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Relations Between the Respiration and Filtration Intensity of Mytilus Edulis from the Southern Baltic Sea

by

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The problem of filtration as one of the methods of animal nourishment and the problem of respiration intensity (oxygen demand) absorbed the attention of many scientists. Until now both processes have been most frequently studied separately, and even the results of investigations were often derived from one definite season.

Having in view that both these processes are simultaneous in the organism of Mytilus edulis and their subject is the same water, as well as the anatomic filter-respirative organ is the same, it was intended, therefore, to investigate whether there exists any correlation between the two processes mentioned.

In the years 1961-1962 investigations on the intensity of respiration and filtration of Mytilus edulis were carried out in a wide seasonal aspect. We wanted to show especially the intensity changes of these processes in relation to changing seasonal conditions of environment.

The investigations on respiration intensity were based on the methods (Krogh et al) consisting in the water flowing through a chamber containing organisms subject to investigations. The quantity of water was applied in limits 900-1000 ml per hour, constantly during one experiment. This quantity of flowing water was sufficient to show the real changes in oxygen content in the experimental and control samples. The application of flowing water was necessary because in the chamber there were some (5-6) individuals, which did not begin the respiration (the opening of shells) at the same time. The oxygen content in the water was determined according to Winkler's method.

The tests on filtration intensity were based on the method given by Voskresenskiy, modified by the author. The modification and improvement of the method were introduced by the application of Pulfrich photometer for determination of concentration of suspension which enables to eliminate the inconvenient drying and weighing of the filtered suspension. In these experiments the single individuals of sea mussel were placed in each of the vessels.

All results obtained dealing with the respiration and filtration intensity were based in relation to 1 cm^3 of the whole organism mass to get the comparable data. The correlation between these processes was determined on the basis of arithmetical means from several variants of experiments.

In the year 1961 four fundamental seasonal series of experiments were made simultaneously on respiration and filtration and in 1962 also, two comparative, as well as seasonal series, were made. In every series of experiments in 1961 6 variants were applied, while in 1962 only one, the first variant. From each variant 6 repetitions were taken by accidental choice. Results of these repetitions were used for further determination.

The variants of the experiment in the year 1961 were as follows:-

The 1st variant - the low concentration of the organic and mineral suspension similar to natural conditions in the calm state of sea. Temperature and salinity were chosen respectively to seasonal ones.

The 2nd variant - the high concentration of organic and mineral suspension, similar to the sea state of littoral zone in stormy weather; temperature and salinity seasonal.

The 3rd variant - the low concentration of organic suspension; temperature and salinity seasonal.

The 4th variant - the low concentration of mineral suspension; temperature and salinity seasonal.

The 5th and 6th variants - the low concentration of organic and mineral suspension; salinity - seasonal.

In these variants of the experiments the temperature in a particular season was as follows:-
in February artificially heightened to about 10°C and to 18°C; in May reduced to about 3°C and heightened to about 18°C; in August reduced to about 10°C and about 3°C; in November such as in May.

The author's investigations show that the seasonal changes of respiration and filtration are essential. At first let us analyse the correlation between the respiration and filtration intensity on the results of the first variant (Table 1) in February, May, August and November 1961, and February and May 1962. The direction of arrow shows either the increase or decrease of the process of intensity in relation to the previous season. The concurrence of arrow directions indicates the identicaldevelopment of the process; the contrary directions of the arrows show the different development. This allows us to conclude (though to a limited degree) on the existence correlation or its lack, giving however, no evidence with regard to the degree of correlation. There are two incompatibilities in the direction of arrows and the statistical correlation coefficient is very low (0,2214), its statistical index being smaller than 3. These data show that there is no correlation between the respiration and filtration intensity in the experimental conditions similar to natural conditions of the environment in different seasons.

