ON THE MARINE FREE-LIVING COPEPODS OFF BRAZIL

(Received 15/10/62)

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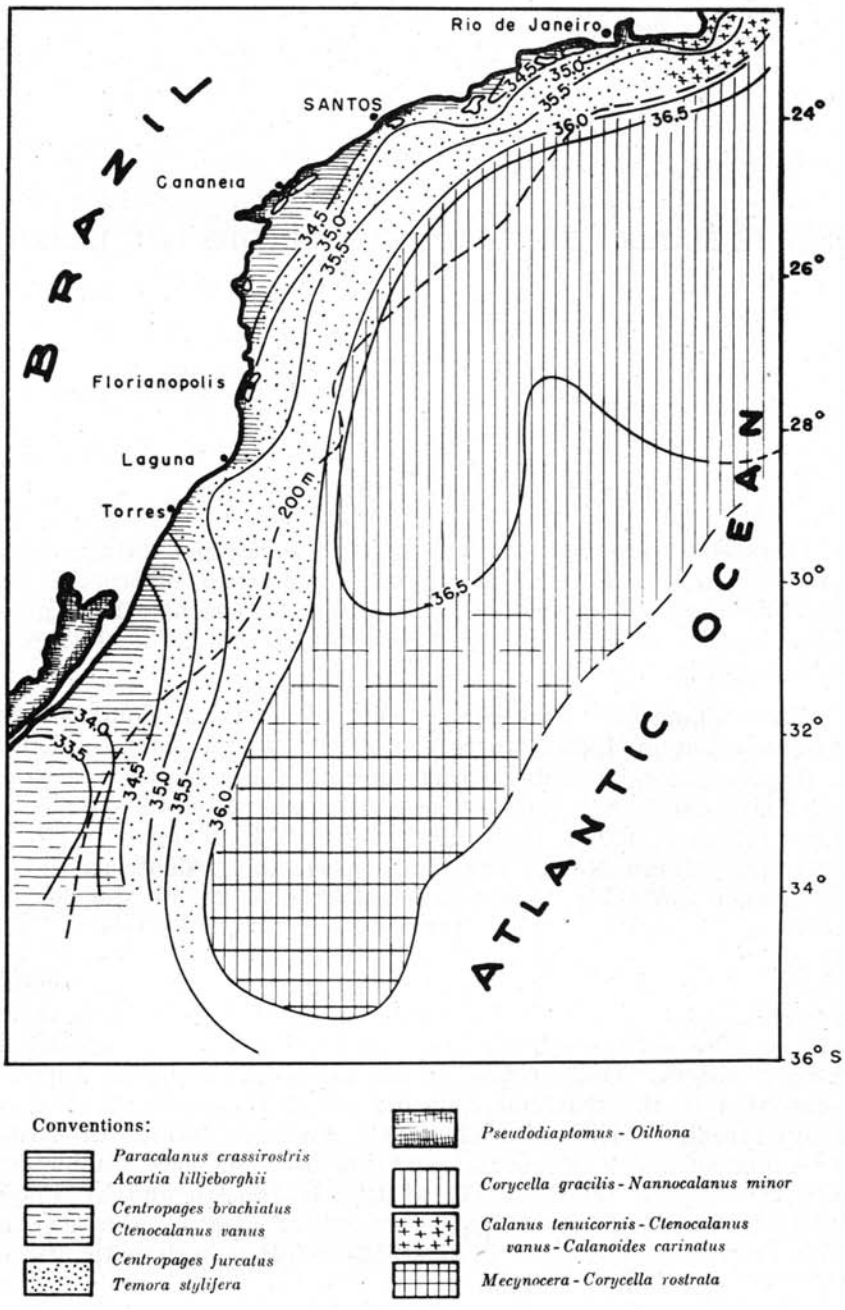
INTRODUCTION

Copepods were best studied in coastal, Boreal, Arctic, Antarctic and deep waters. Those from tropical and subtropical waters have been little studied. Little attention has also been given to the marine copepods of the western tropical and subtropical South Atlantic.

The "Plankton" Expedition collected samples along all the northern coast of Brazil up to the mouth of the Amazon River, but it gave general results concerning chiefly the smaller copepods, as a fine meshed net (Hensen egg net) was used to sample the water (Hensen 1911; Dahl 1894). The "Challenger" (Brady, 1883), the "Terra Nova" (Farran, 1929), the "Albatross" (Wilson, 1950, p. 353-354) Expeditions collected at a few stations off Fortaleza, Salvador, Rio de Janeiro and Trindade Island. The cruises undertaken by the Research Ship "M. Lomonosoff" has surveyed the South Atlantic copepod fauna along the 30° meridian (Kanaeva, 1960) up to 20° S. During the "Meteor" Expedition stations were occupied along the coast of Brazil, but usually in offshore waters. Only a few of the numerous copepods families represented in the material collected by this expedition were especially treated (Klevenhusen, 1933; Steuer, 1937). In Brazil the ecological study of coastal and inshore copepods was undertaken by Oliveira (1945; 1947) at Rio de Janeiro and by Jakobi (1953-59) in the inshore waters of the States of Paraná and Santa Catarina. Carvalho (1939-1952) made a systematic survey of the copepods occurring in the vicinity of Santos and Paraná.

Publ. nº 176 do Inst. Ocean. da USP.



Conventions:

Paracalanus crassirostris
Acartia lilljeborghii

Centropages brachiatus
Ctenocalanus vanus

Centropages furcatus
Temora stylifera

Pseudodiaptomus - Oithona

Corycella gracilis - Nannocalanus minor

Calanus tenuicornis - Ctenocalanus vanus - Calanoides carinatus

Mecynocera - Corycella rostrata

Map 1 — Typical associations of copepods off the southern coast of Brazil based on map 1 of Emilsson (1961, p. 106).

Still, in all these studies, coastal and chiefly brackish water have been sparingly sampled. A general survey is here presented, not only of coastal and open-sea waters but principally of shelf waters.

It has been the aim of the Instituto Oceanográfico to study the water masses off the southern coast of Brazil not only hydrographically (Emilsson, 1959-1961) but also biologically (Björnberg & Forneris, 1956a; 1956b; Vannucci, 1957a; Almeida Prado, 1961). A natural consequence of these studies is the determination of the ecological parameters of each species in the area studied.

In the study of copepods, the depth of the layers sampled has been generally the chief concern of researchers.

Unfortunately few authors have checked the hydrographical conditions of the water layers where the copepods lived at the moment of the catch and failed to consider them. Many copepods considered as coastal by some authors would figure in the species lists as characteristic of higher salinity waters and the "strange" behaviour of some copepods would be considered quite normal, since they belonged to a body of water which carried them to the proximity of the coast when pushed exceptionally near it.

Another point not usually considered is that most ecological and zoogeographical conclusions can only be safely drawn when the number of samples studied come from as wide a range as possible. Thus, what is here found to be true for the waters off Brazil may not be valid for the Pacific Ocean or for Northern Atlantic waters.

After giving a preliminary account of the geographical distribution of pelagic marine copepods (Björnberg, 1959) for the area between 23°58.5' S and 34°42.0' S off Brazil, more samples taken at widely scattered locations at different months and in different years complete the preliminary list of the epipelagic copepods which may occur in a wider interval off the Brazilian coast. The ecological requirements of some species and their probable horizontal dispersion off Brazil were tentatively established in relation to salinity, temperature, depth of the waters and distance from the coast. From a comparison of these data with those from other seas some parameters concerning the optimum environments of some copepods were determined here for the first time. For this study preference was given to the data published on collections which covered the largest areas.

MATERIAL AND METHODS

Plankton samples were taken either superficially or vertically from different depths (see lists) to the surface, between 4°57' N and 34°42' S off the coast of Brazil.

These plankton samples belong to the collections of the Instituto Oceanográgico. Some were donated by foreign institutions like the Japanese Government (samples from the "Toko Maru" cruise) and the Woods Hole Oceanographic Institution ("Atlantis" cruise n.° 247 along the 36° S lat.). Some were donated to the Instituto by the Brazilian Navy. The others were collected by the Institute's staff for several purposes (hydrographical, biological and fisheries research).

Of a much greater number studied only 102 samples are listed in Tables I, III, V, VII, VIII, IX, XI, XIII, XV, because of their value for comparative purposes. Some were chosen because of the homogeneity of their temperature and salinity or because of the localization of the water layers sampled or because special water layers were sampled along with others. In the samples where the fauna or different water layers of different salinity and temperature was mixed, the characteristic copepods of a certain water layer were determined by exclusion from the comparison with samples where only one kind of water was sampled.

So as to be sure that all copepods large and small were observed in the various waters, when possible, samples were chosen which had been caught both by zooplankton and by phytoplankton nets in the same water. It is a known fact that the number of *Oncaea, Microsetella, Corycaeus* and *Oithona* present in the sample can be strongly influenced by the type of net used (Hensen 1911, p. 8-20; Almeida Prado, 1962). The larger *Euchaeta, Eucalanus, Haloptilus, Neocalanus* and *Pleuromamma* escape the fine meshed nets (Hensen 1911, p. 318; Steuer 1933, p. 102) by active swimming.

A cruise which takes about a month to collect samples may fish only inside a very large patch of a temporary association of species, which will then be misleadingly considered as characteristic for that region (Vannucci 1957b, p. 218). To avoid this wrong interpretation of data, samples of quite different dates and expeditions were selected in which only salinity, temperature and depth of haul were the same. All the copepods of 52 samples with similar parameters were counted and the volume of some of the most common species calculated by the settling method. Of 50 samples, only sub-samples taken with the 5 cc Stempel-

pipette were counted. The percentage of each species in the sample was calculated. Some samples, taken by horizontal hauls without flowmeter, were only used qualitatively.

The samples in which the same association of species occurred together were grouped and the groups of samples with the greatest distributional affinity were then segregated and regarded as belonging to distinct communities.

The salinity, temperature, depth and distance from the shore of the groups of samples were then analysed to establish some of the characteristic features of the environment where the community occurred. This method has been used before in biocoenology (Macfadyan 1957, p. 223).

For the most common species graphs were drawn which indicate the probability of finding each species in each of the different environments studied. Five environments were represented in each graph by a column each. The one representing "Tropical Waters" is labelled *T* (above 36.00 $^{o}/_{oo}$ salinity and above 20°C temperature); *SST* stands for "Surface Subtropical Waters" (salinity around 36 $^{o}/_{oo}$ and temperature of 18°C or less); *DST* for "Deeper Shelf Waters" (salinity between 34 $^{o}/_{oo}$ and 36 $^{o}/_{oo}$, temperature under 20°C); *SS* for "Surface Shelf Waters" (same salinity and temperature above 20°C); *C* for coastal waters with low salinity and variable temperature. In each column no shading means no probability of finding the species in the samples from this environment; horizontal shading indicates the probability of finding the species in percentages less than one in samples from this environment; cross shading indicates the probability of finding it in percentages higher than one and black shading represents the probability of finding it in the largest percentages of the total number of copepods. For example: in Figure 1, in tropical waters there is no probability at all of finding *Calanus tenuicornis;* in surface subtropical waters there is a probability of finding it in half of the samples examined from this environment, as it was present in one sample in percentage above one and in four samples in percentages under one, in a total of 11 samples from the represented environment. Thus, of this total (= 1), a quantity of 0.1 of the column is horizontally striped, another of 0.4 is cross-striped and the rest is not shaded. For greater drawing facilities the numbers were approximated to the first decimal. In Figure 19 black shading shows that *Ctenocalanus vanus* has a probability of being found in dominant percentages of the total number of copepods in 0.3 of the total number of samples examined from deeper shelf waters off the Brazilian coast.

The expression "tropical waters", "surface shelf waters", "deeper shelf waters", etc., were chosen in order to avoid the use of the expression "water mass", because the associations studied in this paper clearly indicate the existence of several environments in the same water mass. The nomenclature used delimitates the environments better and was therefore preferred.

Warm water is here considered as that which shows temperature above 23°C. Cool water is considered that with 22°C to 18°C. Cold water is considered water with less than 18°C. High salinity is here considered as salinity above 36 °/₀₀. Medium salinity are salinities between 34 and 36 °/₀₀. Low salinity is the salinity under 34 °/₀₀ and brackish water that with salinity below 32 °/₀₀. The expression "eurythermic cryophile" is applied in this paper to species which are usually found in the lower temperatures (around 18°C or less) of the waters off the Brazilian coast.

All the copepods caught were fixed in 4% formalin and were measured in millimeters in dorsal or in lateral view from the anterior extremity of the cephalon to the end of the furca, as indicated under the heading SIZE for each species. So as not to prolong this paper unnecessarily no list of synonyms was usually given for each species. Descriptions of nearly all species mentioned are found in Giesbrecht (1892) and in Rose (1933) which were mostly used for identification. In a few cases synonyms not mentioned before by other authors were exceptionally referred to.

The numbers which follow the sample numbers under the heading OCCURRENCE refer to the absolute number of specimens of the species found in the sample. When the total number of animals was calculated from the number of specimens present in a sub-sample an asterisk (*) follows the number in question. The "Pr." standing after the sample number means "present in the sample".

The total quantity of plankton was measured by the settling method and the volume of plankton and of the copepods per cubic meter of water was computed from the data on the total volume of water filtered through the plankton nets used. The different nets used are indicated in the Station lists and the type of haul is also indicated there.

