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MEETINGS OF THE ROYAL BOTANICAL SOCIETY OF THE NETHERLANDS

SYMPOSIUM "WATERPLANTEN" ON NOVEMBER 22, 1975

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Pollination problems in aquatic plants

Aquatic plants are, very often, terrestrial plants living in water. The pollen grains are destroyed, when they come into contact with water. The aquatic plants having pollen which cannot withstand the contact with water, need means for pollen transport or, anyhow a possibility to avoid destruction of the pollen grains.

A "natural" way of escaping the water is flowering above the water surface. Some specializations on this principle are e.g. found in *Ottelia* (Hydrocharitaceae): the flower opens and closes in accordance with the rippling of the water surface caused by air currence. The flower rests on the water surface and, when submerged, closes and keeps and retains an air bubble. The air movement within the flower causes pollen transport.

In Araceae the genus *Cryptocoryne* has a tubular closed spatha which protects in shallow water the spadix situated in the base of the spatha. Although the pollen is transported by entering insects, nevertheless the pollen grains appear suspended in a slimy liquid pressed from the ripe anther. Actually here is a peculiar contradiction in a biological sense.

Pollination in *Elodea* and *Vallisneria* is well known. Here the male flowers are released and go to the surface of the water where they open. The pollen reaches the stigma which also floats on the surface and which is placed vertically in European *Vallisneria* and horizontally in American *Vallisneria*. Both ways of pollination are equally effective.

In Nymphaeaceae *Barclaya* seems to have means to prevent every possibility of self-pollination by the structure of its flower which remains closed. Nevertheless, a large amount of viable seeds is regularly produced.

More examples are at hand to demonstrate that here again plants function most inefficiently and illogically. However, with very satisfactory results.

SYMPOSIUM "ORCHIDEEËN" ON MARCH 27, 1976

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Cytological observations on genome homology in eight interspecific hybrids of Phalaenopsis

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P. VERMEULEN (*De Blomhof 3, Heiloo-West*)

Structure and origin of the rostellum

Of the three families constituting the order of the Orchidales viz., the Apostasiaceae, Cypripediaceae and the Orchidaceae, only the Orchidaceae possess a rostellum. The rostellum is either an organ producing a sticky substance, or it is represented by a lump of sticky matter.

The sticky material acts as an adhesive which attaches the pollinia, so characteristic of the Orchidaceae proper, firmly to the body of visiting animals. In this way the pollinia are easily carried away, and there is a fair chance that another flower becomes pollinated. Although the probability of a "legitimate" pollination may be small, thousands of ovules may become fertilised simultaneously, bacause each pollinium consists of numerous fused pollen grains.

As regards the origin of the rostellum, the text books always repeat the view of Darwin and of Eichler that the rostellum is the median stigmatic lobe. That this idea can not possibly be correct is evident from the fact that although in several orchidaceous genera a rostellum is present there are also three stigmatic lobes, as in *Platanthera, Disa, Oncidium*, etc. In *Platanthera bifolia* (of the tribe Orchideae) a viscidium or adhesive disc originates above each of the lateral stigmatic lobes. The two viscidia are connected by a strand of tissue, and together with the latter constitute the rostellum. Starting from this situation, two alternative series of derivatives can be recognised. In the first the two viscidia approach one another progressively (the connecting strip being bent) ultimately to fuse into a single one as in *Anacamptis*. In the second series the connecting structure enlarges progressively and becomes bulkier whilst the third stigmatic lobe tends to become vestigial and even to disappear. The rostellum in this case becomes a broad, laterally extended band bearing a viscidium laterally at each end. When an insect visits a flower with this kind of rostellum the viscidia become united with the tips of the caudiculae protruding from the elongated pollen sacs as in *Bonatea*. In the subfamily Orchicoideae (tribe Orchideae) there is always a rostellum with two viscidia, whereas the other subfamily, the Epidendroideae, including the tribe Neottieae among other ones, has a single rostellum. This can be observed in, e.g., *Epipactis*, in which genus the uppermost portion of the median stigmatic lobe forms a viscidium. In *Cephalanthera* and in *Dendrobium* the rostellum is represented by a quantity of sticky matter and there is no separate organ. The adhesive substance is, in the genera in question, secreted above the stigma. In the tribe Vandeae the distance between the stigma and the caudiculae, which are found at the base of the pollinia, is rather large owing to the abaxially directed development of the pollen bed or clinandrium forming the top of the column. At maturity the pollinia are deposited in this clinandrium by the thecae. When an insect descends on the flower, a strip of tissue from the apex of the column, the stipe, becomes detached. This stipe forms the connection between the caudiculae at the base of the pollinia and the rostellum lying above the stigmatic cavity. By means of the sticky matter of the rostellum the latter attaches itself, with the stipe and the pollinia, to the visiting insect and pollination of a different flower may take place. From the location of the beginning of the stylar canal, in the centre of the stigmatic surface, it follows that also in this case there is a median or third stigmatic lobe and that the rostellum is a separate structure.

