

PORPHYRA LEUCOSTICTA ALONG THE
DUTCH COAST

BY

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Since VAN GOOR's publication "Die Holländische Meeresalgen" appeared in 1923, the marine algae flora of Holland has not received much critical study. Since the war, however, the interest in this subject increased, and we have started a survey of our coast. During this work algae which had not been known to occur in our waters were found regularly. Probably this was because they were collected in localities which had never been investigated before. It may be assumed that some of the newly found species had settled here only a short time ago, while other species had probably been overlooked.

Porphyra leucosticta e.g. is a species which has been washed ashore on our beaches since the days of old (i.a. 1844), but had never been recognised before. In the province of Zeeland this species now has been discovered as an autochthonic. There it forms a very characteristic association together with *Monostroma wittrockii* Bornet.

Porphyra leucosticta Thuret in Le Jolis, Alg. mar. de Cherbourg, 1863, p. 100; Børgesen, Bot. Faerøes, 1903, p. 346; Kolderup Rosenvinge, Mar. alg. Denm. I, 1909, p. 65, Pl. II fig. 4-13; Woronichin, Trav. Soc. Imp. Nat. de St. Pétersbourg vol XL, 1909, p. 180; Hamel, Rev. Alg. I, 1924, p. 438, fig. V; Newton, Handb. Brit. Seaweeds, 1931, p. 240; Feldmann, Rev. Alg. XI, 1939, p. 248. *Porphyra atropurpurea* De Toni (non Olivi), Syll. Alg. IV sect I, 1891, p. 17; VI sect 5, 1924, p. 9; Lakowitz, Algenfl. ges. Ostsee, 1929, p. 300, fig. 409; Hoffmann, Wiss. Meeresunt, Kiel, XXI, 1931, p. 9. *Porphyra elongata* (Aresch). Kylin, Stud. Algenfl. schwed. Westk., 1907, p. 110, Pl. 3, fig. 1; De Toni, Syll. Alg. VI, sect 5, 1924, p. 8.

In *Porphyra leucosticta* the spermatia are formed in small longitudinal patches, specially in the upper part of the thallus, often parallel with the margin. The length of these patches is rather variable. ROSENVINGE (1909) and NEWTON (1931) give 5-10 mm, but in the Dutch specimens I have found sizes ranging from 1.5 to 20 mm. The breadth varies from 1-2 mm which agrees with the data given in literature. The spermatangia of the Dutch specimens have very irregular forms. This

is in accordance with the statement of BØRGESEN (1903) from the Faerøes, who found broader and more irregular antheridial sori in this species than he observed in specimens from France. He also stated that the arrangement of the sori was more irregular. Probably he compared his specimens with samples from the Mediterranean coast, for HAMEL (1924) distinguished two forms in the French material of *Porphyra leucosticta*, viz. an Atlantic and a Mediterranean form. The differences are:

- f. *atlantica*: Large Alga, up to 35 cm long. Irregularly formed, rather large spermatangia grouped along the margin of the frond.
- f. *mediterranea*: Smaller Alga, up to 20 cm. The spermatangia often stretch towards the centre of the thallus; they are narrow and linear, so that the thallus sometimes looks striped.