LIST OF SPECIES

Calanoida

Calanus tenuicornis Dana
Nannocalanus minor (Claus)
Calanoides carinatus (Kröyer)
Neocalanus gracilis (Dana)
Neocalanus robustior (Giesbr.)
Undinula vulgaris (Dana)
Eucalanus attenuatus (Dana)
Eucalanus monachus (Giesbr.)
Eucalanus subcrassus (Giesbr.)
Eucalanus pileatus Giesbr.
Eucalanus elongatus (Dana)
Eucalanus subtenuis (Giesbr.)
**Rhincalanus nasutus* (Giesbr.)
Rhincalanus cornutus (Dana)
Mecynocera clausi Thompson
Paracalanus aculeatus Giesbr.
Paracalanus parvus Claus
Paracalanus crassirostris Dahl
Acrocalanus longicornis Giesbr.
Acrocalanus gracilis Giesbr.
**Calocalanus pavo* Dana
**Calocalanus styliremis* Giesbr.
**Calocalanus plumulosus* (= *C. tenuis* Farran)
Clausocalanus arcuicornis Dana
Clausocalanus furcatus (Brady)
Ctenocalanus vanus Giesbr.
**Aetidiid* sp. 1
**Aetidiid* sp. 2
**Euaetideus giesbrechti* Cleve
Undeuchaeta major Giesbr.
Candacia simplex Giesbr.
Candacia pachydactyla (Dana)
Candacia bispinosa (Claus)
Candacia bipinnata (Giesbr.)
Candacia curta (Dana)
Candacia aethiopica (Dana)
**Euchirella rostrata* (Claus)
**Euchirella brevis* Sars
Euchaeta marina (Prestand.)
**Euchaeta acuta* (Giesbr.)
Scolecithrix danae (Lubb.)
**Scolecithricella dentata* (Giesbr.)
**Lophothrix latipes* (T. Scott)
**Scaphocalanus curtus* (Farran)
Centropages furcatus (Dana)
Centropages violaceus (Claus)
**Centropages brachiatus* (Dana)
Pleuromamma abdominalis (Lubb.)
Pleuromamma gracilis (Claus)
Pleuromamma xiphias (Giesbr.)
Pleuromamma borealis F. Dahl
Temora stylifera Dana
**Temeropia mayumbaensis* T. Scott
Lucicutia flavicornis (Claus)
**Lucicutia ovalis* Wolfencen
**Lucicutia clausi* (Giesbr.)
**Heterorhabdus spinifrons* (Claus)
Heterorhabdus papilliger (Claus)
Haloptilus acutifrons (Giesbr.)
Haloptilus spiniceps (Giesbr.)
Haloptilus fertilis (Giesbr.)
Haloptilus longicornis (Claus)
Euaugaptilus hecticus Giesbr.
Pseudodiaptomus acutus (F. Dahl)
Pseudodiaptomus richardi (F. Dahl)
Pontellopsis brevis (Giesbr.)
Pontellopsis villosa Brady
Pontellopsis perspicax (Dana)
Pontellina plumata Dana
Labidocera fluviatilis F. Dahl
Labidocera acutifrons (Dana)
Calanopia americana F. Dahl
Acartia lilljeborghii Giesbr.
Acartia danae Giesbrecht
Acartia negligens Dana
**Acartia longiremis* Lilljeborgh
Acartia clausi Giesbrecht
Acartia tonsa var. *cryophylla* var. n.
Acartia giesbrechti F. Dahl

Harpacticoida

Clytemnestra scutellata Dana
Euterpina acutifrons (Dana)
Macrosetella gracilis (Dana)
Oculosetella gracilis Sars
Microsetella rosea Dana
Microsetella norvegica (Boeck) ?
Miracia efferata Dana
Parathalestris sp.
Longipedia mourei Jakobi

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* New records

Cyclopoida

Oithona robusta Giesbr.
**Oithona similis* Claus
Oithona plumifera Baird
Oithona ovalis Herbst
Oithona setigera Dana
Oithona nana Giesbr.
**Oithona oculata* Farran
Oncaea venusta Philippi
Oncaea media Giesbr.
**Oncaea conifera* Giesbr.
**Oncaea mediterranea* Claus?
Oncaea minuta Giesbr.
Oncaea venusta var. *venella* Farran
**Oncaea subtilis* Giesbr.
Lubbockia squillimana Claus
Corycaeus speciosus Dana
Corycaeus amazonicus F. Dahl
Corycaeus limbatus Brady
Corycaeus flaccus Giesbr.
Corycaeus furcifer Claus
Corycaeus lautus Dana
Corycaeus giesbrechti F. Dahl
Corycaeus ovalis Claus
Corycaeus latus Dana
Corycaeus crassiusculus Dana
Corycaeus typicus Kröyer
Corycaeus africanus Dahl
Corycella rostrata Claus
Corycella gracilis Dana
Sapphirina angusta Dana
Sapphirina auronitens-sinuicauda Brady
Sapphirina opalina-darwini Dana
**Sapphirina metallina* Dana
**Sapphirina stellata* Giesbr.
**Sapphirina maculosa* Giesbr.
Sapphirina nigromaculata-scarlata Claus
Sapphirina intestinata Giesbr.
Sapphirella tropica Wolfenden
Copilia vitrea (Haeckel)
Copilia mirabilis Dana
Copilia mediterranea (Claus)
Copilia quadrata Dana
Copilia lata Giesbr.

SYSTEMATIC NOTES AND DISTRIBUTION OF THE INDIVIDUAL SPECIES

Fam. Calanidae

Calanus tenuicornis Dana

(Fig. 1)

SIZE — ♂ 1.85 mm — 1.6 mm; ♀ 2.0 mm.

OCCURRENCE — M 409 (1), M 395 (1), M 163 (9), M 162 (9), M 161 (1), M 160 (Pr.), M 78 (3), M 76 (45), M 75 (51), M 74 (12), M 73 (32).

ECOLOGY — This species appeared only sparingly in the samples belonging to southern waters off Brazil with larger frequency in surface subtropical and in greater numbers in deeper shelf waters (Fig. 1). It also appeared sparingly south of the Cape Colony on the eastern part of the Atlantic (Table XVI). Kusmorskaya (1959) considers it as one of the most abundant

* New records

copepods in Autumn in the transition zone between boreal and southern warm water species in the North Atlantic. The temperature of the transition zone ranges between 16° and 12°C and salinities between 36.00 and 35.5 °/₀₀, which are approximately the hydrographical characteristics of the waters where *C. tenuicornis* occurred, off the Brazilian coast. Farran (1926, p. 228) and Heinrich (1961, p. 38, tab. 1) pointed out that the animal occurs usually in greater numbers between 100 and 200 m depth in the subtropical region of the North Atlantic and Pacific. Vervoort (1957) did not register this animal in Antarctic waters but he found it in samples taken from 250 to 100 m depth in the tropical region by the "Snellius" Expedition (Vervoort 1946, p. 22).

Tables X and VIII show that *C. tenuicornis* is characteristic of subtropical waters in all the oceans. It can be classified as an eurythermic cryophile preferring the lower end of the temperature range for warm waters.

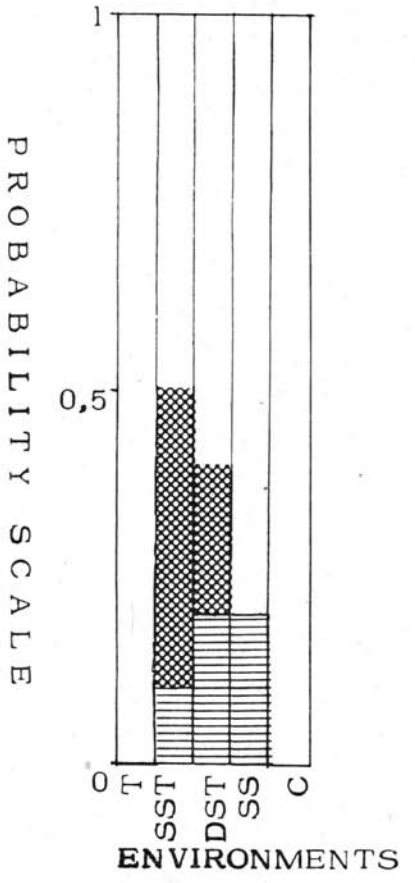

Fig. 1 — Probability of occurrence of *Calanus tenuicornis* in different environments.

Nannocalanus minor (Claus)

(Fig. 2)

SIZE — ♂ 1.4 mm to 1.8 mm; ♀ 1.8 to 1.9 mm. Present in two different forms, a smaller and stouter one and a longer and more transparent one; only copepodites of the latter were found.

OCCURRENCE — M 513 (3), M 510 (8), M 497 (1), M 489 (2880)*, M 451 (20), M 409 (15), M 407 (71), M 403 (123), M 402 (240)*, M 400 (17), M 395 (115), M 394 (640)*, M 389 (Pr.), M 368 (3), M 364 (200)*, M 363 (11), M 315 (61), M 314 (55), M 247 (209), M 246 (73), M 245 (5), M 244 (178), M 243

(12), M 242 (33), M 241 (33), M 240 (36), M 232 (120)*, M 208 (1), M 189 (8), M 187 (Pr.), M 186 (34), M 166 (69), M 164 (2), M 163 (4), M 162 (12), M 161 (206), M 160 (25), M 114 (31), M 113 (3), M 112 (6), M 111 (5), M 100 (4), M 99 (18), M 98 (5), M 97 (Pr.), M 96 (15), M 95 (15), M 93 (1), M 89 (1), M 88 (6), M 78 (2), M 76 (7), M 75 (52), M 74 (26), M 39 (3), M 38 (20)*, M 37 (41), M 36 (29), M 35 (15), M 33 (58), M 32 (4), M 30 (Pr.), P 10 (1), E 164 (2).

ECOLOGY — It was one of the most common of the euryhaline and eurythermic copepods. Abundant in waters with salinity higher than 35.00 °/₀₀ and temperature above 21°C and present in small numbers in the colder coastal waters (20°C or between 15.40 and 14.38°C) off the south of Brazil. It was found off the Brazilian coast in the Brazil Current, in the South Equatorial Current, in higher percentages in tropical and in surface subtropical waters (Fig. 2) and in surface shelf waters (Table VIII and XIII). In deeper shelf waters it did not occur or only occurred sparingly, thus indicating its preference for the surface layers. The histogram (Fig. 2) indicates that it may occur in colder waters of lower salinities. Deevey (1952a, p. 110) considers it as an indicator of offshore waters of high salinities in North American Atlantic waters. Bainbridge (1960, tab. 1, p. 932-933) registered it in the Guinea Gulf between temperatures 27.8 and 22.1°C. It occurs off the African Atlantic coast at Angola (Marques 1958, p. 205) where temperatures range from 30 to 14°C in the upper 50 m being usually under 20°C, and the salinities are usually around 35.5 °/₀₀ (Vilela 1953, tab. 4-5). In the Pacific, Wilson (1950, p. 268) recorded the presence of this

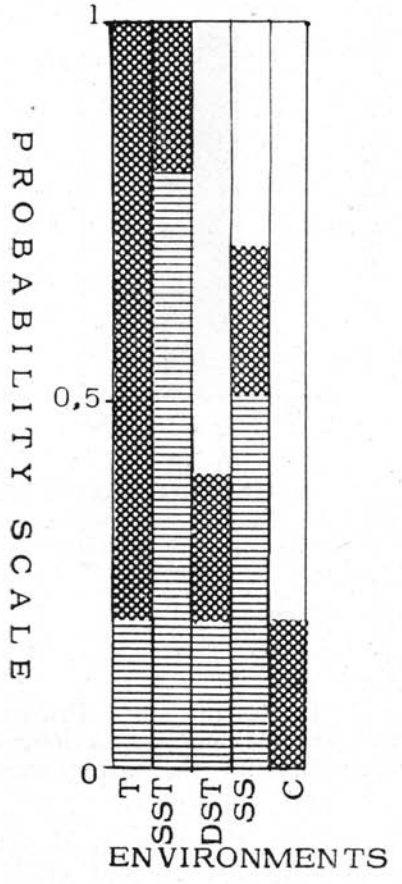

Fig. 2 — Probability of occurrence of *Nannocalanus minor* in different environments.

species in Philippine waters with much lower salinities than in Atlantic oceanic waters but unfortunately no data were given as to the number of specimens per sample. It was abundant between latitudes 32 and 33° S in the middle of the Atlantic and off South Africa in subtropical waters (Table XVI). Farran (1929, p. 215) found its greatest numbers in the tropical Atlantic and next, off New Zealand in subtropical waters. Vervoort (1946, p. 26) usually records this species in samples from upper layers of tropical waters in the Indo-Pacific equatorial region, but also in samples from deep layers (1,000 — 555 m). According to Brodsky (1959, p. 146) it is characteristic of the subtropical epipelagial of both hemispheres. Heinrich (1961, p. 83) observed a diurnal migration down to 200 m depth in the western subtropical Pacific.

Neocalanus gracilis (Dana)

(Figs. 3, 4, 5)

SIZE — ♀ 2.5 to 3.5 mm. Vervoort (1946, p. 41) registered sizes from 2.43 to 3.5 mm in the "Snellius" Expedition material. The specimens studied here are among the largest recorded till now. Oliveira (1947, p. 457) registered sizes of 3.5 mm also.

OCCURRENCE — M 513 (120)*, M 510 (20)*, M 407 (7), M 403 (12), M 402 (Pr.), M 400 (5), M 395 (40), M 364 (320)*, M 315 (23), M 314 (5), M 247 (76), M 246 (8), M 245 (16), M 244 (46), M 243 (13), M 242 (23), M 241 (4), M 240 (33), M 232 (40), M 223 (Pr.), M 166 (11), M 161 (7), M 114 (2).

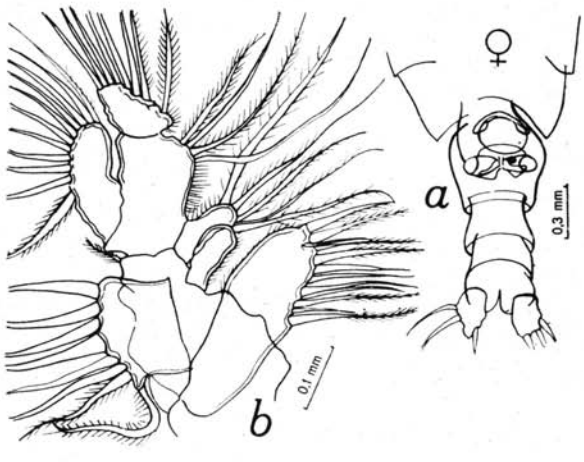

Fig. 3 — *Neocalanus gracilis*: a — thorax and abdomen of adult female, ventral view; b — first maxilla.

