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ON THE POPULATIONS OF *Melinna palmata* GRUBE AT THE ROMANIAN LITTORAL OF THE BLACK SEA

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ABSTRACT:

On the basis of the samples collected in 1982 it was established that the populations of the tube polychaete Melinna palmata at the Romanian littoral that had been scarce before, have become extremely abundant lately (on an average 2,331 specimens/m^2 and 73.2 g/m^2, but the maximum exeeds 17,7oo specimens/m^2 and 57o g/m^2); they live at depths of 2o - 4o m in a zone larger than 2,2oo km^2. The increase of the Melinna populations which is the result of recent accumulations of organic matter in sediments has a great importance. Under the circumstances of organic pollution in the north-western part of the Black Sea and of frequent decreases in the oxygen concentration as a result of the "red tide", Melinna is the only organism able to stand these conditions, to use the organic matter and thus become an important trophic basis for demersal fishes (for sturgeons, especially).

By 197o, the tube polychaete, Melinna palmata GRUBE, was a species rare enough on the continental shelf in front of the Romanian coast. Thus, in 196o-1961 Melinna was found in the predeltaic sector only in 3 stations out of the about one hundred ones performed in this zone (3), its densities and biomasses being

relatively small (4o - 2oo specimens/m^2 and 1.8 - 9.o g/m^2). In the periazoïc zone with white ooze containing Modiolus phaseolinus (PHILIPPI), low quantities of Melinna (1o-1oo specimens/m^2) were found only in two stations out of the fifty ones performed (1), though NIKITIN (11) shows that the average frequency of the populations of this polychaete along all the shores of the Black Sea between 11o - 17o m is 68% and their average density reaches 22 specimens/m^2. The qualitative, quantitative and comparative analysis of the pontic benthal fauna (2) proves that within the boundaries of the continental shelf in front of the Romanian coastline no mention can be made of the presence of Melinna as a determining species for biocoenosis; it forms small enclaves, without a permanent character perhaps, on the bottoms occupied by the typical subcoenosis of Mytilus.

The scarcity of Melinna populations at the Romanian littoral was striking in comparison with their abundance in the North - the Gulf of Odessa or in the South - the Gulf of Varna, where the species formed a specific biocoenosis on the bottoms with fine alluvial muds, poor in shells (8, 12, 14, 15).

In 1976, while investigating the quantitative distribution of Mya arenaria L. populations on the Romanian continental shelf, we registered the presence of dense populations of Melinna in 15 stations out of the 88 performed; that made us consider that the distribution of this tube polychaete over a fairly large surface of the Romanian continental shelf (38o km^2) has taken place recently and can be considered as a major ecological event occurring within benthal populations (7).

The observations upon the populations of Melinna have continued yearly from 1976 to 1982 when we performed the first quantitative valuation of this polychaete.

METHODS OF WORK AND SAMPLES

From 1976 to 1981, the presence of the tubes of Melinna was registered yearly in the samples belonging to the network of stations meant for the study of Mya arenaria populations (7). Observations have been made on 11 profiles (Fig. 1, I-XI) ± perpendicular on the shore, in stations established at depths of 4 m,

9 m, 15 m, 22 m and 30 m and at 35 m depth since 1981. References to the stations are made by using the profile number and the depth (e.g., X/15 - points to the station situated at 15 m depth on profile X). In 1982 the quantitative samples containing tubes of Melinna were collected with Van Veen grab (1/20 m^2) and washed aboard through a sieve of 1 mm diameter meshes, all the material kept by the sieve being fixed and preserved in formaldehyde. All the tubes of Melinna from the samples were counted in the laboratory; all the individuals escaped from the tubes were counted as well. The percentage of the empty tubes was determined for each sample. As a rule, about 50 tubes were taken from each sample and controlled; the worms were carefully taken out of the tube and weighed on the analytical balance in order to establish the biomass.The structure of the Melinna palmata populations per classes of tube length was determined in some stations. In each station the density (D) and biomass (B) of Melinna were reported for 1 m^2.

The presence of Melinna tubes from the samples helped calculate the average frequency of the populations in each station studied from 1976 to 1982.