The specimens found on the Dutch coast are to be classified as

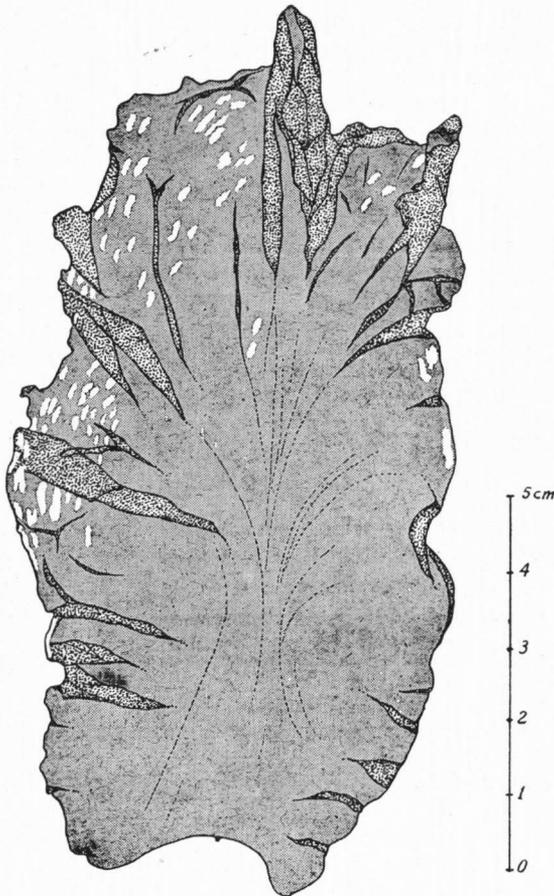


Fig. 1. *Porphyra leucosticta* Thuret f. *atlantica* Hamel from the Zuid Beveland Canal

f. *atlantica*. The samples from the Faeröes may belong to this form, too. The type specimen of THURET (1863) belongs to the Atlantic form as well; in the diagnosis THURET described the spermatangia as "antheridiis in soris maculiformibus dispositis". The carpogonia are found scattered between the antheridia, so the alga is monoecious.

The frond, which is very short stalked, is attached with a disc and often umbilicate. The margin of the thallus is undulate.

In the Dutch waters *Porphyra leucosticta* does not reach the dimensions given by HAMEL (35 cm) and NEWTON (10–40 cm). The largest specimen, collected in an autochthonic locality, measured 12 cm in length. On drifting objects specimens 14–15 cm long are found. Also in Denmark ROSENINGE (1909) only found specimens of 10–11 cm (–16).

The colour of the thallus is of a much brighter purple than that of *Porphyra umbilicalis* (L.) J. Ag. ROSENINGE pointed out, however, that both species may occur with exactly the same colour. Another character, apparently not mentioned in the literature, is that *Porphyra leucosticta* adheres very easily to paper, while *Porphyra umbilicalis* does not, although this difference is not absolute.

FELDMANN (1939) pointed out, that *Ulva atropurpurea* Olivi 1793 is not a synonym of *Porphyra leucosticta* Thur., as was assumed by De Toni (1891), but it is probably identical with *Porphyra umbilicalis* (L.) J. Ag. In this article therefore the name given by THURET is used since it is the oldest legitimate one.

Porphyra elongata (Aresch.) Kylin cannot be separated specifically from *Porphyra leucosticta*. According to KYLIN (1907) the two species are related because both are monoecious and in both the antheridia occur in distinct sori. *Porphyra elongata*, however, should have an elongated, equally broad frond, a thickness of thallus of 25–33 μ and smaller (to 2 mm) antheridial sori. These differences, however, cannot be maintained.

Porphyra leucosticta is often elongated. The thickness of the thallus was found 28–44 μ which is in accordance with the statement of ROSENINGE (1909). KYLIN, however, gives 33–40 μ . Since specimens of *Porphyra leucosticta* with very small antheridial sori were seen together with larger ones, ranging from 1.5 to 4 mm, *Porphyra elongata* is, in the writer's opinion merely a young form of *Porphyra leucosticta*, in which the antheridial sori are beginning to differentiate.

Summarizing the differences between *Porphyra leucosticta* and *Porphyra umbilicalis*, a common species along the whole Dutch coast, we get:

<i>Porphyra leucosticta</i> Thuret	<i>Porphyra umbilicalis</i> (L.) J. Ag.
Spermatia formed in longitudinal patches. Monoecious.	Spermatia formed in the marginal zone of the frond. Dioecious, sometimes monoecious, but then the antheridia and carpogonia are strictly separated.

GEOGRAPHICAL DISTRIBUTION

Porphyra leucosticta Thuret is very widely distributed in the Mediterranean (French coast, Algiers, Corsica, Tangier, Naples, Adriatic Sea, according to FELDMANN, 1939) and is met with in the Black Sea, too (WORONICHIN, 1909).

In the Atlantic the species is known from the Canary Islands to the West coast of Sweden and the Faeröes. It is even found in the Baltic Sea (HOFFMANN, 1931). BØRGESEN and JONSSON (1908) as well as FELDMANN (1939) state the occurrence of *Porphyra leucosticta* on the Atlantic coast of North America. There are in the collection of the Rijksherbarium, Leiden, some American specimens, but in the writer's opinion they are not identical with the European form. In the same herbarium there are some specimens, collected in Japan.

