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DISTRIBUTION OF *Mya arenaria* L.POPULATIONS IN THE WESTERN PART OF THE BLACK SEA

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ABSTRACT:

The quantitative and qualitative distribution of the Mya arenaria bivalve in 1981 is presented on the basis of the samples collected on the Romanian littoral in 114 stations (down to 35 m depth north of Constanta and 50-60 m south of it). It is considered that the settlement of this bivalve in the Black Sea is an unfinished process continuing with the spread of its populations to greater depths in oozy zones with mussels.

Among the spectacular ecological events lately registered in the Black Sea, especially its north-western part, the extraordinary development of the Mya arenaria bivalve has been noticed - a species recently coming into the Pontic basin. Only 15 years have passed since the first records concerning its presence in the Black Sea (2, 10, 13, 17, 21). In a relatively short period, this species of boreo-atlantic origin,whose area of maximum distribution consists in the Atlantic littoral of USA, has spread and developed its populations in the north-western part of the Pontic basin so that it has become a common element, a mass one,prevailing quantitatively over all the other aboriginal shell fish populations in sedimentary zones of shallow waters where it settled. Mya arenaria bivalve has been registered even in some

epibenthic communities, thus being mentioned among the marine fouling organisms (11, 12). Numerous Soviet and Romanian papers deal with the settlement and biology of Mya arenaria in the north-western part of the Black Sea (3, 4, 7, 8, 9, 14, 16, 18, 22). However, the best proof for that are the beach deposits lying from the North of Constantza to the Danube mouths. If until the start of the 1970s these deposits were relatively small from a quantitative point of view and their composition was predominated by Corbula mediterranea (Costa) (1), today they impress through their structure which is nearly monospecific owing to the abundance of the bivalve Mya. According to our estimations 3,500 tons of Mya arenaria, out of which 1,500 tons shells, can be deposited in a year on a 1 km stretch along the beach at Mamaia-in the North of the seaside resort.

The acknowledgement of the great scientific and practical importance of Mya arenaria from the Romanian littoral, not only as a potential biological resource with prospects of development (alimentary or biochemical), but also on account of the especially important ecological role of its populations in the littoral ecosystem (formation of a powerful biofilter, utilization of the primary trophic basis - which has become surplus because of the rising eutrophication of the sea, the production of a great quantity of larval plankton - food for fish, then a source of shell material to enter the sedimentary processes etc.), led to initiating a series of researches concerning this bivalve recently penetrated into the Black Sea since 1970.

Between 1970-1976 the qualitative and quantitative state of Mya arenaria populations was registered yearly and its stocks were estimated, first for zones down to 10 m depth, then, since 1973, to 30 m isobath. Since 1976 the populations of Mya arenaria and the other molluscs living together have been studied simultaneously.

The results of the researches, partially published (4, 7), prove that the populations of Mya arenaria and of the other cohabiting forms pass through qualitative and quantitative modifications every year. Generally, the areas of the aboriginal Molluscs have decreased and the populations have diminished their effectives. An obvious example for that is the case of the popu-

lations of Corbula mediterranea on the Romanian littoral (6). However Mya arenaria, in spite of all the quantitative modifications, has become the dominant species in zones with mobile sediments down to 30-40 m depth at the Romanian coast.The great quantitative fluctuations of the Mya populations in the zones where they have settled, the spreading of its populations to new zones towards the depth, prove the fact that the new immigrant has not reached stability and ecological equilibrium in the ecosystem it has occupied. Moreover, during the fifteen years of its penetration into the Black Sea, numerous structural and functional modifications of the associations of benthic organisms where the new bivalve has settled have been registered,as a consequence of some interspecific relations not yet in equilibrium.

It is certain that the settlement process of the Mya bivalve in the sedimentary communities at the Romanian littoral took place and is still taking place against the background of ecological events with negative effects upon the whole ecosystem, amplifying the ecological pressure and delaying even more the appearance of the steady state among the populations of benthal organisms.

The ecological disturbances registered in the Black Sea in the last years (4, 23) are far from being catastrophic, as some authors consider tendentiously (20). A proof for that is the relatively good state in 1981,as we shall see, of the populations of Mya arenaria at the Romanian littoral which has been continuously subjected to strong ecological pressures not only because of the Danube waters,but also because of numerous local anthropic influences.

