

NOTE ON THE DISTRIBUTION OF GARVEIA FRANCISCANA
(TORREY, 1902) AND CORDYLOPHORA CASPIA (PALLAS, 1771)
IN THE NETHERLANDS

by

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INTRODUCTION

In 1956 Kinne (1956, p. 257) published the description of a new athecate hydroid, *Perigonimus megas*, discovered by him in the Nordostseekanal, a canal connecting the North Sea with the Baltic. Kinne's new species resembles a well known and widely distributed fresh- and brackish-water hydroid, *Cordylophora caspia* (Pallas), in fact the resemblance between both species, though belonging to two different families of athecate hydroids (*Perigonimus megas* to the Bougainvilliidae; *Cordylophora caspia* to the Clavidae) is such that confusion is likely to occur and Kinne pointed out two occasions where the species have been confused by students of hydroids from the Netherlands. Both cases will be discussed below. The fact that on one of these occasions I have myself confused both species and contributed to the confusions arising from the misidentification, has prompted me to go through all available material of both species in the collections of the Zoological Museum at Amsterdam (Z.M.A.), the collections of the Division for Delta¹⁾ research of the Hydrobiological Institute, (= Delta Institute), Yerseke (D.I.), and the collections of the Rijksmuseum van Natuurlijke Historie, Leiden (R.M.N.H.). These studies brought forward the surprising result that Kinne's *Perigonimus megas* was a very common species in the former Zuiderzee, where it has now completely disappeared.

The study of the very abundant material from the Netherlands has shown that both species, in well preserved form and especially when bearing gonophores, can be separated without any difficulty. The well developed, male colony of *Perigonimus megas* in external appearance

1) The terms "Delta" and "Delta area" are at present commonly used in the Netherlands to indicate the southwestern region of the country, where the estuaries of the Rhine, Meuse and Scheldt rivers form a great number of larger and smaller islands and peninsulas.

is so completely different from even luxuriously growing colonies of *Cordylophora caspia* that it appears unlikely that Kinne's species should not have been observed before 1946. A survey of the available literature shows that it has in fact been described several times; moreover, there are various references to a *Cordylophora*-like athecate hydroid that may refer to the present species.

Furthermore, the use of the generic name *Perigonimus* M. Sars, the genus to which Kinne brought his new species, presents serious nomenclatorial difficulties. These are fully discussed below.

I want to express my gratitude to Prof. Dr. H. Engel and Dr. J. H. Stock of the Zoological Museum, Amsterdam, Dr. K. F. Vaas and Dr. C. den Hartog of the Division for Delta Research, Yerseke, and Dr. Fenner A. Chace, Jr., Division of Marine Invertebrates, U.S. National Museum (Smithsonian Institution), Washington, U.S.A., for the loan of material.

NOMENCLATORIAL NOTES

Rees (1938, p. 5) has pointed out that the type of the genus *Perigonimus*, *Perigonimus muscoides* M. Sars, 1846, produces free medusae which must be referred to the genus *Bougainvillia* Lesson, 1836. Since *Bougainvillia* is the older name, Sars' species must henceforth be named *Bougainvillia muscoides* (M. Sars, 1846), whilst the generic name *Perigonimus* becomes a junior subjective synonym of *Bougainvillia*. The many species that have in the course of time been ascribed to *Perigonimus* must be distributed over other genera and it appears that two genera are available for such species that have, like *Perigonimus megas*, fixed gonophores and are "real" Bougainvilliidae, viz., *Bimeria* Wright, 1859 (type species *Bimeria vestita* Wright, 1859) and *Garveia* Wright, 1859 (type species *Garveia nutans* Wright, 1859). Both genera are very closely related, so much so that they have been united by various authors and kept separate by others (cf. Rees, 1938, note on p. 25). As the microscopical structure of the various species referable to *Bimeria* and *Garveia* is almost completely unknown, the only observable difference between both genera is the fact that in *Garveia* the peridermal covering of the hydranth, which on retraction forms the pseudo-hydrotheca, terminates under the insertion of the tentacles, whilst in *Bimeria* the basal parts of the tentacles are encased in short, peridermal tubuli connected with the peridermal covering of the hydranth. In *Perigonimus megas* the detectable peridermal sheath on the hydranths terminates some distance below the whorl of tentacles and the basal portions of these tentacles, even in microscopical sections, are absolutely free from periderm. Kinne's species, therefore, should be placed in the genus *Garveia* as *Garveia megas*

(Kinne, 1956), where its place, as long as the structure of the gonophores of the other species of *Garveia* is unknown, must be provisional. As shown below *Bimeria franciscana* Torrey is the oldest available name for the present species; the binomen *Garveia franciscana* (Torrey, 1902) has therefore been used in the following description and in the notes.

***Garveia franciscana* (Torrey, 1902) (figs. 1-4)**

Bimeria franciscana Torrey, 1902, p. 28, pl. 1 fig. 4; Fraser, 1911, pp. 12, 22; Leloup, 1932, p. 139, textfigs. 12, 13, pl. 17 figs. 1, 1a; Weill, 1934, pp. 77, 386, fig. 71a, b; Fraser, 1937, p. 31, pl. 3 fig. 14; Deevey, 1950, p. 335; Crowell & Darnell, 1955, pp. 516-518; Buchanan, 1956, p. 276.

Bimeria Monodi Billard, 1927, p. 467, figs. 1, 2a.

Bimeria tunicata Fraser, 1943, pp. 76, 86, pl. 15 fig. 2; Fraser, 1944, p. 50, pl. 5 fig. 18; Fraser, 1945, p. 21; Fraser, 1946, p. ? (not available).

Bougainvillia ramosa, Funke, 1922, p. 192, fig. 3.

Cordylophora caspia p.p., Wagenaar Hummelinck, 1936, p. 42, fig. 1a, b; Vervoort, 1946, p. 118, fig. 47a.

Cordylophora lacustris p.p., Pennycuik, 1959, p. 165, pl. 2 figs. 4, 5.

Perigonimus megas Kinne, 1956, pp. 256-268, figs. 1-7; Den Hartog, 1959, p. 10, fig.

