# Observations on taxonomy and distribution of some salps (Tunicata, Thaliacea), with descriptions of three new species.

van Soest, R.W.M.

**Publication date**
1975

**Document Version**
Final published version

**Published in**
Beaufortia

Link to publication

**Citation for published version (APA):**
van Soest, R. W. M. (1975). Observations on taxonomy and distribution of some salps (Tunicata, Thaliacea), with descriptions of three new species. *Beaufortia*, *23*(302), 105-130.

# BEAUFORTIA

SERIES OF MISCELLANEOUS PUBLICATIONS

INSTITUTE OF TAXONOMIC ZOOLOGY (ZOOLOGICAL MUSEUM)

UNIVERSITY OF AMSTERDAM

No. 302 Volume 23 April 24, 1975


## Observations on taxonomy and distribution of some Salps (Tunicata, Thaliacea), with descriptions of three new species

R. W. M. VAN SOEST


### Abstract

The Salp genera *Traustedtia* Metcalf, 1918, *Weelia* Yount, 1954 and *Brooksia* Metcalf, 1918 are revised, resulting in the conclusion that *Traustedtia* is a monotypical genus, and that *Brooksia* on the other hand, contains two taxa, one of which is newly described under the name *B. berneri*. *Weelia* shows a confusing variation, which must await further study. The variation in *Ihlea punctata* (Forskål, 1775) shows that there is no ground for the assumption that the species described as *Ihlea asymmetrica* (Fowler, 1896) is separate from *I. punctata*. Two undescribed taxa, reported upon in previous studies of the present author, are now fully described as new species: *Cyclosalpa danae* and *Thalia rhinoceros*.


### Introduction

The present study completes the inventory of the known and newly recognized taxa of the Salpidae. In previous papers (van Soest, 1973, 1974a, 1974b) the larger genera have been revised. Left over are the smaller genera *Traustedtia* Metcalf, 1918, *Weelia* Yount, 1954, *Brooksia* Metcalf, 1918, *Ihlea* Metcalf, 1919, *Iasis* Savigny, 1816, *Metcalfina* Ihle & Ihle-Landenberg, 1935 and *Thetys* Tilesius, 1802. The latter three genera (*Iasis, Metcalfina* and *Thetys*) have been studied extensively by the present author, but no significant new data can be revealed, so these monotypical genera are excluded from the present paper. Some new distributional data will be published in a future paper.

The genera *Traustedtia, Weelia* and *Brooksia* have been studied only cursorily by most past authors. Metcalf (1918) proposed a new species and a new subspecies in the genus *Traustedtia* next to *Traustedtia multitentaculata* (Quoy & Gaimard, 1834); the existence of them was doubted by Sewell (1926)

Received: January 13, 1975

and Yount (1954). Sewell (1926, 1953) reported with sufficient clarity the existence in *Salpa cylindrica* Cuvier, 1804 of solitary specimens with eight and nine body muscles. Yount (1954) gave *S. cylindrica* a new generic status (*Weelia*) in which he is followed by some of the recent students of pelagic tunicates. *Brooksia rostrata* (Traustedt, 1893) is considered a rare species, of which little is known. The present study has led to the discovery of a new taxon in this genus separate from *B. rostrata.*

Only one of the three species now recognized in *Ihlea* is treated here, as Foxton (1971) published an extensive account of the two southern species *I. magalhanica* (Apstein, 1894) and *I. racovitzai* (van Beneden & de Sélys Longchamp, 1913), to which nothing new can be added. Observations made on the third species *I. punctata* (Forskål, 1775) will be presented here, as the alleged existence of a separate taxon, *I. asymmetrica* (Fowler, 1896) has been reported frequently in literature.

Past studies made by the present author on *Thalia* Blumenbach, 1798 and *Cyclosalpa* de Blainville, 1827 (van Soest, 1973, 1974a) mentioned deviating specimens unnamed at that time. In the case of the one deviating solitary specimen of *Thalia* presumptions were made that it could be a hybrid of *T. democratica* (Forskål, 1775) and *T. cicar* van Soest, 1973. Additional material studied by the author recently revealed many such specimens from the western Pacific Ocean. It is concluded that they belong to a new species described below. To the unnamed *Cyclosalpa* specimens (referred to as *C.* spec. aff. *affinis* Chamisso, 1819) new material can now be added, among which a solitary specimen conforming to the description and figure of Yount's (1954) *C. affinis.* Examination of the new material has led to the conclusion that it concerns a new species closely related to *C. affinis* which will be described below.

## MATERIAL

The studied material is listed below. It consists of samples collected by various oceanic expeditions (Dana Expeditions, Siboga Expedition, Discovery Expeditions, Galathea Expedition) and a number of incidental samples. Of the major expeditions only the station numbers are given; for the data on these stations one is referred to the station lists. The Ocean Acre Project was held in the immediate vicinity of Bermuda.

The author is indebted to Dr. E. Rasmussen (Zoologisk Museum Copenhagen, ZMUC), to Dr. P. David and Dr. P. Foxton (Institute of Oceanographic Sciences Great Britain, IOS), to Dr. C. F. E. Roper and Dr. D. Pawson (United States National Museum, Washington, USNM), to Miss Dr. A. M. Clark (British Museum, Natural History, London, BMNH) and to Prof. Dr. W. Vervoort (Rijksmuseum van Natuurlijke Historie, Leiden, RMNHL) for the loan of material under their care.

*Atlantic Ocean (including the Mediterranean):*

Dana Expeditions st. 3980 IV; 3997 III; 3998 IV, V; 3999 II, III; 4000 VI;

4762 (all ZMUC). Discovery Expeditions st. 696, 701, 702, 704, 708 (all IOS). ACRE Cruise 10-8A, 11-1S, 11-3C, 11-12B, 11-12M, 12-13B, 12-14M, 12-21M, 13-11M, 13-23M, 13-30A, 13-32B, 13-32M (USNM/ZMA). CICAR Cruise 13, 14, 15, 18 (vicinity Curaçao, Aruba and Bonaire), 16/17, 22 (off the Guyanas); Chazalie Expedition, st. Los Testigos (West Indies); Snellius 1965 cruise, st. India (33° N 19° W); Tridens 1972 cruise, st. 8 (38° N 21° W), st. 9 (39° N 23° W); Villefranche, coll. Ihle 1932; 51°45′ N 11°46′ W, coll.?, 16-V-1907 (all ZMA).

*Indian Ocean:*

Dana Expeditions st. 3815 III; 3843 I, II; 3856 IV; 3893 IX; 3903 III; 3904 II; 3914 III; 3917 X; 3918 IV; 3919 II; 3921 VII, VIII; 3922 V; 3927 II; 3934 II+VII+IX; 3935 II, V; 3946 I; 3948 II, III; 3955 IV; 3957 II; 3958II; 3962 III, IV; 3964 II; 3969 IV. Galathea Expedition st. 301 (all ZMUC). Discovery Expeditions st. 2886, 2887, 2888 (all IOS). Red Sea collection, don. J. Godeaux, st. 27°39′ N 34°34′ E; 26°52′ N 34°30′ E; 26°08′ 34°22′ E (all ZMA).

*Pacific Ocean (including the Indo-Malayan Archipelago):*

Dana Expeditions st. 3550 V; 3553 I, II; 3561 IX, X; 3563 V; 3567 II; 3569 III; 3578 V; 3579 III, IV; 3584 VI; 3585 VII; 3587 XI; 3591 IV; 3593 X; 3620 II 3686 III; 3714 IV ; 3720 I; 3722 IV; 3723 V; 3729 IV; 3731 V; 4760; 4761; 4768; 4772; 4773; 4775; 4777; 4779; 4789; 4790; 4791; 4798; 4812; 4813; 4815; 4818; 4820. Galathea Expedition st. 412 (all ZMUC). Great Barrier Reef Expedition st. 13 (16° S 145° E) (BMNH). Snellius Expedition 1929, st. 300 (04°45′ N 124°31′ E) (RMNHL). Siboga Expedition st. 106, 109, 144, 145, 168, 172, 173, 282, Sanguisapio; Java Sea, coll. Delsman; Ambon, coll. R. Simon; Semarang, coll. Buitendijk 1912; Leba-Leba Bay, Lomblem (Indonesia), coll. Laurense, 1909; Pulu Komba (Indonesia), coll. Van der Sande, 1909 (all ZMA).

## Genus **Traustedtia** Metcalf, 1918

Type species: *Salpa multitentaculata* Quoy & Gaimard, 1834.
Metcalf (1918) has described apparently deviating solitary specimens of *Traustedtia multitentaculata* as a separate subspecies *T. multitentaculata* subsp. *bicristata* and a separate species *T. radiata.* Some later authors have acknowledged these descriptions (e.g. Kashkina, 1973b: *T. multitentaculata* forma *radiata*). However, mostly these forms were considered synonymous with *T. multitentaculata* proper. Sewell (1926) and Yount (1954) described specimens intermediate between *T. radiata* and *T. multitentaculata* as far as the number of "tentacles" was concerned. Moreover, the alleged absence of one or two echinated dorsal crests in *T. radiata* and *T. multitentaculata* proper has been shown to be incorrect. Careful analysis of the present material of *Traustedtia* confirmed the latter observations. It appears, firstly, that all

solitary specimens bear two dorsal echinated crests. Secondly, the number of "tentacles" (and the length of the "tentacles") generally increases with the body length (cf. figs 1 and 2). Thirdly, the difference in appearance between *T. multitentaculata* and *T. radiata* is based solely on the dorso-ventral flattening of the body in the latter. "Normal", laterally flattened specimens of *T. multitentaculata,* however, can be made to look like *T. radiata* simply by putting pressure on the dorsal side. It seems clear, that *Traustedtia* is a monotypical genus with the type species as the sole representative.