PHAENOLOGY

In almost the whole of its area *Porphyra leucosticta* behaves as a winter species. It begins to develop in autumn, in the early spring it reaches its highest development, and towards the end of spring it disappears. In literature the following phaenological data were found.

Mediterranean	October–May–June	FELDMANN, 1939
French West coast	December–April–June	HAMEL, 1924
Great Britain	spring and early summer	NEWTON, 1931
Netherlands	October–April	
Denmark	April–July, disappearing in summer	ROSENVINGE, 1909
Baltic Sea	October–July	HOFFMANN, 1931
Swedish West coast	July–August	KYLIN, 1907
Faeröes	April–August	BØRGESEN, 1903

So we can say that the growth period is longer the farther north the locality is situated. It is very likely that in Great Britain and Denmark the species also occurs in autumn, but no statement on this subject was found.

BØRGESEN and KYLIN only mentioned the seasons in which they found fructifying specimens, not the entire growth period. In the Dutch specimens I found organs for sexual reproduction in autumn as well as in spring.

DISTRIBUTION OF PORPHYRA LEUCOSTICTA ALONG THE DUTCH COAST

Up to the present *Porphyra leucosticta* has never been recognized on the Dutch coast. In 1950 and 1951 the species was discovered as an autochthonic as well as on drifting objects. We distinguish sharply between the two categories. The algae, growing on our coasts, belong to the Dutch flora, but the algae washed ashore, the *natural adventives*, may be transported by the wind and sea currents over a distance of hundreds of miles before they reach the coast. Among these algae there are many species which are never found growing attached on the Dutch coast, e.g. *Himanthalia elongata* (L.) Setchell, *Halidrys siliquosa* (L.) Lyngb., *Cystoseira* species, *Rhodomenia palmata* (L.) Grev. and many others.

a. *Finds on drifting objects:*

After the gale of Easter 1950 a great quantity of drifting algae, chiefly consisting of *Himanthalia elongata*, *Fucus vesiculosus* L., *Ascophyllum nodosum* (L.) Le Jol. and *Halidrys siliquosa* were washed ashore along the whole beach of the province of North Holland. The southern origin of this material could be ascertained as among the algae there were four species which are not known growing north of the Channel, viz. *Cystoseira fibrosa* (Huds.) Ag., *Cystoseira granulata* Ag., *Gastroclonium ovale* (Huds.) Kütz. and *Antithamnionella sarniensis* Lyle (VAN GOOR, 1923; LUCAS, 1950). Among the numerous epiphytes on the Fucaceae *Porphyra leucosticta* was found a few times. The exact data are:

Den Helder, 12-IV-'50, on *Fucus vesiculosus* and *Polysiphonia lanosa* (L.) Tandy, Den Hartog;

Huisduinen, 14-IV-'50, on *Fucus* and *Polysiphonia lanosa*, Lucas and Swennen.

Beach between Callantsoog and Petten, 14-IV-'50, on *Fucus vesiculosus* and *Himanthalia elongata*. The largest specimens, which were collected, measured 14-15 cm, Den Hartog.

In the spring 1951 only a few algae and other drifting objects were washed ashore; nevertheless *Porphyra leucosticta* was found, together with a number of other algae. This material had a southern origine too, for *Cystoseira fibrosa* and *Halobityx incurvus* (Huds.) Batt., both species with a southern distribution, were present. The substrates on which *Porphyra leucosticta* was collected are given underneath.

Katwijk, 26-III-'51, on *Himanthalia elongata*, Lucas.

Den Helder, 29-III-'51, on an inner shell of *Sepia officinalis* L. and on *Fucus vesiculosus*, Den Hartog.

Beach between Huisduinen and Groote Keeten, 3-IV-'51, on *Ascophyllum nodosum*, *Fucus vesiculosus*, and an inner shell of *Sepia officinalis*, Den Hartog.

