

THE ALGAL VEGETATION OF A BRACKISH INLAND WATER-BASIN IN THE NETHERLANDS (GAT VAN OUWERKERK)

P. H. NIENHUIS

Hydrobiological Institute, division Delta-Research, Yerseke

Communication No. 58

SUMMARY

The benthic algal vegetation of the Gat van Ouwerkerk, a brackish inland water-basin, with a relative high and only slightly varying salinity, situated in the south-western part of the Netherlands, was surveyed in 1966 and 1967. Some ecological factors are mentioned. A survey of the vegetation-units is given. Four zones could be distinguished, the most striking belt being the permanently submerged vegetation where remarkable algae such as *Dasya pedicellata* (C. Ag.) C. Ag. and *Bryopsis hypnoides* Lamour. were found. Owing to the collaboration of divers some profiles could be drawn in which the vertical distribution and some seasonal aspects were emphasized. A comparison of the analysis of the sample-plots of DEN HARTOG (1964) with the author's observations showed that the vegetation has strongly changed since 1961. The diagnosis of an unknown *Acrochaetium* species, living epiphytically on *Dasya pedicellata*, is given.

I. INTRODUCTION

During the disaster of February 1st. 1953 the dike south of Ouwerkerk on the isle of Schouwen-Duiveland (south-western part of the Netherlands) was pierced at several places, and some large creeks of a length of several kilometers, in which the tides had free play, were formed. In the course of 1953 and 1954 these breaches were sealed and some stagnant saline basins remained. Most of these basins are now used as Nature Reserve Area's of the State.

The Gat van Ouwerkerk also named "Inlaag 1953", is one of these basins. The total surface measures about 6 hectares. Since its closure it had no surface connections with surrounding waters. The original depth of the pool, 25 m, has fallen to 8 m at the time of the present study, probably owing to levelling. As the basin was formed by water from the Eastern Scheldt, 16⁰/₁₀₀ Cl' seems a reasonable estimate for the salinity at the moment of the closure. From the beginning the salinity declined gradually, and from 1961 onwards chlorinity values fluctuated between 11 and 13⁰/₁₀₀. At the moment the water shows signs of strong eutrophication as witnessed by a high phosphorus content ($PO_4''' + \text{organic P} = 85 \mu\text{g-at/L}$, surface, 24 VI 1967).

As compared with other brackish inland waters in the Netherlands the Gat van Ouwerkerk takes a very special place owing to its high, and only slightly varying salinity.

From the point of view of the algologist the Gat is of interest because of the abundant occurrence of *Dasya pedicellata* (C.Ag.) C.Ag., an alga living in Europe mainly in the Mediterranean Sea and very rare in the north-western part of this continent (DEN HARTOG 1964).

The aim of this article is to give a survey of the algal vegetation of the Gat van Ouwerkerk. To that end an investigation has been carried out in 1966 and 1967, in which – for the first time in the Netherlands – divers collaborated¹.

2. SURVEY OF THE VEGETATION-UNITS

Going from land to water the following vegetation-units can be distinguished in summer:

A. Along the banks of the pond there is at some places a marshy transition-area to the higher situated foot of the dike. Between the flowering plants growing here in summer we find a normal salt-marsh vegetation consisting of the green algae *Percursaria percursa* (C.Ag.) Rosenv., *Enteromorpha torta* (Mert. in Jürg.) Reinb., *Rhizoclonium riparium* (Roth) Harv. and *Vaucheria* spec. (sterile) with, locally, some blue-green algae, a.o. *Lyngbya aestuarii* ((Mert. in Jürg.) Liebm.) Gom.

B. On the stones projecting above the water-level a zone is visible consisting of *Urospora penicilliformis* (Roth) Aresch., blue-green algae and diatoms. This girdle has a width of 10–30 cm, dependent on the angle of inclination (observation of 10 September 1966).

C. Around the water-line follows a small zone of green algae: *Enteromorpha prolifera* (O.F. Müll.) J.Ag., *E. ahlneriana* Blid., scattered plants of *Cladophora laetevirens* (Dillw.) Kütz. and *C. vagabunda* (L.) v.d. Hoek. Further *Ectocarpus confervoides* (Roth) Kjellm. and blue-green algae are found.