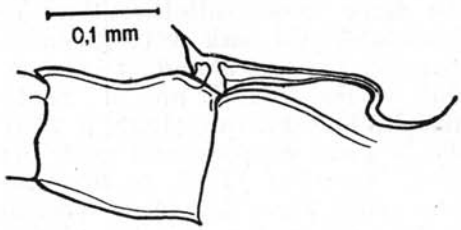

Fig. 4 — *Neocalanus gracilis*: Double hook on the second basal joint of the first pair of legs.

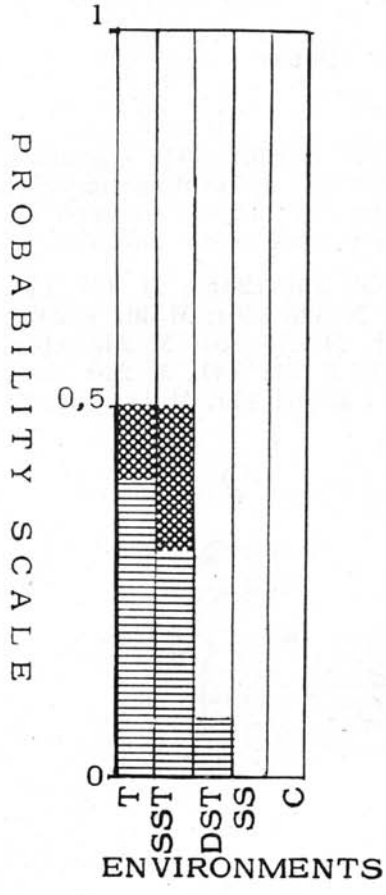

Fig. 5 — Probability of occurrence of *Neocalanus gracilis* in different environments.

SYSTEMATIC NOTES — Unusually large specimens were at first mistaken for *Megacalanus* copepodites (Björnberg 1959, p. 138). The size and the pronounced genital swelling of the genital segment of the female specimens here studied might also lead to a confusion with *N. robustior*. The anatomy of the adult specimens, the abdomen (Fig. 3-a) and the maxilla leave no doubt, however, as to their correct identity. The distinct double hook on the second basal joint of the first pair of legs (Fig. 4) is already present in the young copepodites. The first antenna (5 mm long in the 3 mm long male) reaches far beyond the furca in both sexes, by 6 joints in the male. In the 3 mm long male of *N. robustior* the antenna is short (3 mm long) and reaches only up to the furca. The hook on the second basal segment of the first pair of legs differs from that of *N. robustior*.

ECOLOGY — It was found quite frequently in catches made in very saline water layers (35.90 $^{0}/_{00}$ or more) in the surface tropical and subtropical (Fig. 5) waters. It usually was caught in the upper layers during the night or in the early morning. Catches made during the day were poor in number of specimens, strongly indicating migration of the species to deeper waters during the day. Vervoort (1946, p. 43) states that there are no signs of a diurnal migration of this species, but both this author

and Farran (1926, p. 230) recorded a greater abundance of this species from about 50 m or more to 250 m depth approximately in tropical and subtropical waters. Vervoort (1957, p. 31) registered *N. gracilis* in Antarctic waters at depths between 250 m and 750 m in salinities between 34.50 and 35.00 ‰ and temperatures of 1.79 to 11.73°C. The animal may be more frequent at 130 m depth (Moore 1949, p. 42-43) in the North Atlantic off the Bermudas. It was present in samples of subtropical waters in the middle South Atlantic. Heinrich (1960, p. 36) registered the animal in greater numbers between 0° and 25° Lat. N in the Western Pacific where the salinity according to Burkov (1960, p. 117, tab. 7) ranges from 34.2 to 35.0 ‰ and temperatures from 26 to 20°C.

N. gracilis as well as *N. minor* are the two characteristic copepods of the subtropical oceanic epipelagial in both hemispheres according to Brodsky (1959, p. 146). Kusmorskaya (1959) considers them as partially subtropical and points out that *Calanus helgolandicus* and *Neocalanus gracilis* have the same distribution in the transition zone between boreal and southern warm water species during Spring.

Neocalanus robustior (Giesbr.)

SIZE — ♂ 3.1 mm.

OCCURRENCE — M 244 (1), M 240 (2), M 78 (1).

REMARKS — *N. robustior* was present in very small numbers in three samples. It is here recorded for the first time in Brazilian waters. Marques (1958, p. 205) registered it in African Atlantic waters. It is a moderately deep water species according to Vervoort (1946, p. 46) and few specimens were captured here as nearly all our samples were taken in the upper 150 m. It appeared only in samples of high salinity, but the few data do not permit further considerations.

Undinula vulgaris (Dana)

(Figs. 6-7)

SIZE — ♂ 2.0 mm; ♀ 2.5 mm.

OCCURRENCE — M 510 (12), M 497 (25), M 489 (1380)*, M 451 (60), M 409 (Pr.), M 407 (16), M 403 (8), M 402 (200)*, M 394 (280)*, M 368 (4), M 365 (Pr.), M 364 (8), M 363 (1), M 357 (Pr.), M 315 (100), M 314 (27), M 283 (1), M 247 (56), M 246 (42), M 245 (22), M 244 (55), M 243 (27 juv.), M 242 (19), M 241 (108), M 240 (40), M 232 (80), M 189 (1), M 114

(2), M 99 (26), M 98 (56), M 97 (30), M 96 (3), M 95 (8), M 78 (34), M 75 (3), M 39 (3), M 38 (5), M 37 (4), M 36 (2), M 35 (15), M 33 (6), M 30 (1).

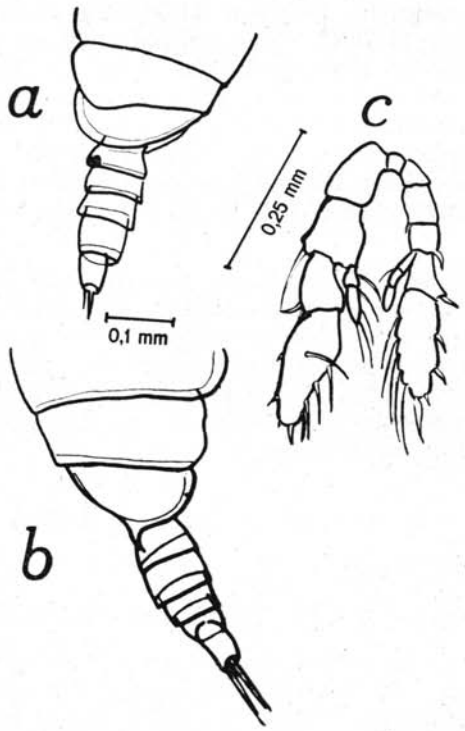

Fig. 6 — *Undinula vulgaris*: a — Thorax and abdomen of young specimen in profile; b — the same in adult female specimen; c — fifth legs of last copepodite of male specimen.

SYSTEMATIC NOTES — The female specimens which occur in Brazilian waters have two hooklike spines on the last thoracic segment (Fig. 6-b) as in *U. vulgaris* forma *typica* Sewell (Vervoort 1946, p. 73). In the young specimens the segment is rounded off and presents no spines (Fig. 6-a). The fifth legs of the male's last copepodite also have been figured (Fig. 6-c).

ECOLOGY — One of the most numerous copepods in waters of high salinity (above 36.00 $^{0}/_{00}$) and high temperature (above 25°C) in our samples (Fig. 7). The number of specimens of this species was smaller in waters of high salinity and lower temperatures at the surface and disappeared in the samples taken from deep waters with temperatures lower than approximately

20°C. It appears in surface waters of approximately 35.00 to 36.00 °/₀₀ salinity and temperature between 18 and 22°C. It is absent or rare in samples from deep layers. In the Indo-Pacific (Vervoort 1946, p. 74-75) it occurred in maximum numbers at the surface in temperatures around 28°C and salinities around 34.00 °/₀₀. Farran (1936, p. 75) classified it as "coastal"; other authors, as "oceanic" (Yamazi 1958, p. 417). It had already been recorded from the South West Atlantic (Sewell 1948, p. 450) and off Rio de Janeiro (Vervoort 1946, p. 76). It is recorded here also in the Middle South Atlantic and off South Africa in waters of temperature and salinity as mentioned above. Although it did not usually occur in large numbers in our shelf waters, the results of the "Great Barrier Reef" Expedition (Farran 1949, p. 296), of Fleminger (1959, p. 154) for the Gulf of Mexico and of Bainbridge (1960, tab. 1) for the Gulf of Guinea show that this copepod prefers shelf waters with an influence of oceanic water.

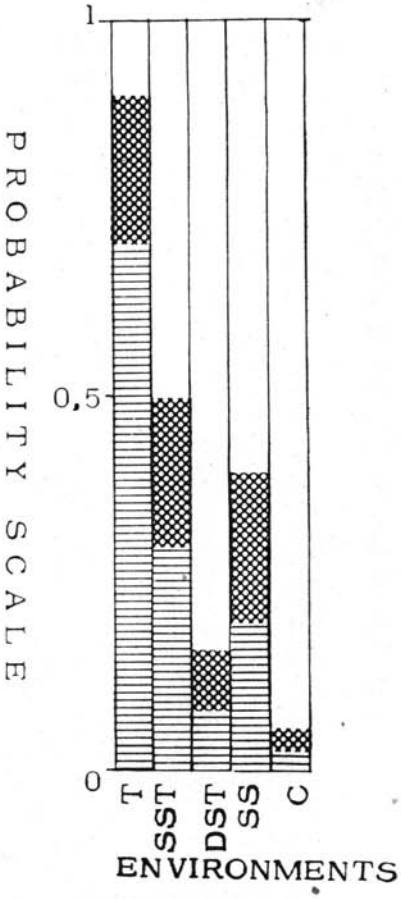

Fig. 7 — Probability of occurrence of *Undinula vulgaris* in different environments.

Calanoides carinatus (Kröyer)

(Fig. 8)

SIZE — ♀ 1.6-2.5 mm; ♂ 2.5 mm.

OCCURRENCE — M 395 (1), M 389 (Pr.), M 238 (140), M 236 (402), M 100 (3), M 95 (Pr.), M 89 (11), M 88 (109), M 78 (2), M 75 (6), M 38 (7), M 36 (1), M 33 (1), E 5 (1)*, V 19 (360)*, V 2 (Pr.), V 1 (Pr.).

ECOLOGY — In two samples it was one of the most numerous copepods in coastal surface waters (14.38-15.40°C) of low salinity.

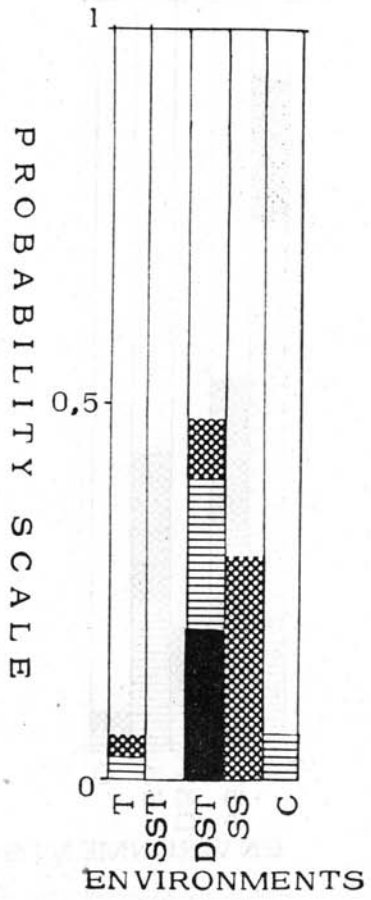

Fig. 8 — Probability of occurrence of *Calanoides carinatus* in different environments.

In the other samples it was sometimes quite numerous especially in deeper waters (V 1, V 19). Farran (1926, p. 229) and Vervoort (1946, p. 35) mention it as occurring in deep waters in tropical and subtropical regions and the first considers it as a deep water species in the Bay of Biscay. As our hauls were nearly always on the surface, it was present only in a few samples. All the other samples in which it occurred were of water layers of high salinity (36.8-35.0 ‰) and temperatures between 22.8 and 16.4° C. These water layers show the approximate limits of temperature and salinity of the subtropical water mass (Emilsson 1959, p. 46). It was frequently observed in African waters off the Atlantic coast of Angola (Marques 1958, p. 205) in salinities around 35.5 ‰ and temperatures usually under 20°C (Vilela 1953, tab. 4-7). It was exceptionally abundant in African waters on the edge of the shelf in the Gulf of Guinea (Bainbridge 1960, tab. 1) in catches made through layers of water with temperatures under 21°C (Bainbridge, personal information). *C. carinatus* seems to have the same salinity preferences as *N. minor*, but while the latter species seems to prefer superficial layers and appears also in warmer waters, *C. carinatus* prefers the deeper and cooler layers of the shelf waters in the subtropical region (Fig. 8). Both occur in the cold coastal, surface waters of the south, *N. minor* sparingly and *C. carinatus* as one of the dominant species of copepods. This species is the dominant copepod in the colder waters (around 12°C) of the upper 50 m of the epipelagial near the southern subtropical convergence line (Vervoort 1957, p. 29). Its occurrence in southern Brazilian cold coastal and deep shelf waters is evidence of the influence of the cold current of the South (Falklands Current).

Fam. Eucalanidae

Eucalanus attenuatus (Dana)

SIZE — ♀ 4.5 mm; ♂ 3.0 mm.

OCCURRENCE — M 403 (1), M 394 (Pr.), M 368 (Pr.), M 364 (Pr.), M 363 (4), M 247 (1), M 240 (2), M 187 (1), M 173 (1), M 113 (1), M 88 (1), M 78 (1).