MATERIALS AND METHOD OF WORK

In order to establish the qualitative and quantitative distribution of the Mya arenaria populations, in 1981, the researches took place in a large zone,more than 5,800 km^2,delimited by the parallels of the localities of Sulina and Vama Veche and towards the off-shore by the depth of 35 m in Sulina - Constantza zone and 50 - 60 m in Constantza - Vama Veche zone (Fig.1).

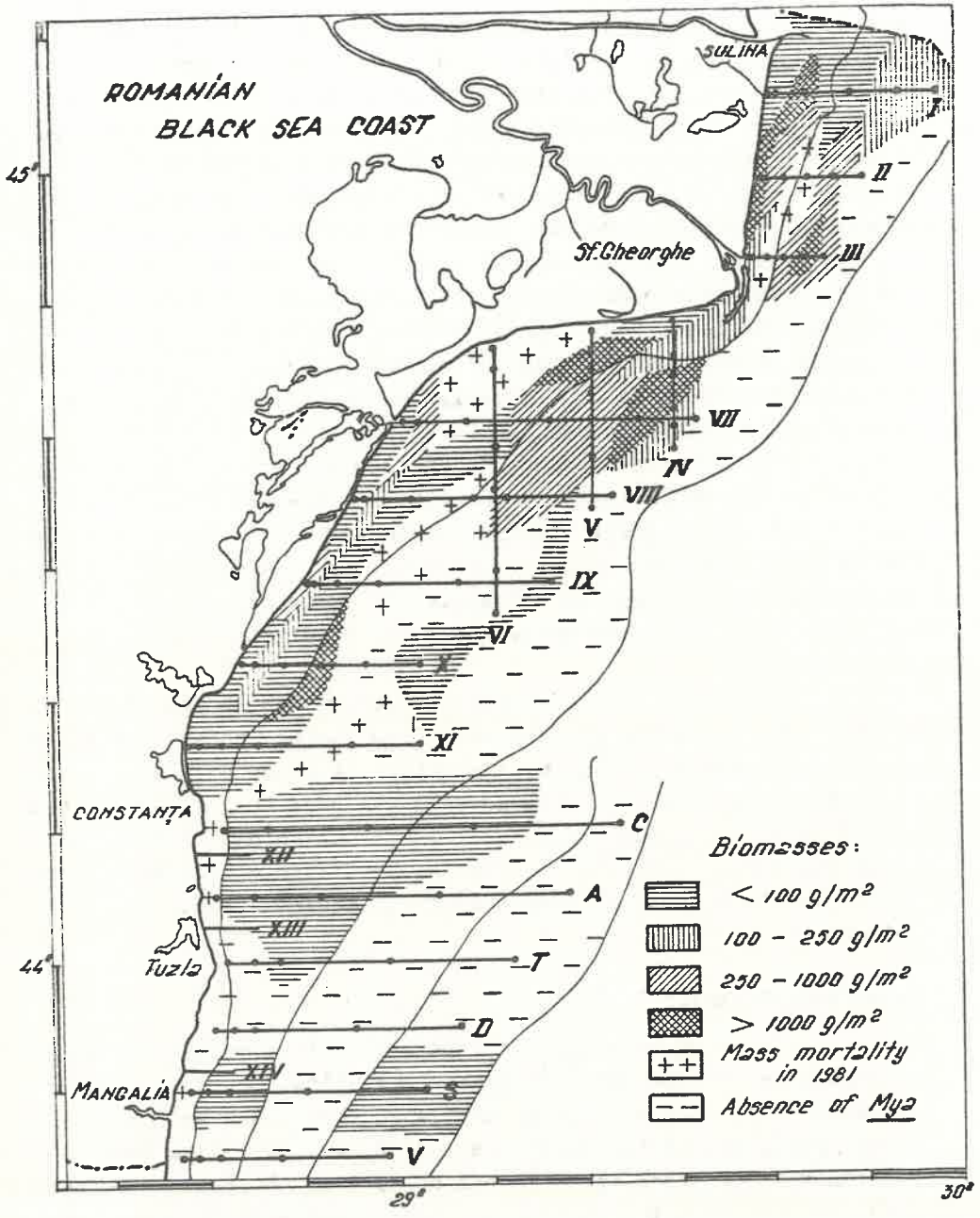

Fig.1 - Quantitative distribution of Mya arenaria populations at the Romanian Black Sea coast in 1981