Another strongly deviating type of rostellum is found in the Southeast-Asian genus *Stereosandra*, a genus the species of which have scale-like leaves devoid of chlorophyll. In this taxon the stamen does not only produce the pollinia, but also the adhesive disc as a part of the anther, so that the stigma does not participate in the formation of the viscidium.

I am much indebted to Prof. Dr. A. D. J. Meeuse for the translation of this English.

REFERENCES

VERMEULEN, P. (1959): The different structure of the rostellum in Ophrydeae and Neottieae. *Acta Bot. Neerl.* **8**: 338–355.

— (1965): The place of Epipogium in the system of Orchidales. *Acta Bot. Neerl.* **14**: 230–241.

— (1966): The system of the Orchidales. *Acta Bot. Neerl.* **15**: 224–253.

— (1966): *Proceedings of the 5th World Orchid Conference, Long Beach, Calif.*

SYMPOSIUM "PRODUCTIVITEIT VAN DE ZEE" ON MARCH 18, 1977

J. J. ZIJLSTRA (*Nederlands Instituut voor Onderzoek der Zee, NIOZ, Texel*)

General aspects of productivity of the oceans

The share of marine products in the human food supply is low and insignificant (1 %).

Total production of organic matter by autotrophs in the sea most likely equals that of the land-masses. Marine primary production is limited less by light than by physical processes as vertical mixing of the waters, determining nutrient transport to the photic zone.

The utilization of primary food by herbivores in the sea is probably more complete and efficient than in terrestrial systems. Indications are that 20 % of the marine autotroph production is turned into herbivore tissues against less than 1 % on the land.

It seems therefore unlikely that the low production of human food in the oceans is determined mainly by a low primary production or a poor utilization of plants by herbivores in the sea. Rather, the length and complexity of the food chains in the oceanic system, ultimately determined by the small size of the autotrophs, is responsible.

W. W. C. GIESKES (*Nederlands Instituut voor Onderzoek der Zee, NIOZ, Texel*)

Phytoplankton, primary production and eutrophication in the southern North Sea

The Rine discharges up to 70% of all the freshwater that reaches the Southern Bight of the North Sea each year. Phosporus and nitrogen concentrations have increased dramatically in this river during the last decades. Phosphate concentrations measured nowadays in Dutch coastal waters during the dark winter months, when nutrients are not consumed by phytoplankton, are three times higher than they were some 10–15 years ago (FOLKARD & JONES 1974: VAN BENNEKOM et al. 1975).

Nevertheless, annual primary production in the coastal zone (salinity less than 32‰) is lower than farther offshore (salinity 32–35 %). Dutch coastal waters are more turbid than the water in the central Southern Bight. Therefore, conversion of solar energy into organic matter is least efficient in the coastal zone: light limits production in this well-mixed, vertically homogeneous water mass, rather than nutrients. In the clearer water away from the coast, silicate and phosphate may become limiting to algal growth. During the spring, summer and autumn months the phytoplankton crop may also be limited by grazing. In the coastal zone primary production (of particulate plus dissolved organic matter) is 200 g $C.m^{-2}year^{-1}$; offshore production is higher: around 250 g $C.m^{-2}year^{-1}$.

Consumption of organic matter was estimated during the spring bloom period (February to June) of 1975 by means of budget calculations of oxygen concentrations. Both production and consumption of organic matter fluctuated considerably from week to week and occasionally consumption fell far behind primary production; but over the whole period, consumption (by zooplankton, bacteria, and other heterotrophs) nearly equalled production. In the area close to the Rhine outflow the situation was exceptional: more organic matter was consumed here in February–March than was produced through photosynthesis. Apparently, the Rhine discharges into this region organic matter that is readily available for heterotrophic consumption.

In Dutch coastal waters the phytoplankton crop has been consistently higher during the seventies than it was during the fifties. This is probably only partly due to the increase in eutrophication by man: also in other North Sea areas, even in the adjacent English Channel, there has been a considerable increase in phytoplankton since the mid-sixties. British scientists have established links between a number of biological events and climatic and oceanographic changes (GLOVER et al. 1974; REID 1975). However, the algal increase has been steeper in Dutch coastal waters than elsewhere (GIESKES & KRAAY 1977). We suggest that natural variability, related to Atlantic-wide changes in environmental conditions, no longer overrides the effect of eutrophication on the phytoplankton of Dutch coastal waters.