In order to discuss the results we will take into account a series of average values for density and biomass calculated per bathimetric zones and the following geographic sectors delimited by the parallels:

- the eastern sector of the Danube mouths (ED), between $44^{o}50'N$ - $45^{o}10'N$;
- the southern sector of the Danube Delta (SD), between $44^{o}40'N$ - $44^{o}50'N$;
- the central part (CP), between $44^{o}20'N$ - $44^{o}40'N$;
- the southern part (SP), between $44^{o}10'N$ - $44^{o}20'N$.

RESULTS AND DISCUSSIONS

From 1976 to 1982 the main distribution zone of Melinna palmata populations at the Romanian littoral was delimited by the parallel $44^{o}10'N$ (Constantza) and $45^{o}10'N$ (Sulina) and the isobath of 10m and 40m (Fig.1).In this large zone (nearly 3,800 km^2) Melinna permanently or temporarily occupied an area of about 3,000 km^2 (Table 1). The stable populations, whose frequency at

the end of seven years of observations was greater than 75% occupy a surface of about 1,1oo km^2; the populations in the process of settlement, with frequencies ranging from 50% to 75% occupy almost 1,3oo km^2, and those occuring occasionally with a frequency less than 50% were recorded only on 75o km^2. Only on 15.7% out of the bottoms delimited by the parallels of the localities of Constantza and Sulina and the isobath of 1o - 4o m Melinna was not recorded in the period from 1976 to 1982.

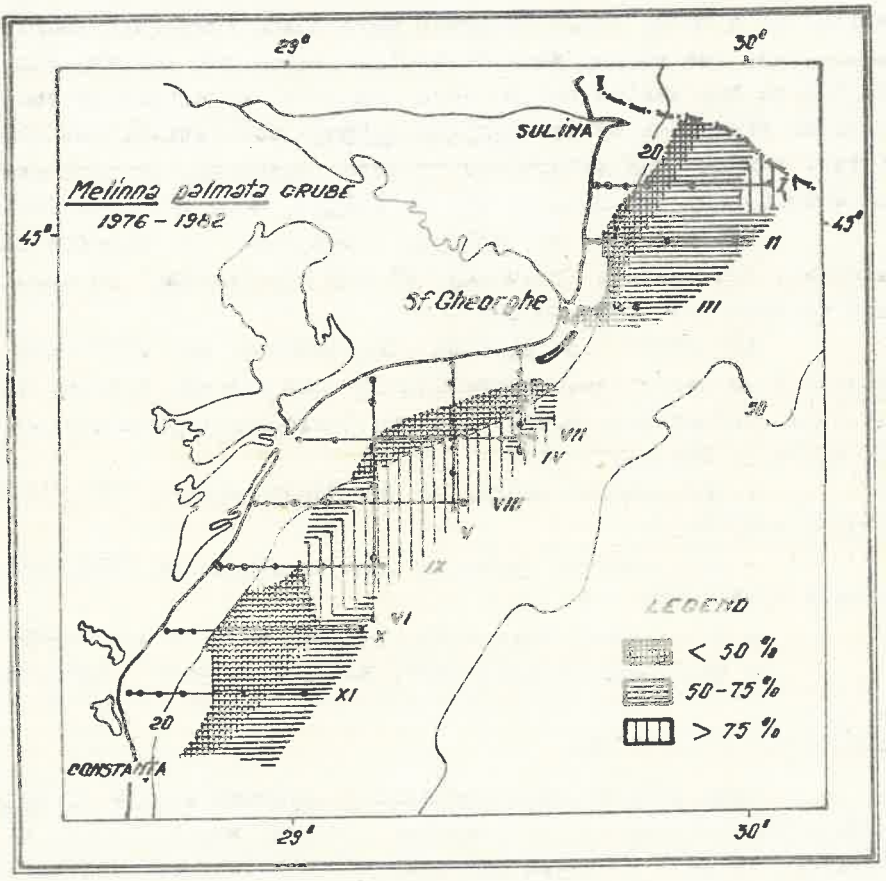

Fig.1 - Distribution of average frequencies of Melinna palmata populations studied in 1976-1982 in the stations of the 11 profiles on the Romanian littoral

Table 1

Areas of the bottoms with *Melinna palmata* populations on the Romanian continental shelf of the Black Sea

