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DYNAMICS OF THE SETTLEMENT OF THE BIVALVE MYA ARENARIA L.ON THE ROMANIAN SHORE OF THE BLACK SEA

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ABSTRACT

A number of 327 samples collected in 1972 between Constanța and Sulina from depths between the sea shore and 30 meters provided data for establishing the qualitative and quantitative distribution of the bivalve Mya arenaria on the Romanian shore of the Black Sea. Comparison of 1972 data with those obtained in previous years showed that the settling of Mya at the Romanian coast was not a completed process.

Penetration of the Corbula biocenosis by Mya involved no essential qualitative or quantitative alterations in the a-boriginal malacofauna, the settling of this further bivalve bringing about an increase in the biological output of the sites it occupied.

Penetration by and settlement of Mya arenaria in a very short lapse of time in the Black Sea - a biological phenomenon of a high practical and theoretical value - required complex research activities for understanding the species ecology and for estimating prospective commercial exploitation of the species under its new life conditions.

As a faunal element newly settled in the Black Sea, Mya arenaria made the object of several investigations meant primarily to establish the qualitative and quantitative distribution of this species in the different areas of the Black Sea north-west zone.

All published papers on the presence of Mya arenaria in the Black Sea (BESHEVELY & KOLYAGYN, 1967; GOMOIU & PORUMB, 1969; IVANOV, 1969; PETRAN & GOMOIU, 1972; SAVCHUK, 1969, 1970; ZAMBRIBORSCH, MARCHENKO & TELEGIN, 1968) reported its presence at depths less than 10 m, on sandy and muddy-sandy beds. IVANOV himself, 1969, with all his round 3,200 samples taken from 800 stations uniformly distributed throughout a vast area north of the line from the Danube Delta to Cape Tarkhan, at depths to 50 m found no specimens of Mya arenaria, except for three restricted shallow sectors covering only 90 sq.km. However, the literature records Mya at depths of as much as 90 meters (HAAS, 1926).

In 1971, on examining several samples of benthos collected from a strip laying between the 10 m and 50 m isobaths off the Romanian continental shelf, we established the occurrence of this bivalve on bottoms more than 30 to 32 m in depth. The results of our 1971 research enabled us to state that the settling of Mya arenaria on the Romanian coast was still going on and even expanding towards both the shallow and the deep water areas (PETRAN & GOMOIU, 1972).

Resuming in 1972 our investigations of 1970 and 1971 on the presence of the bivalve Mya arenaria on the Romanian coast, the results of which had been partially reported (PETRAN & GOMOIU, 1972; GOMOIU & PETRAN, 1972), our attention was focused on the following activities:

- checking on the qualitative and quantitative state of the Mya population in the shallow waters (less than 10 m depth) investigated by us in 1970 and 1971 and determining several elements of the species dynamics ;

- prospecting the zones between the 10 and 30 m isobaths in order to obtain some knowledge of how Mya populations expanded to deeper waters.

In this paper we present the results of our 1972 investigations in answer to the questions mentioned above, together with 1971 results relevant to the qualitative and quantitative changes occurred in the psammobiont mollusk population from Corbula biocenosis following settlement of the bivalve Mya arenaria.

Material and techniques

In 1972, the littoral zone was investigated down to depths of 30 meters, between the latitudes of Sulina and Constanța, involving an area of some, 1,765 sq. km. 88 sampling stations were dealt with, dispersed over 11 profiles intersecting the respective zone (Table 1).

In 1972, the checking on the qualitative and quantitative Mya population was carried out on only 11 profiles out of a total 23 done in the previous years (PETRAN & GOMOIU, 1972). In order to facilitate the comparison between the results throughout the years concerned, Table 1 gives the corresponding profile numbers from 1972 as against those from 1970 and 1971. For each of the profiles, sampling and observation stations were

made at depths of zero; 1.5; 3.0; 4.0; 9.0; 15.0; 22.0; and 30.0 meters. Between the sea shore and the line of 15.0 meters depth, the sampling was done by diving (PETRAN & GOMOIU, 1972), and from 15.0 to 30.0 meters a Van Veen-type grab (1/20 sq. m) and a dredge were used.

Table 1

Profiles of the Romanian sea shore on which sampling stations were carried out in 1972 in order to determine the qualitative and quantitative distribution of the Mya arenaria bivalve

Profiles:	Site :	Date of sampling:	Corresponding profile number in the 1970 and 1971) ^{x)} investigations:
I	Impușita (45°05' N)	02.08.1972	I
II	Sud Roșuleț (44°59' N)	02.08.1972	IV
III	Sf. Gheorghe (44°53' N)	02.08.1972	VI
IV	Ciotic (29°29' E)	01.08.1972	IX
V	Zăton (29°21' E)	01.08.1972	XI
VI	Perișor (29°17' E)	01.08.1972	XII
VII	Portița (44°41' N)	01.08.1972	XVI
VIII	Sud Periboina (44°35' N)	31.07.1972	XVIII
IX	Chituc (44°29' N)	10.08.1972	XX
X	Nord Cap Midia (44°23' N)	10.08.1972	XXII
XI	Mamaia sat (44°17' N)	10.08.1972	XXIII

x) See the map in PETRAN and GOMOIU (1972)

On most of the sampling stations, 4 to 5 samples were picked up at 1 to 2 meters apart from one another, which got us in 1972 327 samples containing 5.923 specimens of Mya arenaria.

The 1971 samples commonly processed in order to get some qualitative and quantitative knowledge about the malacofauna in the fine grain sand zones where Mya settled (BACESCU & all., 1965, 1967; PETRAN & GOMOIU, 1972) were collected with a Van Veed grab (1/20 sq. m.) On these samples we shall deal in some detail when discussing the results.

Results discussion

It should be mentioned from the beginning that all the results obtained from our studies in 1972 on the Mya arenaria bivalve proved that this species, after only 10 years of existence in the Black Sea, has developed from a poor and randomly distributed population covering a reduced area between the 4 to 8 meters isobaths (GOMOIU & PORUMB, 1969) to become a common element on all alluvial bottoms to depths of 30 meters in the Romanian littoral waters.

The active settling of Mya detected in 1970 and 1971 (PETRAN & GOMOIU, 1972) continued with marked intensity in 1972, when there were registered both significant quantitative changes of this population and modifications in the species area of distribution.

The analysis of density and biomass values of Mya samples collected from various sectors of the Romanian littoral in 1972 (Table 2) provided us with data for establishing the present qualitative and quantitative state of the population of this species.

At shallow depths to 3 meters in the open sea, we found in 1972 Mya populations much better settled than in the previous years (maximum density and biomass values recorded were 4,360 individuals on the square meter and 943.6 g/sq. m.) Since 1970 those areas were minutely investigated through diversings and continuous observation carried out from the line of 3.0 m depth to the shore, but only in 1971 and only on the 1.5 m isobath at Mamaia was a young Mya population discovered (300 indiv./sq. m., and 1.20 g/sq. m. with individual average lengths of 13.9 mm). This population was extinct by 1972 and was replaced by a new generation, with individual average lengths under 20 mm (Table 3), which settled in two main zones.

The first (Zăton - Perișor) zone (profiles V and VI) was rather poor in population (336 indiv./sq. m. average density and 51.8 g/sq. m. average biomass value), consisting in 60 per cent individuals under 10 mm in length and 40 per cent individuals between 10 and 20 mm in length (average length was 9 mm).

In the second, north zone (extending from cape Midia to Mamaia) (profiles X and XI), at 1.5 m depth, Mya was very abundant (average values of 3,332 indiv./sq. m. and 661.5 g/sq. m.), with 40 per cent individuals having up to 10 mm length and 60 per cent individuals with lengths ranging from 10 to 20 mm (average length 11 mm).

The Mya populations established in the sheltered zones of the Cape Midia, Tomis, and Mangalia harbours, living at very small depths of a few centimetres only, were not taken into account in 1972. However, on the basis of some probing observations, we came to the conclusion that those populations were still prosperous by 1972. For instance, the survey made on Mya population at Cape Midia harbour, a zone from which we usually collect samples for physiological and biochemical laboratory experiments, showed that Mya had not been subjected to significant qualitative or quantitative changes as in the previous years. The Cape Midia population consisted of all ranges of individual lengths (Table 5), but big sized

Table 2

Densities (indiv./sq. m.) and biomass (g/sq. m.) of the bivalve Mya arenaria detected in 1972 on the Romanian Black Sea coast.