D. From about the water-line downwards we see a beautiful vegetation of the red algae *Polysiphonia urceolata* (Lightf. ex Dillw.) Grev., *P. nigrescens* (Huds.) Grev. (few individuals), *Dasya pedicellata* (C.Ag.) C.Ag., *Callithamnion roseum* (Roth) Lyngb. and, on 5 September 1967, epiphytic on *Dasya*, an unknown *Acrochaetium* species (see p. 32), the green algae *Cladophora laetevirens*, *C. vagabunda*, *Enteromorpha flexuosa* (Wulf. ex Roth) J.Ag., *E. linza* (L.) J.Ag. (spring), *Bryopsis plumosa* (Huds.) C.Ag., *B. hypnoides* Lamour. and *Codium fragile* (Sur.) Hariot, and several blue-green algae a.o. *Spirulina subsalsa* (Oerst.) Gom. and *Lyngbya aestuarii*.

During the whole year a striking aspect of the vegetation mentioned is the plentiful appearance of sessile diatoms. On many spots they form a brown-green cover over the short, turf-forming plants of *Polysiphonia urceolata*, and it seems as if they have a somewhat suffocating influence on this species. In many other cases they fill up the “open” space in the vegetation.

The number of benthic algal species is small. This can be ascribed to the fact that the Gat communicated with the sea only during about one year. BODDEKE (1958) mentions *Callithamnion corymbosum* (Smith) Lyngb. and *C. byssoides* Arn. We did not find these two species during our investigation.

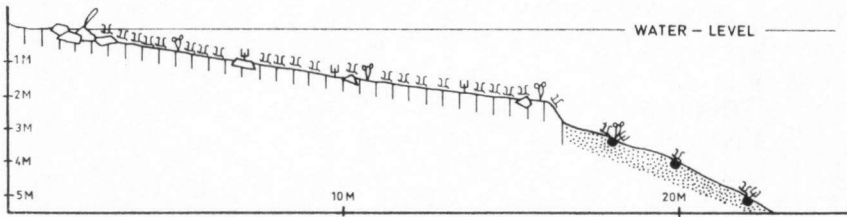
¹ A short survey of the flora and fauna was published in “Het Zeepaard” (1967): 27 (2).

3. DIVING PROFILES

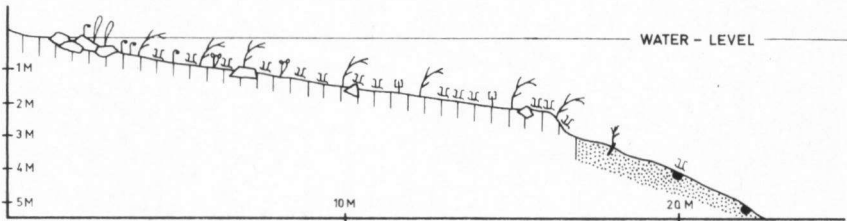
Some profiles could be drawn of the north side of the Gat, based on data collected by the divers (fig. 1).

Profile 1. From this transect it appears that *Polysiphonia urceolata* and *Callithamnion roseum* are still to be found at a depth of 5 m, if a suitable substratum is available (sticks, shells). Deeper than 5 m no algae are encountered, in spite of possibilities for attachment. *Polysiphonia urceolata* of a length of sev-

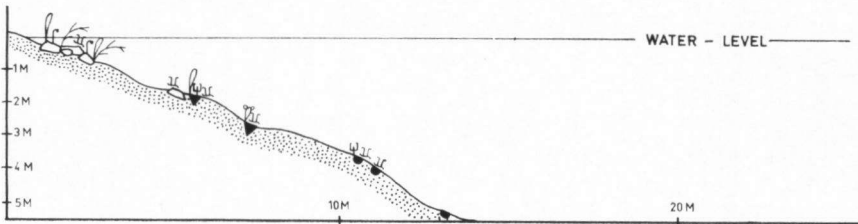
Profile 1 7 May 1966



Profile 2 19 June 1966



Profile 3 19 June 1966



LEGENDA

Fig. 1. Diving profiles in the Gat van Ouwerkerk.

eral centimeters, grows in shallow water; at a depth of 5 m however, it only reaches a length of 0.5 cm. The same applies to *Callithamnion roseum*. *Bryopsis plumosa* has not been found below a depth of 4 m. For this species as well we find shorter plants at greater depth. The matting of willow-twigs, on which the samples have been taken, reaches a depth of 2.5 m; it appears to be a very suitable substratum for the species mentioned above.