		Bathimetric zones 10-20 m	20-30 m	30-40 m	Total 10-40 m
Area of investigated bathimetric zone	km^2	786.8	1053.4	1930.4	3770.6
	%	21	28	51	100.0
Zones without *Melinna* in 1976 - 1982	km^2	369.8	105.3	115.8	590.9
	%	47	10	6	15.7
Zones with *Melinna* frequency less than 50%	km^2	417.0	337.1	-	754.1
	%	53	32	-	20.0
Zones with *Melinna* frequency 50-75%	km^2	-	316.0	965.2	1281.2
	%	-	30	50	34.0
Zones with *Melinna* frequency 75-100%	km^2	-	295.0	849.4	1144.4
	%	-	28	44	30.3
Total zones with *Melinna*	km^2	417.0	948.1	1814.6	3179.7
	%	53	90	94	84.3
Zones with *Melinna* in 1982	km^2	-	684.7	1563.6	2248.3
	%	-	65	81	60

The frequency of *Melinna* varied from one place to another but it was usually greater in the stations situated both at depths of 30 m and 35 m and in the middle sectors of the Romanian littoral (Fig.1 - profiles IV-IX). The general average frequency of *Melinna* populations was about 44%, but the average values in accordance with various depths are: 9% at 15 m depth, 47% at 22 m depths, 65% at 30 m and 73% at 35 m depth. In various sectors of the Romanian continental platform, the average frequency had the following values: 33% - the sector East of the Danube mouths, 52% - the sector South of the Danube Delta, 48% - the central part of the platform and 10% - the southern part. As a rule, the frequency or the stability of Melinna populations on the Romanian littoral decreases from North to South and from great depths of 30 - 35 m to the small ones of 15 m (Fig.2).

In 1982 the populations of *Melinna* were registered only in the deeper bathimetric zones (20-40 m); they occupied an area of over 2,100 km^2 (Table 1), and their average frequency was 73%. On the isobath strip of 22 m the frequency was only 54% (*Melinna* was not recorded in the stations I/22, II/22, III/22, IX/22 and

XI/22, but it rose to 82% in the zones of 30-35 m, where biomasses are much higher. The populations of Melinna can be considered to be widely spread at the Romanian littoral at present.

The quantitative estimations from 1982 have shown that the populations of Melinna palmata have very high densities and biomasses in many zones of the Romanian continental platform (Table 2).

Table 2

Densities (D - individuals/m^2) and biomasses (B - g/m^2) of the tube polychaete worm Melinna palmata at the Romanian Black Sea littoral in 1982

Stations	22 m		30 m		35 m	
	D	B	D	B	D	B
I	o	o	1,82o	58.24	5oo	24.82
II	o	o	1o	o.35	2,6oo	129.o6
III	o	o	o	o	o	o
IV	28o	5.96	13,566	285.o9	1o,72o	268.oo
V	6,18o	182.95	2,4oo	62.96	2,14o	63.56
VI	56o	18.79	4,825	164.o5	o	o
VII	6,11o	232:18	o	o	17,76o	577.91
VIII	6,24o	262.o8	6,96o	239.56	2,278	71.45
IX	o	o	1,19o	42.13	2,11o	67.52
X	78o	28.oo	54o	18.9o	1,2oo	5o.42
XI	o	o	41o	14.72	3,285	12o.89
Average $\bar{R}$	1,83o	66.36	2,884	8o.54	3,872	124.88
Average $\bar{A}$	3,355	121.66	3,524	98.44	4,732	152.62

Note: Average $\bar{R}$ - relative average (for all the stations);
Average $\bar{A}$ - absolute average (only for stations with Melinna)

Usually, as depth grows, the abundance of the populations grows too, the general averages rising to 1,83o individuals/m^2 - 66.36 g/m^2 for the isobath zone of 22 m, 2,884 individuals/m^2 - 8o.54 g/m^2 for the zone of 3o m and 3,872 individuals/m^2 - 124.88 g/m^2 for the isobath of 35 m. The average values of the densities and biomasses estimated for various sectors of the investigated area show that the greatest abundance of Melinna is on the bottoms situated in the southern sector of the Danube Delta (SD) and in the central part (CP) (Table 3).