Densities (D - individuals/m^2) and biomasses (B - g/m^2) of the populations of Mya arenaria at the Romanian littoral, registered in 1981

Table 1

Depths / Profiles	4 m		9 m		15m		22 m		30 m		35 m	
	D	B	D	B	D	B	D	B	D	B	D	B
I	178o	43.oo	75o	24.oo	64o	19o6.oo	9o	64.3o	86o	172.oo	1o	12o.oo
II	32o1o	4365.oo	1549o	3o7.3o	13o	495.5o	+	+	4o	53o.5o	-	-
III	2436o	1778.oo	584o	2o1.oo	+	+	8o	8o9.oo	17o	1598.oo	6o	48o.oo
IV	16o	3.oo	334o	2o8.56	9o	244.1o	39o	23oo.oo	2o	15o.oo	2o	185.oo
V	+	+	28o	1623.oo	19o	1187.oo	1oo	947.5o	11o	86o.oo	-	-
VI	+	+	+	+	1o	5.oo	3o	321.oo	-	-	o	o
VII	18o	12.oo	39o	638.oo	+	+	1oo	876.oo	19o	1568.oo	o	o
VIII	5o	12.5o	5o	143.oo	2o	12.oo	+	+	1oo	653.oo	-	-
IX	695o	926.oo	323o	198.5o	1o	6.5o	+	+	-	-	1o	51.5o
X	655o	62.5o	456o	153.5o	7o	84.oo	73o	2514.oo	-	-	1o	1,oo
XI	35o	76.oo	1o95o	57.oo	5o	7o.5o	13o	35.oo	+	+	o	o
XII	15o	1o.oo	2o	1.oo	2o	16.oo	+	+	+	+	-	-
XIII	77o	1294.75	7o	292.oo	29o	5o9.oo	42o	368.oo	2o	15o.oo	1o	185.oo
XIV	32o	524,5o	18o	4,oo	+	+	+	+	+	+	o	o
Average I-XI	6581	661.64	4o8o	323.o8	11o	364.6o	15o	715.16	135	5o2.86	1o	76.14
Average I-XIV	5259	65o.52	3225	275.o6	1o8	323.97	148	588.2o	1o8	4o5.82	8	73.o4

Remark: Sign "+" shows recent mass mortalities of Mya arenaria populations; in stations, only blackened shells, sediments rich in organic substance smelling of H_2S. Sign "o" shows the absence of Mya arenaria populations and the presence of other molluscs. Sign " - " shows the absence of any molluscs.

The quantitative samples have been collected (at least two samples from each station by using the Van Veen grab -1/2o m^2) at depths of 4 m, 9 m, 15 m, 22 m, 3o m and 35 m on the profiles I - XIV (Fig.1), arranged ∓ perpendicular to the shore and at an approximately equal distance between them, along the whole coast.

In the southern zone Constantza - Vama Veche six supplementary profiles have been carried out towards West -East (Constantza - C, Agigea - A, Tuzla - T, 23 August - D, Saturn - S and Vama Veche - V), with five stations, one at each bathimetric interval of 1o m, down to 6o m depth.

As the discussion of the results progresses, references to the 114 stations performed will be made as usual through the indicative of the profile and depth (for instance,XI/4 designates the station lying 4 m deep of the profile XI - Mamaia).

All the samples of Mya arenaria were counted,weighted and measured.More than 1o,1oo specimens were measured in order to establish the structure of the Mya populations according to class of size. For each station from the two series of profiles, the density (N - individuals/m^2) and biomass (g/m^2) of the respective Mya arenaria populations were established (Tables 1 & 2).