Description. — Monopodially built, racemose colonies, usually reaching a height of 10 to 20 cm and very richly developed. The hydrocauli rise from a matting of fine, anastomosing and intertwining hydrorhizal fibres covering a variety of substrata (empty shells, stones, fragments of wood, etc.). One tuft of hydrorhizal fibres usually gives rise to a number of hydrocauli, resulting in the formation of bushy colonies. The hydrocauli remain monosiphonical throughout their entire length and at their base, where they rise from the hydrorhiza, they may have a diameter of about 300 μ . They terminate in a hydranth. In some colonies the basal part of the hydrocaulus may be covered by some secondary tubes, apparently consisting of the hydrorhizal fibres of some colony developing on the first. The hydrocauli give rise to sidebranches (or hydranth pedicels in the higher parts) that are helically arranged and occur at very regular intervals. In many colonies the hydrocaulus is geniculated and helically twisted, curving from sidebranch to sidebranch. This very regular construction of the colonies is retained in many, particularly male colonies, but it may be completely absent in other colonies that develop under extreme conditions. The periderm of the hydrocaulus is thick and yellowish-brown in colour; some rings may occur at the extreme base but for the rest it is completely smooth. There are very slight constrictions of the periderm under each sidebranch.

The sidebranches are the lengthened, original pedicels of the primary hydranths, that are still to be found at their extreme ends. The sidebranches are ringed at their base, the number of rings is variable and may vary

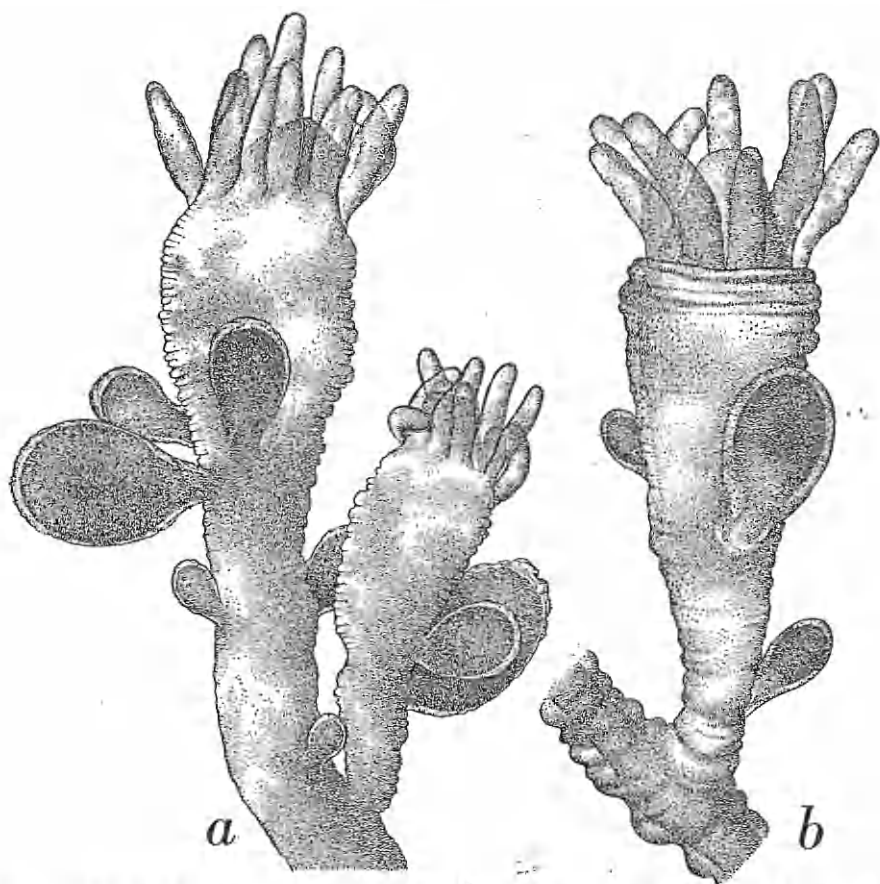


Fig. 1. *Garveia franciscana* (Torrey), Singelgracht, Amsterdam, 1930 (Z.M.A.), male colony. a, fully expanded hydranths with male gonophores; b, partly retracted hydranth, showing the pseudohydrotheca, with some male gonophores. $\times 75$.

between 5 and 20. They rise from the hydrocauli under an angle of about 60° . They bear secondary hydranths, that are originally spirally arranged and shortly stalked. The pedicels of these secondary hydranths may lengthen and give rise to tertiary hydranths. Usually there are only secondary hydranths and they tend to occur along the upper side of each sidebranch. The pedicels of the secondary hydranths are fully ringed or they are distinctly ringed at their base and wrinkled for the rest of their length.

The above described condition may result in very regular, monopodially built colonies of 8 tot 15 cm height, with the sidebranches gradually shortening from base to apex: many male colonies are of this type. The female colonies usually are much more irregularly branched, whilst the pedicels of

the various hydranths are long and fine, resulting in a densely intertwining mass of branches with hydranths directed in all directions. In many cases, therefore, it is possible to discriminate between male and female colonies even in absence of the gonophores. The structure of the colony may furthermore become obscured by the development of algae and diatoms, that may develop richly upon the hydrocauli and its sidebranches.

The hydranths have the structure characteristic of the family Bougainvilliidae; they are more or less ovoid; their shape in expanded condition can best be judged from figs. 1a, 2b. The periderm of the pedicels covers the basal part of the hydranths and reaches as far as the base of the whorl of tentacles. Upon contraction of the hydranth the periderm forms a distinct pseudohydrotheca, investing the basal parts of the tentacles (fig. 1b). As appears quite distinctly from sections of the hydranths the periderm does not continue along the basal part of the tentacles (fig. 4a), as is the case in *Bimeria fluminalis* Annandale (cf. Millard, 1959, pp. 309, 310, fig. 4h, i).

There are 8 to 12 filiform tentacles arranged in one distinct whorl around the conical proboscis. They consist of a row of very flat entodermal cells, piled to form a cylinder, and covered by a sheath of ectodermal cells. The periderm of the hydranths stands out quite distinctly though there appears to be only a very small quantity of grit which adheres to it.

The male and female gonophores are born on separate colonies; the species consequently is dioecious. They are borne, usually in great profusion, upon the pedicels of the secondary hydranths and only very occasionally directly on the sidebranches.

The male gonophore is an elongated, ovoid structure, completely invested by a thin covering of periderm. In a male colony all stages of development may be observed between very young male gonophores and mature male gonophores; as many as 20 may be found on a single pedicel (fig. 1). There is, in each developing male gonophore, a distinct spadix, around which the spermatozoa develop; in the mature gonophore the spadix is completely obscured by the dense mass of spermatozoa (fig. 4c).

The female gonophores (fig. 2) are globular and smaller than the mature male gonophores: they invariably contain a single egg (fig. 3). The spadix is not curved around the egg, but terminates under the egg. Here too the gonophores are completely invested by thin periderm, but there is a hyaline zone between this peridermal sheath and the egg or the developing planula, which gives the female gonophores a very characteristic appearance.

The eggs (one in each gonophore) are fecundated in situ and develop into a complete planula inside the gonophore (fig. 4b). The fully developed planula leaves the gonophore after rupture of the peridermal covering.

