

The Netherlands coastal waters as an environment for Nudibranchia

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So far 30 species of nudibranchs have been found on the Netherlands coast, two of which are visitors transported to the Dutch coast on floating material.

The occurrence of most of the autochthonous species must date from historical times, because for all our species a firm substratum is more or less obligatory. Originally, however, the Netherlands coast and the sea bottom in front of it consisted of fine sediments, such as sand, sand with silt, and silt. Only west of the islands of Vlieland and Texel is there a region of the sea bottom where there are many boulders, the so-called Texelse Stenen. The fauna of this pleistocene moraine bottom has never been studied and, therefore, does not concern us here.

When dikes, moles, and harbour works were built, lightvessels, buoys, and rafts laid out, wrecks of ships and aircrafts abandoned, and refuse like cinders and rubble dumped in sea, gradually substrata became available on which species formerly occurring incidentally only, could spread and species new to the region could settle.

Sea slugs are not very mobile animals, they usually live on or near their food. The small species could be considered ecoparasites, and not these parasites but their hosts need a solid substratum. The nudibranchs are stenophagous, i.e., each species feeds on a special species or genus of food animals only. These are of very different systematic origin; they can be sponges, hydroids, anthozoans, polyzoans, tunicates, or crustaceans.

In our country the horizontal distribution of the slugs appears to agree with that of their food animals. There are no instances in which the latter penetrate farther into brackish water than their predators do. As to the vertical distribution it appeared that in the upper tidal zone *Balanus balanoides* (L.) and *Laomedea flexuosa* Ald. are not attacked respectively by *Lamellidoris bilamellata* (L.) and *Tergipes despectus* (Johnst.), because they are more resistant to desiccation during low tide than their predators.

We can divide the region discussed here into: (1) the sea of a depth of 2 m or more; (2) the sea of a depth of less than 2 m and the tidal zone; (3) the brackish waters. Nudibranchia do not occur in fresh water.

THE SEA OF A DEPTH OF 2 M OR MORE

The bottom consists of sand or sand mixed with silt (with the exception of the "Texelse Stenen", not discussed here, see above). The sea slug *Preclibona peachii* (A. & H.) is nowhere so abundant as here, because its host, *Hydractinia ecbinata* (Flem.) nowhere thrives so well as on prosobranch shells inhabited by *Pagurus bernhardus* (L.), and it is this species which has a preference for these sandy soils. Besides, *Acanthodoris pilosa* (Müll.) is rather common here. It lives on polyzoans belonging to the genus *Aleyonidium*, of which large colonies develop on valves of lamellibranchs and on empty tests of *Echinocardium*.

As the North Sea is one of the seas where traffic is most dense, ship wrecks are not rare on its bottom. To these a great number of aircraft wrecks were added during the second world war. With rubbish from ships (mainly cinders and coal) these wrecks form a solid substratum for many species which elsewhere live on rocks.

THE SEA OF A DEPTH OF LESS THAN 2 M AND THE TIDAL ZONE

The coastal zone and large parts of the estuaries in the south and of the Wadden Sea belong to this region. The slugs *Eubranchius exiguus* (A. & H.) and *Tergipes despectus* (Johnst.) have their optimum here, because their hosts, hydroids of the genus *Laomedea*, prefer shallow water. These hydroids need only a small solid substratum for settling. Shell fragments, dorsal shields of *Carcinus maenas* (L.), and even the terminal parts of the siphons of *Mya arenaria* L. are substrata sufficient for large colonies of these hydroids.

In order to protect the land against the sea, dikes have been built in many places; since the first half of the 18th century they were reinforced by stones. Later the seaward slope was wholly covered by stones and provided with loose stones at the base. In addition, stone piers were constructed, and harbour works were lined with stones, wood, or iron. In many places the Netherlands thus obtained an artificial rock coast, with its characteristic flora and fauna.

The most interesting part of a dike is its base. Here loose stones are accumulated, enabling animals which shun the light or cannot settle on top of the stones because of competition by algae, to settle under, in, or between them. These animals consequently form a crypto-fauna.

