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THE PERIODS OF MAXIMUM OSCILLATIONS OF THE BIVALVE CORBULA MEDITERRANEA (COSTA) DENSITY

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A b s t r a c t

On the basis of the mathematical method of self-correlation the multiannual periods of the maximum variations of the bivalve *Corbula mediterranea* density at Mamaia (Romanian Black Sea littoral) are established. These periods are : 3.1 years for *Corbula* populations at a depth of 4 m, 11.5 years for those at a depth of 8 m and 6.9 years at a depth of 12 m.

It is well known that the densities and biomasses of organisms are subject to permanent oscillations, from month to month, from year to year, and from a period of years to another period, because of both the biological rhythms of the species and the influence of ecological factors. The biorhythms and the oscillations of environmental factors have different periods, but they interfere and act as a polyharmonic process, which is reflected in the multiannual variations of the density or the biomass.

The monthly or yearly variations of the bivalve *Corbula mediterranea* (COSTA) densities and biomasses - the most important psammobiontic species on the Romanian littoral, were well analysed in a series of papers (BACESCU & Others, 1965, 1967 ; GOMOIU, 1965 a,b, 1966, 1972).

Another aspect of the species dynamics, namely the periods of maximum oscillation of density, will be discussed in the present its paper. The analyses are based upon a series of data representing the density values of Corbula mediterranea, recorded at Mamaia during the 1960–1965 period (GOMOIU, 1965, a, b, 1966, 1972)

To determine the natural periods of the data series representing the bivalve Corbula densities, the self-correlation method was applied (SEREBREANYKOV & PERVOZVANSKY, 1965). The method consists of the following :

It is considered that the data series is given as a trigonometric series, which has the following formula :

$$x(t) = \sum_{i=1}^{n} A_i \cos \frac{2\pi . t}{T_i} \qquad (1)$$

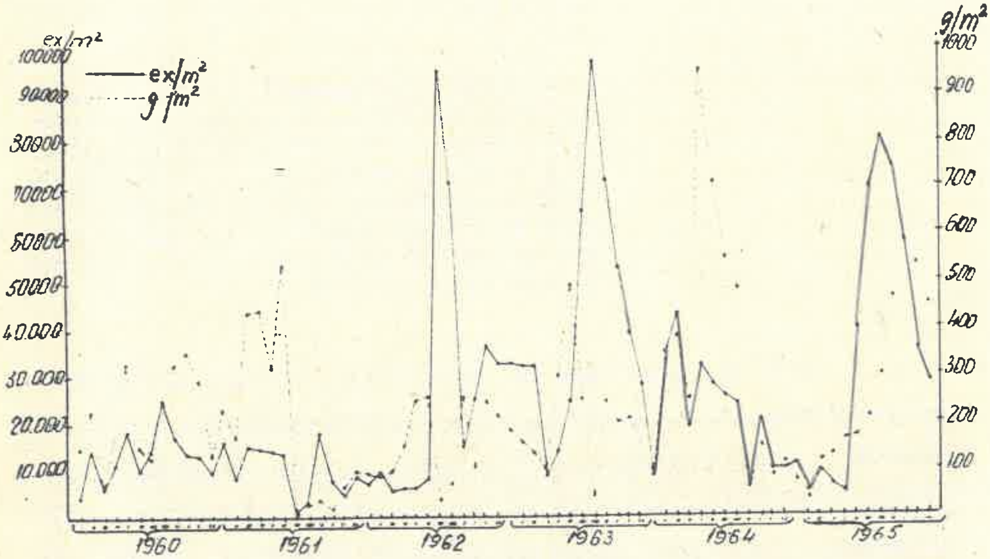


Fig. 1 – The variations of the Corbula mediterranea bivalve density (ex./m^2) and biomass (g/m^2), at P_2, a depth of 4 m, in Mamaia zone during the 1960–1965 period

Where x is the density (specimens/m^2) ; A_i – the amplitude for the T_i period (T_i are the different natural periods of the density variation) ; t – the magnitude of time interval from the beginning of the observations.

The self-correlation coefficient is determined according to the formula :

$$c(t) = \frac{1}{2a} \int_{-a}^{+a} x(\tau) . \ x(\tau + t)\, d\tau \qquad (2)$$

Where a is the semi-length of the summing interval.

The integral was, practically, replaced by a sum.

It is known that, if x is given by the formula (1), then the self-correlation coefficient (c(t)) is given by the equation :

$$c(t) = \sum_{i=1}^{n} A_i^2 \cos \frac{2\pi . t}{T_i} \qquad (3)$$

As it is seen in formula (3), the self-correlation coefficient has its components with the same periods as the initial product, but its amplitudes are equal with the square of the initial process amplitudes.