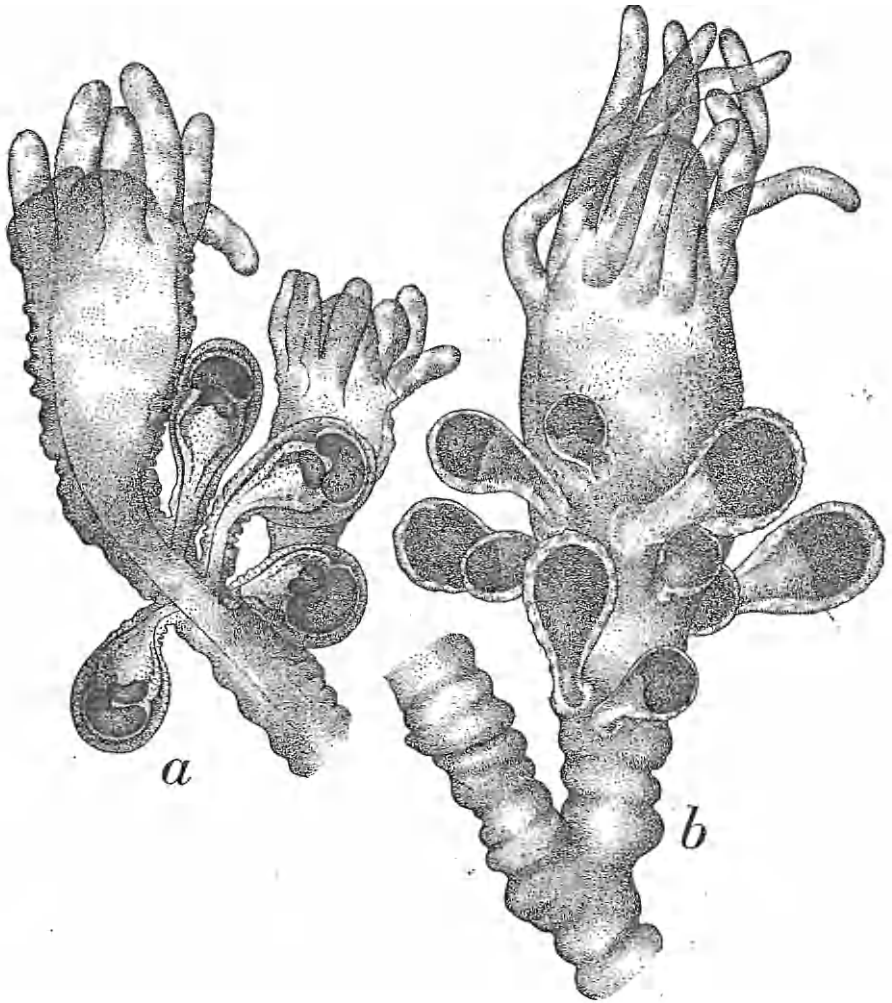


Fig. 2. *Garveia franciscana* (Torrey). a, slightly retracted hydranths with female gonophores with developing planula from Enkhuizerzand, Zuiderzee (Wn. 51, 1928, Z.M.A.); b, fully expanded hydranth with young female gonophores from De Knar, Zuiderzee (Buoy, 1931, Z.M.A.). $\times 75$.

The following measurements (in μ) are taken from preserved material:

hydranths, diameter of pedicel	100—130
length in expanded condition	500—650
greatest diameter	250—300
greatest diameter of female gonophore with egg	100—150
greatest diameter of female gonophore with planula	200—235
greatest diameter of mature male gonophore	250—275
greatest length of mature male gonophore	390—410

The nematocysts of this species have been studied and described by Weill (1934, pp. 77, 386, fig. 71). There are two types, desmonemes and microbasic euryteles. The desmonemes are oval structures with a total length of $5\ \mu$. The microbasic euryteles are of the heterotrichous type, with a pear-

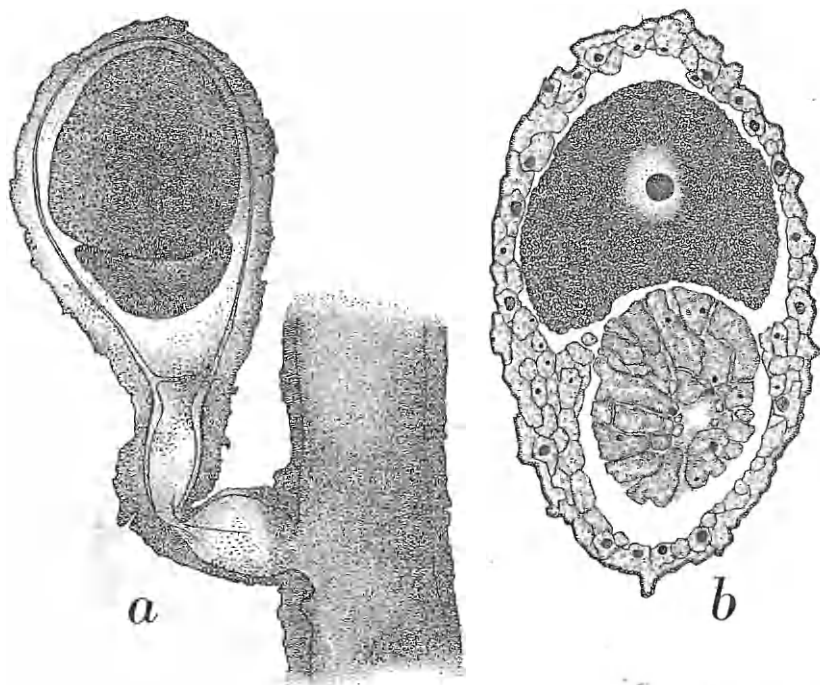


Fig. 3. *Garveia franciscana* (Torrey). a, fully mature female gonophore from Vuile Gat, Zuiderzee (Wn. 77, 1926, Z.M.A.); b, longitudinal section through this female gonophore, to show the large egg, the spadix, and the layer of ectodermal cells secreting a thin layer of periderm. a, $\times 150$; b, $\times 225$.

shaped capsule of $15\ \mu$ length and $7\ \mu$ maximal diameter. In the exploded capsules the thread is fairly short ($40\ \mu$) and has two basal swellings, the proximal of which is the larger and has three strong spines placed in a whorl and directed upwards. The material which I have been able to study is unfit for the detailed study of the nematocysts. The unexploded nematocysts, apparently as a result of fixation, are structureless (as they were in Weill's material), and exploded nematocysts I have been unable to trace. There is nothing, however, in my material, that contradicts Weill's observations, whilst the nematocysts that are present have identical dimensions.