Table 2

Average densities (D - individuals/m^2) and biomasses (B - g/m^2) of Mya arenaria populations in the South of the Romanian littoral in 1981

Profiles		Station/depth interval 1/1o-2om	2/2o-3om	3/3o-4om	4/4o-5o m	5/5o-6o m
Constantza (C)	D	+	1.6o	o.o7	1.4o	o
	B	+	31.78	o.4o	6.89	o
Agigea (A)	D	+	o.o3	o.o2	o	o
	B	+	o.o7	o.13	o	o
Tuzla (T)	D	o	o	o.36	o	o
	B	o	o	6.32	o	o
23 August (D)	D	o	o	o	o	o
	B	o	o	o	o	o
Saturn (S)	D	o	1.48	o.13	o	o.o15
	B	o	34.66	1.74	o	o.1o
Vama Veche (V)	D	o	o	o	o	o
	B	o	o	o	o	o

Remark: Signs"+","o"and"-"have the same significance as in Table 1

RESULTS AND DISCUSSIONS

In the network of the 84 stations performed between 4 - 35 m depths (Table 1) in 1981, Mya arenaria had a general frequency of 7o.2% which shows that this new species penetrated into the Black Sea belongs to the constant species of the Romanian littoral. In zones with unconsolidated sediments, usually, as the depth increases the frequency of Mya arenaria decreases from 85.7 - 92.8 % at 4 - 9 m, to 78.5 % at 15 m, 64.3 % at 22 m, and 5o.o - 57.1 % at 3o - 35 m. On the basis of the samples collected in the South of the Romanian littoral (Table 2) we can appreciate that the populations of Mya arenaria, although in full process of extension, has yet a very low frequency at depths of 4o - 6o m (below 2o.o %).

From a quantitative point of view, the Mya arenaria populations of the Romanian littoral have had an ununiform bathimetric and geographic distribution, which is well illustrated by the biomasses registered in 1981 (Fig.1). The most abundant populations, considering both the number of the individuals and their biomass, lie 4 m deep in the zone of the Danube mouths; there, there were registered agglomerations of thousands of Mya arenaria juvenile specimens (6o - 8o % of them having the size under 1o mm length) per 1 m^2 which form biomasses exceeding 1.5 kg/m^2 (Table 1). Populations less abundant numerically, but consisting of individuals greater in size (more than 5o % of the population with individuals over 3o mm long) which give therefore biomasses of more than 1.o kg/m^2 were found in the stations I/15, III/3o, IV/22, V/9, V/15, VII/3o, X/22 and XIII/4 (Fig.1).

On the average, the abundance of Mya arenaria populations per bathimetric zone is as follows: 5,259 individuals/m^2 - 65o.52 g/m^2 at 4 m, 3,225 individuals/m^2 - 275.o6 g/m^2 at 9 m, 1o8 individuals/m^2 - 323,97 g/m^2 at 15 m, 148 individuals/m^2 - 588.2o g/m^2 at 22 m, 1o8 individuals/m^2 - 4o5.82 g/m^2 at 3o m and 8 individuals/m^2 - 73.o4 g/m^2 at 35 m. Thus, the greatest numerical abundance is in the sandy zones of shallow waters where juvenile specimens prevail (o.o8-o.12 g/individual - medium weight); here, where the medium densities exceed 3,ooo individuals/m^2, on an average 92.1% every 9 m depth and 73.4% every 4 m depth, of the

population are juvenile specimens less than 1o mm long (Fig.2). As the depth increases, densities decrease, but the populations consist of greater-sized individuals; if at depths of 4 - 9 m the individuals up to 3o mm length formed about 99.9 % of the population, their percentage has decreased in the off-shore zone - 73.o % at 15 m, 39.4% at 22 m, 43.6 % at 3o m and 18.2 % at 35 m (Fig. 2). The biomasses remain, as a rule, high enough down to 3o m, then decrease in the deeper beds, in accordance with the decrease in densities.