Profile 2. This profile has been investigated more than a month later on practically the same place as profile 1. *Dasya pedicellata* is now one of the aspect determining species down to a depth of 2.5 m, strongly bound to the willow matting and the boulders lying upon it. A single, smaller specimen is found at - 3.5 m on loose sticks. *Cladophora* spp. have their optimal development from the water-line downwards to about 1 m. Under that level they occur only sporadically.

Profile 3. This transect is situated in the north-eastern corner of the basin. Dumped stones are lying on the border, but the willow-twigs are lacking. Here we find a bottom consisting of sand mixed with mud, from 0.5 m downwards, at some places pierced by lumps of peat. A comparison of profile 2 and 3 illustrates the importance of a suitable substrate for algal growth. In profile 3 *Dasya* reaches only 0.5 m deep and is partly replaced by *Enteromorpha* spp. *Bryopsis hypnoides* is especially found in somewhat deeper water growing on peat lumps.

Summarizing it can be said that at a depth of 4 to 5 m red algae only are encountered and moreover on this level they are considerably smaller and fructify less intensively than in higher regions.

4. ECOLOGY

Table 1 gives a survey of the sample-plots analysed according to the method of BRAUN-BLANQUET (1951). All these observations were taken on comparable data on the northern side of the Gat. Den Hartog's survey-plots all refer to a variant of the *Callithamniëtum rosei*, an association of salt-water canals and harbours, where it lives on substrates that follow the movements of the tides, and where the mean temperature of the water is some degrees higher than that of the open arms of the sea (DEN HARTOG 1959, 1964). A comparison of the surveys of 1959 and 1961 with those of 1966 shows the following differences: *Codium fragile* strongly declined in five years. Probably this is a result of the drop in salinity and the increasing eutrophication and pollution of the Gat. *Codium fragile* is a species of quiet, euhaline water (more than 16.5 ‰ C1') with regular refreshment and thus it cannot maintain itself in the Gat. Here and there however, cushions are to be found consisting of loose masses of threads which must be reckoned among - what we call - the "thin form" of *Codium*, recognizable by the specific septum-formation in the thallus. It is a question whether these forms belong to *Codium fragile* or not. *Polysiphonia urceolata*, on the contrary, has strongly increased; *P. urceolata* f. *roseola* (Ag.) J.Ag. was often found among the material (identification with VELDKAMP 1950).

Table 1. Analysis of the sample-plots at the Gat van Ouwerkerk

Substrate: In all cases willow-twigs and stones
CdH = C. den Hartog; PN = P. H. Nienhuis

Sample-plot	CdH			PN			
	8-10-59	8-10-59	28-8-61	66086	66087	66088	66089
Date	8-10-59	8-10-59	28-8-61	10-9-66	10-9-66	10-9-66	10-9-66
Surface in m ²	4	6	10	1 × 6	1 × 5	1 × 4	1.5 × 2
Depth of the water in cm				0-30	0-30	0-30	0-40
Inclination/exposition				5°/S	5°/S	5°/S	5°/SE
Covering of diatoms and blue-green algae				90%	80%	50%	60%
Covering of other algae	40%	80%	100%	70%	60%	60%	90%
<i>Dasya pedicellata</i>	2	5	4/5	2.2	2.2	3.2	4.3
<i>Callithamnion roseum</i>	1	1	+	2.2	1.	+	1.
<i>Cladophora utriculosa</i>	1	+	2	XXX	XXX	XXX	XXX
<i>Cladophora laetevirens</i> +							
<i>Cladophora vagabunda</i>	XXX	XXX	XXX	1.	2.2	2.2	2.2
<i>Codium fragile</i>	3	2	3	+	—	—	+°
<i>Polysiphonia urceolata</i>	—	—	+°	3.3	3.3	2.3	3.3
<i>Bryopsis plumosa</i> +							
<i>Bryopsis hypnoides</i>	—	—	—	1.	1.	1.	+
<i>Enteromorpha flexuosa</i>	—	—	—	—	—	+	1.
<i>Enteromorpha prolifera</i>	—	—	+	—	+	—	—
<i>Ectocarpus siliculosus</i>	+	—	—	—	—	—	—
<i>Callithamnion corymbosum</i>	+	—	—	—	—	—	—
Cyanophyceae	1	2	+	see above			

XXX *Cladophora laetevirens* and *C. vagabunda* = *C. utriculosa* Kütz. pp. (VAN DEN HOEK 1963).