Profile Nr.	1,5 m		3 m		4 m		9 m		15 m		22 m		30 m	
	ind/m ²	g/m ²	ind/m ²	g/m ²	ind/m ²	g/m ²	ind/m ²	g/m ²	ind/m ²	g/m ²	ind/m ²	g/m ²	ind/m ²	g/m ¹
I	-	-	2788	796,4	946	337,6	-	-	50	216,5	100	109,0	10	11,0
II	-	-	3550	976,0	2043	484,1	2520	246,4	60	230,0	10	43,0	40	157,0
III	-	-	4312	1155,5	4306	896,7	-	-	40	193,0	30	86	30	178,0
IV	-	-	3640	1192,8	560	92,4	140	1093,0	540	1043,0	50	129,0	290	615,5
V	364	37,8	412	40,9	5880	826,7	2520	246,4	150	515,0	10	16,0	-	-
VI	308	65,8	4048	1439,8	9198	1397,9	330	651,0	482	1070,8	50	94,0	-	-
VII	-	-	5768	1495,2	8036	1243,9	21	23,6	314	553,7	490	490,0	210	537,0
VIII	-	-	-	-	11990	562,0	56	495,6	30	71,0	37	79,0	10	3,5
IX	-	-	308	33,6	420	1350,3	81	529,8	-	-	-	-	-	-
X	4368	943,6	7532	1066,8	1960	1560,3	280	346,3	4060	341,0	40	208,0	10	265,0
XI	2296	379,4	90	2453,0	834	1484,5	1575	516,0	1070	93,0	10	52,0	-	-

Table 3

Length class structure of Mya arenaria population sampled on the Romanian Black Sea coast in 1972

Profile nr.	Depths (meters)	Number of individuals examined	Length class (in mm) structure per cent									Average length (mm)
			< 10 %	+ 10 %	+ 20 %	+ 30 %	+ 40 %	+ 50 %	+ 60 %	+ 70 %	+ 80 %	
I	30	1	-	-	100	-	-	-	-	-	-	25,0
	22	10	-	-	100	-	-	-	-	-	-	25,0
	15	6	-	17	50	33	-	-	-	-	-	26,6
	4	33	6	84	4	4	2	-	-	-	-	17,2
	3	100	7	86	2	3	2	-	-	-	-	15,7
	0	15	-	-	-	-	27	33	40	-	-	56,3
II	30	4	-	-	75	-	25	-	-	-	-	30,0
	22	1	-	-	100	-	-	-	-	-	-	25,0
	15	8	-	12	25	63	-	-	-	-	-	30,1
	9	90	53	47	-	-	-	-	-	-	-	9,7
	4	25	-	-	28	52	20	-	-	-	-	34,2
	3	127	9	88	1	2	-	-	-	-	-	14,6
0	190	-	93	-	-	1	2	2	1	1	18,4	
III	30	3	-	-	33	67	-	-	-	-	-	31,7
	22	3	-	-	66	34	-	-	-	-	-	28,4
	15	4	-	25	75	-	-	-	-	-	-	22,5
	4	344	17	83	-	-	-	-	-	-	-	13,3
	3	154	10	90	-	-	-	-	-	-	-	14,0
	0	50	-	-	-	-	12	22	-	54	12	68,2

Table 3 - continued -

IV	30	29	-	8	75	17	-	-	-	-	-	25.9
	22	5	-	-	80	20	-	-	-	-	-	29.0
	15	54	-	12	76	12	-	-	-	-	-	25.0
	9	14	-	-	-	64	36	-	-	-	-	38.6
	4	20	35	65	-	-	-	-	-	-	-	11.5
	3	130	6	93	-	-	1	-	-	-	-	14.7
	0	105	-	6	3	25	26	19	12	9	-	47.1
V	22	9	-	-	11	22	67	-	-	-	-	40.6
	15	15	-	-	47	53	-	-	-	-	-	30.3
	9	90	53	47	-	-	-	-	-	-	-	9.7
	4	420	20	80	-	-	-	-	-	-	-	13.0
	3	18	-	-	22	44	27	7	-	-	-	37.6
	1, 5	13	84	16	-	-	-	-	-	-	-	6.6
	0	93	-	-	10	51	10	4	19	6	-	43.9
VI	22	18	-	18	32	50	-	-	-	-	-	28.2
	15	11	36	64	-	-	-	-	-	-	-	11.4
	9	33	-	12	88	-	-	-	-	-	-	23.8
	4	655	21	79	-	-	-	-	-	-	-	12.9
	3	88	7	93	-	-	-	-	-	-	-	14.3
	1, 5	11	36	64	-	-	-	-	-	-	-	11.4
	0	310	-	87	2	1	-	6	3	1	-	19.9

(Table 3 - continued)

Profile nr.	Depths (meters)	Number of individuals examined	Length class (in mm) structure per cent									Average length (mm)
			< 10 %	+ 10 %	+ 20 %	+ 30 %	+ 40 %	+ 50 %	+ 60 %	+ 70 %	+ 80 %	
VII	30	21	-	-	86	14	-	-	-	-	-	26,4
	22	49	-	10	86	4	-	-	-	-	-	24,4
	15	73	-	1	88	11	-	-	-	-	-	22,5
	9	214	-	-	75	25	-	-	-	-	-	27,5
	4	574	90	9	-	-	-	1	-	-	-	6,4
	3	206	37	63	-	-	-	-	-	-	-	11,3
	0	66	-	-	-	2	-	12	47	15	24	69,5
VIII	30	1	• -	100	-	-	-	-	-	-	-	15,0
	22	32	-	-	53	41	6	-	-	-	-	30,3
	15	3	-	-	100	-	-	-	-	-	-	25,0
	9	2	-	-	-	50	50	-	-	-	-	40,0
	4	1199	93	7	-	-	-	-	-	-	-	5,7
	0	10	-	1	7	36	52	2	1	1	-	40,4
IX	9	29	-	-	10	48	38	4	-	-	-	38,6
	4	15	-	-	34	36	-	-	-	-	-	31,6
	3	11	100	-	-	-	-	-	-	-	-	5,0
	0	97	-	1	12	36	28	22	1	-	-	40,0

Table 3 - continued -

X	30	1	-	-	-	-	-	100	-	-	-	55,0
	22	4	-	-	50	25	25	-	-	-	-	32,5
	15	203	100	-	-	-	-	-	-	-	-	5,0
	9	10	-	-	100	-	-	-	-	-	-	25,0
	4	70	-	100	-	-	-	-	-	-	-	15,0
	3	267	-	100	-	-	-	-	-	-	-	15,0
	1,5	156	-	100	-	-	-	-	-	-	-	15,0
0	170	-	2	9	23	31	28	7	-	-	-	44,5
XI	22	1	-	-	-	100	-	-	-	-	-	35,0
	15	107	100	-	-	-	-	-	-	-	-	5,0
	9	63	16	79	5	-	-	-	-	-	-	13,9
	4	36	16	69	3	3	3	3	3	-	-	17,8
	3	9	-	-	-	11	-	11	67	11	-	61,7
	1,5	62	80	20	-	-	-	-	-	-	-	7,0
0	70	-	1	26	26	30	11	3	3	-	39,5	

individuals were generally numerically dominant. During the spring months of 1972 (March and April) the individuals smaller in size (20 to 30 mm in length) were more numerous, whereas during the summer and autumn months those of bigger size (30 to 40 mm and 40 to 50 mm length) were dominant. It seemed that the hard winter of 1971/1972 and particularly the heavy frost of January-February 1972 did not affect really those populations. In more recent times, amateur fishermen found Mya flesh to be an excellent bait for the fish and as a consequence these bivalve populations from the sheltered zones are more and more often disturbed.

In 1972, the whole zone ranging in depth from 2 to 10 meters was taken over, with few exceptions, by Mya arenaria. Out of the 33 sampling stations in this area, Mya was absent in only three. The bivalve's absence from the 3 m isobath in Periboina zone (profile VIII) cannot be easily explained. Here Mya was represented in 1970 and 1971 by growing individuals (average length 28 mm in 1970 and 41.6 mm in 1971) with rather small densities (448 and 169 indiv./sq. m. respectively), but quite large biomass values (1,980 and 1,722 g/sq. m. respectively). It may be that during the autumn storms of 1971 the whole Mya population was shifted from the substrate and washed down on the shore. The average length of Mya individuals sampled out from 3 m depth in 1971 was very close to that of the ones collected in 1972 from the thanatocenosis of the beach in the same area (41.6 mm and 40.4 mm respectively), proving that the two analyzed samples represented the same population.