ECOLOGY — It was usually found in water over great depths in salinities between 35.00 and 36.00 °/₀₀ and temperatures from 27°C to 18.2°C and also in one sample of very cold and less saline water from the South (M 88).

It always appeared in small numbers excepting in one sample in which it represented 6.2% of the total number of copepods.

It had been previously recorded off Rio de Janeiro (Farran 1929, p. 218), off Santos and Guaratuba (Carvalho 1944, p. 91; 1952, p. 140) and off the Atlantic coast of Africa. The present data enlarge its distribution considerably.

It is considered by Deevey (1952a, p. 90) as an indicator of the off-shore waters of high salinity from the Gulf Stream. It occurs in the Brazil Current but probably at greater depths for it was captured several times at night or in the early morning, suggesting that its presence in surface layers might be due to vertical migration.

In the colder subtropical waters off South Africa and in the southern mid-Atlantic it is sometimes substituted by *E. mucronatus*.

In the Pacific open-sea waters off the South American coast, off the Philippines and off Hawaii (Wilson 1950, p. 207-208) it occurred in waters of salinities between 32.00 and 35.5 °/₀₀. It was recorded in the cold waters of the Bering Sea. Farran (1929, p. 218) found large numbers of this copepod in the South Temperate Atlantic. It was frequently the most numerous calanoid copepod between 30 and 60 m depth in the collection of the "Snellius" Expedition made in the Indo-Pacific (see Vervoort's data 1946, p. 96-97). It was usually absent in the surface layer and in the deeper layers where it sometimes occurred, but singly. The salinities of the 50 m deep layers sampled by the "Snellius" showed a temperature average of approximately 25.5°C (ranging from 28.7 to 24.54°C) and a salinity average around 34.4 °/₀₀ (ranging from 33.03 to 34.60 °/₀₀). Thus, as a true eucalanid, this species prefers the middle and lower salinities in the off-shore waters. This explains its scarcity in the Brazil Current where the salinity is too high. It is strongly eurythermic, but prefers warmer

waters and thus was not recorded by Heinrich (1961), Vervoort (1957), Furuhashi (1961), Colebrook *et al.* (1961), Fleury (1950), etc., who studied material from colder waters.

Eucalanus subcrassus Giesbrecht

(Fig. 9)

SIZE — ♂ 1.7-2.03 mm; ♀ 2.00-2.25 mm.

OCCURRENCE — M 510 (20)*, M 451 (1), M 389 (480)*, M 368 (Pr.), M 365 (Pr.), M 283 (70), M 265 (690)*, M 246 (1), M 189 (4), M 186 (4), M 173 (14), M 144 (1), M 111 (2), M 107 (Pr.), M 95 (5), M 93 (21), M 89 (3), M 88 (22), M 78 (67), M 76 (57), M 74 (53), M 73 (11), M 39 (140), M 38 (30), M 37 (16), M 36 (28), M 35 (13), M 33 (18), M 32 (50), M 31 (11), M 30 (8), E 164 (Pr.), E 39 (8), E 24 (140)*, E 16 (340)*, E 15 (800)*, E 13 (260)*, E 12 (20)*, E 10 (Pr.), E 8 (2), E 7 (540)*, E 6 (Pr.), E 2 (180)*, E 1 (375), V 1 (600), II 68 (33), III 322 (Pr.).

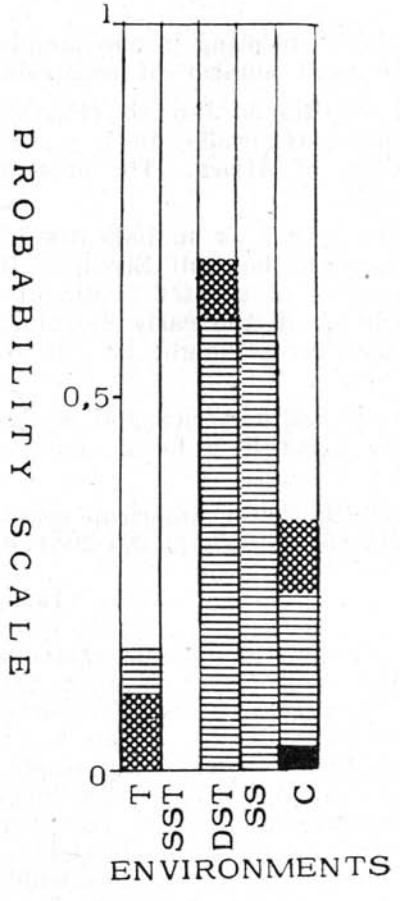

Fig. 9 — Probability of occurrence of *Eucalanus subcrassus* in different environments.

ECOLOGY — In our samples it was usually present in warm coastal water in 11 out of 31 samples, in warm surface shelf water in 8 out of 13 samples. Present also in two cold coastal water samples and in deep cold shelf waters in high percentages. Present only in six out of 31 tropical water open-sea samples. It was absent in surface subtropical waters. Farran (1929, p. 219) had numerous specimens taken off Rio de Janeiro by the "Terra Nova" Expedition and found it "the most plentiful of the larger species" inside the Great Barrier Reef, next to *Undinula vulgaris*, excepting during the cold months of "maximum

salinity of the reef" (Farran 1936, p. 78). This corroborates our data, which show *E. subcrassus* as more numerous in warm coastal waters or in warm shelf waters. It was not present or present in small numbers in tropical and subtropical waters of high salinity. Therefore it may be classified in Brazilian waters as a thermophile eurythermic copepod which is also euryhaline, but prefers middle salinities, between 35.00 and 33.00 ‰. This explains why in the Pacific it is classified as "oceanic" (Yamazi 1958, p. 147), because off Japan open-sea waters have a salinity range between the limits established above.

Eucalanus monachus Giesbrecht

Syn. *E. vadicola* F. Dahl 1894

(Fig. 10)

SIZE — ♂ 2.3 mm; ♀ 2.05 mm.

OCCURRENCE — E 170 (240)*, E 164 (41), E 41 (20)*, E 32 (Pr.), E 30 (Pr.), E 28 (560)*, E 24 (Pr.), E 14 (20)*, E 13 (260)*, E 12 (20)*, E 11 (280)*, E 9 (20)*, E 8 (20), E 7 (160)*, E 4 (180)*, E 3 (920)*, E 1 (75)*, P 10 (10), P 9 (18), P 7 (Pr.), P 3 (Pr.), P 1 (94), V 19 (510)*, V 13 (100), V 1 (100), M 261 (15), M 257 (32), M 208 (1), M 203 (1), M 190 (118), M 107 (16), M 78 (11), M 75 (121), M 39 (2), M 38 (164), M 35 (164), M 37 (3), M 30 (8).

SYSTEMATIC NOTES — F. Dahl recorded *E. vadicola* at the mouth of the Amazon River, characterizing it by a wider and flatter cephalon similar to that of the female of *E. crassus,* second furcal seta stronger than that of the European *E. monachus,* a fatter, not hairy last segment of the fifth pair of legs in the male and a shorter terminal spine than in the European *E. monachus.* Intermediate forms besides the described *E. vadicola* and *E. monachus* are present in the samples from coastal waters.

ECOLOGY — Apparently *E. monachus* is a very variable species which prefers coastal or shelf waters of salinities below 35.00 ‰. The samples in which it showed up always contained a water layer of salinities under 34.5 ‰ and temperatures between 29°C and 20°C. It was registered in 17 out of 31 samples of coastal water and in 5 out of 13 samples of surface shelf water. Bainbridge (1960, tab. 1) registered it in large numbers in the shelf waters of the Guinea Gulf. *E. monachus* and *E. subcrassus* are both characteristic of the neritic zone off the Brazilian coast and are among the species on which the coastal plankton-eating fishes feed (Table XII, p. 116).

Fig. 10 — Probability of occurrence of *Eucalanus monachus* in different environments.

The Eucalanidae are probably an important constituent of the biomass present in our waters because of their great bulk. Fishes like 'oveva' (*Larimus breviceps* Cuvier) and 'corvina' (*Micropogon furnieri* Desmarest) have large numbers of *Eucalanus* in their stomachs, but usually not sufficiently well preserved so as to determine whether they are *E. subcrassus* or *E. monachus* (Table XII, p. 116).

Other species of *Eucalanus*

The following *Eucalanus* also occurred in the samples: one specimen of *E. elongatus* (Dana) in one sample (M 36); *E. subtenuis* Giesbr. in sample M 188 (4) and in sample M 389 (2); and *E. crassus* Giesbr. in four samples: M 33 (2 females); M 35 (1); M 36 (2); M 78 (13 specimens, among which adult females, males and copepodites).

These species were all found in shelf and subtropical waters. Off Brazil the Eucalanidae excepting *E. attenuatus*, seem to prefer the shelf and coastal waters and avoid the very saline waters of the open sea. This agrees with Fleminger (1959, p. 154) who considers *E. pileatus* as characteristic, together with *Paracalanus parvus*, of the neritic slope-facies in the Gulf of Mexico. In the Pacific, where the open sea waters are less saline (more or less 35.5 ‰) they are also found far from the coast (see Wilson 1950, p. 207-211; Yamazi 1958, p. 147; Vervoort 1946, p. 85-115). *E. pileatus* was registered by Bainbridge (1960, tab. 1) in large numbers in waters over the shelf in the Gulf of Guinea. It is probably a variety of *E. subcrassus* and is cited by some authors (Deevey 1960, p. 16-33) as *E. pileatus-subcrassus*.

E. elongatus is according to Farran's (1949, p. 218), Kusmorskaya (1959) and Wilson's (1950, p. 208-209) data an euryhaline

and eurythermic cryophile open-sea copepod. Vervoort (1946, p. 85) registered *E. elongatus* in maximum numbers in 60 to 100 m depth layers in the Indo-Pacific, where temperatures are more or less between 20 and 25°C and salinities around 34.00 °/₀₀ (Van Riel *et al.*, 1950). It endures narrower salinity ranges than *E. attenuatus* and is therefore generally absent from our open sea waters.

The species of *Rhincalanus*

Schmaus & Lehnhofer (1927, p. 392) summarized the known data on the distribution of the species of *Rhincalanus* (*R. cornutus, R. nasutus, R. gigas*) in the Atlantic and in the Indian Oceans. The study of Wilson's (1950, p. 318-319) and Farran's data (1929, p. 220) of samples taken in the Pacific Ocean show that the same distribution prevails there, with the difference that in the warmer months, *R. cornutus* reaches well into the Bering Sea, above 50° N Lat., further north than in the Atlantic. Farran (1929, p. 220) and Vervoort (1957, p. 33) registered the largest numbers of *R. nasutus* off the New Zealand and Australian waters where the salinity is around 35.5 °/₀₀ and the temperature around 15 and 10°C. The salinities in which *R. cornutus* and *R. nasutus* occurred in the Pacific were sometimes as low as 33.00 °/₀₀ probably.

R. cornutus and *R. nasutus* seem to prefer open-sea waters (Farran 1936, p. 79) also off Brazil. *R. cornutus* is the most eurythermic of the two and the less cryophile.

Rhincalanus cornutus (Dana)

SIZE — ♂ 2.5 mm; ♀ 3.5 mm.

OCCURRENCE — M 497 (Pr.), M 368 (Pr.), M 365 (200)*, M 283 (1), M 246 (12), M 245 (1), M 240 (1), M 232 (1), M 113 (1), M 95 (1).

DISTRIBUTION — It occurred in samples of waters of high temperature (25.5-28°C) and high salinity (more than 36.16 °/₀₀) and in one shallow water sample where the deepest layer showed higher salinity in the region of the Amazon River's mouth. The samples were mostly from tropical waters. Dahl (1894, p. 3) registered it off the mouth of the Tocantins, but not further south off the Brazilian coast. Vervoort (1946, p. 121) found it in samples taken from 2,500 to 0 m, usually in mid-water layers. The larger numbers of *R. cornutus* were registered by him between 60 and 200 m depths, in salinities around 34.50 °/₀₀ and temperatures between 16.0 and 26.6°C approximately.

Rhincalanus nasutus Giesbr.

SIZE — ♀ 4.5 mm.

OCCURRENCE — M 80 at 27°09.4' S and 47°16.5' W on September 26th, 1955 (12.40 h).

ECOLOGY — It only occurred in sample M 80, which was not included in the general list, with salinities between 36.01 to 35.24 ‰ and temperatures from 14.01 to 20.99°C. The fact that it usually occurs in deeper layers and does not migrate apparently during the day (Vervoort 1946, p. 126) explains its rare presence in our samples. It had not been previously recorded in Brazilian waters. The haul was made with a closing net from 125 m depth up to the surface, and the animal was probably swimming in the deeper layer when caught.

Thus *Rhincalanus nasutus*, contrary to Steuer's (in Sewell 1948, p. 365) idea, occurs in the western part of the South Atlantic, but probably in deep cooler layers.

Mecynocera clausi I. C. Thompson

(Fig. 11)

SIZE — ♀ 1.0 to 1.1 mm.

OCCURRENCE — M 510 (1), M 497 (2), M 451 (Pr.), M 409 (41), M 407 (4), M 403 (164), M 402 (160), M 400 (Pr.), M 395 (108), M 394 (1080)*, M 368 (3), M 365 (400)*, M 364 (240)*, M 363 (Pr.), M 315 (48), M 314 (7), M 247 (2), M 246 (7), M 245 (1), M 244 (2), M 243 (1), M 242 (2), M 241 (3), M 240 (16), M 236 (1), M 208 (1), M 189 (24), M 187 (1), M 186 (2), M 173 (1), M 166 (1), M 163 (116), M 162 (77), M 161 (327), M 160 (74), M 114 (11), M 113 (6), M 112 (4), M 99 (14), M 97 (1), M 96 (1), M 78 (7), M 76 (3), M 74 (1), M 39 (2), M 36 (3), M 35 (4), M 31 (3), P 13 (Pr.), P 12 (7), P 11 (3), P 10 (4), P 9 (6), P 8 (Pr.), P 7 (5), P 6 (1), P 5 (Pr.), P 4 (5), P 3 (2), P 2 (15), P 1 (Pr.), E 4 (1), E 3 (8).