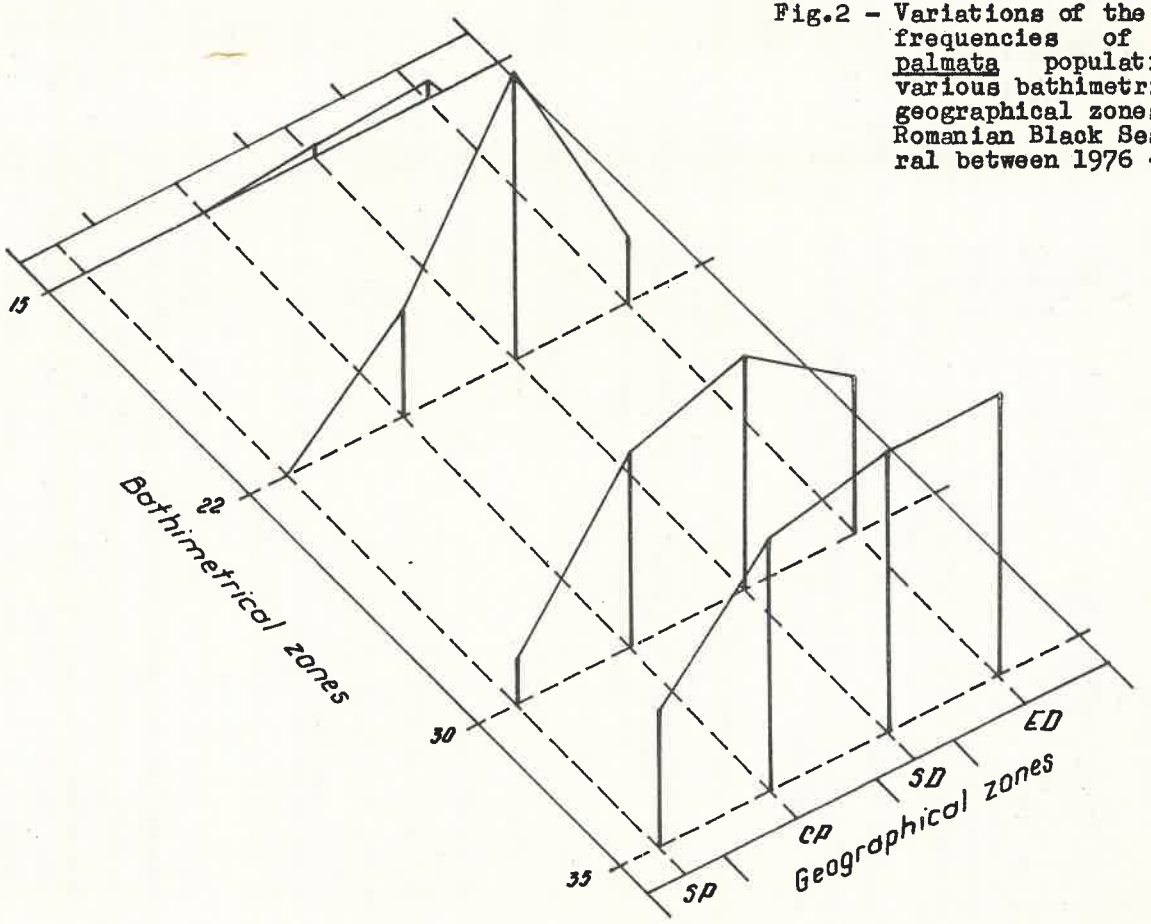

Fig.2 - Variations of the average frequencies of Melinna palmata populations in various bathimetrical and geographical zones of the Romanian Black Sea littoral between 1976 - 1982

Table 3

Average densities (D - individuals/m^2) and biomasses (B - g/m^2) of the Melinna palmata populations registered in various sectors of the Romanian littoral in 1982

Sectors	20 - 30 m		30 - 40 m		20 - 40 m	
	D	B	D	B	D	B
East Danube mouths (ED)	305	9.8	822	35.4	705	29.6
South Danube Delta (SD)	3,138	105.3	8,870	289.0	5,986	196.4
Central Part (CP)	3,582	106.4	4,310	117.0	3,974	112.1
South Part (SP)	432	15.4	1,350	51.2	1,037	39.0
Average of the zone	2,171	66.4	2,418	77.0	2,331	73.2

The average densities and biomasses we recorded in 1982 at the Romanian littoral are usually much higher than those presented in 1975 for other sectors synthetized by LOSOVSKAIA (11) and completed by us afterwards (Table 4).