It is probable that the storms in the fall of 1971 affected Mya populations settled in Romanian shallow waters (3 to 4 meters) destroying and drifting them out to the shore. The big sized Mya individuals were the first to suffer the damaging consequences of the storms by being washed down on the beach, a phenomenon already reported on the Romanian coast for the mollusks (GOMOIU, 1968; PETRAN & GOMOIU, 1972). Thus, in 1972, most of the Mya population found at 3 to 4 meters depth zones was made up by small sized individuals (Table 3 - average length 65.0 to 34.2 mm), i.e. only those originated from the last 1971 generation, with some of the 1972 generation mixed in, all the big size individuals being absent.

The damaging action of the storms resulting in digging up sediments and shifting the Mya population out of the substrate was observed when we scanned the Mamaia beach (profile XI) after a several days long storm in November 1971. Thus, out of a beach strip 2,800 meters long and 10 meters wide, with an area 80 per cent covered with shells laid down by the storm, we collected all Mya individuals found on a 2,500 square centimetres area. The size class structure of the picked up population indicated the predominance of big sized individuals (almost 75 per cent belonged to a length class over 50 mm, i.e., the average individual length was 50 mm). Their estimated number and weight showed that after a storm, on a rather narrow beach strip, more than 27 million Mya individuals could be washed ashore, with a biomass reaching up to nearly 644 tons.

Similarly, it is rather difficult to account for the absence of

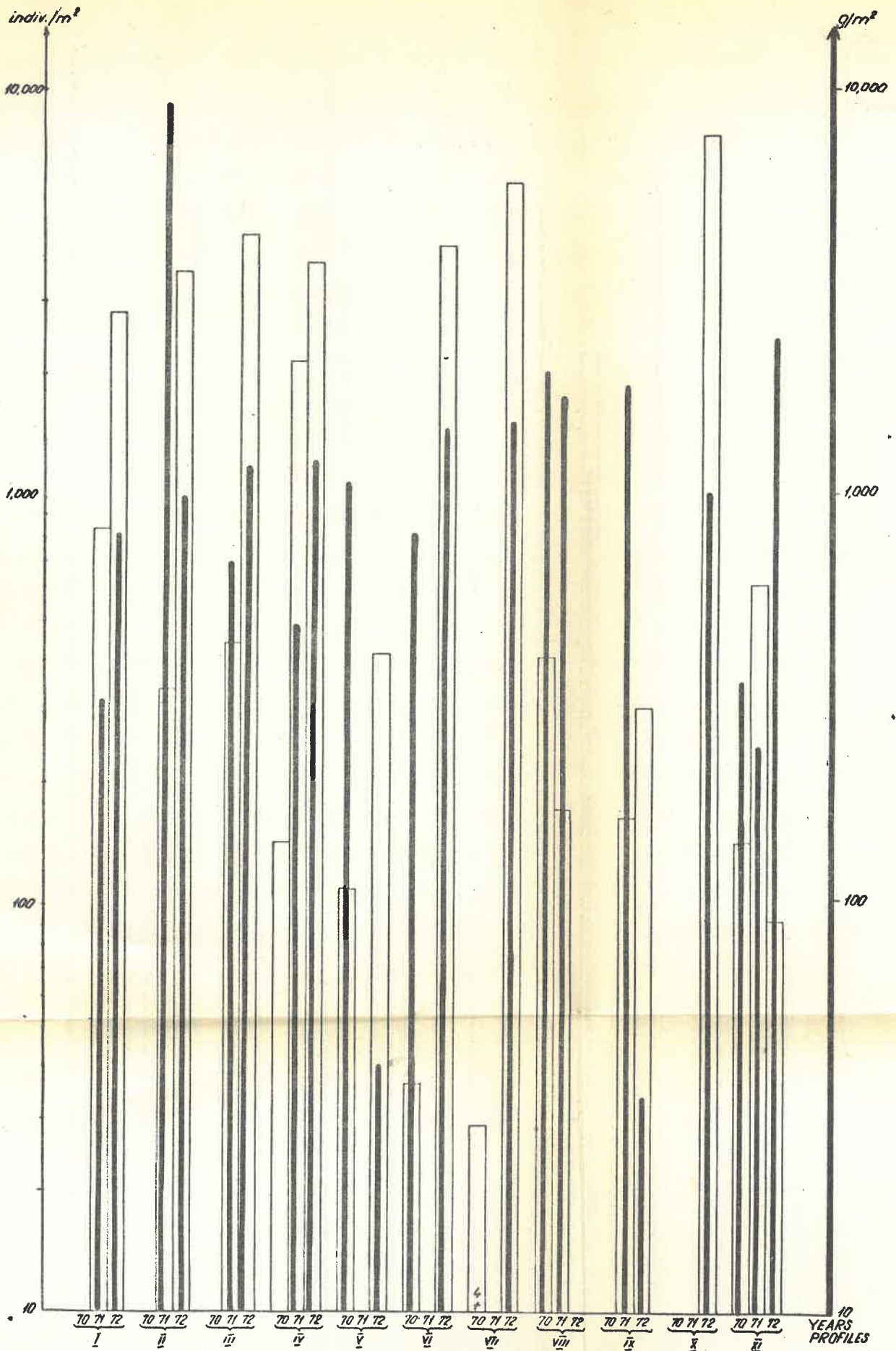


Fig. 1 - Densities and biomass values variation from 1970 to 1972 of the bivalve *Mya arenaria* found at different sampling stations on the 3 meters isobath off the Romanian coast