ECOLOGY — It was present in nearly all samples of the most saline and warm waters off Brazil. It was found in higher percentages (20.7-4.7%) in colder very saline waters (36.00 ‰ or more) and in cool coastal waters with 22°C temperature or less. It had been registered in Brazilian waters before (Carvalho 1952, p. 137). Farran (1929, p. 221) and Heinrich (1960,

p. 33) found its largest numbers in subtropical waters in the Pacific in the latitudes above 30° S and in temperatures between 21°C and 15°C (Sverdrup *et al.* 1948, chart II and III). It is considered by Deevey (1952, p. 90) as characteristic of the Gulf Stream and of warm waters (Deevey 1952b, p. 156). It also occurs on the south African side of the Atlantic, where it was among the most frequent and abundant copepods in subtropical waters (Table X). It is a surface copepod, because it did not occur in the samples collected in deep layers and its environmental optimum lies in cooler temperatures between 18 and 10°C (Fig. 11).

Heinrich (1961, p. 83, tab. 1) found it in large numbers off southern Japan in the 25-30 m deep layers during the day. During the night it was caught in deeper layers from 50 to 200 m. It is not usually found at the surface (20-0 m) probably because the 18 to 10°C optimum of temperature is found in deeper layers in that region.

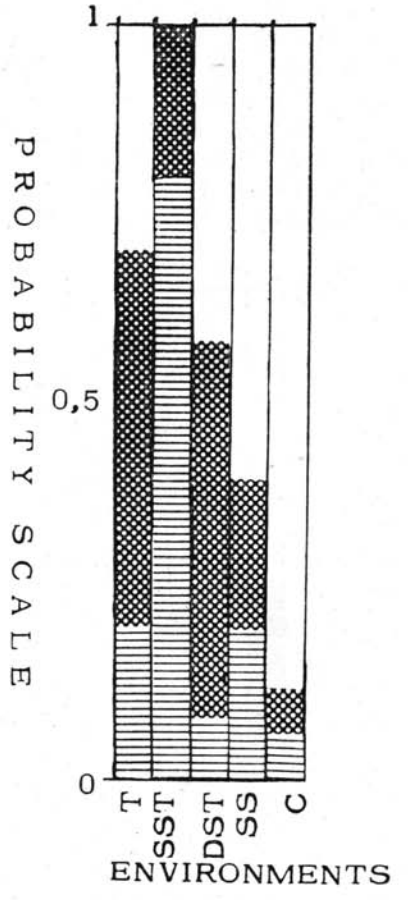

Fig. 11 — Probability of occurrence of *Mecynocera clausi* in different environments.

Fam. Paracalanidae G. O. Sars

According to Hensen (1911, p. 307) *Paracalanus* must be chiefly neritic for it made up almost half of the total of the Tocantins region copepod fauna.

Paracalanus aculeatus Giesbr.

(Fig. 12)

SIZE — ♂ 1.2-1.0 mm; ♀ 1.2 mm.

OCCURRENCE — M 513 (300)*, M 510 (29), M 489 (60)*, M 451 (6), M 407 (Pr.), M 400 (89), M 389 (80)*, M 365 (160)*, M 283 (7), M 265 (3), M 257 (2), M 247 (292), M 246 (4),

M 245 (2), M 244 (23), M 241 (4), M 240 (32), M 236 (177), M 208 (1), M 190 (157), M 189 (223), M 188 (10), M 173 (6), M 160 (6), M 114 (11), M 112 (2), M 107 (16), M 99 (7), M 98 (62), M 97 (6), M 96 (2), M 95 (17), M 93 (6), M 88 (9), M 78 (51), M 75 (31), M 74 (20), M 73 (5), M 39 (6), M 38 (57), M 37 (16), M 36 (52), M 35 (165), M 33 (7), M 31 (6), M 30 (18), II 68 (62), P 17 (Pr.), P 15 (Pr.), P 14 (Pr.), P 13 (39), P 12 (212), P 11 (19), P 10 (31), P 9 (53), P 8 (Pr.), P 7 (11), P 6 (18), P 5 (14), P 4 (22), P 3 (8), P 2 (140), P 1 (11), E 170 (180)*, E 164 (72), E 41 (60)*, E 39 (1660)*, E 32 (40)*, E 30 (160)*, E 28 (3740)*, E 24 (120)*, E 16 (3380)*, E 15 (4860)*, E 14 (300)*, E 13 (500)*, E 12 (3500)*, E 11 (1200)*, E 10 (1040)*, E 9 (35), E 8 (5), E 7 (900)*, E 5 (880)*, E 4 (17), E 3 (380)*, E 2 (11), V 13 (60)*, V 3 (Pr.), V 2 (Pr.), V 1 (Pr.), III 320 (2), III 321 (4), IV 218 (2).

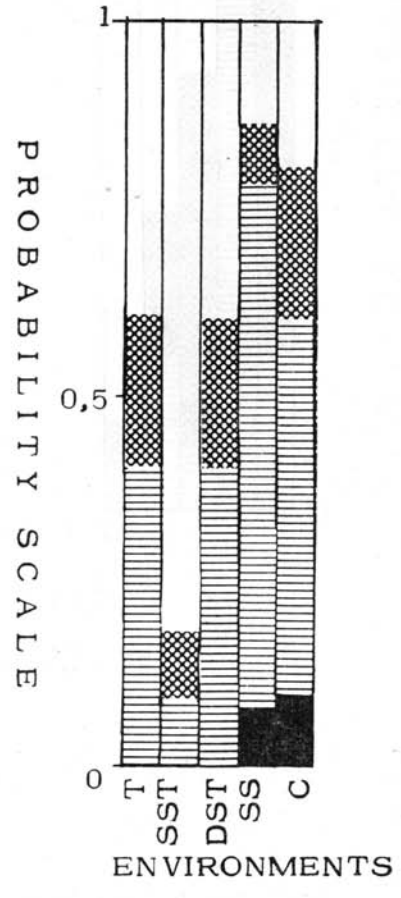

Fig. 12 — Probability of occurrence of *Paracalanus aculeatus* in different environments.

ECOLOGY — It was one of the most frequent, though not numerous copepod in samples of water of high salinity (above 36.00 ‰) and high temperature (above 20°C). In samples of high salinity and low temperatures (less than 20°C) it was not very frequent. It was present in samples from surface layers of low salinity (under 35.00 ‰) and temperatures ranging from 18 to 28°C. It was dominant or subdominant among the copepods in coastal and shelf waters of low salinity. It was registered before off Rio de Janeiro and at the mouth of the Tocantins (Vervoort 1946, p. 129). Farran (1929, p. 222; 1949, p. 297) recorded the largest numbers of this copepod in the tropical region. It seems to prefer surface and coastal or shell waters off Brazil. It is an eurythermic thermophile copepod.

Paracalanus parvus (Claus)

(Fig. 13)

SIZE — ♂ 1.0-0.95 mm; ♀ 0.75-1.1 mm.

OCCURRENCE — M 497 (11), M 365 (240)*, M 315 (232), M 314 (6), M 286 (10), M 283 (10), M 265 (6), M 208 (71), M 203 (1), M 190 (1), M 188 (136), M 186 (2), M 173 (45), M 163 (27), M 162 (882), M 161 (1), M 107 (4), M 89 (102), M 88 (60), M 76 (6), M 75 (43), M 74 (151), M 73 (16), M 38 (25), M 37 (1), M 35 (25), M 31 (5), M 30 (5), P 14 (Pr.), P 13 (7), P 12 (55), P 11 (2), P 10 (10), P 9 (59), P 8 (Pr.), P 7 (8), P 6 (1), P 5 (Pr.), P 4 (Pr.), P 3 (Pr.), P 2 (2), P 1 (10), E 170 (60)*, E 164 (2), E 39 (680)*, E 28 (220)*, E 15 (140)*, E 12 (80)*, E 11 (100)*, E 9 (12), E 7 (60)*, E 5 (2820)*, E 4 (380)*, E 3 (10,900)*, E 2 (908)*, E 1 (3450)*, V 19 (3150)*, V 13 (260)*, V 1 (340), II 68 (113), IV 244 (53), III 320 (8), III 321 (31).

ECOLOGY — *P. parvus* was dominant in four samples where the salinities varied from 36.19 to 34.11 ‰ and the temperatures from 27.5 to 17.76°C. It is possible that this small copepod was not more numerous in more samples because it may pass through the meshes of the zooplankton net. *P. parvus* only occurred in one sample from exclusively warm layers. In all samples where it was dominant there were layers of colder water where the copepod probably thrived. It was found in large numbers among the copepods of a sample of coastal relatively very cold water (14.38°C) from the south of Brazil. It has been recorded in the Atlantic, Pacific and Indian Ocean and also in the Arctic and

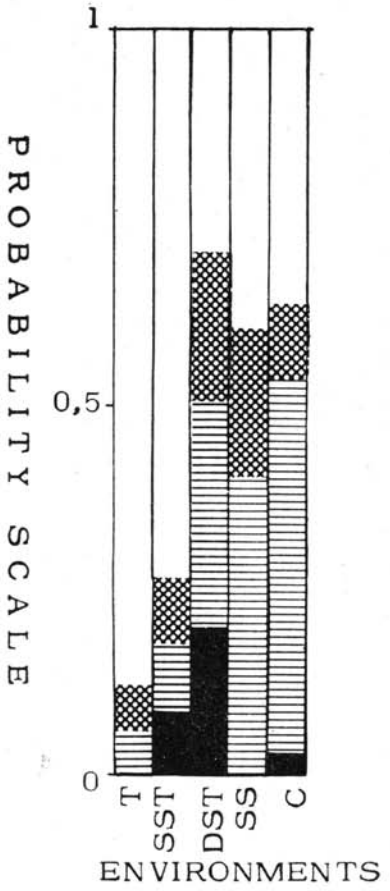

Fig. 13 — Probability of occurrence of *Paracalanus parvus* in different environments.

Antarctic regions (Vervoort 1946, p. 131) in oceanic, coastal and brackish waters. It can be found in deep waters but prefers the surface (Vervoort 1946, p. 132) though in our samples it appeared in larger frequency and number in deep shelf waters (Fig. 13). It seems to prefer cooler temperatures, while *Paracalanus aculeatus* seems to prefer warmer waters as is also pointed out in Farran's study (1949, p. 297) of Australian waters. Like *Clausocalanus arcuicornis* it is abundant in the North Atlantic where it may indicate Atlantic waters (Wiborg 1954, p. 68). In the African waters near Fernando Po (Bainbridge 1960, tab. 1) it was subdominant in the shelf-oceanic facies.

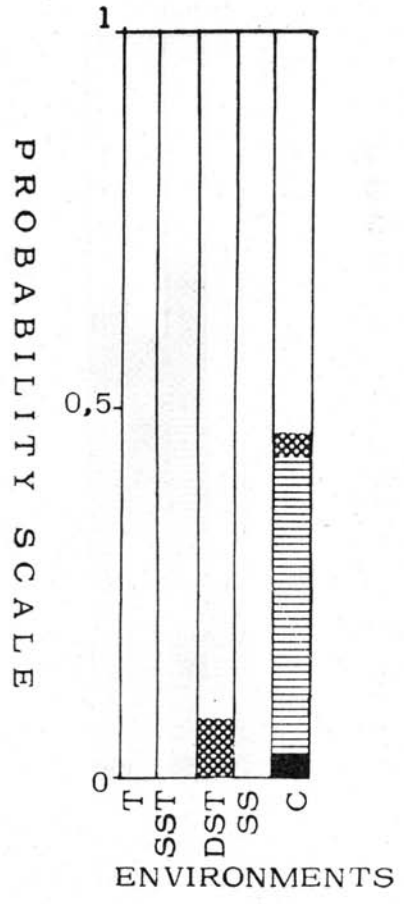

Fig. 14 — Probability of occurrence of *Paracalanus crassirostris* in different environments.

Paracalanus crassirostris Dahl

(Fig. 14)

SIZE — ♀ 0.5 mm; ♂ 0.5 mm.

OCCURRENCE — M 283 (9), M 238 (3), M 208 (10), M 203 (108), E 39 (4540)*, E 32 (60)*, E 30 (120)*, E 28 (1320)*, E 14 (60)*, E 13 (20)*, E 12 (1360)*, E 10 (740)*, E 8 (2), E 7 (22), E 5 (560)*, E 4 (800)*, II 68 (191), III 322 (29), III 321 (117), III 320 (Pr.), IV 244 (37), IV 218 (60).

ECOLOGY — It is a well known coastal water copepod. Table IV summarizes the data obtained in several regions of the world. In Brazilian waters it was observed only in coastal or mixed coastal and shelf waters and once in deep shelf waters near the coastal region (Table XV).

It occurs in waters from salinities 55.00 ‰ in the Suez Canal (Gurney 1927, p. 147) to 3.4 ‰ in the Chilka Lake (Devasundaram & Roy 1954, p. 53), and in temperatures between 1 and 30°C. It is extremely eurythermic and euryhaline, but stenoecius and therefore a good "indicator" species of coastal waters.

Calocalanus pavo Dana

(Fig. 15)

SIZE — ♀ 1.2-0.65 mm.

OCCURRENCE — M 513 (12), M 510 (4), M 497 (44), M 489 (2340), M 451 (40), M 409 (1), M 403 (40), M 400 (11), M 394 (40), M 389 (Pr.), M 368 (2), M 363 (Pr.), M 314 (Pr.), M 247 (45), M 246 (50), M 244 (37), M 243 (21), M 242 (11), M 241 (38), M 240 (22), M 232 (120), M 190 (4), M 163 (6), M 162 (6), M 161 (10), M 160 (14), M 113 (1), M 112 (2), M 111 (1), M 100 (2), M 98 (11), M 97 (1), M 96 (1), M 95 (Pr.), M 75 (7), M 74 (6), M 39 (6), M 38 (21), M 37 (1), M 36 (3), M 35 (15), M 33 (3), E 41 (2).