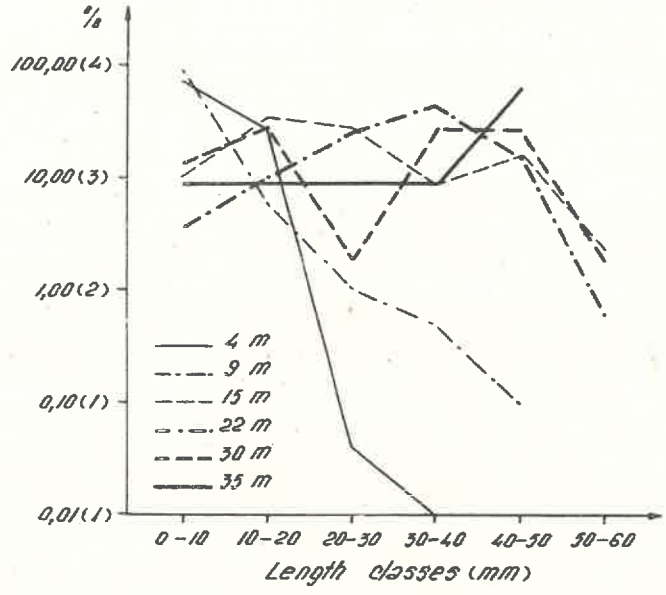

Fig.2 - The average percentage structure per classes of length of Mya arenaria populations in 1981

In bathimetric zones deeper than 3o - 4o m, Mya arenaria penetrated long ago, but less research has been carried out here. For instance, after a control performed in 1977, in the zone of 4o - 5o m we have registered populations with densities and biomasses quite low (on an average o.1 - o.5 specimens/m^2 and 1.1o - 12.3o g/m^2). In 1981, in the southern part of the Romanian littoral isolated populations were found even down to 5o - 6o m, but

with low abundance just like in the past (Table 2). These zones should be better examined in the future; the ecological conditions on the oozy bottoms differing from those in shallow coastal waters might not support the formation of rich populations of Mya arenaria.

Table 3

Mya arenaria stocks estimated in 1980 and reduction of these stocks caused by mass mortalities in the summer of 1981

Bathimetric zone	Zone area km^2	Mya stocks 1980 Tons x 10^3	Areas affected in 1981 km^2	%	Lost Mya stocks Tons x 10^3	%
0 - 6 m	155	40	42	27.1	38	95
6 - 10 m	174	70	44	25.3	14	20
10 - 20 m	780	420	209	26.8	50	12
20 - 30 m	656	330	129	19.7	65	20
0 - 30 m (Total)	1,765	860	424	24.0	167	19

In the table concerning the quantitative distribution (Table 1), as well as on the map for biomasses (Fig. 1) we have marked with "+" the stations where in 1981 mass mortalities of Mya arenaria populations have been registered. The zones of mass mortality were established by comparing the data of this year with those of the previous year (if in 1980 Mya was present in the respective station and in 1981 absent, mortalities were considered to have occurred); moreover, in the stations where mortalities were recorded, closed shells of Mya comprised meat in putrefaction or sediments strongly blackened and smelling H_2S. On the basis of our data from 1980 we have estimated that in 1981 in the large zone Sulina - Constantza down to 30 m depth, in consequence of the mortalities, nearly 170,000 tons of Mya arenaria disappeared, that means about 24% of the total stock of this bivalve; mortalities were registered on a total area of 424 km^2, that is almost one fourth of the zone occupied by Mya (Table 3). The sheltered zones from 4 m and 9 m in the Zaton - Periteasca sector (stations V/4, VI/4 and VI/9) were the most affected ones.

Without going into details,we mention that the mortalities occurred because of the new ecological conditions that appeared in the last decade in the western part of the Black Sea as a result of the eutrophication/pollution phenomenon. In 1975, for example, after a heavy "red tide" with Exuviaella, most of the benthic populations have been affected by mass mortalities (5).Though almost 2o % of the Mya populations at the Romanian littoral were affected by mortalities in 1981,their stocks are considered to be able to restore owing to the high proliferation of this species. Domination of the populations by the new generations, especially in shallow waters (Fig.2) is a proof of the high capacity of this species to survive in fluctuating conditions with strong bursts of ecological pressure.

For more general references, concerning for instance the quantitative characterization of the Mya populations in accordance with the geographic division into zones of the Romanian littoral down to 35 m, we have calculated the average values of densities and biomasses for 4 sectors (Table 4).