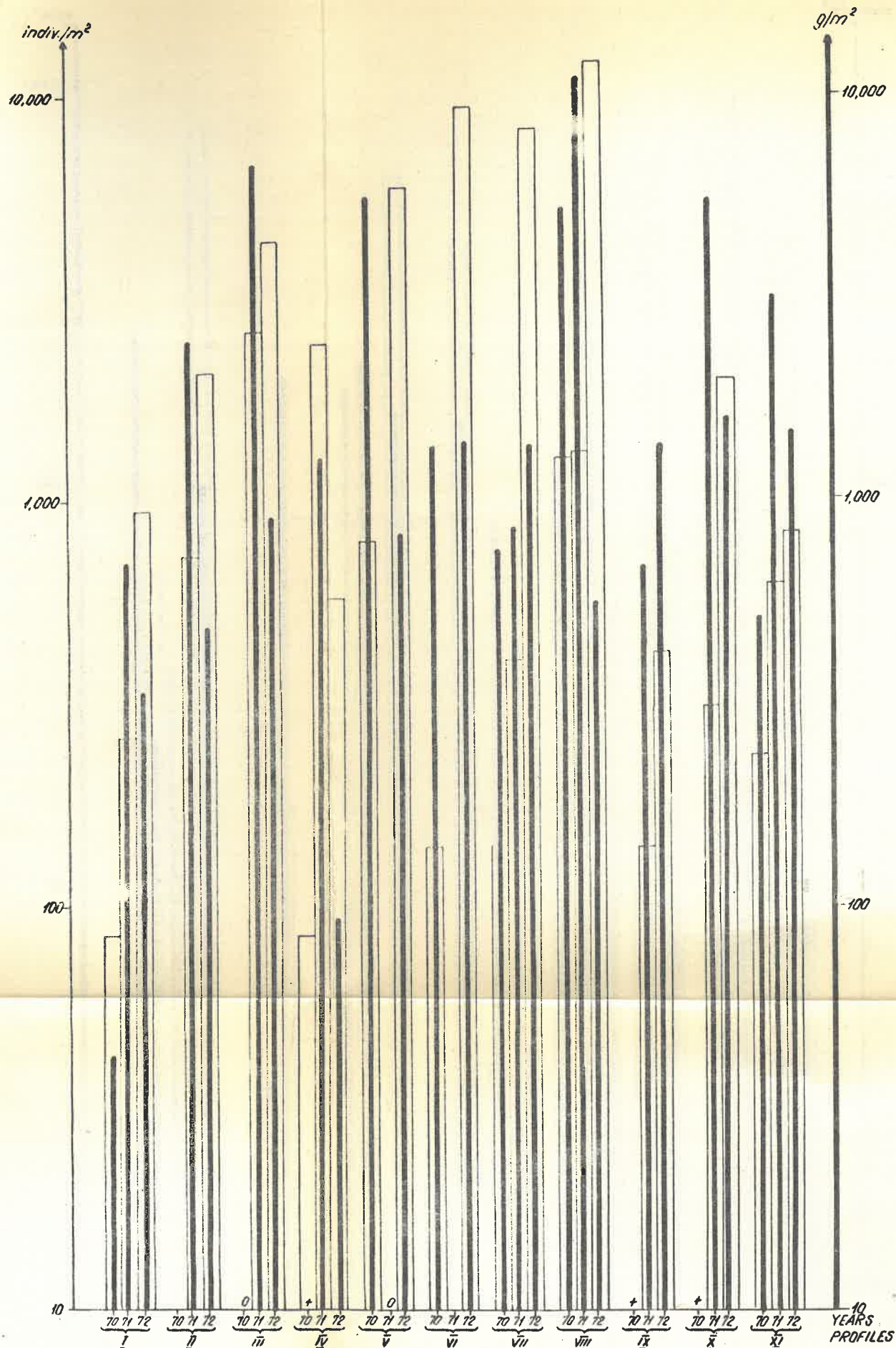


Fig. 2 - Densities (indiv./sq. m.) and biomass (g/sq. m.) values variation from 1970 to 1972 of the bivalve *Mya arenaria* found at different sampling stations on the 4 meters isobath off the Romanian Black Sea coast

Mya from the samples collected in two stations at 9 meters depth at the Danube mouths zone (Profiles I - Sulina and III - Sfintu-Gheorghe). In 1970 and 1971, particularly in 1971, on profile I Mya was found in relatively large quantities (in 1971 1,075 ind./sq. m. and 289.0 g/sq. m., the population consisting of small size individuals - 93 per cent of these comprised in the 10 to 20 mm length class). At the station on profile III only a few small Mya individuals were reported in 1971 (under 10 mm length) It is probable that all those populations of small size specimens of the year's generation could not survive high turbidity conditions and the intensive alluvial depositing process going on in the immediate vicinity of mouths Sulina and Sfintu-Gheorghe. We believe therefore that in this zone Mya will never develop steady populations, the young stages of its development having not the necessary ambient conditions to mature.

By further analysing Mya abundance in 1972 in comparison to previous years at depths from 3.0 to 9.0 meters we found a non-uniform quantitative distribution in time and space of the species.

In the area of the 3 m isobath, the settlement of Mya was completed in 1972 when maximum densities reached 7,532 indiv./sq. m. From 1970 to 1972 densities gradually increased (table 4), with few exceptions the populations always being made up of small size specimens (table 3). In 1970, Mya was completely missing on the 3 m depth line in the Danube mouths zone, but in 1971 it appeared again with relatively low densities (up to 816 indiv./sq. m.) to develop exuberantly (up to 4,312 indiv./sq. m.) in 1972 (fig. 1).

In the sheltered zone Sakhalin-Perisor (profiles IV to VI) Mya occurred irregularly in reduced numbers between 1970 and 1971, but in 1972 it was well represented by young populations (reaching in some instances densities over 4,000 indiv./sq. m.).

In the median zone of the Romanian coast (profiles VII to XI) in 1972 Mya was well represented on the 3 m depth line, especially by small size individuals, high densities following then the low ones or even Mya absence in previous years (figure 1).

Young populations of Mya being established on the 3 meters depth line (Table 3), biomass values are generally proportional to densities.

For the 4 m isobath, Mya densities increased with few exceptions from 1970 onwards (Table 4), reaching in 1972 the maximum value of 11,990 indiv./sq. m. (profile VIII) (fig. 2).

The less abundant populations found in 1970-1971, generally consisting of big and medium size individuals (which gave biomass values up to 10,940 g/sq. m. in profile VIII), were replaced by 1972 by younger generations, most of the individuals belonging to the 10 to 20 mm length class (giving rather low biomass values - maximum 1,560.30 g/sq. m., profile X) (Table 4).

Mya highest densities in 1972 on the 4 m depth line occurred in the Zaton - south Periboina zone (profiles V to VIII), where in previous years the bivalve was also very abundant (PETRAN & GOMOIU, 1972).

Table 4

Minimum, average, and maximum values of densities (indiv./sq. m.) and biomass (g/sq. m.) of the bivalve Mya arenaria off the Romanian sea coast registered at various depths in 1970-1972.

Depths:	1 9 7 0		1 9 7 1		1 9 7 2		
	indiv./m ²	g/m ²	indiv./m ²	g/m ²	indiv./m ²	g/m ²	
3 m	Minimum	28	4,00	160	240.00	90	33,60
	Average	82	384,07	418	1,308,27	2,950	968,00
	Maximum	448	1,980,00	2,088	9,121,00	7,532	2,453,00
4 m	Minimum	2	2,50	140	686,00	420	92,40
	Average	248	1,241,00	765	2,937,82	4,161	930,00
	Maximum	1,260	5,681,00	2,560	10,940,00	11,990	1,560,30
9 m	Minimum	28	2,50	13	5,00	21	23,60
	Average	1,053	734,18	827	1,443,09	684	377,00
	Maximum	8,418	2,359,80	3,960	5,855,00	2,520	1,093,00

It should be added that on both the 3 m and the 4 m depths lines, the medium and maximum values of Mya densities were steadily increasing from 1970 to 1972, when the maximum values were registered for the Romanian sea coast. Owing to the fact that in 1972 Mya populations were made up of small size individuals (Table 3), biomass values of the bivalve were much lower that year than in the previous years (fig. 3).

On the 9 m isobath strip of the Romanian littoral waters, Mya arenaria populations were less abundant than in the smaller depth range (3 to 4 meters) discussed above (Table 2). It is worth noting that in 1972 overall average Mya densities and biomass values (and extreme values too) for the 9 meters depth strip were much lower than in 1970 and 1971 (Table 4). However, considering the data resulted from each of the 11 stations sampled out on the 9 m bathymetric curve, in 1972 Mya was found missing in 2 sampling stations (as shown above), numerically more abundant in 6 further sampling stations and less abundant in only three of them, in comparison to previous years results. Increment or decrement in density and biomass values in Mya in 1972 was uneven along the 9 meters depths in the Romanian coastal waters; moreover, biomass changes were not proportional to density alterations within the same station. Thus, in 1972, densities were 2 to 194 times higher than in 1971, and biomass values increased from 6,6 to 103 times as compared to 1971; densities decreased from 12 to 90 times as against 1971. A particular case occurred in profile V, where in 1972 densities were almost twofold those in 1971, while the biomass was 7 times lower. Seemingly, the population of 1971, made up of 10 to 30 mm length class individuals (average length being 17.60 mm), was extinct and completely replaced by the new generation

