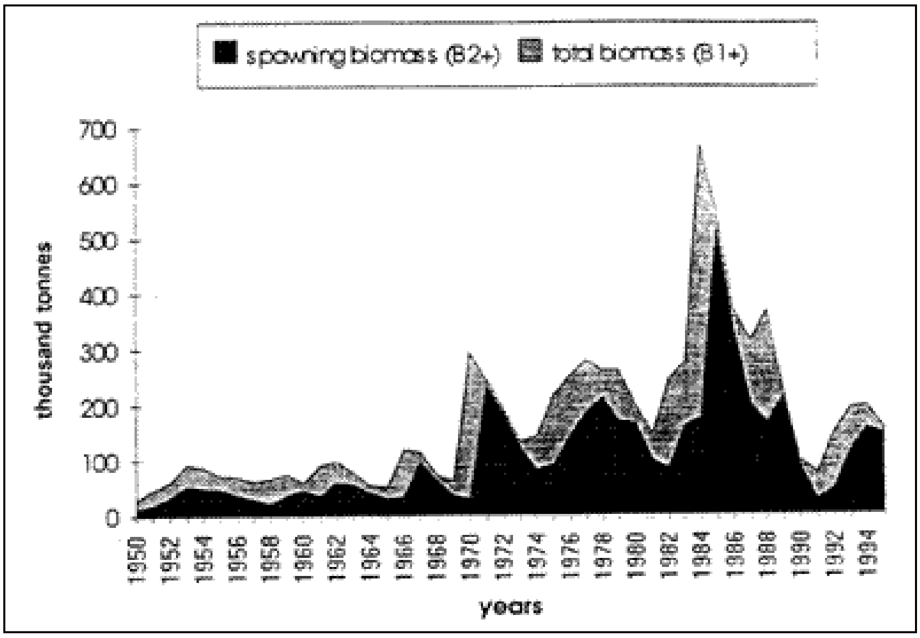

FIGURE 19. Spawning (B_{2+}) and total biomass (B_{1+}) of Black Sea horse mackerel

TABLE 53. Horse mackerel biomass (x 10^{-3} tons) in the Black Sea during the period 1950-1994

Years	(A0+)	(A1+)	(A2+)	Years	(Â0+)	(Â1+)	(Â2+)
1950	54.73	29.10	12.30	1973	180.99	133.90	123.30
1951	67.93	46.30	19.30	1974	239.60	142.70	81.30
1952	90.16	60.40	32.30	1975	300.21	216.80	91.00
1953	129.26	92.80	54.10	1976	322.77	251.90	143.80
1954	114.60	87.30	49.60	1977	317.05	279.10	186.90
1955	105.70	72.60	47.90	1978	332.26	261.30	211.90
1956	103.92	70.80	36.20	1979	287.35	261.90	170.10
1957	105.11	60.90	29.70	1980	235.70	199.10	166.10
1958	101.38	66.40	21.90	1981	272.93	147.50	99.90
1959	86.22	75.60	35.20	1982	337.29	244.00	83.20
1960	103.18	59.00	46.10	1983	650.37	273.90	160.90
1961	119.38	90.20	34.50	1984	689.52	665.60	176.10
1962	115.75	97.50	59.60	1985	573.86	544.80	514.70
1963	88.35	77.70	56.10	1986	456.90	368.40	331.30
1964	70.63	53.90	41.10	1987	471.08	315.20	200.10
1965	118.11	51.60	29.90	1988	380.61	368.50	166.20
1966	133.94	118.60	32.80	1989	234.71	224.70	214.70
1967	124.66	116.30	96.30	1990	136.14	99.30	87.00
1968	93.72	73.70	62.80	1991	154.53	74.70	26.90
1969	267.68	61.90	35.70	1992	210.03	149.80	46.00
1970	303.15	294.90	28.80	1993	224.61	193.50	115.20
1971	250.18	243.90	233.20	1994	206.24	197.90	157.40
1972	202.47	193.70	185.60	1995		156.50	145.89