Remarks. — This species has only been confused with *Cordylophora caspia*

(Pallas) because both species have in common the occurrence in brackish waters. I am inclined, however, to consider *Cordylophora caspia* as an originally fresh water species with a high tolerance for increase of salinity in its surroundings, whilst *Garveia franciscana* is almost certainly a marine species

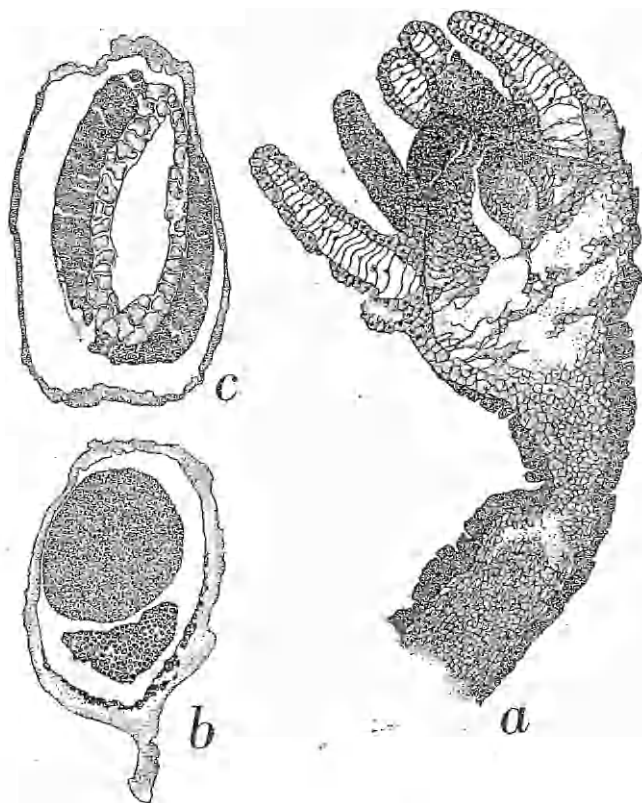


Fig. 4 *Garveia franciscana* (Torrey). a, longitudinal section through partly retracted hydranth, from De Knar, Zuiderzee (Buoy, 1931, Z.M.A.); b, longitudinal section through female gonophore containing a developing planula, from Enkhuizerzand, Zuiderzee (Wn. 51, 1928, Z.M.A.); c, longitudinal section through mature male gonophore from De Knar, Zuiderzee (Buoy, 1931, Z.M.A.), showing the spadix covered by developing spermatocytes. a, $\times 100$; b, c, $\times 150$.

that has migrated into brackish water habitats. There are very few morphological points of resemblance between both species. The structure of the colonies of *Cordylophora caspia*, though extremely variable, is usually quite different from that of *G. franciscana*, whilst polyps and gonophores are very different.

Though under certain conditions the colonies in *Cordylophora caspia* develop fairly regularly and monopodially, there is never a distinct hydro-

caulus with helically arranged sidebranches. The pedicels of the hydranths in *C. caspia* are usually elongated and give the colonies a very irregular appearance; this combined with the much larger hydranths usually suffices to distinguish *C. caspia* at a glance.

The hydranths of *Cordylophora caspia*, as mentioned above, usually are much bigger than those of *G. franciscana*, though in extreme cases, apparently in current water, much smaller hydranths have been observed. In expanded condition the hydranths of *G. caspia* have 12 to 15 filiform tentacles distributed over the whole body; the tentacles are much longer than those of *G. franciscana*, but on contraction of the hydranths they may become just as thick; in this contracted state they may even give the impression of being arranged in a single whorl. In *C. caspia*, even in a very contracted state, there is never a pseudohydrotheca at the base of the hydranth.

The gonophores in *C. caspia* occur in numbers varying between 1 and 5 at the pedicels of the hydranths, there is never the accumulation of gonophores observed in *G. franciscana*. In *C. caspia* male and female gonophores occur on the same colony; the male gonophores usually are larger in mature state and taper gradually near the apex. The female gonophores, too, are larger and contain a large number of eggs developing near a reticulated spadix. After fecundation of the eggs the planulae develop in a large gelatinous mass invested by extremely thin periderm. The female gonophores of *C. caspia*, containing the developing planulae, are a very characteristic feature of this species and if present, place its recognition beyond any doubt.

Sterile colonies of *Garveia franciscana*, particularly small specimens, can very easily be confused with *Bougainvillia ramosa* (Wright, 1858), especially with the form distinguished as forma *benedeni* Bonnevie, 1898. In the structure of the hydranths there are practically no differences (though I have not studied in detail the structure of the nematocysts), so that young, sterile colonies of both forms cannot possibly be separated. In *Bougainvillia ramosa* forma *benedeni* the colonies are of very irregular structure with the periderm wrinkled rather than ringed. Fully developed colonies of *Bougainvillia ramosa* have a fairly regular structure and thick, polysiphonical hydrocauli which make them distinguishable from *G. franciscana*. Both species can be separated very easily if the gonophores are present: those of *Bougainvillia ramosa* develop into free medusae, but even in young state the presence of the four radial canals is easily observed.

Synonymy. — The reason for the identification of *Perigonimus megas* with Torrey's *Bimeria franciscana* will now be discussed. It seems quite clear

that the above mentioned material from the Zuiderzee, the material from Hellevoetsluis and the colonies from the Schelde, the Elbe and the Nordostseekanal all belong to the same species. Kinne's original account of *Perigonimus megas* is based, to some extent, on material from the Netherlands, though he has contented himself with studying the figures of this material and did not study any of the Dutch specimens. Kinne consequently did not fully realize the variability of his new species and unfortunately he failed to deal adequately with the available literature. His (Kinne, 1956, p. 258) survey of the northern species of *Perigonimus* is not complete, as appears from a comparison of Kinne's table 1 with Rees' (1956, pp. 346--348) revision of *Perigonimus*. As I have pointed out above Kinne's species must be referred to the genus *Garveia* Wright, 1859.