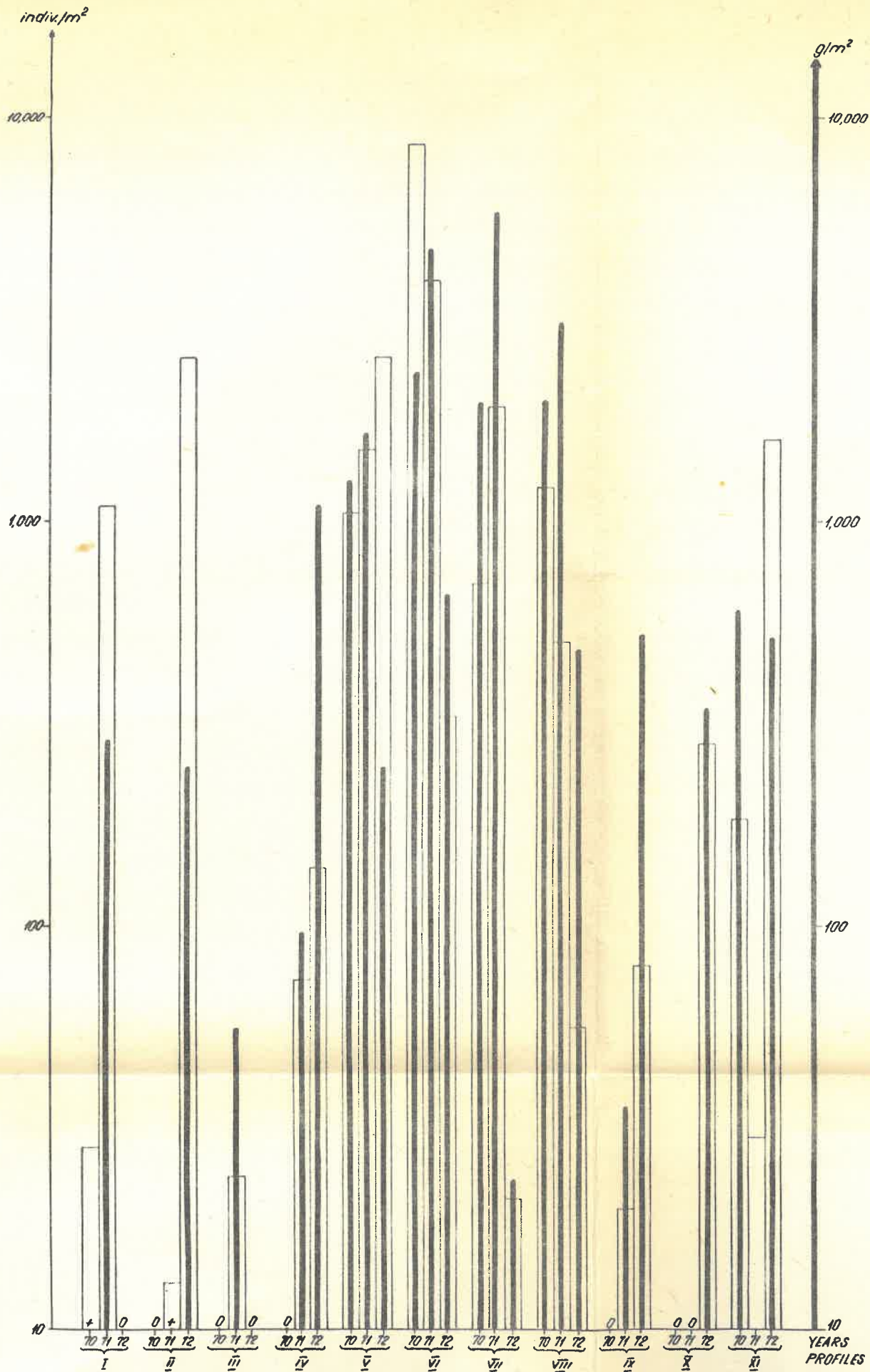


Fig. 3 - *Mya arenaria* bivalve density (indiv./sq. m.) and biomass (g/sq. m) values variation from 1970 to 1972 in different sampling stations on the 9 meters depth isobath off the Romanian Black Sea coast

of 1972, which was made up of individuals of the length class under 20 mm (9.70 mm average length).

Of the remaining Mya population on the 9 meters depth strip, the last 1971 generation were found also in 1972. Thus, the average length of Mya individuals in 1972 was 25.20 mm, but in 1971 it was only 18.85 mm. The examination of the results given by the different sampling stations showed that in one year only Mya had grown in length with 20 mm average value.

Mya distribution in the Romanian sea coastal waters between the 10 and the 30 meters isobaths was for the first time investigated by us in 1972. The bivalve's densities and biomass values were rather low (Table 2) and unevenly distributed in the zone. In 6 out of 33 sampling stations Mya was missing altogether.

Firstly, the bivalve was not found on the whole profile IX (Chituc). We consider that the absence of the species in this area is due to the fact that the substrate, represented by coarse and heterogeneous sands mixed with dead shells of mollusks (Cardium, Spisula, Chione, Corbula, Paphia, Nassarius, etc.) (GOMOIU, 1969) is not convenient for the settling of Mya.

Secondly, Mya was missing in some of the 30 meters depth sampling stations, which showed that the species further distribution towards deeper waters was developing non uniformly.

Generally, Mya abundance decreases with the growing depths. Thus, average densities and biomass values, plotted against depth values were as follows : 618 indiv./sq. m and 393 g/sq. m at 15 m depth ; 75 indiv./sq. m, and 119 g/sq. m at 22 m depth ; 54 indiv./sq. m, and 161 g/sq. m at 30 m depth.

Further south, in Mamaia-Cape Midia zone (profiles X to XI), Mya established itself in 1972 on the 15 meters depth strip, its population being made up of under 10 mm long individuals (Table 3) with very high densities (up to 4,060 indiv./sq. m.) and low biomass values (up to 341 g/sq. m.).

On the 22 meters isobath, Mya occurred regularly, but in small numbers. Maximum densities and biomass values were registered on profile VII (490 indiv./sq. m. and 490 g/sq. m.). Similarly as for the 15 m isobath strip, the one year old specimens from the 1971 generation were predominant on the 22 m depth line.

At 30 meters depth, Mya settled unevenly. Its densities were rather low, the maximum value hardly reaching 290 indiv./sq. m. The populations were made up of small size individuals (10 to 30 mm length) and only exceptionally bigger individuals were found in a few places. In comparison to the populations settled at 22 meters depth, where an average of 10 per cent individuals belonged in the 40 to 50 mm length class, on the 30 meters isobath strip, 18 per cent of the individuals were exceeding 40 mm in length. This population length class structure accounted for the higher biomass values at 30 meters depth, although densities were lower than at 22 m depth.

On the strip between 10 and 30 meters isobaths, Mya settled

massively first in 1971-1972 as it was proved - as mentioned above - by the length class structure of the population found (generally the average Mya individuals length was less than 30 mm - Table 3). But still, survival of the younger Mya population registered in 1972, normal size and maturation of the individuals are rather doubtful since the substrate found here, mostly silt, is not a favourable factor for the species' subsequent development.

The fact that no empty Mya valves but only alive individuals were found at those depths led us to the conclusion that the populations registered in 1972 were mostly newcomers to the zone. Our investigations till 1970 had shown no evidence of the occurrence of Mya in the deeper waters off the Romanian sea coast. Therefore, it is to be considered that, as long as the environmental circumstances are the silt substrate of the deep bottom, Mya will not be able to form abundant mature populations. Year by year, the bivalve larvae brought by waves and currents from the shallow waters will form abundant young populations, whose lives will not exceed 2 or 3 years.

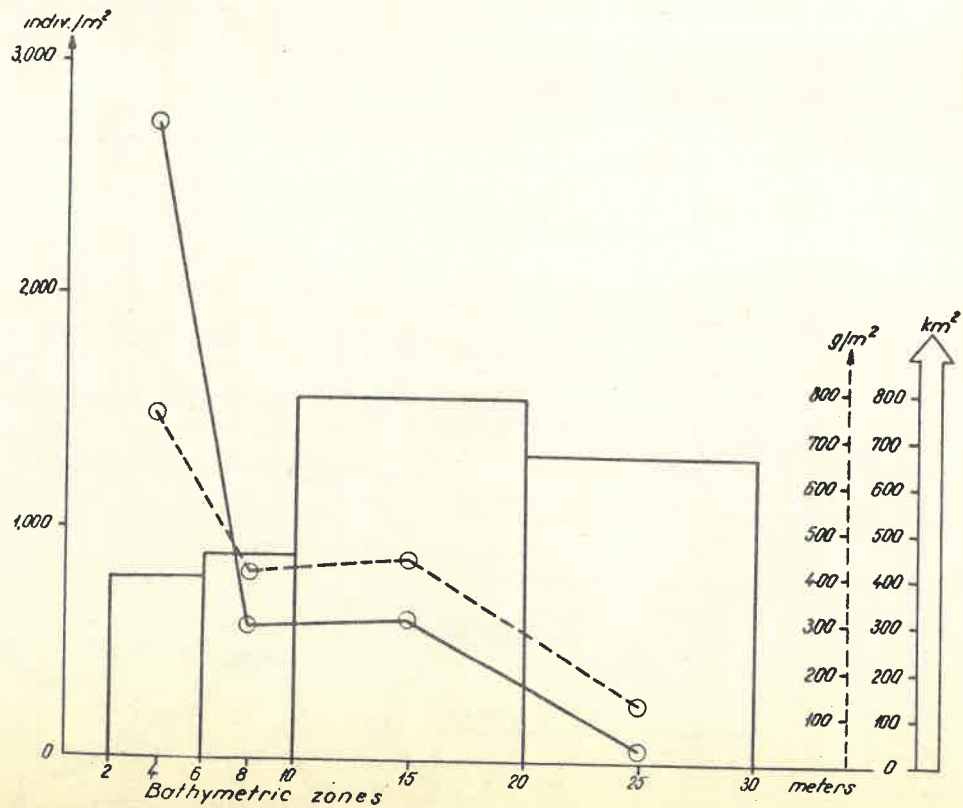
As Mya arenaria is still in full settling process in the Romanian sea coastal waters and active in conquering new biotopes, the further survey of the species dynamics over a longer period of time is essential.