**Traustedtia multitentaculata** (Quoy & Gaimard, 1834)

Synonymy:

*Salpa multitentaculata* Quoy & Gaimard, 1833: pl. 89 fig. 19, 1834: 596; Ihle, 1911: 588; Bomford, 1913: 244.
*Salpa henseni* Traustedt, 1893: 9, pl. 1 figs 6—9; Apstein, 1894: 19, pl. 2 fig. 8; Apstein, 1904: 651, pl. 12 fig. 11; Apstein, 1906a: 257, pl. 29 figs 28—29; Apstein, 1906b: 175, figs 38—39; Dober, 1912 (after Metcalf, 1918).
*Salpa verrucosa* Apstein, 1894: 12, pl. 2 figs 11—13.
*Salpa (Traustedtia) multitentaculata* subsp. *bicristata* Metcalf, 1918: 143, pl. 14 figs 34—35.
*Salpa (Traustedtia) multitentaculata*; Metcalf, 1918: 147, figs 133—137; Sewell, 1926: 105, figs 34—40.
*Salpa (Traustedtia) radiata* Metcalf, 1918: 152, figs 138—139.
*Traustedtia multitentaculata;* Oka, 1921: 10, figs 1—2; Tokioka, 1937: 230; Belloc, 1938: 325; Tokioka, 1938: 234, pl. 14 figs 1—3a, text figs 1—7a; Thompson, 1948: 147, pl. 63 figs 1—2, pl. 64 figs 1—2, pl. 65 figs 1—2, pl. 66 figs 1—2, pl. 67 figs 1—4; Yount, 1954: 319, figs 26—27; Godeaux & Goffinet, 1968: 68, fig. 1; Godeaux, 1969: 73; Kashkina, 1973b: 202; Godeaux, 1973a: 61; Godeaux, 1973b: 281; Kashkina, 1974: 197.

Type locality: Near New Ireland (East of New Guinea).

*Description:*
Solitary zooid: Test soft, voluminous, provided with three prominent echinated crests: two parallel longitudinal ones at the dorsal surface and a transverse one at the posterior end underneath the atrial aperture. The area surrounding the ventral lip of the oral aperture is echinated too. Test bulging over nucleus. Oral aperture terminal, atrial aperture dorso-posteriorly. Test and body generally flattened laterally, sometimes dorso-ventrally. Body oval in shape and bearing numerous projections ("tentacles") protruding into the test, some of them far beyond it. These tentacles are mostly arranged in pairs (one on the left side and one on the right side of the body), except for one, which runs from the nucleus to the posterior test wall beyond it. In contrast to the assumption of Oka (1921), the number of tentacles appears to increase with increasing size (fig. 1), although there is obviously a wide variation. It also appears that the length of the tentacles increases with size. In small specimens they do not or do only barely protrude beyond the test wall. In big specimens the length of some of them may be equal to or exceed the length of the animal itself (particularly the prominent posterior pair of tenta-

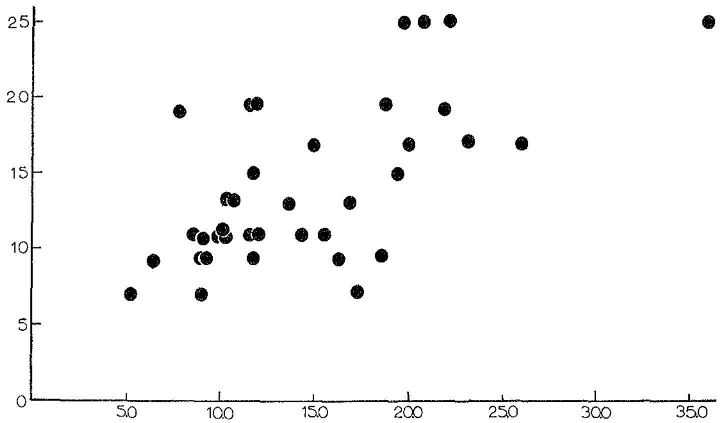


Fig. 1: The relation of the number of tentacles (y-axis) and the length (mm) of the body (x-axis) in solitary *Traustedtia multitentaculata*.

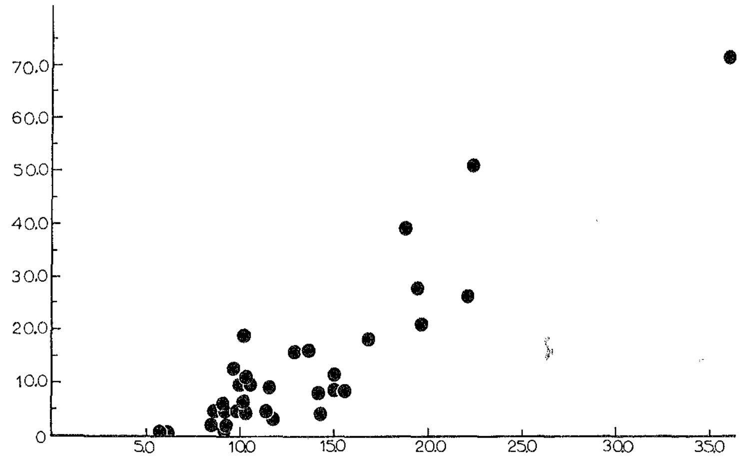


Fig. 2: The relation of the length (mm) of the longest tentacle (y-axis) and the length (mm) of the body (x-axis) in solitary *Traustedtia multitentaculata*.

cles; cf. fig. 2). Some of the tentacles terminate in a club-shaped thickening.

Length (excluding tentacles): up to 36.4 mm (n = 56). There are five body muscles, arranged in two groups: M I - M III and M IV - M V. The body muscles only cover the dorsal surface of the body and part of the lateral surface. The number of muscle fibres of M I - M V is 52 - 93 (m = 71.4, n = 46). Oral and atrial musculature as described and figured by Thompson (1948). Intestine: coiled into an elongated nucleus, which protrudes postero-ventrally. Dorsal tubercle: a simple stick. Stolon: coiled around the nucleus.

A g g r e g a t e z o o i d s : Test soft, rounded, voluminous. Posteriorly there are three long projections: two lateral ones and a median one directly beyond the nucleus. According to Tokioka (1938) there may be three accessory protuberances surrounding the base of the median projection. All three long projections contain a tentacle-like protrusion of the body wall. Oral aperture terminal, atrial aperture dorso-posteriorly. Body rounded and bearing, next to the three posterior tentacles, four pairs of short lateral and ventral attachment organs. Length (excluding projections): up to 16.0 mm (n = 36), up to 20 mm according to Thompson (1948). There are four body muscles arranged into two groups dorsally: M I - M II and M III - M IV. The body muscles only cover the dorsal and lateral surface of the body. The number of fibres of M I - M IV is 15 - 25 (m = 19.8, n = 36). Oral and atrial musculature arranged as described and figured by Tokioka (1938) and Thompson (1948). Intestine: coiled into an elongated nucleus, which protrudes posteriorly distally pointed. Dorsal tubercle: a small stick. Ovary and embryo: situated between M III and M IV on the right side.

*Distribution* (fig. 3):

It has been frequently stated by past authors that this species is very rare. This designation must be considered as exaggerated at present. Although it is not one of the commoner species, primarily because mostly the numbers taken are small, it has a wide distribution over the warmer parts of all three oceans, roughly between 40° N and 30° S.

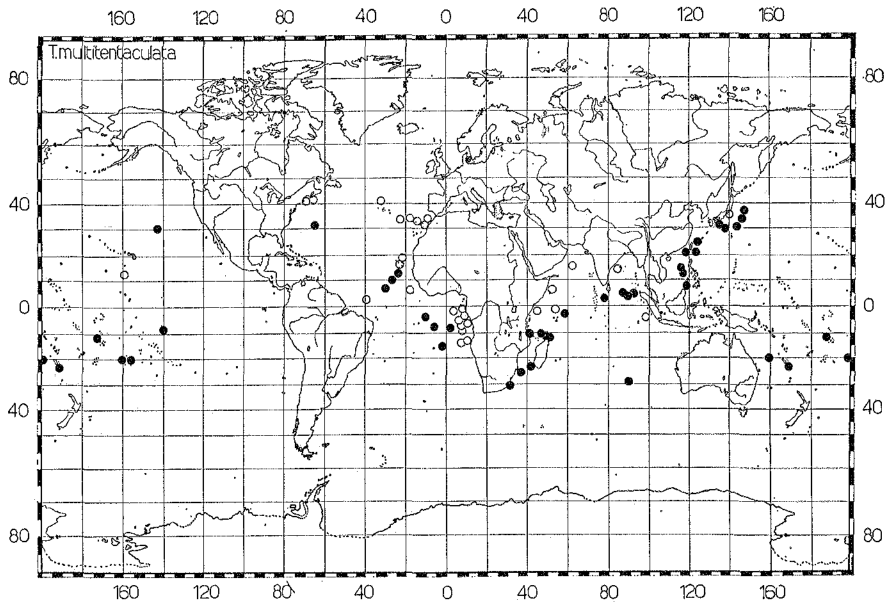


Fig. 3: Distribution of *Traustedtia multitentaculata*. Black dots represent studied material, open circles represent literature records.