REFERENCES

BENNEKOM, A. J. VAN, W. W. C. GIESKES & S. B. TIJSSEN (1975): Eutrophication of Dutch coastal waters. *Proc. R. Soc. (B)* **189**: 359–374.

FOLKARD, A. R. & P. G. W. JONES (1974): Distribution of nutrient salts in the southern North Sea during early 1974. *Mar. Poll. Bull.* **5**(12): 181–185.

GIESKES, W. W. C. & G. W. KRAAY (1977): Changes in the plankton of the North Sea and its eutrophic Southern Bight from 1948 to 1976. *Neth. Inst. Sea Res., M.S. Series* (in press).

GLOVER, R. S., G. A. ROBINSON & J. M. COLEBROOK (1974): Marine biological surveillance. *Environment and Change* **2**: 395–402.

REID, P. C. (1975): Large scale changes in North Sea phytoplankton. *Nature* **257** (5523): 217–219.

P. H. NIENHUIS (*Delta Instituut voor Hydrobiologisch Onderzoek, Yerseke*)

Primary production in the Grevelingen

The Grevelingen estuary in the SW Netherlands became a stagnant salt-water lake in 1971, when the connection with the North Sea was cut off by a dam, built in the mouth of the estuary. After the closure the tidal movements dropped out, resulting in sedimentation of particles and consequent increase in transparency of the water (to 2–5 m Secchi disc visibility).

Primary production of the phytoplankton was measured during many years with the ^{14}C method. Up to now no measurements of the production of the microphytobenthos are available but on the strength of the yearly average chlorophyll a content in the topsoil some extrapolations to the production of the benthic microalgae could be made. Production of macrophytobenthos, *viz.* eelgrass and large algae, was estimated using data on changes in biomass.

The pool of particulate organic matter in the Grevelingen estuary was fed from various sources. The amount of organic carbon from the North Sea, entering the estuary as detritus, equalled the *in situ* primary production. Primary production in the estuary was by far dominated by the phytoplankton share, approximately 100–130 g C/m^2/yr. Phytobenthos production played only a minor role.

After the closure of the estuary the import of organic matter from the North Sea was completely cut off. Overall yearly production of the phytoplankton was not markedly influenced by the closure, notwithstanding the large changes in environmental circumstances. The picture of the production curve, however, changed drastically: production starts earlier (february) and stops later (november) than before the damming up. In contradistinction with the situation before the closure nitrate and ammonium are limiting factors now for phytoplankton development in late spring and summer. The significance of the phytobenthos production increased considerably. Especially the role of the macrophytes became obvious in the clear water of the sheltered lake, and increased from less than 10 to about 35 g C/m^2/yr, with local peaks of more than 200 g C/m^2/yr.

The relative significance of the *in situ* primary production increased strongly after the closure, owing to the fact that the subsidy of organic matter from the North Sea was brought to an end. The total amount of organic matter available for consumers, however, decreased considerably, calculated on a yearly basis.

H. G. FRANZ (*Nederlands Instituut voor Onderzoek der Zee, NIOZ, Texel*)

Zooplankton productivity in the Southern Bight

The estimation of biomass, growth and production of zooplankton species from net samples taken in the Southern Bight is discussed. In copepod nauplii and young copedites, P/B-values ranged in 1973 from 0.12 d^{-1} in spring to 0.25 d^{-1} in summer. In older copepodites and adults, the range is 0.03–0.09 d^{-1}. The yearly production of total zooplankton amounted to about 45 gC/m^2 near the coast and 30 gC/m^2 offshore. Biomass and productivity per m^3 were highest near the Dutch coast in June-July, presumably due to the relatively high phytoplankton density. The high phytoplankton densities of clear offshore waters in early spring do not enhance the zooplankton production.

J. J. BEUKEMA (*Nederlands Instituut voor Onderzoek der Zee, NIOZ, Texel*)

The trophic function of marine zoobenthos

The main food organisms of most marine benthic animals are unicellar algae and bacteria. These tiny primary food particles are thus converted into food pieces large enough to be handled efficiently by such marine carnivores as bottom fishes and sea birds.

Zoobenthos is particularly important as a link in food chains of shallow seas and intertidal areas. In these ecosystems they consume a major part of the primary production. and allow of the existence of huge numbers of bottom fishes and birds.

With increasing depth an increasingly smaller part of the primary production reaches the bottom. Consequently, the biomass of the zoobenthos decreases steeply with increasing depth.