In 1973, Mya overall densities and biomass values, plotted over depths and geographical zones (whose areas computed against studied profiles, were plotted in graphs - figures 4 and 5), gave the following distribution in Romanian littoral waters :

- from the zone between the depths of 2 and 6 meters, where Mya was reported to be in greatest abundance, down to the 30 m isobath, densities and biomass values were generally gradually decreasing (fig. 4); down to 2 meters depth Mya occurred only in a few places ;

- geographically, Mya's greatest abundance (especially as a biomass) was reported from the Ciotic-Portița zone (profiles IV to VII) (fig. 5), an area generally sheltered against the more frequent storms occurring on Romanian sea shore (those produced by north and north-east winds); the very high densities found in the Cape Midia area were the results of a quite exceptional case of the year 1972, when a massive deposit of Mya larvae developed into a rich young population.

An analysis of the quantitative distribution of the bivalve Mya arenaria for the Romanian littoral waters, in 1972, showed that most of its populations were made up of small size individuals (Table 3). Commercial size individuals, exceeding 50 mm in length, were only sporadically found (in only 6 out of 77 sampling stations at various depths) and only in small numbers. Thus, with few exceptions (at 4 meters in 2 profiles : 1 to 3 per cent of the population; at 9 meters in one profile : 4 per cent; at 30 meters depth in one profile : 100 per cent, but this value was given by the only existing individual in the sample), only at the 3 meters depth and particularly in Mamaia zone (profile XI), Mya individuals exceeding 80 mm in length represented 89 per cent of the population.



277 Fig. 4 - Mya arenaria bivalve densities and biomass values overall average distribution for 1972 in the bathymetric zones of the Romanian Black Sea coast.

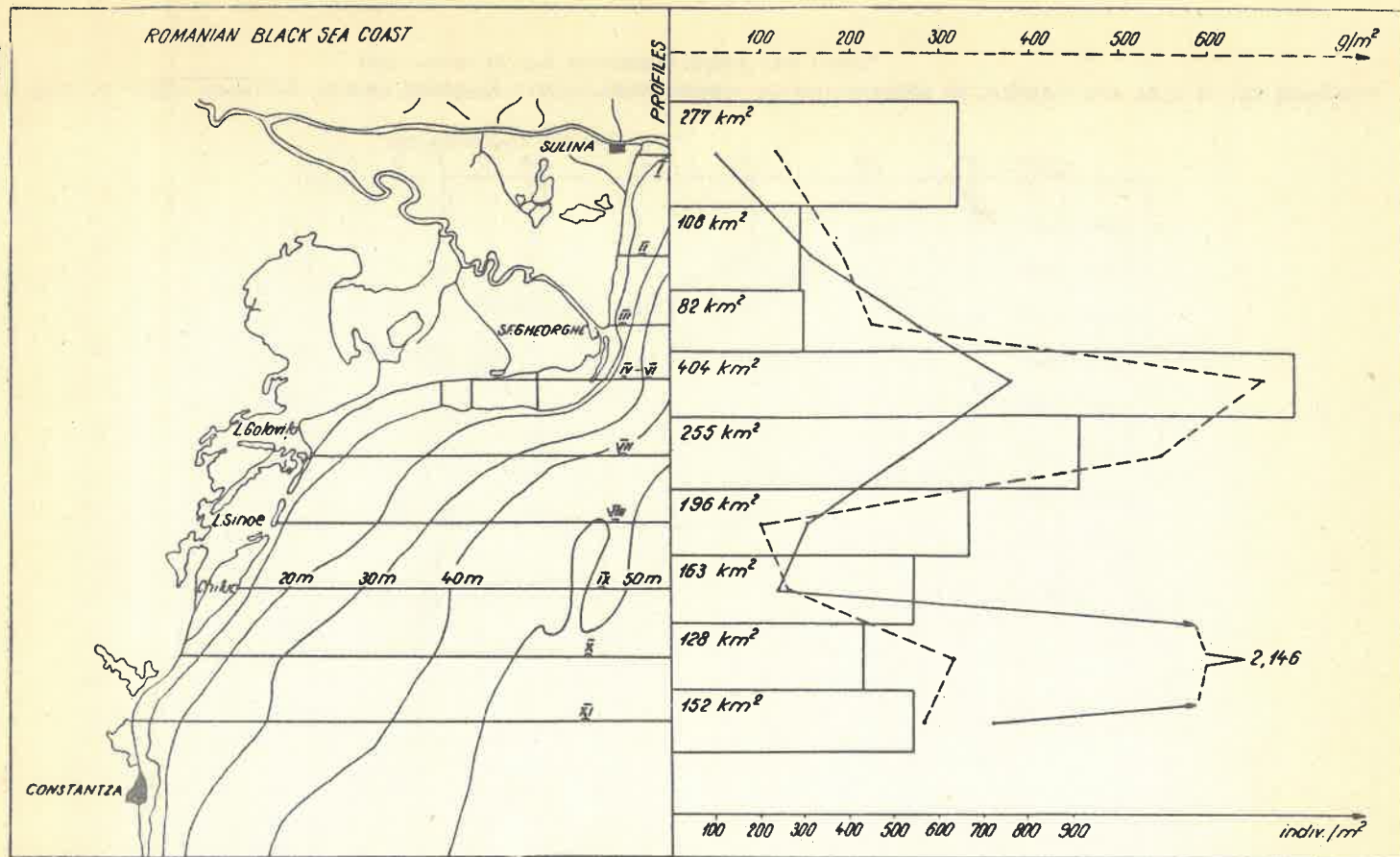


Fig. 5 - *Mya arenaria* bivalve densities and biomass average value distribution in 1972 in the different zones (limited by the studied profiles) off the Romanian Black Sea coast

The analysis of the length class structure of Mya populations found in 1972 on different isobaths (Table 5) gave the following results in comparison to the 1970 and 1971 data :

- at 1.5 meter depth, Mya individuals were generally small, the populations being made up of the last larvae deposits, i.e., new populations ;

- at 3.0 to 4.0 meters depths, although the small size individuals were predominant (the new generation), there were present in variable proportions specimens belonging to all length classes up to 60-70 mm; it was found that annually, from 1970 to 1972, the new generations have been more and more characteristic of the length class structure, the average Mya individuals lengths being continuously decreasing ;

- at 9 meters depth, in 1972, structural balanced populations were generally encountered, the biggest size individuals being in the 50 to 60 mm length class ; the predominant class was 20 to 30 mm (30.89 per cent), the average individual length being only 25.20 mm, a value somewhat higher than that of the previous years ;

- at 15, 22, and 30 meters depths, the individuals of the 20 to 30 mm length class were intensely predominant over the Mya populations.

It is significant to note that Mya individuals found out in the open sea all along the Romanian shore were very small comparatively to the populations from the sheltered zones, like Cape Midia harbour waters for example, or those from the beach thanatocoenosis (Table 5).

The occurrence of big size populations in sheltered zones was reasonable, since these zones offer all favourable conditions for the Mya larvae to develop normally after being disposed of on the substrate.

Much less easily to explain was the predominance of big size Mya valves washed ashore by the storms. At present, we hold that though the Mya larvae "planting" conditions on the sediment bottoms were equal for all the Romanian sea coastal waters, larvae and sapling mortality rate was extremely high, the survivals being very few in number and highly unevenly distributed. This uneven distribution of big Mya individuals lowered very much the chances for their occurrence in our samples. After storms, as we already mentioned, big size individuals unevenly distributed on large areas are shifted from the substrate and washed ashore on narrow stretches of beach, which partly accounts for their absence or scarcity in the open sea.

Analysis of the data relating to Mya arenaria qualitative and quantitative distribution in Romanian sea coastal waters shows that this species lately settled in the Black Sea is still developing its process of establishment.

In relation to Mya massive penetration and settlement in the shallow waters of the Black Sea, a problem of importance is arising, viz. the understanding of all changes liable to occur to the aboriginal populations of the biosenosis occupied by this bivalve. The penetration of a new element into a biocenosis entails right from the beginning a structural alteration which in turn may result in a quantitative and qualitative loss of balance in the aboriginal populations forming the association of organisms.