## Genus **Weelia** Yount, 1954

Type species: *Salpa cylindrica* Cuvier, 1804.
As the genus *Weelia* is monotypical the diagnosis of the genus is equal to that of the only species *W. cylindrica.* Yount's (1954) designation of *Salpa cylindrica* to a genus separate from the species of *Salpa* proper is based on the different arrangement of the body muscles in both the solitary and the aggregate zooid. Moreover, the number of body muscles in the solitary zooid appears to be subject to variation, a feature which is never found in species of the genus *Salpa.* The present author endorses Yount's arguments for a separate generic status of *Salpa cylindrica.*

### **Weelia cylindrica** (Cuvier, 1804)

Synonymy:

*Salpa cylindrica* Cuvier, 1804: 381, pl. 68 figs 8—9; Lamarck, 1816: 119; Cuvier, 1817: 22, figs 8—9 (not fig. 10!); de Blainville, 1827: 113; Meyen, 1832: 417; Traustedt, 1885: 377, pl. 1 fig. 22, pl. 2 figs 35—37, 43; Herdman, 1888: 72, pl. 7 fig. 10; Traustedt, 1893: 6; Brooks, 1893: pl. 3 figs 5—7; Apstein, 1894: 16; Ritter, 1905: 79, fig. 22; Ritter & Byxbee, 1905: 199; Apstein, 1906a: 249, pl. 26 figs 7—7a; Apstein, 1906b: 163, figs 9—10; Ihle, 1910: 31; Bomford, 1913: 243; Oka, 1915: 31; Metcalf, 1918: 95, figs 82—89; Stiasny, 1919: 12, figs 4—5; Sewell, 1926: 77, figs 7—13; Russell & Colman, 1935: 217; Ihle & Ihle-Landenberg, 1935: 19; Tokioka, 1937: 223; Belloc, 1938: 320; Krüger, 1939: table 34; Thompson, 1948: pl. 72 figs 1—2, pl. 73 figs 1—5; Sewell, 1953: 11, fig. 2; Godeaux, 1962: 24, figs 4—5; Godeaux & Goffinet, 1968: 74; Godeaux, 1969: 73; Godeaux, 1973a: 46; Godeaux, 1973b: 285; Godeaux, 1974: 94.
*Iasis cylindrica*; Savigny, 1816: 124, pl. 24 fig. 2.
*Salpa coerulescens* Chamisso, 1819 (after Metcalf, 1918).
? *Salpa garnoti* Lesson, 1830 (after Traustedt, 1885).
? *Salpa cymbiola* Dall (after Traustedt, 1885).
*Weelia cylindrica;* Yount, 1954: 304, figs 16—17; Fagetti, 1959: 221, pl. 6 figs 1—2; Esnal, 1970: table 4; Dossman, 1970: 71, fig. 3; Kashkina, 1974: 191.

Type locality: unknown.

*Diagnosis:*

S o l i t a r y  z o o i d : Test soft, smooth, elongated cylindrical. No protuberances or projections. Length: up to 41 mm (n = 122), up to 45 mm according to Thompson (1948). Body cylindrical. The number of body muscles appears to be either 8 or 9. It is as yet not clear whether this difference points to the existence of two taxa within *Weelia.* In the Atlantic Ocean so far only specimens with 8 body muscles have been found, while in the Indo-Pacific waters both specimens with 8 and specimens with 9 body muscles have been found, sometimes within the same sample. The first four body muscles are generally approaching, touching or fused in the mid-dorsal line. There appears to be great variation in the manner these four muscles are convening (see for example Sewell, 1926). This variation could not be linked with the number of body muscles. Great variation is also found in the number of muscle fibres of M I - VIII + x or M I - IX (x being the first atrial sphincter, which is

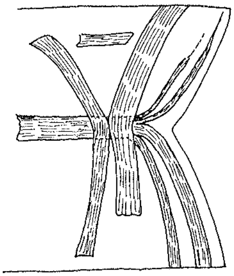

Fig. 4: Oral musculature of solitary *Weelia cylindrica,* pictured from the inside of the body.

considered a body muscle proper by several authors). The number of fibres varies from 91 to 261 (m = 182.3, n = 139). This variation also could not be linked definitely to the number of body muscles: the variation in specimens with 8 body muscles is 136 - 261 muscle fibres, in those with 9 body muscles it is 91 - 244. In the Indian Ocean and the western Pacific generally the number of muscle fibres of specimens with 9 body muscles is smaller than in specimens with 8 body muscles. In the eastern Pacific Ocean the reverse was found, as can be seen in table I. At any rate, the geographical distribution of the number of muscle fibres appears quite confusing. Concerning the oral musculature Sewell (1926, 1953) states, that in specimens with 8 body muscles the oral musculature is slightly different from that in specimens with 9 body muscles, as the former was reported to possess only two dorsal sphincters. The present study revealed no such differences. The oral musculature in both types of specimens is exactly like that given by Sewell (*l.c.*) for specimens with 9 body muscles. The arrangement of the oral musculature is represented in fig. 4. Atrial musculature: up to 10 sphincters. Intestine: coiled into a tight nucleus. Dorsal tubercle: a simple slightly arched stick. Stolon: running forward in a straight course on the mid ventral line.

TABLE I. The number of muscle fibres of M I - M IX (or M I - M VIII + x) of solitary specimens of *Weelia cylindrica* from different oceanic areas, divided into specimens with eight and with nine body muscles (r = range, m = mean, n = no. of specimens).

| Area | No. of muscle fibres of M I - M VIII + x | No. of muscle fibres of M I - M IX |
|---|---|---|
| Atlantic Ocean | r=135—205, m=180.0, n=29 | — |
| E-Indian Ocean | r= — , m=171.0, n= 1 | r=126—187, m=151,2, n=20 |
| N-Indian Ocean | r=163—261, m=203.8, n=10 | r=120—197, m=157,9, n=17 |
| Indo/Malayan Archipelago | r=155—236, m=195.5, n=11 | — |
| NW-Pacific Ocean | r=147—190, m=156.7, n= 7 | r=121—177, m=154.3, n=13 |
| SW-Pacific Ocean | r=140—185, m=163.6, n= 5 | r= 91—115, m=105.8, n= 5 |
| E-Pacific Ocean | r=169—221, m=196.1, n= 7 | r=197—221, m=221.8, n=12 |

A g g r e g a t e z o o i d s: Test voluminous, thickly fusiform, often angular posteriorly. Length: up to 11.7 mm (n = 37), up to 17 mm according to Thompson (1948). Body rounded, fusiform due to the presence of a short anterior and posterior projection. Five body muscles, all convening in the mid-dorsal line in two distinct groups: M I - M III are fused in the mid-dorsal region as are M IV - M V; both groups generally touch in the mid-dorsal line. The number of muscle fibres of M I - V ranges from 35 to 101 (m = 70.6, n = 49). Oral and atrial musculature as pictured by Metcalf (1918). Intestine: coiled into a tight nucleus. Dorsal tubercle: a slightly arched stick. Ovary and embryo: situated between M IV and M V.

*Distribution* (fig. 5):

Although *Weelia cylindrica* has a typical warm water distribution in all three oceans, it has been reported to occur off the coast of Rhode Island and Block Island (Metcalf, 1918), near Woods Hole (Massachusets, about 42° N) (material of the Institute of Oceanographic Sciences, Great Britain, collected by Dr. P. Foxton), and somewhat further out in the North Atlantic (Plankton Expedition). Elsewhere it has not been found north of 30° - 35° N (Eastern Atlantic, Pacific) and south of 30° S (all three oceans). Herdman's (1888) southern records (46°41′ S 38°10′ E and 52° S 72° E) are considered doubtful, as his specimens were fragmentary or in bad condition. The species is rather common in certain parts of the ocean, such as the southern Carribean (CICAR-cruises), eastern South Atlantic, Indian Ocean (including the Red

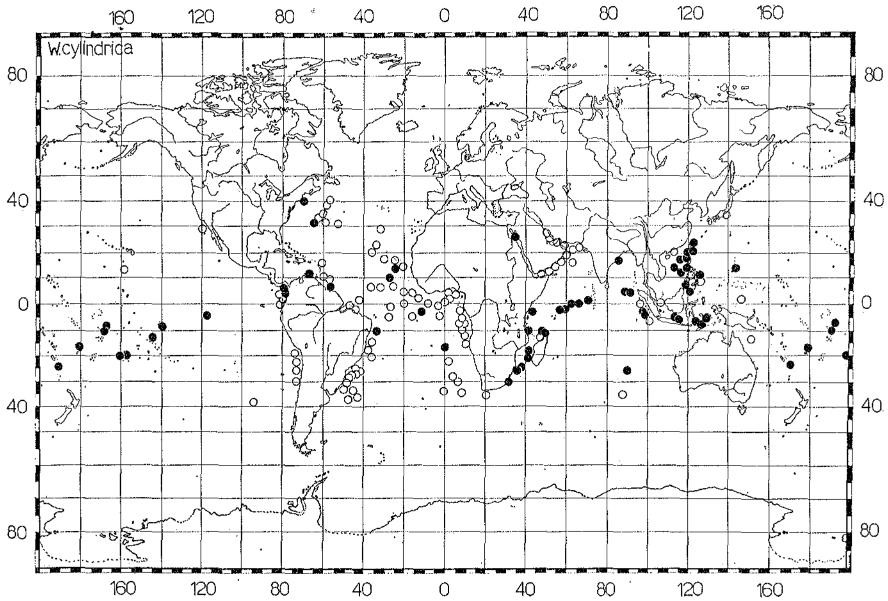


Fig. 5: Distribution of *Weelia cylindrica*.

Sea), Indo-Malayan Archipelago, South China Sea and the Philippine Archipelago (Metcalf, 1918).

## Genus **Brooksia** Metcalf, 1918

Type species: *Salpa rostrata* Traustedt, 1893.

*Diagnosis of the genus:*

Solitary zooid: Test soft, rather closely adhering to the body wall. Body elongately cylindrical, equipped with a strongly developed anterior projection sheathed with four longitudinal muscles, which are continuations of the dorsal sphincters and two ventral longitudinal muscles. Seven body muscles, which convene or tend to convene in the mid-dorsal line; they are arranged in two groups M I - M III and M IV - M VII; M III and M IV approach or fuse laterally. The body muscles are ventrally interrupted by two longitudinal muscles which run from M VII to the anteriormost tip of the anterior projection. Oral musculature as described by Sewell (1926): there are two dorsal and two ventral sphincters, a distinct oral retractor which joins the first body muscle laterally, and an intermediate muscle, which starts near the ventral longitudinal muscles, crosses the oral retractor and joins the first body muscle dorsally. A continuation of the second dorsal sphincter crosses the oral retractor and runs forward into the anterior projection. Finally, a pair of loose stretches of muscle band are present on each side of the dorsal tubercle (called "dorsal horizontal muscles" by Metcalf, 1918 and Thompson, 1948). The atrial musculature consists of four atrial sphincters. Intestine: coiled into a loose nucleus. Stolon: more or less straightly running forward.