J. H. VOSJAN (*Nederlands Instituut voor Onderzoek der Zee, NIOZ, Texel*)
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Mineralisation in the sea

Almost all organic carbon in oceanic waters is in the dissolved form (> 95%). The remaining part is in the particulate form with sizes varying from colloidal particle to the biggest whale. The concentration of dissolved organic matter (DOM) is 0.2–1.0 mg C/l.

For the measurement of the rate of photosynthesis and hence primary production the method of Steemann Nielsen (1952) with radioactive carbon (C^{14}) is available. For the opposite process, the measurement of mineralization of organic matter, no completely satisfactory method has been developed thus far. In the case of respiration, the rate limiting factor is the electron transport system (ETS) which is nearly universal in animals, plants and micro-organisms. Therefore, Packard (1969) developed a method to measure ETS activity in sea water. This method would provide an estimate of the potential oxygen consumption rate in the ocean. Some studies using this method are discussed.

The vertical distribution of ETS activity in the eastern tropical Pacific Ocean indicates that in the euphotic zone a rapid decrease in ETS activity from the surface to 500 m depth and a more gradual decrease from 500 m to the bottom at 5000 m occurs. Repiratory rates in the euphotic zone are low when compared with productivity estimates so that 'photosynthesis to respiration' ratios range from 50 to 300. In the waters below 100 m, only about 3% of the primary production of the euphotic zone is consumed by organisms caught in traditional water samplers (Packard, Healy & Richards 1971). This suggests that most of the organic material in the sea might be respired by larger organisms excaping water samplers.

Devol et al. (1976) determined the vertical distribution of ETS activity, ATP concentration (= biomass), oxygen and nitrite concentration in the eastern tropical North Pacific. An oxygen minimum, a nitrite maximum and a local ETS activity maximum was found at depths between 200 and 700 m. At low oxygen concentrations, nitrate is the most favourable alternative electron acceptor, so that the nitrite maximum indicates continuous decomposition by nitrate reducing bacteria. The ETS activity maximum is associated with the oxygen minimum but there is no corresponding ATP increase. This may suggest that the ETS activity maximum results from intracellular biochemical modifications.

ETS activity was also measured in the Dutch Wadden Sea (Olanczuk-Neyman & Vosjan 1977). In this coastal region large amounts of organic matter are available for mineralization by micro-organisms (JONGE & POSTMA 1974). Tidal movement appears to affect strongly ETS activity. ETS activity measured per liter water is highest during ebb tide but the activity per gram of suspended matter (dry weight) showed a maximum at slack tide. The activity of surface sediment measured per gram dry weight appears to be an order of magnitude lower than the activity of suspended matter in the water. However, by comparing ETS activity in water and sediment per m^{-2} the data suggest that the sediment plays by far the most important role in mineralization. The vertical distribution of ETS activity in the sediment shows a quick exponential decrease from the surface to 2 cm depth and after that a slow exponential decrease. Over a column of 35 cm only 10% of the mineralization occurs in the uppermost cm, while mineralization in the deeper anaerobic layers accounts for the remaining 90% (VOSJAN & OLANCZUK-NEYMAN 1977). In this anaerobic layer mineralization by sulphate reduction plays an important role (VOSJAN 1974).

REFERENCES

DEVOL, A. H., T. T. PACKARD & O. HOLM-HANSEN (1976): Respiratory electron transport activity and adenosine triphosphate in the oxygen minimum of the eastern tropical North Pacific. *Deep-Sea Research* **23**: 963–973.

JONGE, V. N. DE & H. POSTMA (1974): Phosphorus compounds in the Dutch Wadden Sea. *Neth. J. Sea Res.* **8**: 139–153.

OLANCZUK-NEYMAN, K. M. & J. H. VOSJAN (1977): Measuring respiratory electron transport system activity in marine sediment. *Neth. J. Sea Res.* **11**: in press.

PACKARD, T. T. (1969): *The estimation of the oxygen utilisation rate in seawater from the activity of the respiratory electron transport system in plankton.* Ph. D. thesis, Univ. Washington, Seattle. 115 p.

— M. L. HEALY & F. A. RICHARDS (1971): Vertical distribution of the activity of the respiratory electron transport system in marine plankton. *Limnol. Oceanogr.* **16**: 60–70.

STEEMANN NIELSEN, E. (1952): The use of radioactive carbon (C^{14}) for measuring organic production in the sea. *J. Cons. perm. int. Explor. Mer.* **18**: 117–140.

VOSJAN, J. H. (1974): Sulphate in water and sediment of the Dutch Wadden Sea *Neth. J. Sea Res.* **8**: 208–213.

— & K. M. OLANCZUK-NEYMAN (1977): Vertical distribution of mineralization processes in a tidal sediment. *Neth. J. Sea Res.* **11**: in press.

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