Beach between Castricum and Wijk aan Zee, 5-IV-'51, on *Ascophyllum nodosum* and *Polysiphonia lanosa*, Stock.

IJmuiden, 19-IV-'51, on a bunch of cork, Scharrer.

In the collection of the Rijksherbarium there seems to have been some material of older date under the name of *Porphyra vulgaris* Ag.:

Zandvoort, I-1844, on *Chorda filum* (L.) Stackh., Buse.

Scheveningen, without date, on a ship's mast, Vrijdag Zijnen.

In his list of algae from drifting objects LUCAS (1950) published these finds as *Porphyra lacineata* (L.) J. Ag. The two other records of *Porphyra lacineata*, of more recent date given by him also are to be classified as *Porphyra leucosticta*:

Beach between Noordwijk and Noordwijkerhout, 20-I-'49, on a bunch of cork, Lucas.

Beach between Noordwijk and Katwijk, 15-IX-'49, on a branch, Lucas.

b. Find in an autochthonic locality:

Spring 1951: (22-III) *Porphyra leucosticta* was found in great numbers by MULDER and SWENNEN in the Zuid Beveland Canal. Autumn 1951: (25-X) MULDER and the author visited this locality; now there were only a few specimens of *Porphyra* present. Spring 1952: (13-IV) MULDER and DE VUYST visited the canal again; the species now proved to be rather common.

This locality had already been surveyed by MULDER and the author in August 1950, but at that time we had not seen any *Porphyra*; nor had the species been observed by MULDER in August and September 1951 nor by the author in July 1952.

ECOLOGY

The Zuid Beveland Canal is a sea-water canal, shut off from the sea by locks, so that no tidal movements occur in it. Still we can distinguish three algal zones.

At the top *Ulothrix subflaccida* Wille (= *U. implexa* Kütz.) forms a 10-20 cm wide belt, in which it is accompanied by *Rhizoclonium riparium* (Roth) Harv. This vegetation is moistened only by rain and when a heavily loaded ship passes.

The second belt is ca. 50 cm wide and coincides with the wavedashed zone. It is characterized by the dominance of *Enteromorpha compressa* (L.) Grev. *Porphyra leucosticta* and *Monostroma wittrockii* Bornet are limited strictly to this belt.

Under it lies a zone which is unaffected by the waves, and is continually submerged. Among the great number of algae, occurring in this belt are: *Chondrus crispus* (L.) Stackh., *Polysiphonia denudata* (Dillw.) Kütz., *Polysiphonia nigrescens* (Dillw.) Grev., *Dasya pedicellata* (Ag.) Ag., *Gracilaria confervoides* (L.) Grev., *Griffithsia devoniensis* Harv., *Callithamnion* species, *Giffordia sandriana* (Zanard.) Hamel, *Bryopsis plumosa* (Huds.) Ag., etc.

The composition of this algal vegetation bears a distinctly southern stamp.

Although BRAUN-BLANQUET (1928) has elaborated his system only for land and fresh water vegetations the writer has tried, just as KORNAŠ and MEDWECKA-KORNAŠ (1950) did, to apply his methods to vegetations of marine algae. This investigation has not yet been finished, but still it seems to be a fact that the *Enteromorpha*-belt of the sea-water canals of the province of Zeeland presents a separate vegetation type. In Holland *Monostroma wittrockii* is limited almost entirely to these canals. So we can consider *Porphyra leucosticta* and *Monostroma wittrockii* as characteristic species of an association for which the writer proposes the name *Monostrometo-Porphyretum leucostictae*. This association is confined to the wavedashed zone of a coast, which is not subject to tidal movements. A survey of this association is given below.

MONOSTROMETO-PORPHYRETUM LEUCOSTICTAE ass. prov.

Zuid Beveland Canal, eastern bank, ca. 50 m south of the Schore-bridge. 25-X-'51; Area: $(30 \times 0,5) = 15 \text{ m}^2$, Exposition: west; Inclination 15° ; Depth: 0–20 cm, Coverture: 65 %.