Aggregate zooid: Test very thin and loose. In most preserved specimens it is lost. Body oval in shape. Musculature strongly asymmetrical, reminding of the condition found in the genus *Helicosalpa* Todaro, 1902. The number of body muscles is a matter of interpretation, but most authors agree that there are four. All body muscles are completely continuous, both dorsally and ventrally. Dorsally the intermediate muscle is strongly fused with the first and the second body muscle. Due to the asymmetry of the musculature the zooids are divided in dextral and sinistral individuals. The body muscles run from anterior right to posterior left or from anterior left to posterior right in dextral and sinistral individuals, respectively. In the mid-dorsal line the fused M I + M II + the intermediate muscle join M III and M IV. M IV is mostly split into two branches laterally. Ventrally the situation resembles the dorsal situation. Oral musculature: there are two dorsal spincters, two ventral sphincters, and a weakly developed oral retractor. The atrial musculature consists of three sphincters and an atrial retractor. Intestine: coiled into a rather tight nucleus, which lies at the posteriormost part of the body. Ovary and embryo: situated between M III and M IV on the right side.

Two taxa are recognized on the basis of differences in the dorsal arrangement of the first three body muscles and the total number of muscle fibres in the solitary zooid. The aggregate zooid has not been distinguished with certainty. In view of the apparent sympatry, it is proposed to treat these taxa as separate species, one of which is new to science.

**Brooksia rostrata** (Traustedt, 1893)

Synonymy:

*Salpa rostrata* Traustedt, 1893: 8, pl. 1 figs 1—4; Apstein, 1894: 16, pl. 2 figs 9—10, 17—22, text-fig. 9; Apstein, 1906b: 169, figs 23—24; Ihle, 1910: 27, pl. 1 fig. 17; Sigl, 1912: 480, figs 6—7; Fedele, 1926: 295, fig. 1.
*Salpia* (*Brooksia*) *rostrata*; Metcalf, 1918: 50, figs 22—24; Sewell, 1926: 84, fig. 14.
*Brooksia rostrata*; Ihle & Ihle-Landenberg, 1935: 24; Thompson, 1948: 120, pl. 43 figs 1—4, pl. 45 fig. 3; Yount, 1954: 293 (in part?).

Type locality: 31°7′ N 42°7′ - 43°6′ W and 28°3′ - 28°9′ N 34°3′ - 35° W.

*Diagnosis* (fig. 6):

S o l i t a r y z o o i d : Length (excluding the anterior projection): up to 10.4 mm (n = 13), up to 31 mm according to Yount (1954). Musculature: M I (joined by the intermediate muscle) touches or fuses with M II - M III in the

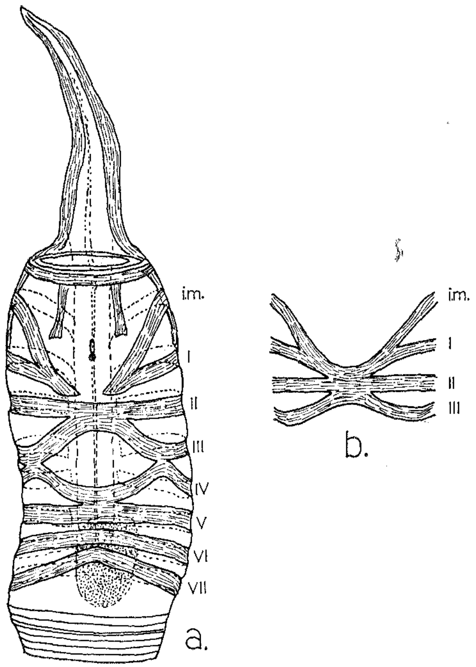


Fig. 6: a, dorsal view of the holotype (solitary specimen) of *Brooksia berneri* nov. spec.; b, dorsal arrangement of the intermediate muscle and the first three body muscles in *Brooksia rostrata* sol. (i.m. = intermediate muscle, Roman numerals indicate body muscles).

middorsal line; it is continuous dorsally. The numbre of muscle fibres of M I - M VII is 63 - 87 (m = 72.8, n = 13). Other characters as in the diagnosis of the genus.

Aggregate zooids: Most of these were badly preserved and not fit for critical studies. However, associated with the above described solitary specimens were some aggregate zooids conforming with Thompson's (1948) figures. The number of muscle fibres in five of these specimens varied from 14 to 26 (m = 21.0). Fedele (1926) figured an aggregate specimen with very long attachment organs; no such specimens were encountered in the present material.

*Distribution* (fig. 7):

Most distributional data on *Brooksia rostrata* given by previous authors cannot be used, as they did not discriminate between the present species and the one described below. Therefore, only limited information is available. It is clear, however, that the species is widely distributed over the warmer parts of all oceans. In the southern Caribbean (CICAR-cruises) it is not uncommon, but it has not been found in the area around Bermuda (ACRE-cruises). Occasionally it has been reported from temperate waters, such as the Mediterranean and the eastern North Atlantic. Several examples from the Indian and Pacific Ocean are found in the present material.

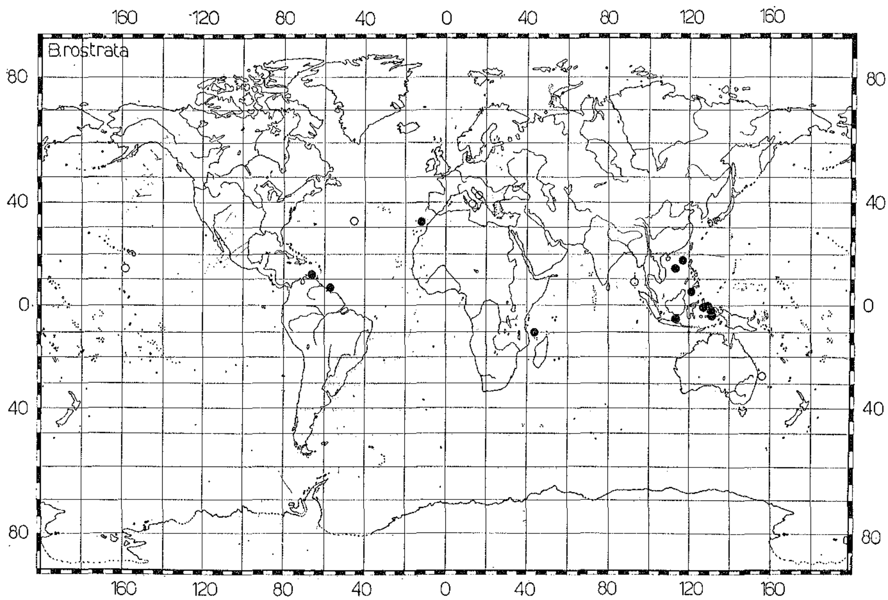


Fig. 7: Distribution of *Brooksia rostrata.*

## **Brooksia berneri** nov. spec.

Synonymy:

? *Brooksia rostrata*; Yount, 1954 (in part).

Type material: holotype: a solitary specimen from Ocean Acre Project st. 13-32 M (32°28′ N 63°45′ W, 28-II-1972, 16.45 - 17.30 h, 0 - 33 m), incorporated in the United States National Museum under reg. no. 12686 three paratypes from Ocean Acre Project st. 11-3C (31°41′ N 63°47′ W, 13-I-1971, 0534 - 06.34 h, 100 m) (solitary specimens), incorporated in the United States National Museum under reg.no. 12685; one paratype (solitary specimen) from Ocean Acre Project st. 13-11 M (32°00′ N 64°00′ W, 25-II-1972, 11.16 - 11.45 h, 0 - 392 m), incorporated in the United States National Museum under reg.no. 12687; one paratype (solitary specimen) from Ocean Acre Project st. 13-30 A (32°08′ N 64°09′ W, 1-III-1972, 02.30 - 03.30 h, 33 - 34 m), donated by the United States National Museum to the Zoological Museum of Amsterdam and registered there under no. ZMA TU 1371.

*Description* (fig. 6):

Solitary zooids: Length of the holotype: 30 mm, excluding the anterior projection, which measures 18.2 mm. Length range of the holotype and paratypes: 13.6 - 36.4 mm. Musculature: M I (joined by the intermediate muscle) is separate from M II and discontinuous in the mid-dorsal line. The number of muscle fibres of M I - M VII in the holotype is 125, the range in the holotype, paratypes and remaining specimens is 110 - 125 (m = 112.3, n = 21). Other characters as described in the diagnosis of the genus.

Aggregate zooid: The identity of these has not been established beyond doubt, due to the generally bad state of preservation of *Brooksia* aggregates; for that reason no aggregate specimens have been included in the type material. However, three aggregate zooids associated with solitary zooids conforming to the description given above, had a number of muscle fibres of M I - M IV almost twice as high as those associated with *Brooksia rostrata* sol. Range: 40 - 48 (m = 43.3).

*Distribution* (fig. 8):

*Brooksia berneri* has been found to occur in tropical and warm parts of all three oceans. Judging from the present material its distribution is more or less the same as that of *B. rostrata.* Yount (1954: 293) described about a dozen solitary specimens of *Brooksia,* all of which conformed to *B. rostrata,* except for one. In this specimen M I was "... dorsally interrupted, probably unnaturally ...". Yount may have studied a specimen of this species.