ECOLOGY — This species was never dominant among the copepods of the samples examined here, though present in large numbers, generally in salinities above 36.00 °/₀₀ and temperatures above 25°C. Its numbers diminished or it disappeared completely in samples of the same salinities but with temperatures under 25°C. It occurred in small numbers in some samples where the salinities were under 36.00 °/₀₀ and the temperatures under 26.3°C. Thus it seems that this species prefers waters of high salinity and high temperature off Brazil. It did not occur in deep waters. In the Pacific (Wilson 1950, p. 179) it was found only in less saline tropical waters, but also in the cold waters of the Bering Sea, though rarely. Its maximum numbers in the Pacific were found at 0° Lat. and between 30 and 40° S (Heinrich 1960, p. 33). Though recorded in the western south Atlantic (Sewell 1948, p. 450), it had not been found off our southern coast.

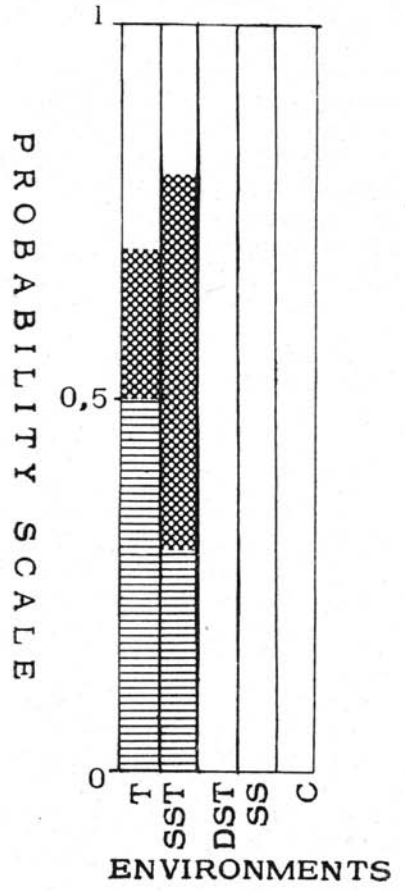

Fig. 15 — Probability of occurrence of *Calocalanus pavo* in different environments.

Calocalanus styliremis Giesbr.

SIZE — ♂ 0.65 mm; ♀ 0.6-0.7 mm.

OCCURRENCE — M 513 (12), M 510 (20)*, M 497 (34), M 489 (300)*, M 451 (60)*, M 407 (1), M 402 (40)*, M 400 (16), M 394 (40)*, M 389 (120)*, M 368 (2), M 365 (Pr.), M 364 (240), M 363 (Pr.), M 315 (107), M 314 (47), M 232 (40)*, M 208 (5), M 190 (5), M 187 (Pr.), M 100 (Pr.), M 96 (1), M 78 (3), M 75 (7), M 74 (6), M 39 (6), M 38 (21), M 36 (3), M 35 (20), M 33 (3), E 41 (40), E 24 (Pr.), P 10 (Pr.).

REMARKS — A very small species, usually caught by the nets of finer meshes. Registered off the Brazilian coast for the first time.

It occurred in samples of oceanic water of high salinity (above 36.00 ‰) and temperatures above 18°C, but Farran (1929, p. 222) found the largest numbers of this species in cooler waters 15 to 21°C, according to Sverdrup *et al.* 1942, charts II and III. Yamazi (1958, p. 148) registers it as an oceanic, tropical species in Japanese waters. Wilson (1950, p. 180) found it in the Pacific Ocean, but it was less frequent than *C. pavo* perhaps because the nets used had larger meshes.

Calocalanus plumulosus (Claus)

Syn. *Calocalanus tenuis* Farran

SIZE — ♀ 0.9 mm.

OCCURRENCE — M 513 (180)*, M 510 (40)*, M 497 (271), M 489 (420)*, M 451 (140)*, M 402 (160)*, M 400 (18), M 389 (360)*, M 365 (200), M 364 (360)*, M 363 (Pr.), M 315 (Pr.), M 314 (15), M 238 (1), M 232 (2), M 208 (1), M 203 (1), M 189 (1), M 166 (Pr.), M 163 (2), M 162 (Pr.), M 114 (1), M 97 (1), M 88 (1), M 75 (4), M 74 (2), M 73 (2), M 38 (2), E 8 (29), E 4 (1), II 68 (5), III 320 (1).

REMARKS — Recorded here for the first time from Brazilian waters and probably quite common, but not usually caught by the nets of larger meshes because of its small size. It seems to prefer oceanic waters and cooler temperatures (see Farran 1929, p. 223). Both *C. styliremis* and *C. plumulosus* were registered in shelf and slope waters off the North American coast (Grice & Hart, 1961). Heinrich (1961, tab. 2) found it concentrated in the surface layer at night and during the day in the 15-100 m layer or deeper between 23 and 35° N and 144 and 150° W Long.

The *Acrocalanus* species

The genus *Acrocalanus* has 5 species. Only one was identified with certainty in our samples *Acrocalanus longicornis* Giesbr.

Acrocalanus longicornis Giesbr.

SIZE — ♂ 0.95-0.8 mm; ♀ 1.1 mm.

OCCURRENCE — M 497 (16), M 489 (120)*, M 451 (20)*, M 407 (5), M 368 (3), M 365 (40)*, M 364 (80)*, M 363 (1), M 315 (15), M 314 (6), M 247 (3), M 246 (41), M 245 (37), M 244 (11), M 243 (18), M 242 (38), M 241 (195), M 240 (94), M 232 (40), M 190 (1), M 160 (6), M 114 (1), M 113 (3), M 100 (2), M 99 (22), M 98 (38), M 97 (12), M 95 (Pr.), M 78 (4), M 76 (6), M 75 (6), M 74 (77), M 73 (42), M 38 (25), M 37 (15), M 36 (8), M 35 (13), M 33 (2), M 32 (1), M 31 (3), P 10 (57).

ECOLOGY — It occurred in samples of very warm and very saline waters (salinities above 36.00 ‰ and temperatures above 25°C). It diminished in frequency and percentage in colder very saline waters (temperatures under 25°C). It was not present in samples from colder (under 20°C) or deep water layers. It was present in samples from coastal waters. *A. longicornis* and *A. gracilis* are surface copepods and the first is an euryhaline, thermophile species. In the Pacific where very warm open-sea waters show smaller salinities it is a constant member of the copepod association. The genus is represented there by three or more species: *A. gibber, A. monachus, A. gracilis, A. longicornis* (Wilson 1950, p. 368-369; Scott 1909, p. 28-30). Off our coast it seems to prefer higher salinities. In the subtropical North-West Pacific *A. longicornis* prefers the surface, excepting near midday when it concentrates in layers 10-100 m deep (Heinrich 1961, tab. 2).

Fam. Pseudocalanidae

Clausocalanus furcatus (Brady)

(Fig. 16)

SIZE — ♂ 0.85 mm; ♀ 1.25-1.75 mm.

OCCURRENCE — M 513 (720)*, M 510 (560)*, M 497 (683), M 489 (18,480)*, M 451 (1740)*, M 409 (227), M 407 (34), M 403 (1840), M 402 (2440)*, M 400 (8), M 395 (51), M 394

(11,920)*, M 389 (2440)*, M 368 (21), M 365 (70), M 364 (116), M 363 (109), M 315 (478), M 314 (108), M 247 (361), M 246 (328), M 245 (145), M 244 (454), M 243 (95), M 242 (102), M 241 (259), M 240 (125), M 232 (760), M 208 (80), M 190 (446), M 189 (219), M 188 (1042), M 187 (441), M 186 (22), M 173 (23), M 166 (513), M 163 (6), M 160 (274), M 114 (13), M 113 (67), M 112 (2), M 107 (51), M 100 (93), M 99 (474), M 98 (1557), M 97 (130), M 96 (57), M 95 (38), M 93 (315), M 78 (107), M 76 (107), M 75 (474), M 74 (499), M 73 (10), M 39 (40), M 38 (335), M 37 (315), M 36 (279), M 35 (268), M 33 (34), M 32 (13), M 31 (6), M 30 (11), E 170 (20)*, E 164 (30), E 41 (20)*, E 24 (20)*, E 16 (120)*, E 15 (2880)*, E 14 (30)*, E 13 (2000)*, E 12 (100)*, E 11 (3020)*, E 8 (3), E 7 (97), E 4 (20)*, E 3 (1060)*, P 13 (6), P 12 (5), P 11 (4), P 10 (14), P 9 (4), P 7 (1), P 5 (1), P 4 (18), P 3 (4), P 2 (26), V 13 (20)*, V 3 (Pr.), II 68 (31).

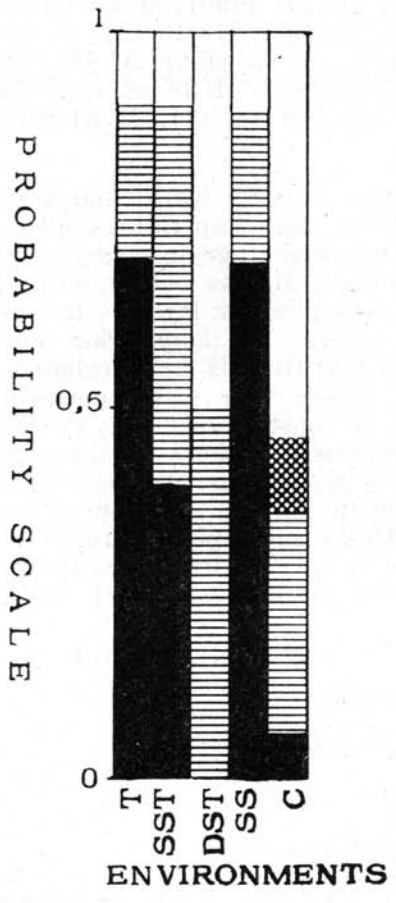

Fig. 16 — Probability of occurrence of *Clausocalanus furcatus* in different environments.

ECOLOGY — The present study reveals this species as one of the most numerous in our high salinity surface waters, but it also occurs in all other environments studied here. It is usually the dominant species among the copepods of waters of more than 35.00 ‰ salinity and 25°C temperature. The histogram shows it to be dominant also in waters of lower temperatures (under 25°C), but the number of samples in which it occurs in highest numbers diminishes with the temperature. Fleminger (1959, p. 154) considered the oceanic shelf facies in the Gulf of Mexico as characterized by *Clausocalanus furcatus* and *Undinula vulgaris*. It is a dominant copepod species in Tropical Water of the Brazil Current and of the South Equatorial Current. It indicates the influence of tropical or shelf water on coastal waters when present

in large numbers. The fact that *Clausocalanus* prefers waters of higher salinities explains its smaller frequency in samples from the Pacific (Wilson 1950, p. 190; Heinrich 1961, tab. 2). Kusmorskaya (1960, p. 147, tab. 5) found *Clausocalanus* as one of the most frequent copepods in the N. Atlantic Intermediate Zone. Hensen (1911, p. 308) registered the maximum numbers of *Clausocalanus* during the "Plankton" Expedition in the "Brazilian Coastal Current" and in the mouth of the Tocantins River, off the North of Brazil. It showed the maximum concentration in surface layers during the day in the North West subtropical Pacific (Heinrich 1961, tab. 2).

Clausocalanus arcuicornis Dana

(Figs. 17, 18)

SIZE — ♂ 1.3 mm; ♀ 0.8 mm and 1.5 to 1.65 mm.

OCCURRENCE — M 497 (1), M 409 (1), M 407 (Pr.), M 403 (2480), M 402 (80), M 365 (Pr.), M 363 (1), M 314 (6), M 247 (19), M 246 (8), M 245 (1), M 244 (21), M 242 (9), M 241 (7), M 240 (10), M 363 (1), M 166 (513), M 163 (22), M 161 (890), M 160 (1)*, M 98 (2), M 78 (8), M 75 (5), M 37 (1), M 36 (3), E 1 (50)*.

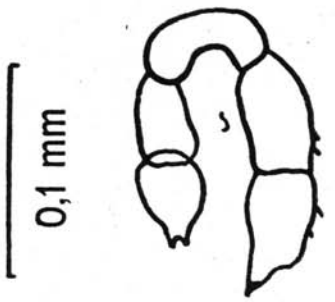

Fig. 18 — *Clausocalanus arcuicornis*: abnormal fifth pair of legs.

SYSTEMATIC NOTES — Both the "major" and "minor" forms were observed in the same sample. In one sample in which the species was very abundant (M 161) the great majority of the specimens belonged to the form "minor". Both forms were mature females with sizes distinctly different (0.8 and 1.65 mm). In sample M 242 one of the specimens showed an abnormal fifth pair of legs (Fig. 18).

ECOLOGY — It was observed (Fig. 16) that while *C. furcatus* prefers warmer waters with salinities above 36.00 ‰, *C. arcuicornis*, stouter than the first when mature, prefers colder waters of slightly lower salinities, around 35.00 ‰ (Fig. 17). Thus it is found in the Gulf Stream (Wheeler 1900, p. 171). It indicates Atlantic water off Norway during Summer and Autumn (Wiborg

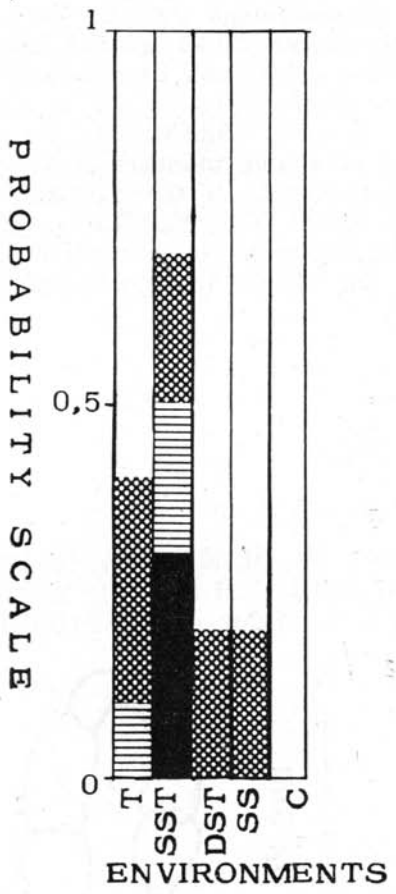

Fig. 17 — Probability of occurrence of *Clausocalanus arcuicornis* in different environments.