Dasya pedicellata appears to maintain itself very well; it propagates intensively, sexually as well as asexually. The only place in the Netherlands, next to the Gat van Ouwerkerk, where *Dasya* is found, is the "Kanaal door Zuid-Beveland", an eutrophic, brackish-water canal (cf. DEN HARTOG 1964). Here however, the plants are smaller and the vegetation is less closed.

Bryopsis spp. are common at the moment, contrary to five years ago. *B. hypnoides* occurs rather frequently in the Gat, although we find this species only seldom elsewhere along the coast of the Netherlands. Recently this alga was mentioned for the first time in the Netherlands, a.o. in the Gat, by DONZE (1964). Among the material of *Bryopsis* we collected from the Gat van Ouwerkerk, we found several transition-forms between the two species *Bryopsis plumosa* and *B. hypnoides*.

About the periodicity of the *Dasya* vegetation the following remarks can be made. *Dasya* dies in winter and is visible again rather late in spring, like *Callithamnion roseum* and *Bryopsis* spp., but no attention however was paid to the occurrence of microscopical surviving stages. *Polysiphonia urceolata* hibernates with a creeping thallus, and reduced parts of *Cladophora* spp. can be found in winter too. All species mentioned have their optimum development in summer.

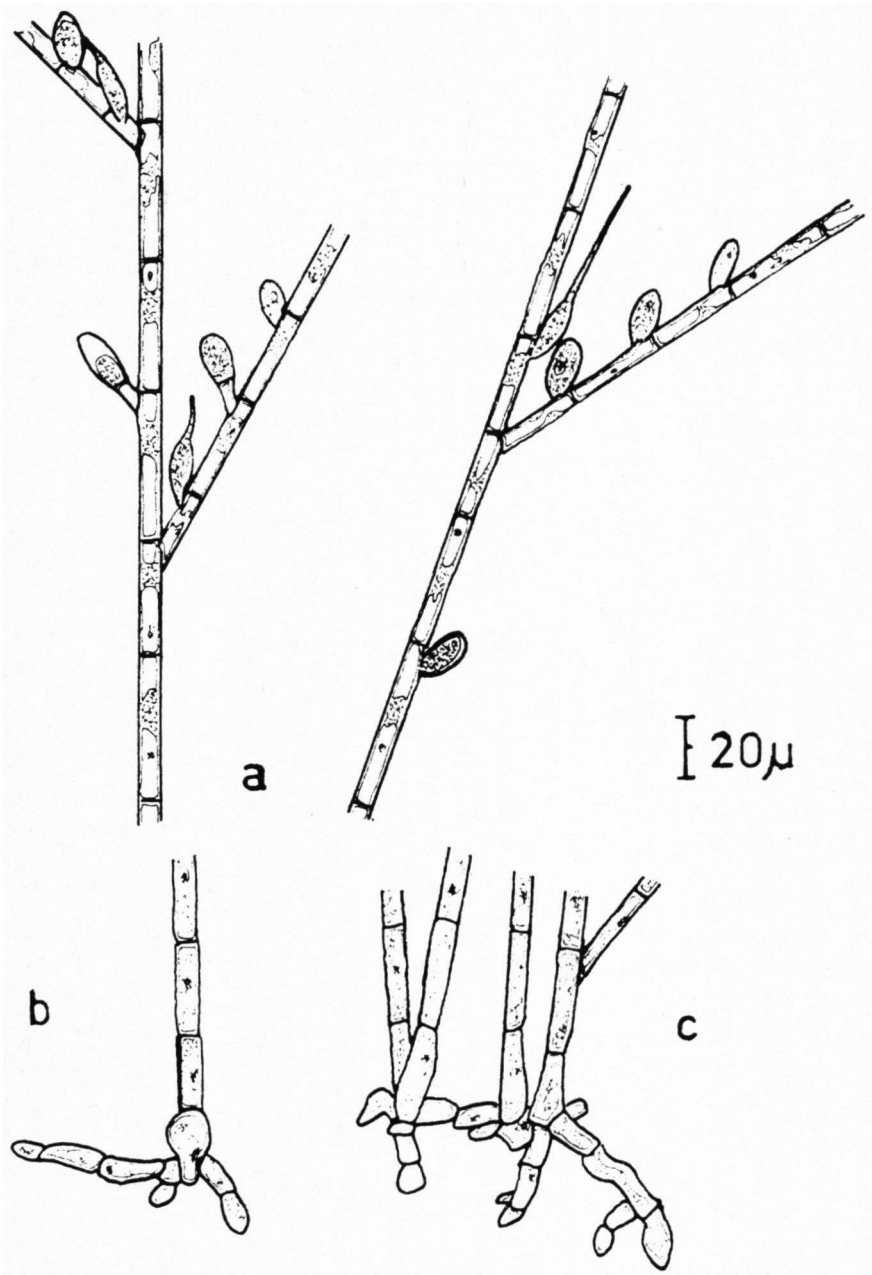


Fig. 2. *Acrochaetium* spec. from the Gat van Ouwerkerk.
a. erect thallus with monosporangia and carpogonia;
b. basal part showing the large, original spore;
c. interwoven basal parts.

5. ACROCHAETIUM SPEC.

On old parts of *Dasya* we found on September 5th, 1967, rather abundantly, an *Acrochaetium* species which appeared to be new for the Netherlands. Neither in the consulted Dutch literature nor in the collection of the Rijksherbarium (Leiden) this species could be discovered. *Acrochaetium* is a very complex genus (PAPENFUSS 1945, 1947). Because the identification of the species is not sure on account of lack of reliable material for comparison, only a description and a drawing (*fig. 2*) will be given here:

Plants epiphytic on *Dasya pedicellata*; the base consisting of the large original spore from which some creeping filaments arise, which are sometimes for a small part endophytic (*fig. 2b*); usually the plants are basically interwoven, and the original spores are no longer conspicuous (*fig. 2c*). Erect thallus strongly branched, unilateral or alternate, 1–3 mm tall; cells 6.5–10.2 μ diam., 4–8 μ diam. long, below a little smaller, hairs or pseudo-hairs absent, chromatophore parietal with a clear pyrenoid. Monosporangia mostly in unilateral rows on the upper side of the branches, solitary, sometimes in pairs, sessile or on one-celled stalks, at the base of the branches, 11.2–14.9 μ diam., 22.4–28.0 μ long. Carpogonia on the same plants as the monosporangia, mostly at the upper side of the branches (*fig. 2a*).

ACKNOWLEDGEMENTS

The author wishes to express his gratitude to the divers of the "Nederlandse Onderwatersport Bond" (Dutch Skin and Scuba Diving Association) for their help in collecting the algae. His further indebtedness goes to his assistant, MR. R. H. G. KLEINGELD, for his help during the fieldwork and for preparing the drawing of the profiles, to PROF. DR. C. VAN DEN HOEK (Groningen) for kindly checking his identifications of *Cladophora* spp., to Miss DR. J. TH. KOSTER (Leiden) for her valuable advices concerning the *Acrochaetium* species and to DR. K. F. VAAS (Yerseke) who kindly corrected the English text.

REFERENCES

- BODDEKE, R. (1958): The genus *Callithamnion* Lyngb. in the Netherlands. *Acta Bot. Neerl.* 7: 589–604.
- BRAUN-BLANQUET, J. (1951): *Pflanzensoziologie*. 2nd Ed. Springer, Wien, 11 + 631 pp.
- DONZE, M. (1964): *Bryopsis hypnoides* Lam. nieuw voor Nederland. *Het Zeepaard* 24: (4) 55–57.
- HARTOG, C. DEN (1959): The epilithic algal communities occurring along the coast of the Netherlands. *Wentia* 1: 1–241.
- (1964): Ecology of *Dasya pedicellata* in the Netherlands. *Proc. Fourth Intern. Seaweed Symp. Biarritz* 1961. 197–201. Pergamon Press, Oxford-London-New York-Paris.
- HOEK, C. VAN DEN (1963): Revision of the European species of *Cladophora*. Thesis. Brill, Leiden, 11 + 248 pp.
- PAPENFUSS, G. F. (1945): Review of the *Acrochaetium*–*Rhodochorton* Complex of the Red Algae. *Univ. Cal. Public. Bot.* 18: 299–344.
- (1947): Further Contributions Toward an Understanding of the *Acrochaetium*–*Rhodochorton* Complex of the Red Algae. *Univ. Cal. Public. Bot.* 18: 433–447.
- VELDKAMP, H. (1950): The genus *Polysiphonia* in the Netherlands. *Blumea* 6 (2): 517–526.