Torrey's *Bimeria franciscana* was very briefly characterized; his diagnosis (Torrey, 1902, p. 28, pl. 1 fig. 4) is accompanied by a single figure which, though it shows a certain resemblance with Wagenaar Hummelinck's (1936, fig. 1b) figure of *Cordylophora caspia*, is not detailed enough to show the identity of both species. I have made reference to *Bimeria franciscana* in 1946 (Vervoort, 1946, p. 292) in a discussion of *Cordylophora caspia*, and made it clear that Torrey's species needed closer investigation. Deevey (1950, p. 335) studied material from the type locality of *Bimeria franciscana*, the Bay of San Francisco, and found it to be identical with material from the coast of Louisiana, described by Fraser (1943, p. 76) as *Bimeria tunicata*. Later on, the species was adequately redescribed by Crowell & Darnell (1955, pp. 516-518); their description permits the identification of European material of *Perigonimus megas* with *Bimeria franciscana*. Buchanan (1956, p. 276) has drawn attention to the fact that the hydroids described by Billard (1927, p. 467) as *Bimeria monodi* also undoubtedly belong to *Bimeria franciscana*. Leloup (1932, p. 139, figs. 12, 13) has identified material from brackish water localities along the Indian west coast and from the delta of the river Ganges as *Bimeria franciscana* and he has completely described his material. Though Leloup, at the time of his publication, must have acted on very meagre evidence, there can be no doubt, after the publication of Crowell & Darnell's paper, about the identity of Leloup's material with the American species. Pennycuik (1959, p. 165, pl. 2 figs. 4, 5) described aberrant colonies of *Cordylophora lacustris*, which she found to resemble closely the figures of *Cordylophora caspia* published by Wagenaar Hummelinck (1936, fig. 1b). Fortunately her material is fully described and adequately figured and it can be identified without any doubt as *Bimeria franciscana*. I have pointed out above that it seems appropriate, at least for the present, to distinguish between the genera *Garveia* Wright,

1859, and *Bimeria* Wright, 1859, on account of the absence or presence of a peridermal tube at the base of the tentacles. As microscopical sections prove beyond any doubt that such a peridermal basal covering of the tentacles is absent in *Bimeria franciscana* the proper place of the species is in *Garveia*, where it should stand as *Garveia franciscana* (Torrey, 1902).

Through the kindness of Dr. Fenner A. Chace, Jr., Curator, Division of Marine Invertebrates, U.S. National Museum, Washington, U.S.A., I have been able to examine some Pacific material of *Garveya franciscana* (Torrey). The material is labelled: "43484, *Bimeria franciscana* Torrey, Oakland, California, Sept. 30, 1901, Univ. of California, may be from type lot, H.B. Torrey?". The material consists of some 7 to 8 cm high, richly branched colonies in fairly poor condition, as nearly all the hydranths have disappeared. I did find, nevertheless, some small branches with hydranths, that have been stained and mounted and which are almost indistinguishable from similar branches of material from the Zuiderzee. The branches of the California material bear male gonophores in various stages of development. There is, however, a difference in the general appearance of the colonies. In the material from Oakland the periderm of the hydrocaulus, as well as the periderm of the sidebranches, is much thicker than has been observed in the European material; moreover, the total diameter of the hydrocaulus is about 800 μ , while a diameter of only 300 μ is observed in the Zuiderzee material. The hydrocaulus is covered by a growth of diatoms and with some grit; as a result it forms a very prominent structure of the colony. The differences in general appearance, however, do not justify specific distinction between both types of colonies as the species, with regards to its wide range of geographical distribution and widely varying ecological conditions under which it has been observed, is apt to be variable in this respect. In the West African *Bimeria monodi* Billard, which is certainly identical with *Bimeria franciscana*, the shape of the colonies approaches closely the type which has been found in the Zuiderzee. In *Bimeria tunicata* Fraser the hydrocaulus, judging from Fraser's figure (1937, pl. 3 fig. 14a), is even thicker than in *Bimeria franciscana*, though in Fraser's figure the actual diameter of the hydrocaulus may be slightly exaggerated because of the development of growth on the hydrocaulus.

Distribution and ecology. — The following records are now available:

Pacific coast of North America: San Francisco Bay (type locality, between tides, Torrey, 1902; low tide to 7 fathoms, Fraser, 1937; Deevey, 1950), Carmel Bay, California (Weill, 1934).

Atlantic coast of North America: Corpus Christi; off Freeport; Galveston Bay; Houston ship channel; Sabine passage, all along the coast of Texas

(Deevey, 1950), Bayou Chene Fleuri, Louisiana (Deevey, 1950), Lake Pontchartrain, Louisiana (2.5-12.0‰ Cl, Crowell & Darnell, 1955), Potomac oyster beds, near Lower Cedar Point Bar, Virginia, (Fraser, 1945; Frey, 1946).

East and West coasts of India: Marmugoa Bay, Goa and East Kumbalam, Cochin, both localities along the Arabian Sea coast of India (Leloup, 1932), Sunderbands, Fraser Guy, and Sunderbands, Barakara, both localities in the Ganges delta (Leloup, 1932), mouth of the river Hooghly, Sagar Islands and an unspecified locality at the Andaman Islands (Leloup, 1932).

West coast of Africa: Souelaba, Cape Cameroun and Kwele Kwele Banc, both localities along the coast of Cameroun (Billard, 1927), Ambas Bay, Victoria, Cameroons (Buchanan, 1956).

Australia: Brisbane River, East Brisbane, Queensland (Pennycuik, 1959).

In the former Zuiderzee *Garveia franciscana* was exceedingly common. The first author who mentioned unmistakable specimens (Funke, 1922, between Ketel and the extremity of the "Knar", depth 3.7 m, salinity 4.50‰ Cl., t = 20.0 C) misidentified his material and ascribed it to *Bougainvillia ramosa* (Wright) (Funke's *Bougainvillia flavida*, p. 193, is the real *B. ramosa*). The enormous material of this species collected during the investigations of the Zuiderzee and preserved in the Zoological Museum at Amsterdam was studied by Wagenaar Hummelinck and without any exception identified as *Cordylophora caspia* (Pall.). I have now revised all the Zuiderzee material with the result that the following records, fully given in Wagenaar Hummelinck's paper (1936, pp. 42, 43) undoubtedly refer to *Garveia franciscana* (the station numbers and years are also given): off Edam (Wn. 202, 1931); Enkhuizenzand (Wn. 51, 1928; Wn. 122, 1929); de Knar (Wn. 72, 1928; buoy, 1931); Lemsterhop (Wn. 81, 1928); off Oosterleek (Wn. 121, 1929; Wn. 170, 1930; Wn. 191, 1931); Steile Bank (Wn. 5, 1927; Wn. 53, 80, 1928; Wn. 101, 1928; Wn. 128, 1929); Val van Urk (Wn. 52, 79, 1928; Wn. 123, 1929), Staart van Urk (Wn. 99, 1928), and Vuile Gat (Wn. 77, 1926). In addition there is material from N.E. of Urk (1929, Z.M.A.) and material from near Urk (1928, R.M.N.H.). After the closure of the Zuiderzee (May 28th, 1932) material was obtained from Steile Bank (Wn. 226, 1932), from near Schokland (Wn. 276, 1933) and from a jetty near Pampus (Wn. 295, 1934). There are no later records than 1934, so that apparently the species has disappeared from the IJsselmeer. In addition to the above mentioned records, based upon unmistakable material, there is a lot of doubtful material, that is listed below under the heading doubtful records. The following list summarises the various data from the former Zuiderzee region.