From the same point of view all the variants of experiments and all the results obtained were analyzed (Table 2). This table shows that in February and November there are less incompatibilities (only 1 in each case) in the processes, whereas in May 3. The correlation coefficients and their statistical indices give the possibility of concluding that the significant degree of correlation between the respiration and filtration intensity is in February (0,7080), smaller in August (0,5185) and almost no correlation in May and November. The correlation coefficient determined for all the experiments in 1961 is very little (0,3298). Therefore, estimation of the correlation between these processes during the whole year is uncertain, particularly in view of the fact that experiments were carried out partly in artificial conditions, not typical of the respective seasons.

The striking fact is the great concurrence of the intensity of these processes in variants of conditions more or less not typical of the respective season (Table 2, arrows with "x"). The same fact is observed in seasons (winter and summer) with the unfavourable conditions for the biology of Baltic Sea Mussel. Also here we can observe that the concurrence of the processes mentioned is very significant, which is evidenced by the correlation coefficients of February and August 1961.

In summary we arrive at the following conclusions:

1) There was no real correlation between respiration and filtration intensity in the conditions similar to natural ones in the cyclic observations made during a year in the same intervals of time. Such conditions give a possibility to the organism of Baltic Sea Mussel to regulate the intensity of the processes so that one of them would be unproportional to the quantity of water filtered by the Baltic Sea Mussel. This process is the respiration, because the filtration intensity is proportional to the quantity of water pumped by the organism.

2) The seasons in which there are unfavourable conditionsfor the biology of Baltic Sea Mussel as well as the conditions artificially made unfavourable influence the positive correlation between respiration and filtration intensity, i.e. under unfavourable conditions the degree and way of organism reaction in both processes is very similar.

Table 1.

Fluctuations of Respiration and Filtration Intensity
in the Experimental Conditions Similar to Natural Conditions

	Respiration	Filtration	The incompatibilities number of arrow directions	Correlation Coefficient	Statistical index of Correlation Coefficient
February 1961	↘ 0,0203	↘ 0,0123			
May 1961	↗ 0,0414	↗ 0,0337			
August 1961	↘ 0,0227	↗ 0,0540			
November 1961	↘ 0,0110	↘ 0,0324	2	0,2214	0,49<3/1,31<3
February 1962	↗ 0,0221	↘ 0,0113			
May 1962	↗ 0,0408	↗ 0,0369			

Table 2

Fluctuations of Respiration and Filtration Intensity in Several Seasons on the Basis of the Results of all Experiments Variations

1961								The incompatibilities number of directions of arrows	Correlation coefficient	Statistical index of correlation coefficient
February		May		August		November				
R	F	R	F	R	F	R	F			
0,0203 ↗	0,0123 ↗	+ ↘ 0,0218	+ ↘ 0,0049	+ ↘ 0,0143	+ ↘ 0,0008	+ ↘ 0,0094	+ ↘ 0,0074			
+ ↗	+ ↗	↗	↗	+ ↗	+ ↗	↗	↗			
0,0450 ↘	0,0129 ↘	0,0414 + ↘	0,0337 + ↘	0,0289 ↘	0,0559 ↘	0,0110 + ↗	0,0324 + ↘			
+ ↘	+ ↘	0,0250 ↗	0,0260 ↘	0,0227 ↗	0,0540 ↘	0,0201 ↘	0,0258 ↘			
0,0115 ↗	0,0015 ↘	0,0491 + ↘	0,0113 + ↗	0,0346 + ↗	0,0139 + ↗	0,0154 + ↗	0,0130 + ↗			
0,0187 + ↗	0,0011 + ↗	0,0402 + ↗	0,0251 + ↘	0,0405 + ↘	0,0437 + ↗	0,0156 + ↘	0,0243 + ↘			
0,0223 + ↘	0,0098 + ↘	0,0492	0,0164	0,0394	0,0772	0,0103	0,0180			
0,0126	0,0043							7	0,3298	1,58 < 3 3,94 > 3
1		3		2		1		The incompatibilities number of directions of arrows		
0,7080		0,1387		0,5185		0,3242		Correlation coefficient		
1,58 < 3/4,18 > 3		0,31 < 3/0,82 < 3		1,16 < 3/3,06 > 3		0,12 < 3/1,91 < 3		Statistical index of correlation coefficient		

R - respiration
F - filtration