1954, p. 167). Kusmorskaya (1959; 1960, p. 147) lists it among the most numerous species of the transition zone between boreal and southern warm water species in the North Atlantic, so it really seems to be a surface species of cool saline waters. Heinrich (1961, tab. 2) registered its greatest numbers by day in the 25-50 m and at night in the 50-100 m depth in the subtropical North Pacific.

In the Pacific it is more frequent than *C. furcatus* (Scott 1909, p. 32; Wilson 1950, p. 190; Brodsky 1957, p. 55; Heinrich 1961, tab. 2) perhaps due to the lower salinities of the waters. It was abundant in South African subtropical oceanic waters and in the same waters in the middle South Atlantic. Vervoort (1946, p. 141) registered *C. arcuicornis* frequently and in larger numbers than *C. furcatus* in the deeper layers (150-300 m) of the Indo-Pacific, where temperatures are between 10 and 18°C and salinities around 34.5 ‰ and (Vervoort 1957, p. 37) also in the surface layers (50-0 m), of 12.6°C and 35.2 ‰ at 44°05' S and 147°35' E in the Pacific.

Ctenocalanus vanus Giesbrecht

(Fig. 19)

SIZE — ♂ 1.25-1.33 mm; ♀ 1.1-1.25 and 1.5 mm.

OCCURRENCE — M 389 (520)*, M 238 (17), M 236 (34), M 208 (20), M 189 (9), M 186 (9), M 173 (25), M 166 (4), M 114 (2), M 89 (112), M 88 (391), M 78 (235), M 76 (215), M 75 (162), M 74 (123), M 73 (48), M 38 (18), M 35 (716),

E 170 (20)*, E 39 (20)*, E 5 (21,600)*, E 4 (1020)*, E 3 (6340)*, E 2 (5960)*, E 1 (2150)*, V 13 (900)*, V 19 (2490)*, V 1 (2520), V 2 (Pr.).

SYSTEMATIC NOTES — *Ctenocalanus vanus* has at least two different forms in our waters — one with longer and one with shorter antennae. It also has a larger and smaller form. The larger is of colder waters.

DISTRIBUTION — *C. vanus* has been reported from the Atlantic, the Pacific, the Antarctic, the Mediterranean and the Red Sea regions (Tanaka 1956, p. 384). It was also recorded in the Western South Atlantic (Sewell 1948, p. 450).

ECOLOGY — This animal occurs in very large numbers in all samples where at least one of the layers fished had salinities ranging from 36.00 to 35.00 °/₀₀ and temperatures under 22°C.

It was listed by Kusmorskaya (1959) as one of the species characteristic of the transition zone between boreal and southern warm water species in the Northern Atlantic. Like some other species listed from this zone, it lives in waters with the salinity and temperature characteristics of the Subtropical Water (Emilsson 1959, p. 46) off the Brazilian coast. It occurs usually in the deeper layers of the waters which cover the continental shelf, but it may appear at the surface too, when this water is upwelled.

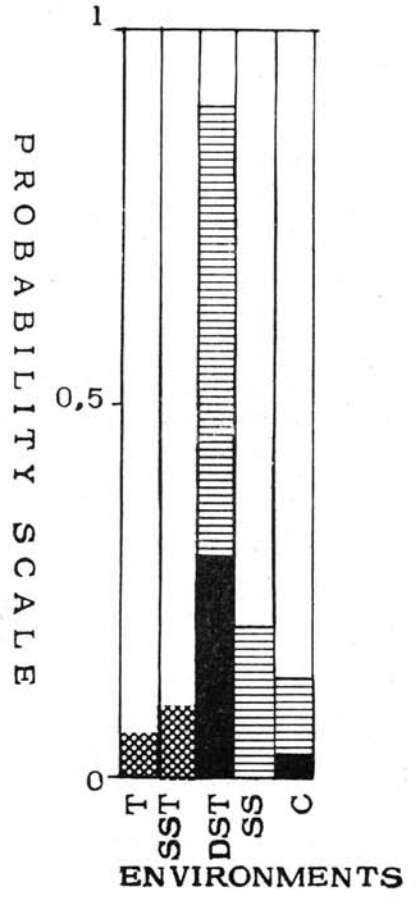

Fig. 19 — Probability of occurrence of *Ctenocalanus vanus* in different environments.

It occurred (Fig. 19) in two samples of low salinity (under 33.22 °/₀₀) and temperatures (15.4 to 14.38°C), in coastal southern waters, and was dominant in the two samples of deep cold shelf water (V 1, V 19). The greatest number of this copepod per haul was taken by the "Terra Nova" Expedition (Farran 1959,

p. 226) in the Antarctic shelf or coastal waters. The fact that Vervoort (1957, p. 37) also registered many specimens of this species during the B.A.N.Z.A.R. Expedition in "waters bordering the Antarctic continent" and not in oceanic waters, shows that it prefers coastal or shelf environments. It is therefore an euryhaline and eurythermic species, but strongly cryophile, a good indicator of colder water off Brazil, though considered as an indicator of warm water in the North Pacific (Brodsky 1950, p. 120).

Fam. Aetideidae

Representatives of this family were rare and unfrequent, but their presence in the samples is important, because being deep water copepods with vertical migration habits they are a proof that a different association lives in deeper layers on the edge of the shelf or just off the shelf, under the waters of the Brazil Current. In the list of species *Aetideid* sp. 1 and *Aetideid* sp. 2 refer to two different males and several females belonging to species of this family. The specimens were rather mutilated and therefore not yet described. They all come from deep layers at the edge of the shelf (sample M 78).

Undeuchaeta major Giesbr.

SIZE — ♂ 3.0-3.5 mm; ♀ 3.5-4.0 mm.

OCCURRENCE — M 161 (1), M 114 (11).

REMARKS — Sample M 161 was collected at the surface (0-50 m) at 23:50 P.M. in 36.26-36.10 ‰ salinity and temperatures between 18.18 and 17.56°C, thus corroborating the observations of the following authors. According to Wolfenden (as in Sewell 1948, p. 512) and Brodsky (1950, p. 183) this is a deep-dwelling species belonging to a "subtropical or warm temperate area". Farran (1926, p. 254) recorded it in the Bay of Biscay in small numbers regularly in the night epiplankton.

Euaetideus giesbrechti (Cleve)

SIZE — ♀ 1.5 mm; ♂ 1.1 mm.

OCCURRENCE — M 395 (1), M 368 (1), M 88 (1), M 78 (2), M 76 (5), M 75 (1).

REMARKS — It is also a deep-dwelling copepod in the Mediterranean Sea (Sewell 1948, p. 507-508) recorded for the first time in Brazilian waters.

Three samples in which it occurred were taken during the night, two of which in the deeper layers of the shelf water (M 78 and M 76) and one (M 75) in the surface layers (0-50 m), thus partially confirming Sewell's observations. It was also present in a sample from cold coastal water (15.40-15.18°C) in the south of Brazil and in a sample taken from very saline and warm water (25.21-24.54°C) during the day. In this sample it is probably a stray from deeper layers.

Euchirella rostrata (Claus)

SIZE — ♀ 3-3.5 mm.

OCCURRENCE — M 166 (18), M 76 (2).

REMARKS — Farran (1926, p. 215) recorded its presence only at 300 fathoms depth or more. According to Sewell (1948, p. 507-508) and Brodsky (1950, p. 174), it is a deep-dwelling copepod. It is registered off the Brazilian coast for the first time in two samples from very saline and from cooler water, taken during the night and in the early morning, suggesting night vertical migration to the surface. M 76 is a sample taken from deeper water (95 to 50 m) over the shelf.

Euchirella brevis Sars

SIZE — ♀ 3.0 mm; ♂ 2.9 mm.

OCCURRENCE — M 247 (6), M 245 (1), M 244 (2).

REMARKS — Recorded for the first time in Brazilian waters. A deep-dwelling species, probably caught at the surface due to its migration to upper layers during the night.

Fam. Euchaetidae

Euchaeta marina (Prestandr.)

(Fig. 20)

SIZE — ♂ 2.8-3.0 mm; ♀ 3.3 mm.

OCCURRENCE — M 513 (180)*, M 510 (120)*, M 497 (38), M 489 (1380)*, M 451 (40)*, M 409 (Pr.), M 407 (4), M 403

(6), M 402 (120)*, M 395 (20), M 389 (Pr.), M 368 (1), M 364 (Pr.), M 363 (3), M 315 (50), M 314 (21), M 247 (248), M 246 (46), M 245 (38), M 244 (79), M 243 (60), M 242 (93), M 241 (9), M 240 (9), M 232 (80), M 163 (3), M 162 (4), M 161 (6), M 160 (1), M 114 (33)*, M 113 (4)*, M 112 (3), M 111 (2), M 99 (2), M 78 (1), M 76 (22), M 75 (5), M 38 (1), M 37 (32), M 36 (13), M 35 (2), M 33 (3).

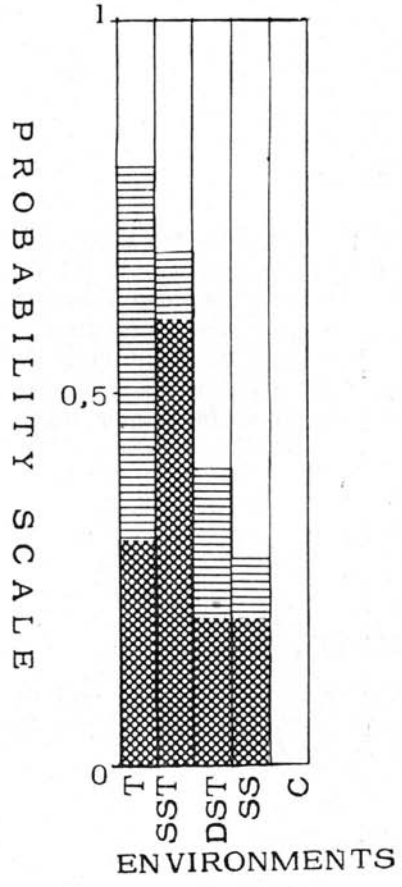

Fig. 20 — Probability of occurrence of *Euchaeta marina* in different environments.

DISTRIBUTION — Already known off the Amazon River's mouth (Dahl 1894, p. 12) off Rio de Janeiro, off Vitória and off the coast of Bahia (Farran 1929, p. 237). It has also been registered off the Atlantic coast of Africa (Marques 1958, p. 210). The present data enlarge its distribution in Brazilian waters to 34°42' S and to 04°57' N.

ECOLOGY — The study of its distribution in the Pacific (Wilson 1950, p. 355-430) shows that *E. marina* occurs frequently not only in waters usually of low salinity (33.00 °/₀₀ off Central America, Colombia and Panama) but also that it is among the frequent copepods in the Bering Sea and off Alaska, where temperatures are usually as low as 7°C. This was not confirmed by Brodsky (1959, p. 116-117) who found *E. marina* to be characteristic of tropical and transition zones in the Pacific (Brodsky 1957, p. 55-56).

The histogram (Fig. 20) shows *Euchaeta marina* as a copepod which prefers warm, very saline waters, therefore thermophile. Deevey (1952b, p. 157) classifies it as a warm water copepod and Farran (1929, p. 237) as a "common tropical species". As it did not occur in coastal waters it is preferentially a shelf oceanic species in Brazilian waters. It occurred in small quantities

or not at all in the samples from deeper layers: therefore a surface copepod. The same has been established by Heinrich (1961, p. 87) in the Pacific: the species only migrates to the 25-100 m layers during the day. At night it lives at the surface.

Euchaeta acuta Giesbr.

SIZE — ♀ 4.5-4.0 mm; ♂ 4 mm.

OCCURRENCE — M 315 (1), M 166 (13), M 161 (15), off the South African Coast.

REMARKS — Rare in our samples this copepod seems to prefer cooler waters (18.44 to 17.56°C) for it is also listed by Kusmorskaya (1959) as one of the species of the transition zone between boreal and southern warm water in the North Atlantic. It was found here for the first time off the South African Atlantic coast. Farran (1929, p. 237) found it sometimes in large numbers off New Zealand and in the Bay of Biscay (Farran 1926, p. 257). *Euchaeta hebes* is another copepod of the same genus which is considered characteristic of temperate waters (Fleury 1950, p. 48), whereas *Paraeuchaeta norvegica* is characteristic of deep and very cold water in the North Atlantic (35.00 ‰ and 7 to 10°C). Bogorov (1958, p. 151) lists *Paraeuchaeta japonica* in boreal waters (3 to 15°C), *E. marina* and *E. acuta* in tropical waters (from 18 to 27°C) in the North Pacific and all three species in the zone of mixing of these waters (15 to 18°C). Bogorov's (1958, p. 150) opinion is that no distinct subtropical fauna exists but our data are against it, confirming Brodsky's (in Bogorov 1958, p. 150) point of view that such an association does exist. *E. acuta* was only found in cooler very saline surface waters off the Brazilian coast and seems to belong to this association in the South Atlantic.

Fam. Scolecithriciidae

Scolecithrix danae (Lubb.)

(Fig. 21)

SIZE — ♀ 2.1 mm; ♂ 1.9 mm.