Station number (Waarneming)	depth in meters	temperature at surface in centigrade	Salinity at surface in ‰ Cl.
5	2.9	14.2	3.35
51	3.0	17.0	5.1
52	5.0	17.8	5.8
53	3.3	18.0	4.4
72	3.0	16.0	4.7
77	3.0	17.0	3.7
79	4.2	18.5	7.6
80	3.3	20.0	3.7
81	3.0	16.0	3.5
99	4.0	7.0	5.2
101	3.3	8.0	4.1
121	3.6	18.0	6.1
122	3.0	18.0	8.3
123	5.0	19.0	8.5
128	3.3	18.5	4.5
170	3.6	9.0	7.38
191	3.6	17.0	5.14
202	2.7	17.0	5.03
226*	3.3	18.4	5.37
276*	3.0	9.2	1.5
295*	2.2	18.0	1.6

The stations marked * refer to collections made after the closure of the Zuiderzee.

In addition to the material referred to above, the collections of the Zoological Museum, Amsterdam, contain a very rich sample of *Garveia franciscana* collected by Mrs. N. Wibaut-Isehree Moens near the bridge across the Singelgracht, near Muiderpoort, Amsterdam, 11 June 1930¹⁾. No hydrological data of this locality are known.

Recently material of *Garveia franciscana* has only been collected near Hellevoetsluis, province Zuid Holland, by Dr. C. den Hartog, division of Delta Research of the Hydrobiological Institute, Yerseke, on 7 July 1959 and 31 July 1962. Part of this material is in the collections of the Rijksmuseum van Natuurlijke Historie, Leiden, part in the collection of the Delta Institute, Yerseke. On both occasions only sterile colonies have been observed, but in spite of the absence of the gonosome they very certainly belong to *Garveia franciscana* as the shape of the colonies is very characteristic. I have also seen material from the mouth of the river Elbe, western Germany, collected in 1946 by Dr. H. Caspers and originally identified as *Cordylophora caspia*. These colonies have very young male gonophores.

1) The sample was originally labelled "bridge across Lijnbaansgracht, near Muiderpoort". This is evidently a mistake; the bridge near the Muiderpoort crosses the Singelgracht, which had a direct communication with the water of the Zuiderzee.

Kinne (1956, as *Perigonimus megas*) mentions the species from the Nordostseekanal, western Germany. The species appears to be quite common in the Belgian lower Schelde, where Dr. C. den Hartog of the Delta Institute collected a very abundant, fertile material on 17 August 1962 at Doel and Liefkenshoek. It seems almost beyond doubt that this is the species mentioned by Leloup & Konietzko (1956, p. 69, pl. 1 fig. 1) from the same localities as *Bougainvillia ramosa*.

Crowell & Darnell (1955), who studied the species under laboratory conditions, observed growth in colonies cultivated at salinities between 3.5‰ and 35.0‰ Cl., but the animals were able to survive more stringent conditions of salinity. Temperatures of about 34° C were not fatal and even gave rise to luxuriant growth. The colonies did not survive temperatures of 37.5° C, while the hydranths regressed completely when the temperature dropped to 9° C.

Bimeria fluminalis Annandale, 1915

Bimeria fluminalis Annandale, 1915, p. 111, fig. 10, pl. 9 figs. 3, 3a; Annandale, 1917, p. 111, fig. 1; Millard, 1959, p. 309, fig. 4.

Cordylophora caspia, Vervoort, 1946, p. 291.

This species is mentioned here because of its great general resemblance to *Garveia franciscana*. There are various reasons, however, to separate this form from *G. franciscana*:

a. Though the structure of the colonies in both species is nearly identical, the full grown colony of *Bimeria fluminalis* is of a very rigid structure with particularly strong periderm, usually of a blackish colour and strongly encrusted with silt, diatoms, etc.

b. The periderm of the hydranths of *B. fluminalis* forms short tubuli investing the basal part of the tentacles. This peridermal covering of the hydranths is very thin, nevertheless it is present and in sections of the hydranths it can distinctly be demonstrated. On the hydranths the periderm is usually voluminous because of the presence of adhering particles.

c. There are distinct differences in the structure of the female gonophores. In *Bimeria fluminalis* there is also only a single egg, but the spadix curves around the egg in a truly remarkable fashion.

d. There appear to be distinct differences in the heterotrichous microbasic euryteles, as a comparison of Millard's figure (1959, fig. 4j) of these organs in *B. fluminalis* with Weill's figure (1934, fig. 71b) of the same in *G. franciscana* distinctly shows.

I regret to state that I completely overlooked Annandale's description of this characteristic species and consequently misidentified some material mentioned on p. 291 of my 1946 paper as *Cordylophora caspia*.

Bimeria fluminalis occurs in comparable habitats as *Garveia franciscana*, but so far it has only been observed in tropical and subtropical localities: Chilka Lake, Bay of Bengal (Annandale, 1915), Gulf of Siam (Annandale, 1917), mouth of the Koeboe river, West Borneo (Vervoort, 1946, as *Cordylophora caspia*), and from South of Mpate River, St. Lucia Estuary, Natal (Millard, 1959).

***Cordylophora caspia* (Pallas, 1771) (fig. 5)**

Cordylophora lacustris, Funke, 1922, p. 188, fig. 2; Hand & Gwilliam, 1951, p. 207; Pennycuik, 1959, p. 165.

Cordylophora caspia, Kinne, 1956, pp. 565-638, figs. 1-39; Kinne, 1956a, pp. 217, 223, 227, figs. 8, 11, 14, tabs. 6, 12; Kinne, 1957, pp. 445-449, figs. 1-3; Kinne, 1957a, p. 330.

Cordylophora caspia p.p., Wagenaar Hummelinck, 1936, p. 42, fig. 1c, d, e, f, g; Vervoort, 1946, p. 118, figs. 47b, 48a, b; Wagenaar Hummelinck, 1954, p. 162, fig. 21.

Bimeria (?) *baltica* Stechow, 1927, p. 306, figs. 1, 2.

Through the kindness of Dr. W. Engelhardt of the Zoologische Sammlung des Bayerischen Staates, München, which collection at present contains Stechow's hydroids, I have been able to inspect the type of *Bimeria baltica*, described by Stechow from Greifswalder Bodden, Baltic. The type lot consists of small colonies, preserved in alcohol, and two stained slides, each with 4 colonies embedded in Canada balsam. There is no difference in structure between the alcohol colonies and those preserved on the slides, so that they will be described together.