It is apparent that during the period under consideration, both the total and spawning biomasses varied widely, owing to the different strength of the new year classes. These have ranged during the period 1950-1959 from 1420.27 x 10^6 (1959) to 5891.19 x 10^6 (1957) by number of specimens. During the same period, the total (B0+) and spawning (B2+) biomasses have ranged from 54.7 (1950) to 129.3 (1953) thousand tonnes, and from 12.3 (1950) to 54.1 (1953) thousand tonnes, respectively. In the next decade (1960-1969) these biomasses varied from 76.6 (1964) to 267.9 (1969) and from 29.9 (1965) to 96.3 (1967) thousand tonnes, respectively. It is clear that there is no coincidence between the total and spawning biomasses due to the wide fluctuation in the strength of year classes. Thus, for instance, the size of the total biomass in 1969 was determined by the strong 1969 year class - 27443.83 x 10^6 (numbers). During the next three years the new year classes were weak, especially that of 1971 (833.12 x 10^6). As a result, the total stocks declined from 303.2 (1970) to 181.0 (1973) thousand tonnes. Subsequently, they increased to 332.3 (1978) thousand tonnes. In the late 1970s and the beginning of the 1980s (till 1982 included), the total biomass ranged from 235.7 (1980) to 337.3 (1982) thousand tonnes. In 1983 and 1984 the indicated biomasses grew to 650.4 and 689.7 thousand tonnes. The reason was the very strong 1983 and 1984 year classes, especially the first one, with an extreme value of 50195.58 x 10^6 specimens. However, the next two year classes (1985 and 1986) were weak, resulting in a decline in the total biomass, because of a rise in the spawning biomass that reached its maximum value in 1985 - 514.7 thousand tonnes. The successive 1986-1987 year classes were relatively strong (over the average) and the total and spawning biomasses remained comparatively high - 456.9-471.1 and 313.3-200.1 thousand tonnes, respectively. Weak successive 1988-1989 year classes - 1609.90 x 10^{-6} and 1333.96 x 10-^{6} caused a sharp decline in the total and spawning biomasses -136.1-154.5 and 87.0-26.9 thousand tonnes in 1990 and 1991, respectively. The 1991-1993 year classes varied between 4153.80 x 10^6 (1993) and 10641.33 x 10^6 (1991) as a result of which the total and the spawning biomasses increased to 224.6 and 115.2 (1991) thousand tonnes, respectively. The last 1994 year class was very weak - 1106.3 x 10^6 specimens. As noted, the estimation of year class strength during the last 1-2 years, has been quite difficult, and the errors are probably higher. Nevertheless the spawning biomass seems to remain at the level of 1994 and even it has dropped from 157.4 to 145.9 thousand tonnes. If the estimated abundance of 1994 year class does not differ seriously from the real value it can be expected that the exploited stock (B1+) will continue to decline from 197.9 to 156.5 thousand tonnes. As was pointed out, the accuracy of the assessments depends exclusively on the fishery statistical data. Therefore, the lack of information on horse mackerel catches, or its underestimation by Russia, Ukraine, Georgia, Romania and Bulgaria enhances the risk of an incorrect assessment of biomasses. For example, according to Turkish data, the catches in 1994 were threefold higher than in 1993.

As is the case with anchovy catches, Turkish catches of horse mackerel are taken primarily in winter when the species has an almost sedentary pattern of life, and forms dense concentrations on the wintering grounds. This makes the fishery more effective, and raises the possibility of harvesting larger amounts of fish, for the same stock size.

The improvements of fishing gears and the application of modern echo-acoustics further contribute to a more effective fishery. However, this has an immediate effect on the fishing mortality (**Table 52**). When the level of the horse mackerel stock was low, even small catches caused higher fishing mortality, and vice versa. For example, during 1956-1958, catches varied between 17.370 and 29.735, (on average 24.675 thousand tonnes), and the mean value of $F_{2\text{-}6}$ varied from 0.7022 to 0.8929; averaging 0.7271. In 1985-1988, the period when this species biomass was higher, catches of the order of 93.741-141.078 thousand tonnes caused a fishing mortality in the range 0.2867-0.4367 (average 0.3373). All this stresses the necessity of annual assessments of stock size, of TAC's, as well as of clarifying the causes (natural and anthropogenic) determining fluctuations in year class strength. This problem will be discussed later when the data on year class abundance of horse mackerel, anchovy, sprat, whiting and others species considered, will be juxtaposed to those of the environmental parameters which influence the trophic capacity of the Black Sea. This is of vital importance, since in most cases, the spawning biomass of the fish species concerned have less effect on the recruitment than has the environment, especially after eutrophication and the invasion of a number of new species, most importantly, the ctenophore *Mnemiopsis*. It is not unlikely that new species experience a period of adaptation to the current environmental conditions, such that after some years, they do not cause population outbursts that could further disrupt the balance that the Black Sea ecosystem is striving for.