Etymology:

This species is named after Dr. L. D. Berner (Department of Oceanography, Texas A & M University, U.S.A.) who has made some important contributions to our knowledge of the salps.

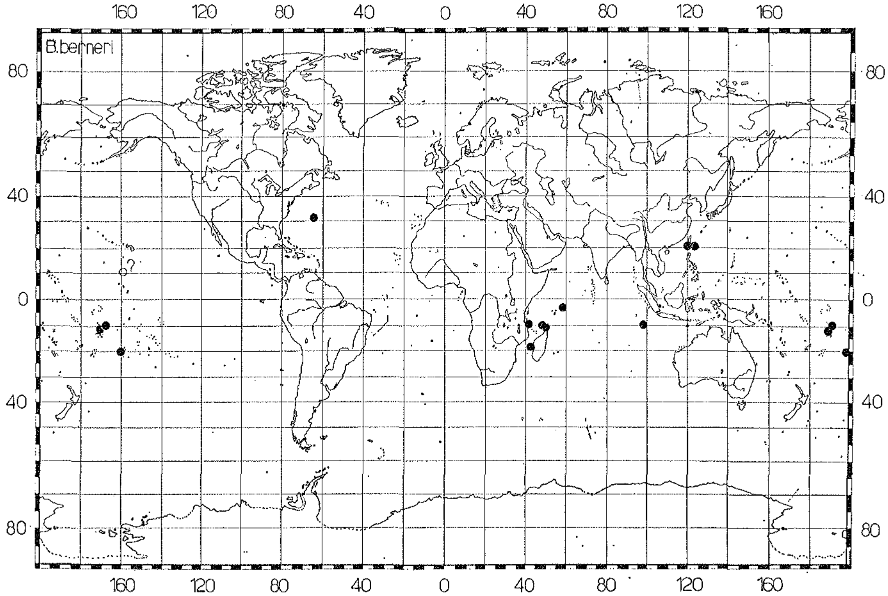


Fig. 8: Distribution of *Brooksia berneri* nov.spec.

## Genus **Ihlea** Metcalf, 1919

Type species: *Salpa punctata* Forskål, 1775.

Note: A diagnosis of the genus *Ihlea* will not be given here, as *Ihlea punctata* on the one hand, and *I. magalhanica* (Apstein, 1894) and *I. racovitzai* (van Beneden & de Selys Longchamp, 1913) on the other hand differ so widely that such a diagnosis would be a repeating of Foxton's (1971) excellent redescription of the latter two species and the description of *Ihlea punctata* (= *I. asymmetrica* (Fowler, 1896)) presented here below.

In accordance with Yount's observations it is proposed here to synonymize *I. punctata* and *I. asymmetrica,* as there are insufficient grounds for the assumption that these are different taxa. Yount (*l.c.*) reviewed the reported differences between both. After an exhaustive study of the literature he found only two differences over which past authors more or less agreed: the presence in *I. punctata* greg. of pigment spots on the ventral surface of the body (absent in *I. asymmetrica*), and the extent of the ventral longitudinal muscle in solitary zooids. As far as the pigment spots are concerned, it has to be conceded, that indeed some aggregate zooids do have them (particularly in the Mediterranean), others do not. Yount (*l.c.*) presumes that long exposion to preservation fluids may cause the pigment to disappear. It may also be a matter of fixation. The second difference cannot be maintained, as the present material revealed the following variation: extension of the ventral longitudinal muscle up till M III, up to between M III and M IV, up till M IV, up till M V. Extension up till M IV appeared to occur most frequently. Godeaux & Goffinet (1968) compared Mediterranean and West African specimens and found no differences other than the pigment spots. Muscle fibre counts of all specimens in the present material gave no indications for the existence of different taxa.

### **Ihlea punctata** (Forskål, 1775)

Synonymy:

*Salpa punctata* Forskål, 1775: 114, pl. 35 fig. C; Vogt, 1854: 6, figs 19—20; Apstein, 1894: 19; Apstein, 1906a: 251, pl. 28 figs 15—17; Apstein, 1906b: 167, figs 19—20; Streiff, 1908: 25, figs 16—21; Ihle, 1910: 29; Sigl, 1912: 478, figs 4—5; Sigl, 1913: 248.
*Biphora punctata*; Bruguière, 1789: 181 (after Metcalf, 1918).
*Salpa musculosa* Herdman, 1888: 64, pl. 6 figs 1—4.
*Salpa musculosa-punctata*; Traustedt, 1893: 6.
*Salpa asymmetrica* Fowler, 1896: 994, pl. 50 figs 5—8; Apstein, 1906a: 252; Apstein, 1906b: 170, figs 25—26; Apstein, 1929: 6, figs 5—6.
*Salpa* (*Apsteinia*) *punctata*; Metcalf, 1918: 72, figs 48—57.
*Salpa* (*Apsteinia*) *asymmetrica*; Metcalf, 1918: 78, figs 58—61, 183, figs 140—150.
*Salpa* (*Ihlea*) *punctata*; Metcalf, 1919: 19.
*Salpa* (*Ihlea*) *asymmetrica*; Metcalf, 1919: 19.
*Ihlea asymmetrica*; Tokioka, 1937: 222; Berrill, 1950: 300; Godeaux, 1973a: 57; Kashkina, 1974: 179.
*Apsteinia punctata*; Belloc, 1938: 318, figs 5—6.
*Apsteinia asymmetrica;* Belloc, 1938: 318.
*Ihlea punctata*; Yount, 1954: 295, fig. 10; Godeaux & Goffinet, 1968: 75, fig. 2; Godeaux, 1969: 73; Esnal, 1970: 124; Godeaux, 1973a: 43; Godeaux, 1973b: 287; Kashkina, 1973a: 196; Kashkina, 1973b: 218; Kashkina, 1974: 181.

Type locality: Western Mediterranean.

*Diagnosis:*

S o l i t a r y  z o o i d s: Test thin, flabby, closely adhering but loosely attached to the body wall, as it is frequently lost in preserved specimens. Length: up to 71.5 mm (n = 28). Nine very wide body muscles, which almost wholly cover the body, leaving only narrow spaces without muscle tissue ("*Salpa musculosa*" Herdman, 1888). In the mid dorsal region, many body muscles touch or fuse, although there is considerable variation in this. But for M VIII, which is interrupted ventrally, all body muscles are completely continuous around the body. The intermediate muscle (Yount's (1954) M C) fuses with the first body muscle on the dorsal surface. The number of muscle fibres of M I is 75 - 256 (m = 149.6, n = 28). There is a distinct clinal variation in this number; in warmer waters (roughly between 30° N and 30° S) it ranges from 75 to 184 (m = 111.7, n = 20), in colder waters it ranges from 200 to 256 (m = 231.4, n = 7). Oral musculature: probably there are three dorsal and four ventral sphincters, although this is hard to judge from adult specimens, as all oral and some of the ventral sphincters are fused over a large area. There are two oral retractors, the ventral one of which divides into two separate muscles, one lateral and one latero-ventral, which continue far posteriorly as the longitudinal muscles. The lateral one extends to M VII - M VIII, the (latero-) ventral one extends to between M III and M V. Atrial musculature: a large number of sphincters (up to 15) and an oblique atrial retractor. Intestine: coiled into a nucleus. Dorsal tubercle: a short straight stick. Stolon: tightly coiled underneath the nucleus.

Aggregate zooid: Test thin, flabby. Body oval-cylindrical. Length: up to 13 mm (n = 22), up to 23 mm according to Yount (1954). Typical aggregate zooids possess two rows of pigment spots on both sides of the endostyl over almost the entire ventral surface of the body. In most specimens examined for the present study these pigment spots were absent. Six body muscles, which are continuous dorsally, but are interrupted ventrally. Body muscles arranged asymmetrically; there are distinct dextral and sinistral individuals which are mirror images. In sinistral individuals the situation on the dorsal side is as follows: M I and M II are fused on the left side and separate on the right side. M III and M IV run at an oblique course from anterior left to posterior right; both are free. M V and M VI are fused in the mid-dorsal region, but separate laterally. On the ventral surface all muscles are separate and interrupted in the mid-ventral region; they run obliquely from anterior right to posterior left. The number of muscle fibres of M I + M II ranges from 50 to 97 (m = 69.0, n = 21). There may be clinal variation in this character, as the highest number was found in specimens from the most northerly locations. Oral musculature: there are three dorsal and three ventral sphincters (the second ventral sphincter is hard to detect), which combine to form one oral retractor (Metcalf, 1918, pictures two separate, but closely adhering oral retractors). Atrial musculature: about seven atrial sphincters, some of which have an erratic course, resulting in a confusing

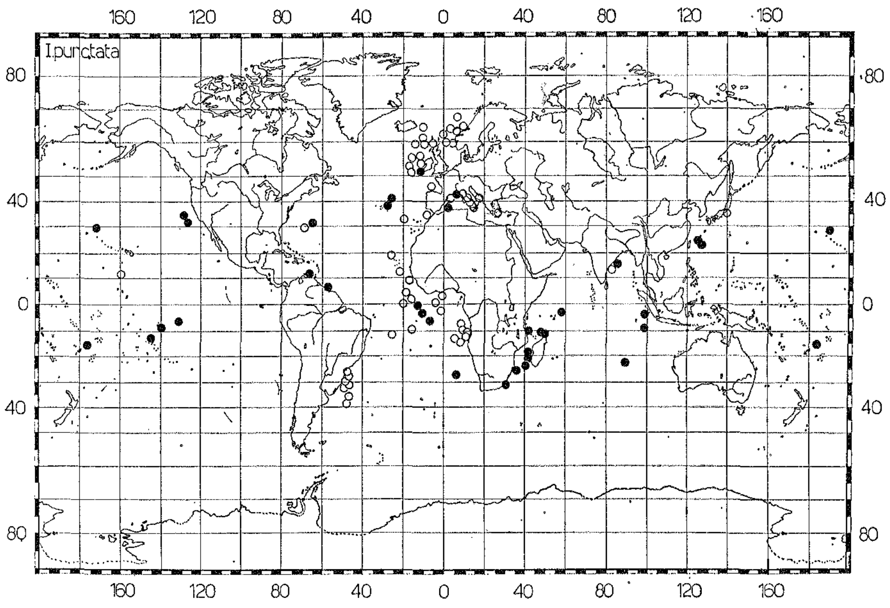


Fig. 9: Distribution of *Ihlea punctata*.

arrangement. The single atrial retractor runs obliquely ventral. Intestine: coiled into a nucleus. Ovary and embryo: situated between M V and M VI on the right side.