All colonies are monosiphonical, with a maximal height of 3 cm, rising from a hydrocaulus creeping on a 8 cm long fragment of root. The hydrocauli have a yellowish-brown periderm with a few wrinkles or rings at the basal part of each hydrocaulus. The sidebranches are more or less arranged in one plane and are given off with great regularity to the left and right sides; the hydrocaulus between the side branches is geniculated. The sidebranches, the original pedicels of the primary polyps, are ringed at their base and wrinkled throughout their entire length.

No more hydranths are present, neither on the alcohol fixed colonies nor in the specimens on the slides. Though Stechow (1927, p. 308) failed to observe well preserved hydranths ("es liegen zahlreiche Gonophoren, aber keine intakte Hydranthen vor") he described the hydranths as being provided with 10 tentacles in one whorl; this conclusion, however, is not borne out by the present material, which has no undamaged hydranths.

In Stechow's type material there are many male and female gonophores, borne upon the pedicels of the hydranths, numbering 2 or 3 to each pedicel. These are indistinguishable from those of *Cordylophora caspia*; the male

gonophores are elongated ovoid, with slightly tapering apex; the female gonophores have many developing planulae and a ramified or reticulated spadix (fig. 6).

length of the male gonophores	600-800 μ
diameter of the male gonophores	350-400 μ
length of the female gonophores	700-900 μ
diameter of the female gonophores	400-500 μ



Fig. 5. Map of the Netherlands to illustrate the distribution of *Cordylophora caspia* (Pall.). The localities from which material has been studied are indicated by dots; reliable records from literature have been indicated with a small triangle.

The structure of the gonophores makes it absolutely clear that *Bimeria*(?) *baltica* is conspecific with *Cordylophora caspia* (Pall.) and the name *Bimeria* (?) *baltica* Stechow, 1927, may disappear as a junior, subjective synonym of *Cordylophora caspia* (Pallas, 1771).

Distribution in the Netherlands. — There are many reasons to suggest that *Cordylophora caspia* was either absent in the former Zuiderzee or

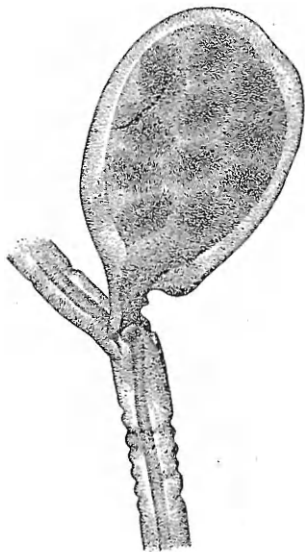


Fig. 6. *Cordylophora caspia* (Pall.). Male gonophore from the type of *Bimeria baltica* Stechow, Greifswalder Bodden, Baltic: X 70.-

occurred sporadically at localities that offered suitable conditions. The only material that I have been able to check is a sample in the collection of the Zoological Museum, Amsterdam, labelled: Zuiderzee, Oosterdel, 2 June 1922, collected by the Rijksinstituut voor Visserij-Onderzoek, no. 85. The colonies are remarkably fine, being 20 mm high, and have poorly preserved hydranths but some unmistakable male gonophores. Funke (1922, p. 188) refers to colonies of *C. lacustris*, creeping on *Heteropanope tridentata* (= *Rhithropanopeus harrisii tridentatus* (Maitland)) from Fems gat in the eastern part of the Zuiderzee. Funke's material seems to have been in poor condition, but if it is the material represented in fig. 2 of his paper (though this is by no means certain as the legend to the figure contains no reference to the locality) there can be no doubt that it really represented *Cordylophora caspia*. No hydrographical data are known of either locality. No

other indisputable Zuiderzee material is available; *Cordylophora caspia* certainly did not represent a normal faunal component of the former Zuiderzee.

In the brackish water areas of the provinces Friesland, Overijssel, Gelderland and Noord-Holland *Cordylophora caspia* occurred plentifully, as appears distinctly from the data given below. Fairly soon after the closure of the Zuiderzee¹⁾ and the change in hydrographical conditions in the IJsselmeer, *Cordylophora caspia* followed the retreat of *Garveia franciscana* at its heels and very soon it appeared to be distributed over the whole IJsselmeer.

I have seen material of the present species, collected during the IJsselmeer investigations (Z.M.A.) from the following localities (the station numbers and years are also given): off Broekerhaven (Wn. 383, 1943); buoy Enkhuizerzand (Wn. 386, 1943); Gammels (Wn. 284, 1934; Wn. 324, 341, 1937); Hoornse Hop (Wn. 328, 1937); off Huizen (Wn. 332, 1937); point of De Knar (Wn. 333, 1937; Wn. 348, 1938); Kraggenburg (Wn. 275, 1933; Wn. 288, 1934; Wn. 319, 1936); buoy of Kreil (Wn. 385, 1943); Kreupel (Wn. 283, 1934; Wn. 323, 1936; Wn. 336, 1938); Marken, lighthouse (Wn. 380, 1943); Middelgronden (Wn. 327, 1936; Wn. 339, 1937); off Muiden (Wn. 313, 1936); near Pampus (Wn. 322, 1936; Wn. 330, 1937); Roggebot (Wn. 334, 1937); Schokland, northern point (Wn. 289, 1934; Wn. 305, 1935; Wn. 318, Wn. 335, 1937; Wn. 351, 1938); 't Spijk near Elburg (Wn. 315, 1936); Steile Bank, northern point (Wn. 354, 1938); Val van Urk (Wn. 291, 1934; Wn. 322, 1936).

The hydrographical data of these stations are listed in De Beaufort (1954, pp. 341-345). The depth at which the species was found varied from 1.9 to 4.2 m.

In addition to the material listed above the following IJsselmeer localities are represented by well preserved material: off Laaksum, 1935 (R.M.N.H., no. 483, 838), near monument on Afsluitdijk, 1938 (Z.M.A.); W.N.W. of Kraggenburg, 1937 (Z.M.A.); Huizen, jetty on south side of harbour, 1937 (Z.M.A.); off Valkeveen near Naarden, 1938 (Z.M.A.); S.E. of Muiderberg, 1953 (Z.M.A.); 3-5 km E.N.E. of Enkhuizen, 1936 (Z.M.A.); Schokland, Noorderbrug, 1933 (Z.M.A.), and Schokland, buoy near Emmeloord, 1933 (Z.M.A.).

Material from the following localities has been checked: Eems estuary (actually collected in the mouth of the river Eems and therefore outside the Netherlands, 1885, R.M.N.H.; 1956, Z.M.A.); Langweerder wielen (1925, Z.M.A.); Rode Klif (1937, Z.M.A.); Anne Ruardi, pool (1937,

1) After the closure of the Zuiderzee its name was changed to IJsselmeer.