Dikes of which the base lies at the low water line, so that the sea bottom on the outside does not emerge during low tide, are always inhabited by one or more species of nudibranch in the Netherlands.

Richest in species are the dikes which are sheltered from gales rubbing off the vegetation by means of the moving sand. Such sheltered dikes are found at Vlissingen, at the southcoast of the island of Schouwen, at Den Helder, and at the southeastern coast of the island of Texel. There the following species are found¹⁾:

on sponges: *Archidoris tuberculata* (Cuv.), and *Jorunna tomentosa* (Cuv.);

on hydroids: *Dendronotus fromdosus* (Asc.), *Doto coronata* (Gm.), *Preclibona peachii* (A. & H.), *Trincheisia aurantia* (A. & H.), *Cuthona concinna* (A. & H.), *Eubranchius exiguus* (A. & H.), *Tergipes desperatus* (Johnst.), and *Facelina coronata* (Forb. & Goodst.);

near anthozoans: *Aeolidia papillosa* (L.);

on *Alcyonium*: *Tritonia plebeia* Johnst.;

on bryozoans: *Acambodoris pilosa* (Müll.), *Goniodoris nodosa* (Mont.), and *Lamellidoris muricata* (Müll.);

on barnacles: *Lamellidoris bilamellata* (L.);

on tunicates: *Goniodoris castanea* A. & H.

Moreover there are three species of which I do not know the food: *Pala adbia* (Sars), *Ancula cristata* (Ald.), and *Anthipella cristata* (Chiaie).

It is difficult to express the density of nudibranch populations in figures but counting *Tergipes desperatus* (Johnst.) in colonies of *Laomedea longissima* (Pall.) in May 1953, I computed at 43 the number of slugs per cm² substratum occupied by the hydroid. The distribution of the hydroids over the substratum is, however, mosaic-like, and consequently the number of slugs per m² cannot be found by multiplying this figure by 10,000.

On the sea dike near Den Helder I made an estimate at some time or other of the number of specimens of different species of slugs per m² for a continuous area of at least 20 m². The results were as follows:

<i>Lamellidoris bilamellata</i>	15/m ²	December 27, 1956
<i>Aeolidia papillosa</i>	10/m ²	October 22, 1950
<i>Ancula cristata</i>	15/m ²	March 17, 1952
<i>Eubranchius exiguus</i>	200/m ²	March 29, 1950
<i>Tergipes desperatus</i>	500/m ²	March 17, 1950
<i>Trincheisia aurantia</i>	40/m ²	July 8, 1956
<i>Facelina coronata</i>	25/m ²	September 5, 1948
<i>Dendronotus fromdosus</i>	20/m ²	June 28, 1953
(Young specimens)		

¹⁾ The rarest species have been omitted.

As in these places the stones are lying in two to three layers, the actual surface of the substratum is much larger. The number of slugs varies from month to month, especially in the small species with a life of less than one year. When corresponding data for different years are compared there appears to be much variation in numbers too.

THE BRACKISH WATERS

Although our largest brackish water region vanished by the closing of the Zuiderzee, there are many localities behind our coast line where ditches, pools, and canals contain brackish water. On the leaves of *Zostera*, *Zammichellia*, *Ruppia*, and on reed and rushes colonies of the hydroids *Laomedea loewii* Allm. and *Cordylophora lacustris* Allm. develop. On the first mentioned *Embletonia pallida* A. & H. settles, and sometimes *Tergipes desperatus* (Johnst.) and *Eubranchius exiguus* (A. & H.), on the latter *Embletonia pallida* A. & H. only.

With the construction of sluices (e.g. near Den Helder and in the island of Schouwen) and jetties (e.g. for the ferries in the Noordzeekanaal) locally the surface of substrata suitable for the hydroids have considerably been extended, and the number of slugs per m² has consequently very much increased. Of late years, however, several areas of brackish water have been affected by pollution.

REFERENCES

For the literature on this subject the reader is referred to a more detailed paper on the Dutch Nudibranchia by the same author, which will appear in the Archives Néerlandaises de Zoologie before long, and to which an extensive list of references will be appended.