*Distribution* (fig. 9):

*Ihlea punctata* is one of the less common salp species, but it has a wide distribution in temperate and tropical waters of all three oceans. There is some doubt about the extent of its distribution in southern regions, where *Ihlea magalhanica* occurs from north of the subtropical convergence southward to the Antarctic convergence. The most southerly location of *I. punctata* in the present material is 31°33′ S 30°07′ E, which, however, is a tropical location influenced by the warm Agulhas current. In the North Atlantic the species has been frequently found as far north as 55° - 60° N.

The following two species belong to genera already treated at length in previous papers of the present author.

### **Cyclosalpa danae** nov. spec.

Synonymy:

*Cyclosalpa affinis*; Yount, 1954: 284 (in part), fig. 4a.
*Cyclosalpa* spec. (aff. *affinis*); van Soest, 1974a: 31, fig. 7.

Remark: Since the present author's paper on the taxonomy of the Cyclosalpinae (van Soest, 1974a), additional material has been acquisited conforming to what has been described as *C.* spec. (aff. *affinis*). It concerns one rather badly preserved solitary specimen exactly like that described by Yount (1954: fig. 4a) and seven badly preserved aggregate specimens with the peculiarly shaped light organs (cf. van Soest, *l.c.*: fig. 7b). As the material now includes also a solitary specimen, which appears to differ from typical *C. affinis* specimens in at least four characters, the present author judges it to be opportune to erect for this material a new species.

Type material: Holotype: a solitary specimen from Dana Expeditions st. 3999 III (03°45′ S 10°00′ W, 2-III-1930, 300 m wire out); paratypes: two aggregate specimens from Dana Expeditions st. 4000 VI (00°31′ S 11°02′ W, 4-III-1930, 6000 m wire out). All type material is incorporated in the Zoologisk Museum of Copenhagen.

*Description* (fig. 10):

S o l i t a r y  z o o i d : Test unknown, as the only solitary specimen (holotype) has lost its test. Length (without test): 32.5 mm. Seven body muscles of which M I and M II are interrupted dorsally, M III - M VII are continuous dorsally. All body muscles are interrupted ventrally, except for M VII. M VI and M VII are laterally linked by a branch from M VII. The intermediate muscle is ventrally interrupted (whereas it is continuous in *C. affinis*). The number

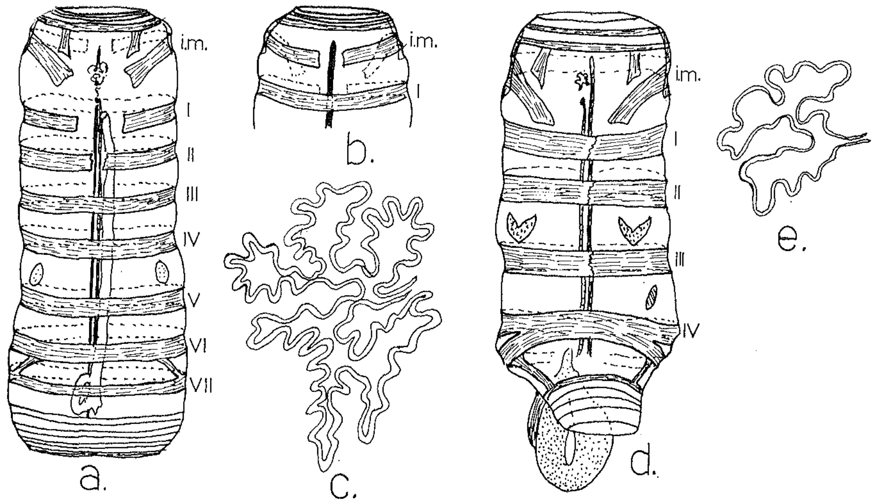


Fig. 10: a, dorsal view of the holotype (solitary specimen) of *Cyclosalpa danae* nov. spec.; b, ventral view of the anterior part of the same; c, dorsal tubercle of the same; d, dorsal view of a paratype (aggregate specimen) of *Cyclosalpa danae* nov.spec.; e, dorsal tubercle of the same. (i.m. = intermediate muscle, Roman numerals indicate body muscles).

of muscle fibres of M I - M VII in the holotype is 151, which lies outside the variation of *C. affinis* (93 - 135, mean 114). Oral and atrial musculature as in *C. affinis*. Luminous organs: one pair of round objects of supposedly luminous nature lie between M IV and M V; they are of a very light colour with some granules in it. Intestine: as in *C. affinis*. Dorsal tubercle: a highly convoluted organ, probably not very different from that of *C. affinis*. Stolon: absent in the holotype.

A g g r e g a t e z o o i d: In general like *C. affinis*. Test soft, voluminous. Length: up to 45.5 mm (n = 6). Four almost parallel body muscles. The number of muscle fibres of M I - M IV is 41 - 57 (m = 51.0, n = 5), which is equal to the number found in *C. affinis* greg. The intermediate muscle is not attached to the first body muscle, which is a small difference with *C. affinis*, where the intermediate muscle does reach the first body muscle. Oral and atrial musculature otherwise as in *C. affinis*. Luminous organs: one pair of peculiarly shaped objects of supposedly luminous nature, lying between M II and M III. Intestine: as in *C. affinis*. Dorsal tubercle: highly convoluted, probably not very different from that in *C. affinis*. Ovary and embryo: situated between M III and M IV on the right side.

*Distribution* (fig. 11):

Apart from the type material, aggregate zooids have been captured in the Indian Ocean at 11°24′ S 50°05′ E, and in the Atlantic Ocean not far from the type locality (03°37′ N 29°14′ W, Disc. Exp. st. 704). Yount's specimen

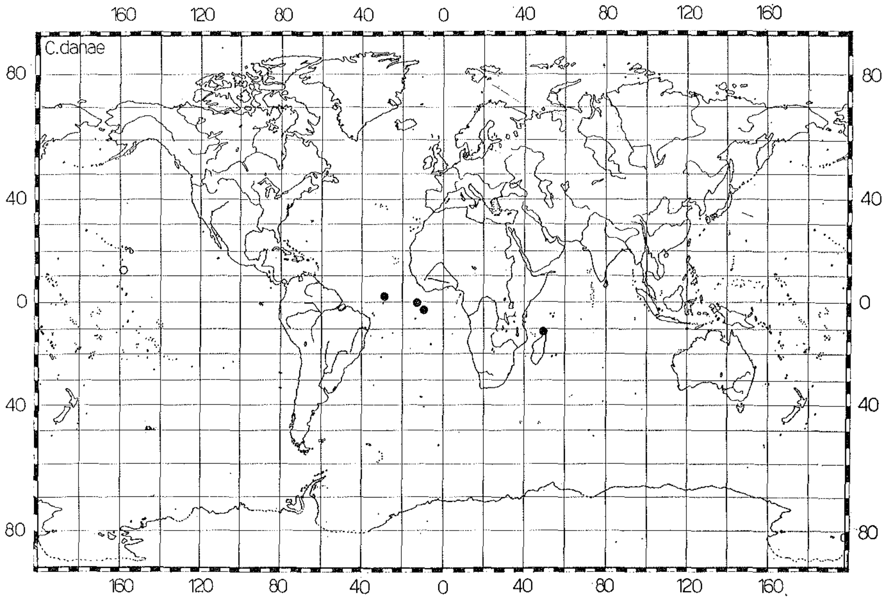


Fig. 11: Distribution of *Cyclosalpa danae* nov.spec.

originated from the area south of Hawaii (Pacific Ocean). The total number of specimens known of this species is 2 solitary and 14 aggregate zooids, originating from warm waters of all three oceans.

Etymology:

The species is named after the Danish research vessel "Dana II".

## **Thalia rhinoceros** nov. spec.

Synonymy:

*Thalia* spec. (hybrid?); van Soest, 1973: 207, fig. 11c.

In a previous paper (van Soest, 1973) the present author mentioned a presumed hybrid specimen of *Thalia democratica* (Forskål, 1775) and *Thalia cicar* van Soest, 1973. Among the many solitary specimens of those species found in the collections of the Great Barrier Reef Expedition, one specimen could not be identified as belonging to either species nor to *T. rhomboides* (Quoy & Gaimard, 1824), the third *Thalia* species represented in that material. As the atrial palp showed an intermediate morphology it was presumed it could be a hybrid specimen. However, in the Pacific Dana-samples studied after the above mentioned paper was published, dozens of exactly the same specimens were encountered. After a careful study, it seems now clear that they belong to a separate species, with a rather restricted distribution in the western Pacific.

Type material:

Holotype: a solitary specimen from Great Barrier Reef Expedition st. 13 (16° S 145° E, 20-VII-1928, 36 m wire out), incorporated in the British Museum (Natural History) under reg.no. 1930.4.3.27 (pt.); paratypes: 10 solitary specimens and 7 aggregate specimens from Dana Expeditions st. 3584 VI (10°51′ S 168°40′ W, 29-X-1928, 100 m wire out), incorporated in the Zoologisk Museum of Copenhagen; paratypes: 2 solitary specimens and 1 aggregate specimen, also from Dana Expeditions st. 3584 VI, donated by the Zoologisk Museum of Copenhagen to the Zoological Museum of Amsterdam and registered there under no. ZMA TU 1370.