Table 4

Average densities (D - individuals/m^2) and biomasses (B - g/m^2) of Mya arenaria populations met in 1981 in various sectors of the Romanian Black Sea littoral

	Predeltaic Sector Sulina-Sf.Gheorghe		Subdeltaic Sector Ciotic-Portiţa		Central Sector Portiţa-Constanţa		Southern Sector Constanţa-Mangalia	
	D	B	D	B	D	B	D	B
4 m	19,383	2,062.o	85	3.8	3,475	269.2	313	6o9.8
9 m	7,36o	177.4	1,oo2	617.4	4,698	138.o	9o	99.o
15 m	257	8oo.5	72	359.o	38	43.2	1o3	175.o
22 m	57	291.1	197	1,374.5	178	574.o	14o	122.7
30 m	357	766.8	1o7	859.3	2o	13o.6	7	5o.o
35 m	23	2oo.o	1o	92.5	3	8.8	3	61.7

1. The predeltaic sector (profiles I - III) characterized by extremely unstable ecological conditions in general and by the direct influence of the Danube especially (the lowest salinities), with mainly oozy-sandy bottoms in shallow waters and

strong hydrodynamism (owing to the Eastern situation of the littoral), was the sector of maximum densities in 1981. The biomass was also higher at the depth of 4 m, in conformity with the maximum value of the medium density of about 2o,ooo specimens/m^2. But it is not likely that the Mya populations should remain with high densities and biomasses in this sector. The structure of the populations at various depths is heterogenous, showing that great fluctuations take place in this sector; mature populations can be found only at depths of 3o m (a medium sized individual was 8.57 g on an average an individual has a weight of 8.57 g).

2. The subdeltaic sector (profiles IV - VII, South of the Delta) characterized by the indirect influence of the Danube waters, surrounded by an unstable anticyclonic current is mostly a zone of quiet waters rich in phytoplankton (19). Usually sheltered from the strong North and North-East winds too, this sector can be considered as one of high biomasses.Here,growth conditions for Mya individuals are good, so biomasses of populations with moderate densities are high at depths of 22 m. In 1981 the subdeltaic sector was strongly affected by mass mortalities of populations lying 4-9 m deep. As the depth increases mature specimens prevail in populations, a fact also shown by the medium weight of an individual (o.o4 g - 4 m,o.62 g - 9 m, 4.95 g - 15 m, 6.99 g - 22 m, 8.o6 g - 3o m and 9.25 g - 35 m).

3. The central sector of the Romanian littoral, delimited by Portiţa and Constantza (profiles VIII - XI) characterized by a low sea shore, accumulating and unstable, with the large submerged beach (the fine sands and the oozy ones can be found down to 15 - 2o m), sector of strong enough hydrodynamism, is the place where Mya arenaria populations are moderate concerning both density and biomass; it is also the sector in which the qualitative and implicitly quantitative structure of these populations register great oscillations. For instance, in comparison with the northern sectors, this one, with few exceptions, had mostly juvenile individuals in 1981 (the medium weight of an individual being o.8 g - 4 m, o.o3 g - 9 m, 1.15 g - 15 m, 3.22 g - 22 m, 6.53 g - 3o m and only 2.62 g - 35 m).

4. The southern sector, lying between Constantza and

Vama Veche (profiles XII - XIV) characterized by domination on the coast of the active cliff which is interrupted in front of the old limans by sandy littoral barriers, by alternation of hard, rocky bottoms with sedimentary ones, a zone with strong hydrodynamism, with more stable saline conditions, but subjected in the past years to strong anthropic influences (the building of new ports, coastal improvement etc.) is the last sector occupied by Mya arenaria on the Romanian littoral. Here the populations dispose of less large areas than zones in the North not only because of the steeper bottom slope but also because of the rocky bottoms reduced than in the previous sectors, but in some places with special local conditions (sheltered zones lying either between the rocky spurs or between harbor piers) insular Mya arenaria colonies with great abundance. It is significant that in the bathimetric strip 4-22 m of the southern sector, the Mya individuals are all of a similar average age; for the populations living 30 m deep and especially 35 m deep, the average age increases (for instance 35 m deep, a medium individual weights 18.5 g and it is 52.5 mm long, which corresponds to the age of approximately 5 years).

The sector Constantza-Vama Veche seems to be the southern limit for the spread of the Mya arenaria populations in the Black Sea; up to now we do not have any information concerning the presence of this species on the Bulgarian littoral. We do not exclude the possibility that Mya arenaria penetrates more towards the South in the same way it extends towards greater depths.

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