The small amplitudes can be neglected in comparison with the great ones because in the self-correlation coefficient the amplitudes are squared. To have a smaller error, the self-correlation coefficient is considered as an initial process and its coefficient of correlation is determined, obtaining thus the second self-correlation coefficient :

$$c_1 (t) = \sum_{i=1}^{n} A_i^4 \cos \frac{2\pi . t}{T_i} \qquad (4)$$

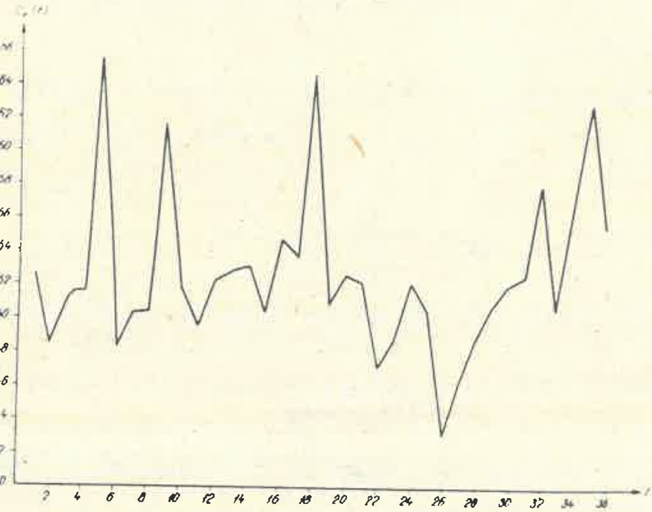
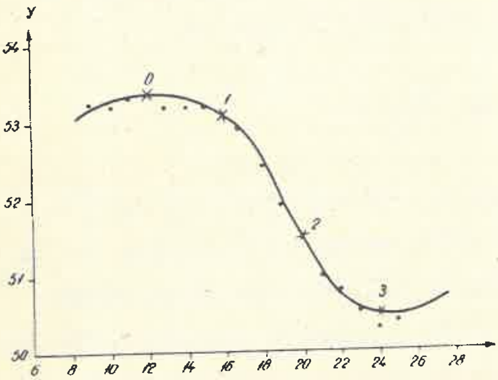


Fig. 2 - The curve of the second sliding mean of the second self-correlation coefficient

The process can be repeated untill the most of harmonics are eliminated. Sometimes, after a number of interations, the sliding mean is also determined to have a better filtration. The obtained results can be approximativeIy represented by the formula :

$$Y = B + A \cos \frac{2\pi . t}{T} \tag{5}$$



Where B is a constant, due to the summings, A a constant

Fig. 3 - The curve for the second self-correlation coefficient

depending upon the value of the highest amplitude and T is the variation period with the highest amplitude.

Essentially, this is the method of natural-periods determination. We must mention that the calculating way for the period determination, applied by us, permits the estimation of some periods whose magnitude can exceed 2-3 times the observation interval. T is determined from the formula (5) as follows : the interval on the y curve is divided in 4 equal parts (fig. 3) ; one interval length being equal with Δt which in our case, $\Delta t = 200$ days.

The following values are obtained from the diagram (fig. 3) : Y_o, Y_1, Y_2. and Y_3. The coefficient K is obtained on the basis of these values :

$$K = \frac{y_3 - y_0}{y_2 - y_1} \tag{6}$$

The period T is determined, using this coefficient, from the formula :

$$T = 2\pi \frac{\Delta t}{\sqrt{3 - K}} \tag{7}$$

For example, we present the values obtained by the processing of data of the depth of 4 meters (P_2) :

$$y_0 = 53,35 \; ; \; y_1 = 53,10 \; ; \; y_2 = 51,45 \; ; \; y_3 = 50,45$$

$$K = \frac{50,45 - 53,35}{51,45 - 53,10} = \frac{-2,90}{-1,65} = 1,75 \qquad (8)$$

$$T = 2.3,14 \frac{200}{\sqrt{3-1.75}} = 2.3,14 \frac{200}{1.12} = 1120 \text{ days} = 3.1 \text{ years}$$

The periods calculated for the other depths were :

- 11.5 years at P_3 - 8 meters.
- 6.9 years at P_4 - 12 meters.

Using the same method and the same error degree we found that the period of maximum variation is very different from one depth to an other (excluding the annual variations). Generally we may assume that :

- at a depth of 4 meters the influence of environment factors, especially the dynamic ones, is maximum, which makes the period of the highest variations to be short ; approximatively 3 years, this representing almost two biological cycles ;

- the zone at a depth of 8 meters, where one notices the maximum period of the variation (11 - 12 years), would be the zone of optimum stabilization of the density, because the influence of dynamic factors is greatly decreased. It is interesting to remark that, at a depth of 8 meters, the period of maximum oscillation corresponds to the principal period of the sun spots activity. This correspondence must be interpreted in the sense of the equality of these periods, but the phases should be different. In our exemple, because of the short series of data and of the lack of an adequate initial method, it has not been tried to determine the phase difference of these oscillations.

- as a paradoxical fact we note that at a depth of 12 meters, the period of maximum variation is smaller than at 8 meters, although the dynamic and thermal conditions are more stable.

However, reasons which determine these differences noticed at one and the same species in an enough restrained zone, are, for the moment, difficult to establish and that is why the accurate study and the carrying on of the observations, in time and space, are necessary.

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