Table 4

Dynamics of the average values for the densities (D - individuals/m^2) and biomasses (B - g/m^2) of Melinna palmata populations in various sectors of the North-Western part of the Black Sea

Sectors	1958-1960		1971-1975		1982	
	D	B	D	B	D	B
Karkinits Bay	230	1.8	242	3.2	-	-
Zone between Dniepr - Dniestr	674	11.9	856	173.6	-	-
Front of Dniestr River	70	0.9	137	27.9	-	-
Front of Danube River (Kilia)	7*)	0.2*)	170	18.7	-	-
Front of Danube Delta	200*)	9.0*)	-	-	1,232	53.1
Chituc - Cap Midia sector (Profiles VIII-X/20-35 m)	730*)	26.2*)	-	-	2,618	98.4

*) Singular values (maximum)

Based on the analysis of the average data presented above (Table 4), we can conclude that Melinna populations have become much more abundant since 1970 not only at the Soviet littoral - their typical spreading zone some time ago, but also at the Romanian shore - where they were usually scarce. If we consider the maximum values recorded at the Romanian littoral in 1982 (Station VII/35: over 17,000 individuals/m^2 and 570 g/m^2; Station

IV/3o:over 13,5oo individuals/m^2 and 28o g/m^2etc.) the conclusion is that they are remarkably high in comparison with those registered by other authors (4,5,6,9,1o,11,12,13,17). For example, the maximum values for the Soviet and Bulgarian littoral were of only 6,31o - 8,3oo individuals/m^2 and 8o - 3oo.o g/m^2 close to Odessa and 1,782 individuals/m^2 and 24.o g/m^2 in the Gulf of Varna (in 1982 the densities in 14 stations, at the Romanian littoral, out of 23 with Melinna exceeded 2,ooo individuals/m^2, and the biomasses were over loo g/m^2 in lo stations!).

The prosperity of the Melinna palmata populations in the last few years in the Black Sea generally and at the Romanian littoral particularly can be correlated with the appearance of new ecological conditions (7,8), that is with an increase in the quantity of particulate organic matter.In consequence of the more and more frequent and ever ampler "blooming"of waters with phytoplankton species, a great quantity of organic detritus is accumulated on the sea-bed.This detritus is an ideal food for a "deposit feeder" like Melinna, which gather food particles at the surface of the sediment ingesting mud; in addition, this form has a great capacity of bearing great oscillations of oxygen concentration. Hypoxy which has occured with an increasing frequency in the north - western part of the Black Sea during the last few years, also as a consequence of the processes of eutrophication/pollution - "blooming" - mass mortalities etc. (7, 8), did not affect Melinna which can stand the diminishing of oxygen down to temporary anaerobiosis and appearance of H_2S (6).

The exuberant development of Melinna populations at the Romanian littoral is an ecological event of great theoretical and practical value. The prosperity of the populations of Melinna worms is a homeostatic answer of the ecosystem influenced by the numerous ecological pressures exerted in the past lo-15 years, a positive answer through which the benthal productivity greatly, affected by mass mortalities and extinction of species is restored.

The populations of Melinna palmata reduce the quantity of organic matter accumulated in sediments, which is a secondary source of pollution,the organic detritus being highly transformed and incorporated as biomass into the body of the polychaete.If we

consider that in 24 hours Melinna deposits a mass of fecal ooze equal to 500-1,000 % of its mass (6) and that the above mentioned mass represents only 60 % of the whole quantity of ingested mud (40 % being assimilated), the conclusion is that a population with an average biomass of 73.2 g/m^2 - the general average biomass for the Romanian littoral in 1982 (Table 3), can process 610 - 1,220 g mud/m^2/day, the maximum quantity of mud processed by the most abundant population we have recorded (Station VII/35-577.91 g/m^2) can reach 4.8 - 9.6 kg mud/m^2/day.

