OCEANOLOGIA, 28, 1990
PL ISSN 0078-3234

The production characteristic of the phytobenthos of the Gulf of Gdańsk

VERA B. VOZZHINSKAYA
Botanical Institute,
Academy of Sciences of the USSR,
Leningrad

MARCIN PLIŃSKI
Institute of Oceanography,
University of Gdańsk,
Gdynia

Phytobenthos plays a very important role in the complex of the ecological interdependences of each water ecosystem, especially the marine one. This role in the coastal ecosystem structure consists in creating excellent conditions for the development of many animals. Hence, a disturbance of the stability of plant communities may lead to irreversible changes in other elements of coastal biocenoses.

The Gulf of Gdańsk, and especially its part – the Puck Bay, is a basin where due to specific hydrological and geomorphological conditions of the sea bottom the phytobenthos flourished. These conditions also caused that the eutrophication process affected the changes in the composition of benthic vegetation and in the ranges of overgrowing area. The Gulf of Gdańsk over the last 20 years was strongly influenced by the high anthropopression, and the changes in the phytobenthos are very evident (Pliński, 1982; Pliński, Florczyk, 1984b). The most important are:

– decrease in the number of species especially of red algae and reduction of *Furcellaria fastigiata* and *Fucus vesiculosus*;

– decrease of the vertical range of occurrence;

– decrease of biomass with the simultaneous increase of percentage of biomass of *Ectocarpaceae*.

Similar phenomena were observed in other coastal waters of the Baltic (Kristiansen, 1973; Kukk *et al*, 1984).

The number of taxa of macroalgae recorded in the Gulf of Gdańsk at present differs significantly from that given by the authors of previous papers. Lakowitz (1907) found 95 species including blue-green algae. Considering the changes in taxonomy and excluding the blue-green algae, 71 taxa of benthic algae were observed at the beginning of this century. All epiphitic algae are included in this figure. In 1979 – 1980 Pliński and Florczyk (1984a) found 35 species of macroalgae in total which were represented by 23 species of green, 4 of brown, and 8 of red algae. After four years, in 1984 – 1985, further lack of certain species was noticed (Pliński, Florczyk, in press). Only 25 species, 17 of green, 2 of brown, and 5 of red algae were found over this period. Such taxa as, for example, species of the genera

Dictyosiphon, *Scytosiphon* and also *Chorda filum* (L.) Stackh, *Rhodomela confervoides* (Hudson) Silva, *Polysiphonia violacea* (Roth) Greville, *Ahnfeltia plicata* (Hudson) Fries, have not recently been found. Relating to the status in the sixties (Kornaś *et al*, 1960; Ciszewski *et al*, 1962), the abundance of *Fucus vesiculosus* and *Furcellaria fastigiata* in the south-west part of the Puck Bay decreased, and in some area we noticed a lack of this two species. On the other hand the abundance of brown seaweeds of the *Ectocarpaceae* family increased. These phenomena suggest eutrophication of the Gulf (Pliński, Wiktor, 1987).

Another example of long-term changes in the phytobenthos consists in a decrease of the vertical range of occurrence. Lakowitz (1907) and Demel (1935) stated that 25 m was the maximum depth of algae occurrence in the Gulf of Gdańsk. According to Kornaś and Medwecka-Kornaś (1973), this depth was 18 m, while in 1980 it decreased to 9 m (Pliński, Florczyk, 1984b), but in 1984 to 6 m only (Pliński, Florczyk, in press). It is probable that this decrease of maximum depth of macroalgae range resulted from a decreasing transparency of water due to an increase of the suspended organic matter. This phenomenon should be connected with the intensity of the photosynthesis and respiration processes of the macroalgae growing in the Gulf of Gdańsk. The dominating group of macroalgae in the Gulf of Gdańsk is now the species of *Ectocarpaceae*. The optimum of light intensity for photosynthesis of this group was examined in a laboratory experiment and determined as 1500–2000 lx (Latała, 1982). An increase in light intensity did not cause the increase of the photosynthetic activity. The intensity of photosynthesis at a given value of illumination was 0.1–1 µl O_2/mg of dry mass. These investigations show that the algae of the family *Ectocarpaceae* have a high accommodation ability to the low transparency of water, what allows them to grow under the shadowed light conditions.

A decrease in the mean biomass from 37.43 g/m^2 in 1977 (Pliński, 1982) to 20.5 g/m^2 in 1984 was noticed (Pliński, Florczyk, in press). The percentage in this biomass of the *Ectocarpaceae* went up three times (Pliński, Florczyk, in press).

The similarity in the species composition of brown algae, their ecology, and biophysiological characteristics between the Baltic Sea and the White Sea allowed to use the same formula for the productivity calculation of this group of algae (Vozzhinskaya, 1979, 1986). After Vozzhinskaya (1979), the same formula for estimation of the primary production of the filamentous and laminar brown algae could be used:

$$\oint(PP) = \sum_{135}^{285} a(n)B(n) \int_{t_{1(n)}}^{t_{2(n)}} e^{-0.028t^2} dt,$$

where:

$$t_{2(n)} = -t_{1(n)} = 1.91 e^{0.0206n - 0.6 \cdot 10^{-4} n^2},$$

n – each consecutive day of the vegetative period,
$B(n)$ – the changes of the biomass over the vegetative period,
$a(n)$ – the coefficient of the relation between the maximum of photosynthesis and a day of the vegetative period.