*Description* (fig. 12):

S o l i t a r y  z o o i d : Test flabby and rather adhesive. No echinations, except for those on the test projections and the oral rim. Test projections: posterior projections almost as long as the body, lateral projections well developed, atrial palp not bifurcate, nor entirely simple: it is broad at the base, pointed at the tip, with a smoothly curved inside rim inbetween. Of

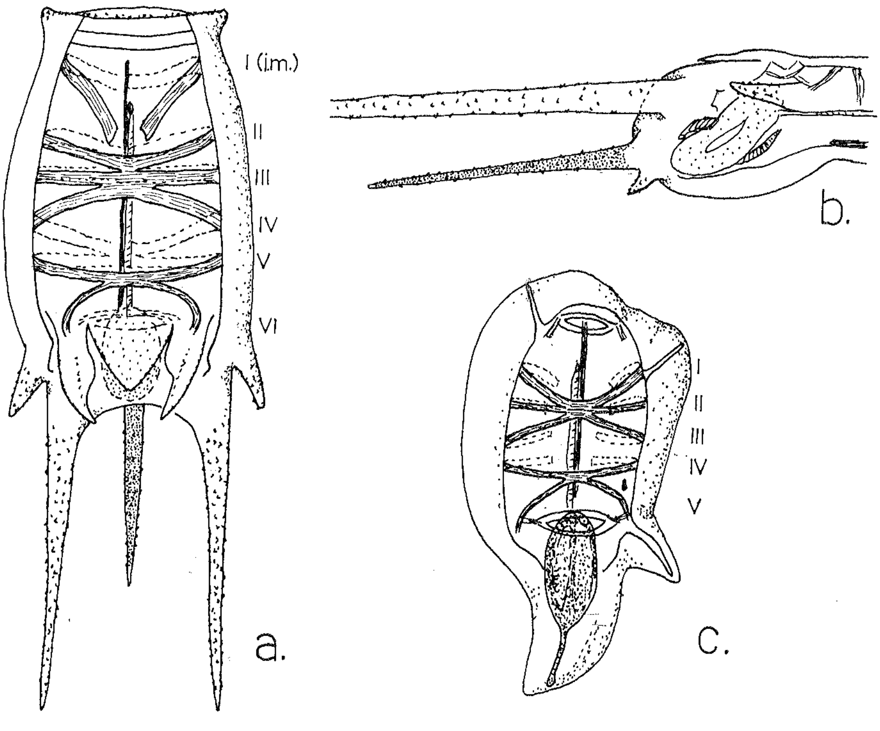


Fig. 12: a, dorsal view of the holotype (solitary specimen) of *Thalia rhinoceros* nov. spec.; b, lateral view of the posterior part of the same; c, dorsal view of a paratype (aggregate specimen) of *Thalia rhinoceros* nov.spec. (i.m. = intermediate muscle, Roman numerals indicate body muscles).

both medioventral projections the posterior one is extremely long and invariably opaque, which is a very striking feature. This opaqueness has been observed sporadically in *T. rhomboides* too, but in the present species it is a normal character. Length of the holotype: 6.5 mm. Length of all investigated specimens: up to 10.8 mm (excluding posterior and medioventral projections). The usual 1 + 5 body muscles (M I - M VI) are presented, arranged in the pattern of the *Thalia democratica*-group (cf. van Soest, 1973). The number of muscle fibres of the intermediate muscle (M I) + the five body muscles (M II - M VI) is 33 - 39 (m = 35.7, n = 28). The fusion of M II and M III dorsally is less strong than the fusion of M III and M IV. All other features exactly as in *Thalia democratica* (cf. van Soest, 1973).

Aggregate zooids: Found associated with the above described solitary zooids were a number of aggregate zooids resembling at first glance *Thalia democratica* greg. from temperate waters, because of their very prominent nucleus projections. However, in the tropical Indo-Pacific waters the aggregate zooids of *Thalia democratica* are typically without such a prominent nucleus projection; at the most they have a very tiny point at their nucleus and often this too is lacking. Comparison of the present aggregate zooids with local *T. democratica* greg. also indicated that the size of the nucleus and the flabbiness of the test were definitely different. Although conclusive evidence of the identity of these aggregate zooids cannot be given (the nucleus projection is absent in stolon individuals, which is also the case in Atlantic *T. democratica*), the author is fairly confident they belong to the above described solitary zooids, the more so as they were not found outside the area in which the latter occurred. Length: up to 4.0 mm. The number of muscle fibres is 16 as in all aggregates of the *Thalia democratica*-group.

*Distribution* (fig. 13):

*Thalia rhinoceros* has been found exclusively in the Western Pacific Ocean, in the area between 21° N and 21° S and 124° E and 160° W. From the Great Barrier Reef area it is known from a single solitary specimen (the holotype) and from the Indo-Malayan Archipelago from one fairly rich sample (Snellius Expedition st. 300).

Etymology:

The name *rhinoceros* has been chosen to indicate the extreme condition of the medio-ventral projections, which resemble the nasal part of a Rhinoceros.

## Discussion

The extreme variation in the number of muscle fibres and also the variability of the number of body muscles found in *Weelia cylindrica* seems out of character when compared to the conservative variation of these characters in all other salps. A varying number of muscles is known in the genus *Ritteriella*, but there it has been found that the total number of muscle fibres

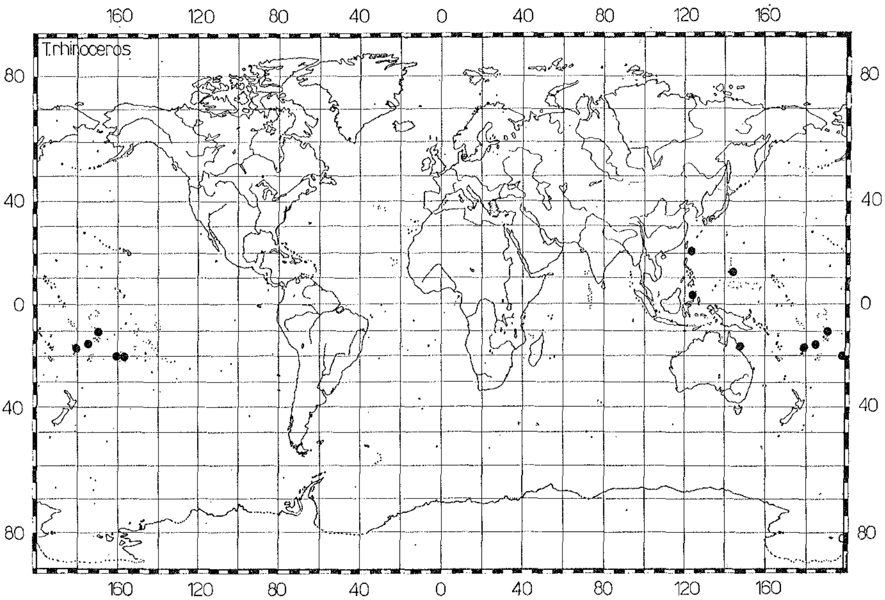


Fig. 13: Distribution of *Thalia rhinoceros* nov.spec.

is comparatively constant within the species, regardless of the number of body muscles (cf. van Soest, 1974b). In *Weelia* no such feature has been found. Future studies on better preserved material will be necessary to determine, whether indeed such a great variation exists within one taxon, or whether more taxa are concerned.

It is clear that *Thalia rhinoceros* bears considerable resemblance to other species of the *Thalia democratica*-group. Therefore, it seems necessary to underline the distinguishing characters. The solitary zooid differs from the local *Thalia democratica* in the morphology of the atrial palp, the comparatively long posterior projections, the anomalous second medio-ventral projectoins, the flabbiness of the test and the number of muscle fibres. It differs from *Thalia orientalis* (Tokioka, 1937) in the absence of the rows of minute echinations on the test, the morphology of the atrial palp, the presence of lateral projections and the anomalous second medio-ventral projection. It differs from *Thalia cicar* van Soest, 1973 in the elongated shape of test and body, the less developed lateral projections, the morphology of the atrial palp and the anomalous second medio-ventral projection. The aggregate zooid differs from all the other species by the prominent nucleus projection and the size and shape of the nucleus. Confusion of *T. rhinoceros* with *Thalia rhomboides* (Quoy & Gaimard, 1824) and *Thalia sibogae* van Soest, 1973 is unlikely to occur.

## REFERENCES


APSTEIN, C.
1894 Die Thaliacea der Plankton Expedition. B. Verteilung der Salpen. — Ergebn. Plankton-Exp., **2** (E, a, B) : 1—68.
1904 Salpes d'Amboine. — Rev. Suisse Zool., **12** (3) : 649—656.
1906a Salpen der Deutschen Tiefsee-Expedition. — Wiss. Ergebn. Deutsch. Tiefsee-Exp. 1898-1899, **12** (3) : 245—290.
1906b Die Salpen der Deutschen Südpolar-Expedition, 1901-1903. — Deutsch. Südpol.-Exp., **9** (Zool. 1) (3) : 159—203.
1929 Das vorkommen von Salpen in Arktischen Gebieten. — Fauna Arctica, **5** (1) : 1—12.

BELLOC, G.
1938 Liste des tuniciers pélagiques (Cinquième Croisière du „Président Théodore-Tissier"). — Rev. Trav. Off. Pêch. marit., **2** (3) : 315—333.

BERRILL, N. J.
1950 The Tunicata, with an account of the British species: 1—354 (Ray Society, London).

BLAINVILLE, H. M. D. DE
1827 Salpa. In: Dictionnaire des Sciences naturelles, **47** : 1—562 (Levrault, Strassbourg).