The development of the populations of Melinna represents the formation of a new benthal trophic basis for demersal fishes, similar to the one in the northern part of the north-western sector of the Black Sea between Odessa and Tendra at 15 - 30 m depth, which feeds fishes such as Acipenser stellatus PALLAS, Pleuronectes flesus luscus PALLAS, Mullus barbatus ponticus ESSIPOV, Odontogadus merlangus euxinus NORDMANN (6). VINOGRADOV (14) shows that the muddy zone with Melinna in the Odessa sector, the so-called "pit of the sturgeons" is used as a wintering place by the sturgeon Acipenser stellatus and Melinna palmata is its favourite food. To what extent Melinna is a potential source of food for fishes can be estimated from the value of the stock.

The stock of Melinna palmata we calculated in 1982 (Fig. 3) rises to almost 220,000 tons (calculations were based on the average values of wet weight of worms, without tubes); this stock is irregularly distributed over a surface of about 3,000 km^2. In front of the Danube mouths, on over 37.4% of the bottoms with Melinna there is 15.2% of the stock (Table 5); in the sector South of the Danube Delta as well as in the central sector which represent 43.5% of the bottoms there is 74.6% of the stock, and towards the South in the sector Cap Midia (X) - Constantza (XI) which represents 19.1% of the bottoms with Melinna only 10.2% of the stock is concentrated (Table 5). It is obvious that the highest concentration of Melinna per unit of surface can be found in the sector South of the Danube Delta which is a sector preferred by sturgeons and also a zone for fishing them; but Melinna is an ideal food for sturgeons in general (6, 14) and particularly nowadays when we witness a great decrease in their favourite food which was abundant 10 - 15 years ago.

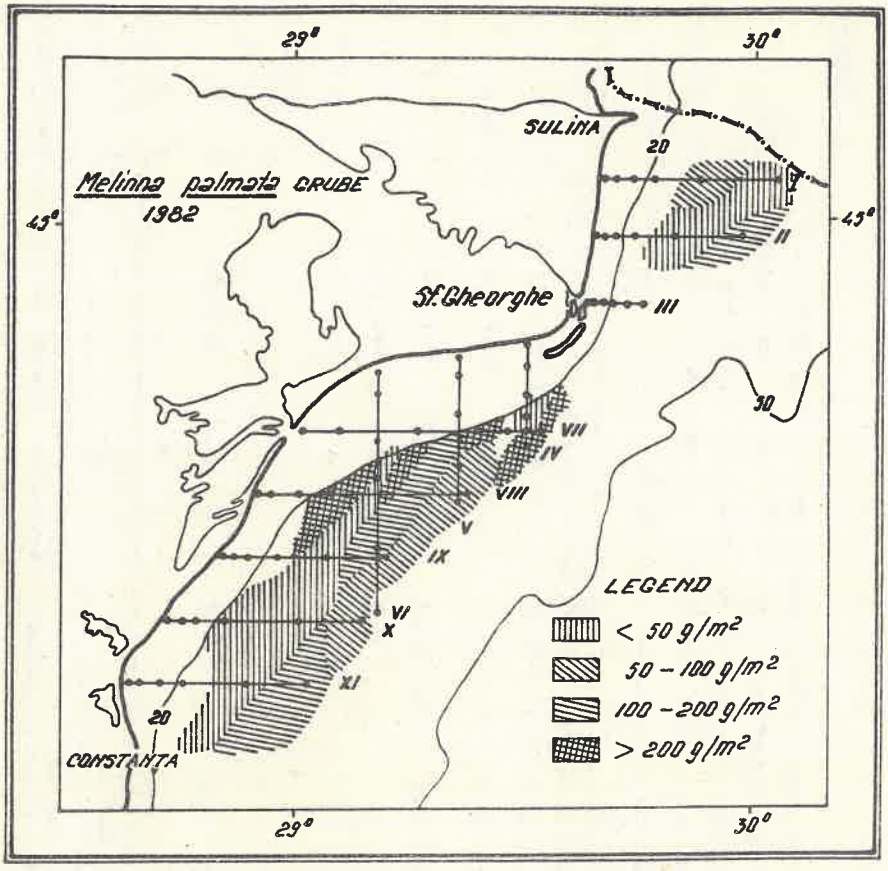

Fig.3 - Quantitative distribution of the tube polychaete Melinna palmata populations at the Romanian littoral in 1982