1939, Z.M.A.); between Blokzijl and Vollenhove, in pools (1938, 1939, Z.M.A.); Zwarte Water near Genemuiden (1937, Z.M.A.); Nijkerk, near entrance to harbour (1937, Z.M.A.); Valkeveen, near Naarden (1939, Z.M.A.); Muiderberg (1937, 1939, Z.M.A.); Muiden, harbour (1921, Wn. 85, 0.62‰ Cl., $t = 17.3^{\circ}\text{C}$, Z.M.A.); Merwedekanaal near Breukelen (1944, R.M.N.H., no. 840); Loenerveenseplas (1944, R.M.N.H., no. 839); Amstel near Amsterdam (1922, Z.M.A.); Bosbaan, Amsterdam (1949, Z.M.A.); Kinsemeer (1932, 1938, 1948, Z.M.A.); Zaan (1938, Z.M.A.); Zaandam (1923, Z.M.A.); Wormerringvaart (1938, Z.M.A.); Uitgeest (1922, Z.M.A.); Akersloot (1919, Z.M.A.); Koedijk (1922, Z.M.A.); Geestmerambacht, lock in polder (1920, Z.M.A.); Schoorldam (1920, Z.M.A.); Etersheim (1938, Z.M.A.); Grote Sloot near Kensmerbrug (1927, Z.M.A.); Kolhorn, canal (1931, 1932, Z.M.A.); Haukes, Wieringen, (1932, Z.M.A.); Amstelmeer (1932, Z.M.A.); Nieuwediep (1932, R.M.N.H. no. 22); Den Helder (1927, R.M.N.H., no. 190); Aalsmeer (1898, Z.M.A.); Rotterdam, siphons near water tower in very polluted water (1884, R.M.N.H., no. 1032); Binnenmaas (1926, Z.M.A.); Biesbos, de Dood (1961, D.I.); Amer near Drimmelen (1959, D.I.); Moerdijk (1919, Z.M.A.; 1959, D.I.); Hollands Diep near Willemstad (1959, D.I.); Willemstad, canal in town (1959, D.I.); Haringvliet (1961, D.I.); Den Bommel, Overflakkee, harbour (1961, D.I.); Walcheren, near Oostsouburg (1961, D.I.).

All localities in the Netherlands from which reliable material has been identified are entered on the map in fig. 5. In addition some reliable literature references have been entered so as to complete the pattern of distribution of *Cordylophora caspia* in the Netherlands. The picture emerging from the map (fig. 5) is that *C. caspia* predominantly occurs in brackish waters of the provinces of Friesland, Overijssel, Noord-Holland, Zuid-Holland, Zeeland and Noord-Brabant. The species, though less frequently, also occurs in fresh waters. Unfortunately it is impossible to couple the pattern of distribution with hydrological peculiarities of the waters in which the species occurs. The only tentative conclusion that may be drawn is that the species has been met with in waters varying in salinity between 1.6 and 0.068‰ Cl with temperatures between 21.2 and 9.0°C. Even these records must be considered with some reserve as the hydrological figures refer to surface conditions.

DOUBTFUL MATERIAL

A. Zuiderzee (all Z.M.A.): Hoornse Hop (Wn. 119, 1929, probably *G. franciscana*); Kraggenburg (Wn. 97, 1928; Wn. 109, Wn. 150, 1929, all probably *G. franciscana*); Kreupel (Wn. 82, 1928, probably *G. francis-*

cana); Kuinre, harbour (Wn. 69, 1921); off Muiden (Wn. 61, 1928); off Oosterleek, (Wn. 140, 1929); northern point of Schokland (Wn. 55, Wn. 98, 1928); between Schokland and Urk (Wn. 148, 1929, probably *G. franciscana*); Steile Bank (Wn. 80, 1928); 't Spijk near Elburg (Wn. 95, 1928); Val van Urk (Wn. 112, 1929, probably *G. franciscana*); southern point of Urk (Wn. 78, 1928; Wn. 111, 1929, probably *G. franciscana*); between Urk and De Knar (1928, probably *G. franciscana*).

B. IJsselmeer (all Z.M.A.): Hindelopen (1937); off Huizen (Wn. 314, 1936; Wn. 342, 1938; Wn. 365, 1939, probably all *C. caspia*); De Knar (Wn. 252, 1933, probably *C. caspia*); Kraggenburg (Wn. 224, 1932); off Muiden (Wn. 279, 1933); Pampus (Wn. 295, 1934; Wn. 345, 1938); northern point of Schokland (Wn. 223, 1932; Wn. 276, 1933; Wn. 305, 1935); Span near Medemblik (Wn. 359, 1938); Staveren (1937); Steile Bank (Wn. 321, 1936); Val van Urk (Wn. 291, 1934; Wn. 355, 1938); Schimmelskolk (1939); Zeeburg, siphons of drainage canal (1933).

C. Further localities: Middelbuurt (1932, Z.M.A.); Geestmerambacht-polder (1920, Z.M.A.); Groote Sloot (1922, Z.M.A.); Hollands Diep (1959, D.I.); Volkerak (1959, D.I.); Haringvliet (Den Bommel, Stad aan 't Haringvliet, Hellevoetsluis, Stellendam) (1959, D.I.); Kagermeer (1924, Z.M.A., probably wrongly labelled as the sample also contains *Dynamena pumila* (L.), a purely marine hydroid. The rest of the sample is unrecognizable).

CONCLUDING REMARKS

Prior to the closure of the Zuiderzee *Cordylophora caspia* was not a normal faunal element of the animal community living in this great salt-water area. As the hydrographical conditions over the vast extent of the Zuiderzee differed considerably, and as moreover great rivers transported large quantities of fresh water to the Zuiderzee, *Cordylophora* may have repeatedly been introduced in the Zuiderzee where, if it found suitable conditions, it may have survived or even reproduced. *Garveia franciscana*, on the other hand was a normal faunal constituent of the Zuiderzee community, occurring throughout the whole area in particularly large numbers and occasionally penetrating into brackish waters communicating with the Zuiderzee. *Garveia franciscana* did not survive the closure of the Zuiderzee in 1932. It did manage to maintain itself for one or two years in the Pampus area near Amsterdam, but it disappeared completely as soon as the salinity dropped below 1.5⁰/100 Cl. Its retreat from the then IJsselmeer area was closely followed by further extension in distribution of *Cordylophora caspia*, probably present at a few localities in the IJsselmeer, but commonly distributed over the brackish area surrounding the Zuiderzee.

At present *Cordylophora caspia* is the only athecate hydroid living in the IJsselmeer (species of Hydridae not considered). In the Netherlands *Garveia franciscana* nowadays exclusively is known from Hellevoetsluis on the Haringvliet, province of Zuid-Holland.

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