BOMFORD, B. M.
1913 Some salps taken by the R.I.M.S.S. "Investigator" in the Bay of Bengal and Andaman Sea. — Rec. Ind. Mus., **9** : 243—245.

BROOKS, W. K.
1893 Memoir on the genus Salpa. — Mem. biol. Lab. John Hopkins Univ., **2** : 1—303.

CUVIER, G.
1804 Mémoire sur les Thalides (Thalia, Browne) et sur les Biphores (Salpa, Forskål). — Ann. Mus. Hist. nat. Paris, **4** : 360—382.
1817 Mémoire pour servir à l'histoire et l'anatomie des Mollusques, **19**. Sur les Thalides et les Biphores: 1—24, 1 pl. (Deterville, Paris).

DOBER, G.
1912 Beiträge zur Kennntnis des Nervensystems der Salpen. — Z. wiss. Zool., **101**: 387—444.

DOSSMAN, D.
1970 Algunas especies de Salpas del Pacífico colombiano. — Boll. Dep. biol. Univ. Vall., Cali, **3** (1) : 65—82.

ESNAL, G. B.
1970 Sobre la distribucion de algunos Tunicados, familia Salpidae, en aguas frente a la Provincia de Buenos Aires. — Physis, **30** (80) : 241—249.

FAGETTI GUAITA, E.
1959 Salpas colectadas frente a las costas central y norte de Chile. — Rev. Biol. Mar. Valparaiso, **9** (1—3) : 201—228.

FEDELE, M.
1926 Thaliacea nuovi o rari del Golfo di Napoli. — Boll. Soc. nat. Napoli, **37** : 291—300.

FORSKÅL, P.
1775 Descriptiones animalium..., Ed. C. Niebuhr: 1—164, 22 pls. (Möller, Haunia).

FOWLER, G. H.
1896 Contributions to our knowledge of the plankton of the Faeroe Channel. — Proc. zool. Soc. London, **64** (1) : 991—996.

FOXTON, P.
1961 Salpa fusiformis Cuvier and related species. — Disc. Rep., **32** : 1—32.
1971 On Ihlea magalhanica and Ihlea racovitzai. — Disc. Rep., **35** : 179—198.

GODEAUX, J.
1962 Tuniciers pélagiques. — Rés. sci. Exp. océanogr. Belge, 1948-1949, **3** (7) : 1—33.
1969 Données sur la faune pélagique vivant au large des côtes du Gabon, du Congo et de l'Angola (0—18° lat. S. et 5—12° long. E). Tuniciers pélagiques: 1. (suite) Salpidae. — Ann. Soc. roy. zool. Belge, **99** : 64—76.
1973a Tuniciers pélagiques récoltés au cours de la troisième croisière atlantique de l' „Armauer Jansen" (1922). — Bull. Soc. roy. Sci. Liège, **42** (1/2) : 53—69.
1973b Tuniciers pélagiques de l'Océan Indien. — J. mar. biol. Ass. India, **14** (1) : 263—292.
1974 Thaliacés récoltés au large des côtes égyptiennes de la Méditerranée et de la mer Rouge (Tunicata, Thaliacea). — Beaufortia, **22** (291) : 83—103.

GODEAUX, J. & G. GOFFINET
1968 Données sur la faune pélagique vivant au large des côtes du Gabon, du Congo et de l'Angola. Tuniciers pélagiques. 1. Salpidae. — Ann. Soc. roy. Zool. Belge, **98** : 49—86.

HERDMAN, W. A.
1888 Report on the Tunicata. — Sci. Rep. Res. Voy. Challenger 1873-1876, Zool., **27** (3) : 1—166.

IHLE, J. E. W.
1910 Die Thaliaceen (einschliesslich Pyrosomen) der Siboga Expedition. — Monogr. Siboga Exp., **56** (d) : 1—55.
1911 Ueber die Nomenklatur der Salpen. — Zool. Anz., **38** (25/26) : 585—589.

IHLE, J. E. W. & M. E. IHLE-LANDENBERG
1935 Ueber eine kleine Salpen-Sammlung aus der Javasee (Zugleich: anatomische Untersuchungen über Salpen V). — Zool. Anz., **110** (1/2) : 19—24.

KASHKINA, A. A.
1973a A contribution to the fauna of Salpidae (Tunicata) in the Indian Ocean. — Zool. Zhurn., **52** (2) : 215—219 (in Russian with English summary).
1973b Salps from the Arabian Sea and the Gulf of Bengal (collection "Piotr Lebediev"). — Oceans, 1973: 193—212 (in Russian).
1974 Rasprostranenhe salp (Tunicata, Salpidae) Atlanticheskom okeane. — Trudy Vzez. Gidrobiol. Obzh., **20** : 171—210 (in Russian).

KRÜGER, H.
1939 Die Thaliaceen der "Meteor"-Expedition. — Wiss. Ergebn. Deutsch. Atl. Exp. Meteor 1925-1927, **13** (2) : 111—152.

LAMARCK, J. B. P. A. DE
1816 Histoire naturelle des animaux sans vertébrés, **3** : 1—770 (Verdière, Paris).

METCALF, M. M.
1918 The Salpidae: a taxonomic study. — Bull. U.S. nation. Mus., **100** (2) : 5—189.
1919 Metcalf and Bell upon Salpidae. — Science, New York, **50** (1279) : 19—20.

MEYEN, F. J. F.
1832 Beiträge zur Zoologie, gesammelt auf einer Reise um die Erde. I. Ueber die Salpen. — Nova Acta Acad. caes. Leop. Car. nat. cur., **16** (1) : 365—422.

OKA, A.
1915 Report upon the Tunicata in the collection of the Indian Museum. — Mem. Ind. Mus., **6** : 1—33.
1921 Ueber Traustedtia multitentaculata (Quoy & Gaimard), eine seltene Salpe. — Annot. zool. Japon., **10** (1) : 1—14.

QUOY, J. R. C. & J. P. GAIMARD
1833 Voyage de la corvette l'Astrolabe pendant les années 1826-1829. Atlas: 198 pls (Tastu, Paris).
1834 Voyage de la corvette l'Astrolabe pendant les années 1826-1829. Zoologie **3**. Mollusques: 1—954 (Tastu, Paris).

RITTER, W. E.
1905 The pelagic Tunicates of the San Diego region, excepting the Larvacea. — Univ. Calif. Publ. Zool., **2** (3) : 51—112.

RITTER, W. E. & E. S. BYXBEE
1905 Reports on the scientific results of the expedition to the tropical Pacific ... Albatross ... 8. The pelagic Tunicata. — Mem. Mus. comp. Zool., **26** (5) : 195—214.

SEWELL, R. B. S.
1926 The Salps of Indian Seas. — Rec. Ind. Mus., **28** (2) : 65—126.
1953 The pelagic Tunicata. — Sci. Rep. John Murray Exp. 1933-1934, **10** (1) : 1—90.

SIGL, A.
1912 Adriatische Thaliaceenfauna. — Sitz. Ber. kais. Akad. Wiss. Wien, math.-naturw. Kl., **121** (1) : 463—508.
1913 Die Thaliaceen und Pyrosomen des Mittelmeeres und der Adria, gesammelt während der fünf Expeditionen S.M. Schiff „Pola" 1890-1894. — Denkschr. kais. Akad. Wiss. math.-naturw. Kl., **88** : 213—290.

SOEST, R. W. M. VAN
1973 The genus Thalia Blumenbach, 1798 (Tunicata, Thaliacea) with descriptions of two new species. — Beaufortia, **20** (262) : 59—68.
1974a Taxonomy of the subfamily Cyclosalpinae Yount, 1954 (Tunicata, Thaliacea), with descriptions of two new species. — Beaufortia, **22** (288) : 17—55.
1974b A revision of the genera Salpa Forskål, 1775, Pegea Savigny, 1816, and Ritteriella Metcalf, 1919 (Tunicata, Thaliacea). — Beaufortia, **22** (293) : 153—191.

STIASNY, G.
1919 Die Salpen Sammlung im Naturhistorischen Reichsmuseum in Leiden. — Zool. Meded., **5** (1, 3) : 5—21.

STREIFF, R.
1908 Ueber die Muskulatur der Salpen und ihre Systematische Bedeutung. — Morph. Jahrb., Abt. Syst., **27** : 1—82.

THOMPSON, H.
1948 Pelagic Tunicates of Australia: 1—196, 75 pls. (Commonwealth Council for Scientific and Industrial Research, Melbourne).

TOKIOKA, T.
1937 Notes on salpas and doliolums occurring on the Pacific coast of middle Japan. — Annot. zool. Japon., **16** : 219—235.
1938 On the aggregated form of the rare salpa Traustedtia multitentaculata. — Annot. zool. Japon., **17** : 234—245.
1954 Descriptions of the aggregated form of Brooksia rostrata (Traustedt), an insufficiently known salpa. — Publ. Seto mar. biol. Lab., **4** (1) : 147—154.
1974 Biological results of the Snellius Expedition. 24. Pelagic Tunicates of the Snellius Expedition. — Zool. Meded., **48** (9) : 75—80.

TRAUSTEDT, M. P. A.
1885 Bidrag til kundskab om Salperne. — Vidensk. Selsk. Skr., (6), naturv.-math. Afd., **2** (8) : 334—400.
1893 Die Thaliacea der Plankton-Expedition. A. Systematische Bearbeitung. — Ergebn. Plankton-Exp., **2** (E, a) : 3—16.

VOGT, C.
1854 Recherches sur les animaux inférieurs de la Méditerranée. Second mémoire sur les Tuniciers nageants de la mer de Nice. — Mém. Inst. nation. Génévois, **2** : 1—61.

YOUNT, J. L.
1954 The taxonomy of the Salpidae (Tunicata) of the Central Pacific Ocean. — Pac. Sci., **8** (3) : 276—330.