Table 5

Percentage distribution of the muddy zones with Melinna (S%) and of Melinna palmata stocks (T%) in various sectors of the Romanian littoral

Sectors	20-30 m		30-40 m		20-40 m	
	S%	T%	S%	T%	S%	T%
East Danube mouths (ED)	8.4	1.1	29.0	14.0	37.4	15.2
South Danube Delta (SD)	3.6	5.1	3.5	13.9	7.1	19.0
Central Part (CP)	16.8	24.4	19.6	31.3	36.4	55.6
South Part (SP)	6.5	1.4	12.6	8.8	19.1	10.2
Total	35.3	32.0	64.7	68.0	100.0	100.0

Table 6

Average values for frequencies(f%), densities (D - individuals/m^2), biomasses (B - g/m^2) and density indices (Id = $\sqrt{f.B}$) of the macrobenthic forms recorded in 1982 at different depths at the Romanian Black Sea littoral

Species	22 m				3o m				35 m			
	f%	D	B	Id	f%	D	B	Id	f%	D	B	Id
Melinna palmata GRUBE	54.5	1,83o	66.36	6o.2	81.8	2,884	8o.54	81.1	81.8	3,872	124.88	1o1.1
Mya arenaria L.	81.8	81	581.8	218.2	81.8	19	161.8	115.o	45.4	22	181.o	9o.7
Mytilus galloprovincialis LAM.	36.4	8o	6o.4	46.9	54.5	19	31.5	41.4	63.6	231	324.o	143.5
Cardium edule lamarcki REEVE	27.3	8	2.5	8.2	27.3	4	2.8	8.7	18.2	1	o.2	1.9
Paphia rugata (B.D.D.)	-	-	-	-	9.1	2	2.4	4.7	18.2	3	6.o	1o.4
Spisula subtruncata (RENIER)	-	-	-	-	-	-	-	-	9.1	1	o.7	2.5
Cardium paucicostatum MIL.	-	-	-	-	-	-	-	-	9.1	1	1.5	3.7
Nassarius reticulatus (L.)	9.1	1	o.1	1.o	9.1	1	o.6	2.3	27.3	5	3.4	9.6
Abra alba WOOD	9.1	1	o.1	1.o	-	-	-	-	-	-	-	-
Total Molluscs	-	171	644.9	-	-	45	199.1	-	-	264	516.8	-
TOTAL MACROBENTHOS	-	2,ool	711.26	-	-	2,929	279.64	-	-	4,136	641.68	-

Besides the valuation of the Melinna stock in 1982 the stock of Molluscs was estimated in the same zone and their value was approximately 1,166 x 10^3 tons. If we subtract Mya arenaria from the stock (662 x 10^3 tons) - a "new" species in the Black Sea - there are still 504 x 10^3 tons of Molluscs out of which mussels (Mytilus galloprovincialis) form 95%(but is less consumed by fishes); the other species considered to be the food preferred by fishes had an extremely low stock in 1982 - about 24,000 tons. Species such as Syndesmia fragilis, so much hunted by sturgeons (14) have not yet been found in our samples this year.

The disappearance or decrease of the Molluscs populations which were a trophic basis of great importance for demersal fishes seems to be counterbalanced first by Melinna and then by Mya arenaria, both species proving great resistance under the actual ecological conditions.

Taking into account the present spreading and abundance of Melinna palmata over such a large surface of the Romanian continental platform, we can appreciate that a new biocenosis has formed on the muddy bottoms lately. At the beginning of the 197os it was known that the biocenosis of the muds with Melinna palmata mentioned in several variants and in various sectors of the Black Sea (2, 9,1o, 12,13, 15, 16, 17) did not appear anywhere in front of the Romanian coasts (2). But, we do not have enough elements at present (data concerning the qualitative and quantitative composition of the meiobenthos are lacking) to characterize a real community of muds with Melinna palmata.

Among the macrobenthic species on the bottoms with Melinna at the Romanian littoral, the polychaete is the dominant form in density and the dominated one in biomass (Table 6). Thus, at any depth Melinna represents over 90% of the density of macrobenthic forms, but only 9% at 22 m depth, 29% at 3o m depth and 19.5% of their biomass at 35 m depth.