Characteristic species:

<i>Monostroma wittrockii</i> Bornet	1.2
<i>Porphyra leucosticta</i> Thuret f. <i>atlantica</i> Hamel	

Other species:

<i>Enteromorpha compressa</i> (L.) Grev.	4.4
<i>Enteromorpha tubulosa</i> Kütz. ¹	+ .2
<i>Ulva lactuca</i> L.	+
<i>Ulothrix subflaccida</i> Wille	+
filiform diatoms	3

Appreciation is expressed to A. VAN DER WERFF, who investigated a sample of diatoms from this survey. He found chiefly the following species: *Navicula crucigera* (W.Sm.) Cl., *Amphipleura rutilans* (Trent.) Cl. and *Navicula gracilis* Ehr., which form filamentous colonies. Among them were found many *Synedra tabulata* (Ag.) Kütz., *Melosira nummuloides* (Dillw.) Ag., *Achnanthes longipes* Ag., and a number of other species. On *Porphyra leucosticta* many little clusters of *Synedra tabulata* were attached.

REFERENCES

- BØRGESEN, F. The Marine Algae of the Faerøes. Botany of the Faerøes, Vol. II, p. 339–532, 1903.
- BØRGESEN, F., The Algae-Vegetation of the Färøese Coasts with remarks on the Phyto-Geography. — Botany of the Faerøes, Vol. III, p. 683–834, 1905.
- BØRGESEN, F. and H. JONSSON. The Distribution of the Marine Algae of the Arctic Sea and of the Northernmost Part of the Atlantic. — Botany of the Faerøes, Vol. III, p. I–XXVIII, 1908.
- BRAUN-BLANQUET, J., Pflanzensoziologie. Berlin, 1928.
- DANGEARD, P., Sur le développement des spores chez quelques Porphyra. — Trav. crypt. vol. jubil. L. Mangin, p. 85–96. Paris, 1931.
- DREW, K. W., Conchocelis-Phase in the Life-History of *Porphyra umbilicalis* (L.) Kütz. — Nature, vol. 164, no. 4174, p. 748–749, 1949.
- FELDMANN, J., Les Algues Marines de la Côte des Albères. — Rev. Alg. vol. X, p. 1–340, 1938; vol. XI, p. 247–330, 1939.
- GOOR, A. C. J. VAN, Die Holländische Meeresalgen. — Verh. Kon. Akad. Wetensch. Amsterdam, 2e sect., vol. XXIII, 2, 1923.
- HAMEL, G., Floridées de France II. — Rev. Alg. I, p. 427–457, 1924.
- HOFFMANN, C., Über eine in der Kieler Förde neu aufgetretene Rotalge: *Porphyra atropurpurea* (Oliv.) De Toni. — Wiss. Meeresunt. Abt. Kiel, vol. XXI, p. 1–9, 1931.
- JOLIS, A. LE, Liste des Algues marines de Cherbourg. — Paris, 1863.
- KORNAŚ, J. and A. MEDWECKA-KORNAŚ, Associations végétales sous-marines dans le Golfe de Gdańsk. — Vegetatio, Vol. II, no. 2–3, p. 120–127, 1950.
- KOSTER, J. TH., Rare and otherwise interesting marine Algae from the Netherlands. — Acta Bot. Neerl. Vol. I, no. 2, p. 201–215, 1952.
- KYLIN, H., Studien über die Algenflora der schwedischen Westküste. — Thesis Uppsala, 1907.
- LAKOWITZ, K., Die Algenflora der gesamten Ostsee. — Gdańsk, 1929.

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- LUCAS, J. A. W., The Algae transported on drifting objects and washed ashore on the Netherlands' Coast. — *Blumea*, vol. VI, no. 2, p. 527-543, 1950.
- NEWTON, L., A Handbook of the British Seaweeds. — London, 1931.
- ROSENVINGE, L. KOLDERUP, The Marine Algae of Denmark I, — *K. Danske Vidensk. Selsk. Skr.* 7, Raekke VII, no. 1, 1909.
- TONI, G. B. DE, Sylloge Algarum omnium hucusque cognitarum. — Padua, 1889-1924.
- WORONICHIN, N. N., Die Rhodophyceen des Schwarzen Meeres. (in Russian) *Trav. Soc. Imp. Nat. de St. Pétersbourg*, vol. XL, p. 173-356, 1909.