The average length class structure of *Mya arenaria* populations distributed off the Romanian Black Sea coast in bathymetric zones during the years 1970 - 1972

Isobaths	Years	Number of analysed individuals	Percentage per length classes (mm)										L) ^x mm
			< 10	+10	+20	+30	+40	+50	+60	+70	+80	+90	
0 m	1970	1,656	-	7.71	33.57	31.00	12.57	7.71	3.72	2.72	0.86	0.14	35.62
	1971	494	-	-	4.44	13.56	18.78	21.11	24.78	16.11	1.00	0.22	55.16
	1972	1,272	-	17.37	6.27	18.18	19.72	14.64	12.27	8.18	3.37	-	44.44
1,5 m	1972	262	50,50	50,00	-	-	-	-	-	-	-	-	10,00
3 m	1970	31	16,00	11,40	10,00	22,60	20,00	10,00	10,00	-	-	-	33,92
	1971	173	17,57	43,29	1,86	3,28	9,00	8,86	12,00	4,14	-	-	28,81
	1972	1,110	17,50	61,30	2,50	6,00	5,00	1,80	6,70	1,10	-	-	20,32
4 m	1970	92	20,43	5,71	35,86	21,29	4,14	6,86	5,71	-	-	-	27,64
	1971	409	16,70	29,80	19,50	8,20	10,20	10,40	3,40	1,80	-	-	26,92
	1972	3,391	27,09	52,36	6,27	11,37	2,27	0,37	0,27	-	-	-	16,16
9 m	1970	248	34,80	20,40	22,00	22,60	0,20	-	-	-	-	-	18,30
	1971	485	0,25	38,88	42,88	10,00	7,87	-	0,12	-	-	-	23,68
	1972	545	13,56	20,56	30,89	20,78	13,77	0,44	-	-	-	-	25,20
15 m	1972	484	23,60	13,10	46,10	17,20	-	-	-	-	-	-	20,69
22 m	1972	132	-	2,80	57,80	29,60	9,80	-	-	-	-	-	29,64
30 m	1972	60	-	15,43	52,71	14,00	3,57	14,29	-	-	-	-	29,86
Cap	1970	525	0,33	1,33	11,84	15,00	12,83	10,50	19,17	23,33	5,50	0,17	54,77
Midia	1971	1,751	-	3,56	28,89	22,89	14,89	11,00	8,89	6,44	3,33	0,11	42,06
	1972	2,738	-	2,62	24,38	38,50	19,62	6,50	4,38	2,38	1,50	0,12	38,39

x) Average length of the individuals from population

Table 6

Densities and biomass values of the Molluscs registered in Mamaia zone during the month of May : M - multi-annual average for the 1960-1965 period; and 71 - the value for the 27th of May 1971

Species:		1,5 m		4 m		8 m		12 m	
		indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²
GASTROPODA :									
<u>Bittium</u>	M	-	-	-	-	-	-	-	-
	71	150	1.85	25	0.22	-	-	-	-
<u>Chrysallida</u>	M	-	-	-	-	60	0.12	15	0.04
	71	-	-	-	-	-	-	-	-
<u>Cyclope</u>	M	20	7.80	63	16.12	120	35.06	15	3.10
	71	-	-	165	51.15	45	13.95	40	12.40
<u>Hydrobia</u>	M	-	-	322	0.80	1,451	3.63	560	1.54
	71	350	0.88	4,020	10.11	3,970	9.91	5,280	13.20
<u>Retusa</u>	M	-	-	-	-	-	-	105	0.32
	71	-	-	-	-	-	-	-	-
BIVALVIA :									
<u>Cardium</u>	M	-	-	-	-	11	13.70	-	-
	71	50	60.00	215	386.25	35	41.00	-	-

Table 6 - continued -

<u>Chione</u>	M	130	84.20	37	23.73	317	371.26	20	0.85
	71	-	-	5	3.00	-	-	-	-
<u>Corbula</u>	M	2,240	56.40	11,790	254.41	20,151	447.08	18,450	311.59
	71	12,150	381.00	27,145	710.10	24,685	518.51	26,440	505.14
<u>Mya</u>	M	-	-	-	-	-	-	-	-
	71	300	120.00	560	2,394.05	15	4.49	-	-
<u>Mytilus</u>	M	-	-	-	-	43	0.97	5	0.05
	71	-	-	-	-	-	-	-	-
<u>Tellina</u>	M	-	-	148	49.72	114	27.49	10	1.25
	71	50	15.00	25	8.25	5	1.50	-	-
T o t a l :	M	2,390	148.40	12,360	344.78	22,267	899.31	19,180	318.74
	71	13,050	578.73	32,160	3,563.13	28,755	589.36	31,760	530.74

Table 7

Densities and biomass values of the Molluscs registered in Mamaia zone during the month of November: M - multiannual average for the 1960-1965 period; and 71-the value for the 6th of November 1971

Species :		4 m		8 m		12 m		16 m	
		indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²
GASTROPODA :									
<u>Bittium</u>	M	3	0.01	72	0.24	40	0.12	-	-
	71	-	-	-	-	-	-	-	-
<u>Chrysallida</u>	M	11	0.02	360	0.66	80	0.14	35	0.07
	71	-	-	-	-	-	-	-	-
<u>Cyclope</u>	M	128	32.00	172	37.51	35	7.60	15	4.96
	71	90	27.90	300	81.00	100	31.00	380	117.80
<u>Hydrobia</u>	M	323	0.81	2.760	6.90	652	1.63	360	0.90
	71	1.590	1.30	3.570	8.92	9.640	24.10	2.420	6.05
<u>Nassarius</u>	M	3	2.28	-	-	-	-	-	-
	71	-	-	10	10.05	-	-	20	20.40
<u>Rissoa</u>	M	3	0.01	-	-	10	0.02	-	-
	71	-	-	20	0.05	-	-	-	-
<u>Retusa</u>	M	37	0.13	38	0.13	688	2.16	535	1.82
	71	-	-	-	-	-	-	-	-
BIVALVIA :									
<u>Cardium</u>	M	-	-	-	-	5	12.00	10	0.20
	71	70	165.00	540	18.90	1.540	189.50	1.140	137.00

Table 7 - continued -

<u>Chione</u>	M	1,394	29.45	284	407.54	10	0.10	70	59.22
	71	-	-	-	-	-	-	-	-
<u>Corbula</u>	M	21,117	213.51	26,320	214.44	27,578	320.02	8,750	78.37
	71	17,580	222.30	7,750	100.80	5,520	83.00	1,880	26.00
<u>Mya</u>	M	-	-	-	-	-	-	-	-
	71	20	1.50	10	5.00	9,100	473.00	20	1.00
<u>Mytilus</u>	M	-	-	16	2.18	-	-	435	0.29
	71	-	-	-	-	20	5.80	80	27.30
<u>Paphia</u>	M	-	-	-	-	32	0.09	10	51.50
	71	-	-	10	25.00	-	-	-	-
<u>Spisula</u>	M	-	-	-	-	5	0.10	-	-
	71	-	-	-	-	-	-	-	-
<u>Tellina</u>	M	150	32.31	236	33.95	5	0.60	35	0.88
	71	10	0.50	-	-	-	-	-	-
Total:	M	23,169	310.53	30,258	703.55	29,140	344.58	10,225	198.21
	71	19,360	418.50	12,210	249.72	25,902	806.40	5,940	335.55

In Romanian littoral waters, Mya settled itself mainly in the finer sands biocenosis, together with Corbula mediterranea Costa, a biocenosis which has been thoroughly studied previously, known to be one of the most eutrophic biocenosis in the Black Sea and a primarily trophic basis for fish (BACESCU & all. 1957, 1965, 1967).

After Mya settlement together with Corbula on the sandy bottoms of the sea, we were interested to know, as a beginning, the quantitative status of the mollusks, one of the most important groups of organisms of the biocenosis. In 1971, we recorded all the densities and biomass values of the psammobiont mollusks at various depths of the three profiles that intercept the Corbula biocenosis in its main sector (profiles XI - Mamaia, IX - Chituc and VII - Portița). We took 34 samples in May and November in Mamaia area, and only in November in Chituc and Portița zones. The data obtained will be further compared with those from previous years (BACESCU & all. 1965, 1967; GOMOIU, 1969).