All calculations are given in a separate publication by Vozzhinskaya (1979), who suggested that the general course of photosynthesis value could be demonstrated by the situation given in Figure 1. The total production of macrophytes is

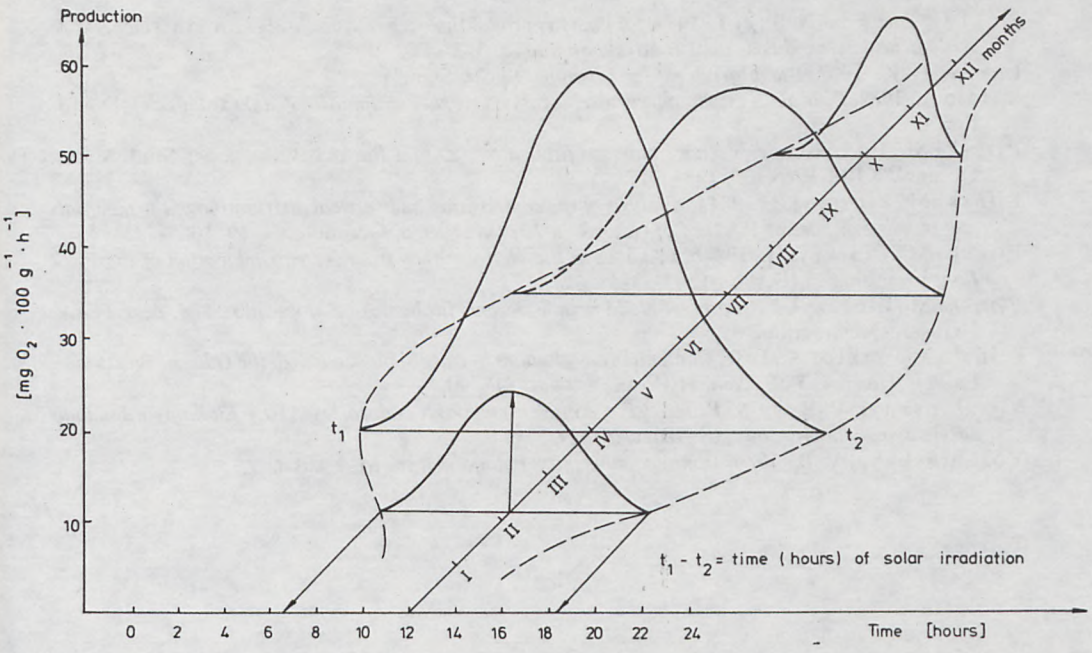

Fig. 1. Theoretical course of photosynthesis of the algae during the vegetative period

dominated by filamentous algae. This phenomenon has been mentioned for the Danish, German and other coasts as well (Kristiansen, 1973; Kukk *et al*, 1984). Adopting the formula given above, Vozzhinskaya suggested that the primary production of the macrophytes of the coastal zone of the Baltic could be calculated as 408 g C_{org}/m^2 year. It is a very high amount of organic matter but relatively low comparing with the value of long-term species in which the accumulating system is better. Concluding, we can say that the ecosystem where the filamentous algae like *Ectocarpaceae* play an important role is at a very advanced stage of eutrophication. Such situation has been observed in the Gulf of Gdańsk during the last several years.

References

Ciszewski P., Demel K., Ringer Z., Szatybełko M., 1962, *Zasoby widlika w Zatoce Puckiej oszacowane metodą nurkowania*, Pr. MIR Gdynia, Ser. 1, 11, 9–36.

Demel K., 1935, *Studia nad fauną denną i jej rozsiedleniem w polskich wodach Bałtyku*, Arch. Hydrobiol. Ryb., 9, 239–333.

Kornaś J., Medwecka-Kornaś A., 1973, *Roślinność polskiego Bałtyku.* [In:] *Szata roślinna Polski*, I, PWN, Warszawa.

Kornaś J., Pancer E., Brzyski B., 1960, *Studies on sea-bottom vegetation in the Bay of Gdańsk off Rewa*, Fragm. Flor. Geobot., 6 (1), 3–92.

Kristiansen A., 1973, *A seasonal study of the marine algae vegetation in Tuborg Harbour in Sound Denmark*, Bot. Tiddskr. Bd., **67**, 3, 201–244.

Kukk H., Pankow H., Trei T., 1984, *Ekologiya i produktivnost bentosa. Fitobentos.* [In:] *Ocherki po biologicheskoy produktivnosti Baltiyskogo morya*, 3, 5–70.

Lakowitz K., 1907, *Die Algenflora der Danziger Bucht*, Danzig.

Latała A., 1982, *Charakterystyka aktywności fotosyntetycznej roślinności Zatoki Gdańskiej* (Doctor thesis).

Pliński M., 1982, *Rozmieszczenie i biomasa fitobentosu Zatoki Puckiej Wewnętrznej*, Stud. Mater. Oceanol. KBM PAN, 39, 195–217.

Pliński M., Florczyk I., 1984a, *Analysis of the composition and vertical distribution of the macroalgae in western part of the Gulf of Gdańsk in 1979 and 1980*, Oceanologia, 19, 105–115.

Pliński M., Florczyk I., 1984b, *Changes in the phytobenthos from the eutrophication of the Puck Bay*, Limnologica (Berlin), 15 (2), 325–327.

Pliński M., Florczyk I., in press, *Skład i rozmieszczenie fitobentosu Zatoki Gdańskiej*, Zesz. Nauk. UG, ser. Oceanografia.

Pliński M., Wiktor K., 1987, *Contemporary changes in coastal biocenoses of the Gdańsk Bay (South Baltic). A review*, Pol. Arch. Hydrobiol., **34**, 1, 81–90.

Vozzhinskaya V. B., 1979, *Produktsiya donnych morskikh vodorosley.* [In:] *Ekologiya donnogo naseleniya shelfovoy zony*, M. Izdat, IOAN.

Vozzhinskaya, V. B., 1986, *Donnyye makrofity Belogo morya*, M. Nauka.