According to the average values (Table 6), the biomass of macrobenthos at depths of 22 and 3o m is dominated by Mya arenaria (82% and 58% respectively), and by Mytilus galloprovincialis (5o.5%) at 35 m depth;the rest of the Molluscs are scarce. We mention that, besides Melinna palmata, other polychaete worm

species were also present in the samples, but their quantities were small (Table 7); it is certain that, when the samples are washed, many polychaetes pass through the 1 mm sieve and consequently the presented values must be considered as being smaller than the real ones. On the basis of these values we estimated that the stock of other species of polychaetes in zones with Melinna was over 21,000 tons in 1982, which is not a very small figure.

Table 7

Average values for frequency (F%), density (individuals/m^2) and biomass (B - g/m^2) of other macrobenthic polychaete species, recorded in the zones with Melinna palmata in 1982

Sectors	20-30 m			30-40 m			20-40 m		
	F%	D	B	F%	D	B	F%	D	B
East Danube mouths (ED)	83.3	118	8.22	66.7	23	1.46	77.7	44	2.98
South Danube Delta (SD)	80.0	114	7.89	66.7	40	4.17	83.3	77	6.04
Central Part (CP)	80.0	81	21.60	63.6	56	5.83	68.8	68	13.10
South Part (SP)	50.0	60	8.51	50.0	19	1.47	50.0	33	3.87
Total	79.2	89	14.59	62.5	33	2.93	70.8	53	7.05

As the values of the density index (Id - square root of the product of frequency and biomass) show, on the oozy bottoms with Melinna the tube polychaete comes second in importance after Mya arenaria among the macrobenthic forms at depths of 22 m and 30 m, and in the third place, at 35 m depth, after Mytilus and Mya (Table 6). If the present ecological conditions do not change, the populations of Melinna palmata might develop and extend, and consequently their importance increases.

A few general observations about the populations that have been analysed will be made in the following lines. First, we established that there were empty tubes, without Melinna, in almost all the samples - exceptions were few (Stations IV/22 and VI/22). We mention that there is no question of tubes abandoned by animals during the preserving of the samples with formaldehyde, because these tubes were considered (the number of the polychaetes found free in the sample - very few, however - were subtracted from the number of empty tubes that had been registered). The

number of empty tubes varied from one sample to another, but on an average they represented 15.0% at 22 m depth, 27.5% at 30 m depth and 17.7% at 35 m depth of the analysed population. For the moment we do not know either the causes of the abandonment of the tube by the animal or "the life" of empty tubes in the structure of the sediments. The observations made by DRAGOLI (4, 5, 6) upon Melinna do not fully clear up the problems of the sedentary life of this polychaete.

Another observation referred to the tube length of Melinna, which also varies from one station to another. The average general structure of the analysed populations, per classes of tube length was as follows: 3.6% - 50 mm, 6.4% - 60 mm, 8.9% - 70 mm, 10.9% - 80 mm, 12.8% - 90 mm, 16.5% - 100 mm, 20.0% - 110 mm, 8.9% - 120 mm, 5.9% - 130 mm, 2.8% - 140 mm, 1.4% - 150 mm, 0.6% - 160 mm and 0.6% - 170 mm. In most of the stations the tube length varied from 60 mm to 130 mm. No correlation has been established between the length of the tube and the length of the animal. Concerning the weight, the tube is usually about 11 times heavier than the inside animal (0.3524 - 0.5573 g vs. 0.03136 - 0.04637 g). In order to establish the biomasses, the animals extracted from the tubes were weighed in each station, as a rule taking into account the individual variations in weight. The general average weight of one individual of Melinna palmata was 0.0311 g, and the average weights of individuals of various length were: 0.016355 g - +20 mm, 0.025466 g - +30 mm, 0.033662 g - +40 mm and 0.046002 g - +50 mm (exceptionally we found an individual of 55 mm length weighing 0.0711 g).

There are still problems referring to the biology and ecology of the tube polychaete Melinna palmata, which are less known. Having become a mass species in a relatively short period in which other species disappeared or reduced their populations, Melinna palmata will have to be better studied in all its aspects in the future.

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