Owing to the investigations made during the 1960 - 1965 period (BACESCU & all. 1965, 1967), many aspects of the quantitative and qualitative dynamics of the malacofauna in Mamaia zone are well known. Therefore, the data obtained in the mentioned period, i.e., before Mya settled in the Black Sea, represent good comparative terms for the preliminary data recorded in May and November 1971, when Mya was already present in the biocenosis.

The quantitative composition of the malacofauna found at Mamaia in 1971 is generally similar to that of the previous years. Beside the new element - Mya arenaria - in the biocenosis there are no other species of mollusks. But in the same year the gastropods Chrysallida interstincta (Montagu) and Retusa truncatula Bruguière were not found in our samples species although these were frequent in the previous years (Tables 6 and 7). Their absence in our samples of 1971 may be considered as accidental rather than due to Mya penetration into the biocenosis.

Quantitatively, there are significant differences between the 1971 situation and that in the previous years. Thus, at 1.5 meters depth, where we collected only in May, both densities and biomass values for the psammobiont mollusks were much higher in 1971 than in 1960 (Table 6). Compared to the May 1960 value, in May 1971 there was a supplement of more than 10,000 indiv./sq. m. and a biomass value of over 430 g/sq. m. This excess in number and weight is only in a small proportion given by Mya, the new settled member of the biocenosis. Corbula mediterranea - the leading species of this biocenosis - showed enormous increases in density and biomass value.

It is however certain that the higher values recorded for the May 1971 abundance of Corbula are similar to the maxima occurred in 1960.

It is well known that for the 1.5 meters depth, environment conditions are very unstable, a fact reflected by the large variance of the densities and biomass values of the organisms (BACESCU & all. 1965, 1967). Consequently, it may be safely admitted that at 1.5 meters depth no essential quantitative changes occurred subsequent to Mya penetration into the biocenosis.

At 4.0, 8.0 and 12.0 meters depth, in May 1971 the mollusks were much more numerous than in the same month in the 1960-1965 period. High density values are due to increased numbers of Hydrobia and Corbula. Mya occurred only at 4.0 and 8.0 meters depth and only with low densities. For the mentioned depths, the mollusks biomass values of 1971 were generally higher and corresponded to the respective densities. But Mya, at 4 meters depth, had a very high biomass value (2,394.05 g/sq. m), which represented an uncommonly high value for the finer sands benthos of the Romanian littoral waters. The lower biomass value of the mollusks at 8 meters depth in May 1971 is mainly due to the absence of the Chione bivalve, which in 1961 - 1965 weighed in average 371.26 g/sq. m.

In November 1971, the mollusks had generally much lower densities, but biomass values were higher than those of the corresponding month of the previous years (Table 7). Even if one would analyse each species in turn, at every depth, it is difficult to ascertain whether Mya has influenced negatively or positively on the quantitative dynamics of the aboriginal mollusks. It is however certain that, in some places, Mya contributes more than 50 per cent to the biomass value and that Corbula represents the numerically dominant species.

For the Chituc and Portița zones, the comparative data of the previous years are rather scarce, the only existing ones being those given by GOMOIU (1969).

The quantitative malacofauna situation recorded by us in 1971 was much dissimilar to that of previous years, especially regarding the biomass values. Thus, in Chituc area (Table 8), the mollusk densities registered at various dates do not present significant variance: for the 4 meters depth, about 20,000 indiv/sq. m. on June 27, 1964, 14,000 indiv/sq. m. on March 7 - 20, 1968 and 20,000 indiv/sq. m. on June 23, 1971; at 8 meters depth, 18,000 indiv/sq. m. on June 27, 1964, 24,000 indiv/sq. m. on March 7 - 20, 1968 and 18,000 indiv/sq. m. on June 23, 1971. The mollusk densities of 1971 were continuously dominated by the number of Corbula, but were little affected by the number of Mya individuals which was varying at different depths between 93 and 580 indiv/sq. m. The biomass values were in return much higher in 1971 due to Mya presence (Table 8).

The mollusk densities in Portița zone were generally lower in 1971 than the values recorded the previous years: for the 4 meters depth about 18,000 indiv/sq. m. on June 25, 1971 and 25,000 indiv/sq. m. on October 14, 1963; for the 8 meters depth, 5,400 indiv/sq. m. on June 25, 1971 and 29,000 indiv./sq. m. on October 14, 1963. The biomass values were, however, higher in 1971, due the presence of Mya for the 4 meters depth, 1,223.27 g/sq. m. on June 25, 1971 and 637.00 g/sq. m. on October 14, 1963; for the 8 meters depth 298.80 g/sq. m. on June 25, 1971 and 271.45 g/sq. m. on October 14, 1963. Since for the previous years the data published by GOMOIU (1969) referred only to the 4 and 8 meters isobaths, we give here the densities and biomass values of the mollusks from Portița zone, for 12 and 16 meters depths (Table 9), but without being able to make any comparisons.

Table 8

Densities (indiv./sq. m.) and biomass (g/sq. m.) of the Molluscs in Chituc zone, recorded at different depths, on the 23rd of June 1971

Species:	4 m		8 m		12 m	
	indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²
GOSTROPODA:						
<u>Cyclope</u>	33	10, 33	-	-	193	59, 93
<u>Nassarius</u>	-	-	-	-	60	31, 80
BIVALVIA :						
<u>Cardium</u>	40	102, 60	10	18, 00	7	7, 00
<u>Corbula</u>	21, 807	584, 97	17, 590	804, 70	15, 153	359, 17
<u>Mya</u>	153	979, 73	580	1, 861, 00	93	104, 00
T o t a l	22, 033	1, 677, 63	18, 180	2, 683, 70	15, 506	561, 90

Table 9

Molluscs densities (indiv/sq. m) and biomass (g/sq. m) values for the Portița zone, recorded at various depths on the 25th of June 1971

Species:	4 m		8 m		12 m		16 m	
	indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²	indiv/m ²	g/m ²
GASTROPODA:								
<u>Cyclope</u>	100	16, 93	10	1, 80	40	12, 40	-	-
<u>Hydrobia</u>	-	-	-	-	970	0, 24	-	-
BIVALVIA								
<u>Abra</u>	-	-	-	-	-	-	80	8, 00
<u>Cardium</u>	333	248, 77	20	13, 00	130	312, 00	80	62, 00
<u>Corbula</u>	17, 460	439, 57	5, 240	149, 00	7, 590	206, 30	340	16, 00
<u>Mya</u>	300	518, 00	120	134, 00	220	157, 00	660	632, 00
<u>Mytilus</u>	-	-	10	1, 00	-	-	120	14, 00
<u>Paphia</u>	-	-	-	-	-	-	40	30, 00
<u>Spisula</u>	-	-	-	-	-	-	20	2, 00
Total:	18, 193	1, 223, 27	5, 400	298, 80	8, 950	687, 94	1, 340	764, 00

From the comparative analysis of the quantitative and qualitative state of the fine sands malacofauna with Corbula, before (1960-1965) and after (1971) penetration by Mya arenaria of the Romanian shore waters, one may single out several interesting aspects already resumed in a paper read to the 23rd Congress of the C. I. E. S. M. M. in Athens (November 3-11, 1972) (GOMOIU & PETRAN, 1972) which we briefly point out in as follows:

1. The quantitative and qualitative composition of the malacofauna existent in the finer sands together with Corbula mediterranea in the Romanian littoral waters of the Black Sea do not present any essential changes during the first years subsequent to Mya arenaria bivalve settling into the biocenosis.

2. The densities and biomass values of the psammobiont mollusks in the Corbula biocenosis, enriched with Mya individuals, are comparable to those registered in previous years, before Mya settled in the respective coenosis.

3. Corbula mediterranea continues to be the numerically dominant element in the finer sands malacofauna of the Romanian coast waters.

4. Mya arenaria, a species of large size, although occurring in low densities, gives high biomass values, thus increasing the biological productivity of the finer sands benthos of the Romanian littoral waters.

5. Owing to the fact that Mya lives deep into the sedimentary bottom, burrowed down to 20-25 centimeters, it may be assumed that this newcomer bivalve occupied a free ecological recess into the finer sands, that it does not trophically compete with other filtering mollusks from the biocenosis and as such, up to the present, it has proved to be no danger to the existing biological balance; furthermore, Mya penetration in the Black Sea represents a positive element for the ecology of this sea.

Since the Mya arenaria process of settlement in the Romanian littoral waters is not completed yet, the problems of the bivalve's integration in the biocenosis it occupied will ask to be solved, as the species will be accomodating itself in the new living circumstances.

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