OCCURRENCE — M 513 (6)*, M 510 (15), M 497 (3), M 489 (2820)*, M 451 (8), M 409 (5), M 407 (23), M 403 (20), M 402 (40)*, M 400 (Pr.), M 395 (17), M 394 (200)*, M 389 (160)*, M 368 (6)*, M 365 (1), M 364 (1), M 363 (1), M 315 (37),

M 314 (28), M 247 (7), M 246 (29), M 245 (39), M 244 (31), M 243 (24), M 242 (18), M 241 (50), M 240 (10), M 232 (40)*, M 166 (3), M 163 (5), M 162 (2)*, M 161 (4), M 160 (4), M 114 (8), M 113 (6), M 112 (3), M 111 (4), M 100 (1), M 99 (10), M 98 (2), M 97 (1), M 95 (5), M 93 (1), M 78 (9), M 76 (1), M 75 (1), M 74 (9), M 38 (1), M 37 (17), M 36 (7), M 35 (4).

DISTRIBUTION — It was registered before off the Brazilian coast between 23°30' S and 01°00' N (Farran 1929, p. 243; Dahl 1894, p. 3). The present study enlarges its distribution to 04°57' N and to 32°24' S off the Brazilian coast.

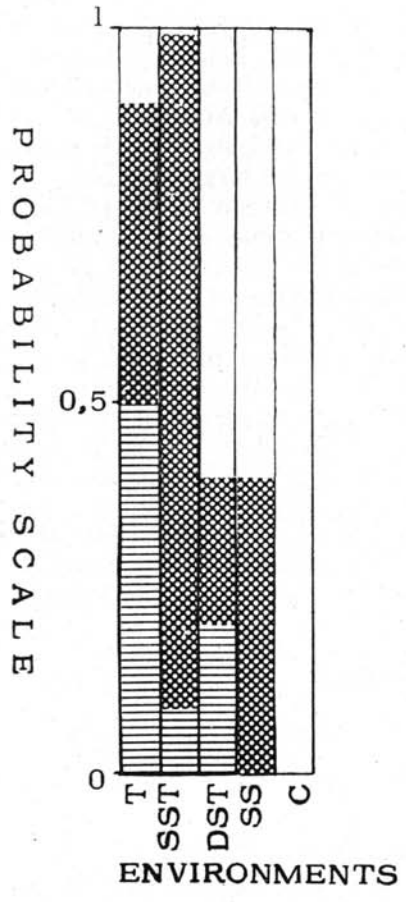

Fig. 21 — Probability of occurrence of *Scolecithrix danae* in different environments.

ECOLOGY — The histogram shows that this animal prefers salinity above 36.00 °/₀₀ and high temperatures (above 25°C) in waters off Brazil. In waters of less than 25°C the number of specimens diminishes. It does not appear in purely coastal waters. The same was verified by Farran (1929, p. 243). Marques (1953, p. 104) registered this species off the African coast of Angola, where the mean August temperature lies between 16 and 20°C (Chart III, Sverdrup *et al.*, 1948). It is found here in 16.51°C and 35.3 °/₀₀ at 32°49.5' S and 16°56' E (Table XVI). Suarez-Caabro (1959, tab. III) recorded this species off Pinos Is. in the Caribbean in waters of temperatures between 25.0 and 29.5°C and salinities from 32.82 to 36.91 °/₀₀. It occurs in the Gulf Stream (Sewell 1948, p. 463) and in the Counter-Equatorial Current (Sewell 1948, p. 457). In the Pacific Ocean this animal occurs in larger numbers in warm equatorial waters where salinities are around 35.5 °/₀₀ and temperatures about 27.5°C on the surface (Heinrich 1960, tab. 2). It is also frequently present in waters with salinities between 32.00 and 34.00 °/₀₀ and temperatures as

low as 7°C in the Bering Sea (Wilson 1950, p. 335) though not confirmed by Brodsky (1957, p. 113-124). It is therefore a copepod which lives in shelf and oceanic waters and may appear in coastal waters. It lives in the 0-100 m deep layer in the North-West subtropical Pacific (Heinrich 1961, p. 87). It is very euryhaline and eurythermic and strongly thermophile off the Brazilian coast. When associated to *Clausocalanus furcatus* and *Corycella gracilis* it is usually indicator of tropical or Brazil Current waters off our coasts.

Scolecithricella dentata (Giesbr.)

SIZE — ♀ 1.2 mm.

OCCURRENCE — M 78 (8), M 76 (1), M 75 (1).

REMARKS — It was registered before at stations 50 and 59 of the "Terra Nova" Expedition in the South Atlantic tropical region by Farran (1929, p. 247). Farran (1926, p. 259) observed that this animal ascends to about 50 m depth during the night and lives at 400 m depth during the day. The present specimens come from a haul taken with a closing-net from 108 to 54 m depth at night (M 78). Its distribution is enlarged here to 25°45.5' S, off the Brazilian coast. It is probably part of the deep-dwelling fauna of the waters on the edge of the shelf.

Lophothrix latipes (Scott)

SIZE — ♀ 3 mm.

OCCURRENCE — M 395 (1 ♀).

REMARKS — This deep-sea copepod (Sewell 1948, p. 546; Brodsky 1950, p. 245) was collected in a haul from 274 m to the surface over a depth of 3,180 m. The salinities of the layers sampled are from 36.04 to 35.53 $^{o}/_{oo}$ and the temperatures are from 20.52 to 14.80°C in the deepest layer (300 m). This animal is here recorded for the first time off the southern coast of Brazil at 33°02' S.

Scaphocalanus curtus (Farran)

Syn. *Scolecithrix curta* Farran, 1926

(Fig. 22)

SIZE — ♂ 0.95 mm; ♀ 1.0 mm.

Fig. 22 — *Scaphocalanus curtus*: Fourth leg.

OCCURRENCE — M 395 (1), M 78 (4), M 76 (2).

REMARKS — Although the animals were not in excellent conditions, they were entire. An accurate drawing of the fourth legs (Fig. 22) was made. They have several groups of spines on the first basipodite. The second joint of the endopodite of the fourth legs also shows two rows of spines. The other anatomical features correspond exactly to the description of Farran (1929, p. 259-260).

ECOLOGY — It is a deep-dwelling copepod and was caught in a haul made with a closing-net between 108 and 54 m in the deeper shelf waters over the slope, with salinities 35.77-35.10 ‰ and temperatures 17.53-12.48°C, therefore subtropical Atlantic water. The animal probably died as the subtropical water was raised over the shelf, as it probably does not live in a shallow habitat. It is an indicator of deep water, registered here for the first time in Brazilian waters.

Fam. Centropagidae

Centropages furcatus (Dana)

(Fig. 23)

SIZE — ♂ 1.6-1.75 mm; ♀ 1.9 mm.

OCCURRENCE — M 389 (520)*, M 283 (11), M 265 (1020)*, M 261 (2), M 257 (52), M 236 (1), M 208 (6), M 203 (1), M 190 (42), M 188 (2), M 187 (1), M 173 (7), M 114 (2), M 107 (5),

M 100 (Pr.), M 95 (1), M 88 (2), M 78 (6), M 76 (12), M 75 (15), M 74 (7), M 73 (13), M 39 (9), M 38 (115), M 36 (9), M 35 (54), M 33 (7), M 32 (2), M 31 (16), M 30 (17), E 170 (100)*, E 164 (18), E 39 (260)*, E 28 (40)*, E 24 (40)*, E 16 (160)*, E 15 (440)*, E 13 (140)*, E 12 (180)*, E 11 (200)*, E 9 (9), E 7 (80)*, E 4 (60)*, E 3 (180)*, E 2 (20)*, E 1 (425)*, II 68 (18), P 13 (22), P 12 (31), P 11 (47), P 10 (17), P 9 (30), P 8 (6), P 7 (41), P 6 (84), P 5 (6), P 4 (34), P 3 (92), P 2 (53), P 1 (79), V 1 (Pr.).

REMARKS — This copepod was recorded off Rio de Janeiro and Cabo Frio by Farran (1929, p. 255); as *Manaia velificata,* off Angra dos Reis, by Oliveira (1947, p. 466); off Santos (Carvalho 1952, p. 145) and off Guaratuba (Carvalho 1944, p. 95).

ECOLOGY — The histogram shows that it is very abundant and usually present in low salinity waters, between 32.00 and 35.00 ‰ and temperature of 20°C or more. It did not appear in the cold very saline surface waters. It appeared sparingly in cold deep layers of the shelf waters and in three samples of very saline and warm tropical waters off Brazil. Yamazi (1958, p. 149) lists it as a warm-water form. It shows a distinct preference for coastal and shelf waters in our samples. Fleminger (1959, p. 154) places it along with *Temora turbinata* as the characteristic copepod of the "coastal neritic facies" in the Gulf of Mexico. Off the southern coast of Brazil it might be placed along with *Temora stylifera* as characteristic of the same facies. Off the African coast it is also very numerous in slope and shelf waters, along with *Centropages chierchiae* (Bainbridge 1960, tab. 1). Off New York, in the same facies it is substituted by *Cen-*

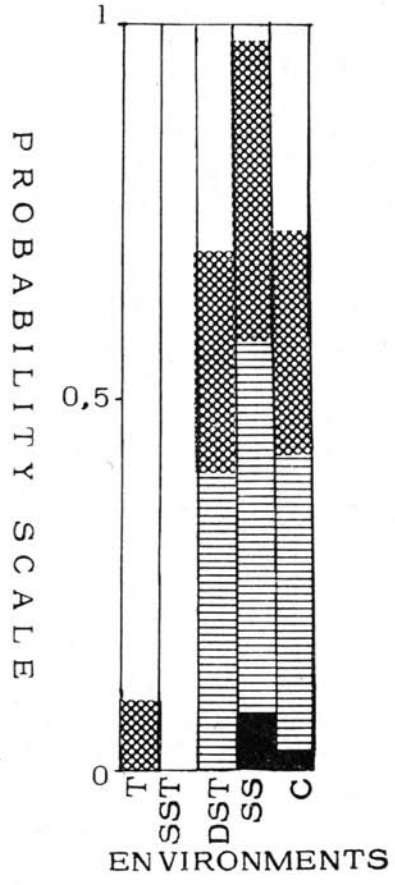

Fig. 23 — Probability of occurrence of *Centropages furcatus* in different environments.

tropages typicus and *Centropages bradyi* (Grice & Hart, unpublished manuscript). It occurs in the tropical and subtropical Pacific (Brodsky 1957, p. 55, p. 69-70).

Centropages violaceus (Claus)

(Fig. 24)

SIZE — ♂ 1.8 mm; ♀ 2.2 mm.

OCCURRENCE — M 497 (3), M 489 (120)*, M 409 (Pr.), M 403 (3), M 402 (40)*, M 394 (Pr.), M 368 (2), M 315 (1), M 247 (1), M 246 (11), M 245 (4), M 244 (7), M 243 (9), M 242 (16), M 241 (6), M 240 (3), M 114 (6), M 99 (4), M 98 (20), M 97 (5), M 38 (1), M 37 (7), M 36 (1), M 33 (2).

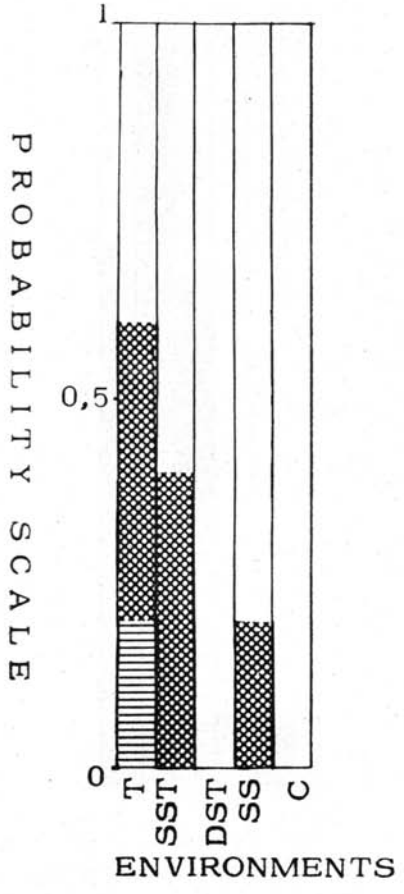

Fig. 24 — Probability of occurrence of *Centropages violaceus* in different environments.

ECOLOGY — It is frequently found off Brazil but not numerously in warm very saline waters, perhaps by migration from deeper layers and is rarer as the water becomes cooler. Farran (1929, p. 255) also recorded its largest numbers in tropical waters. In very saline surface waters with temperatures under 20°C, it occurred only in 3 samples, the same as in samples from shelf waters. Absent in samples taken from deep, cooler waters and in samples from coastal waters off Brazil, but was found in the subtropical waters of the middle South Atlantic and off South Africa. It was registered in the Bering Sea in low temperatures and salinities by Wilson (1950, p. 358-363), but not by Brodsky (1950; 1957).

Centropages brachiatus (Dana)

SIZE — ♀ 1.5 mm; ♂ 1.35 mm.

OCCURRENCE — M 89 (30), M 88 (36).

DISTRIBUTION — It occurred abundantly only in two samples of low salinity (coastal water) and low temperature (under 15.18°C) in large numbers. It seems to be more characteristic of the southern than of the northern hemisphere and is the only cryophile representative of the family found off Brazil for the first time, for *Centropages furcatus* and *C. violaceus* are thermophile, the first in the epipelagial neritic region and the second in the oceanic region.

Sewell (1948, p. 453) registers *C. brachiatus* in the region of the West Wind Drift, in the South Atlantic off the coast of South America and off the Cape of Good Hope and in the Gulf of Guinea off Africa (*op. cit.*, p. 455). It is also mentioned as belonging to the waters of the North Atlantic (Sub-Arctic Atlantic sub-region of Steuer 1933, p. 293). It is not recorded in the Gulf Stream, in the Mediterranean and in the Caribbean Seas. It was recorded off the Pacific coast of South America where it is known that the water temperature is lower than off the Atlantic coast at the same latitudes.

Fam. Diaptomidae

Pseudodiaptomus acutus (F. Dahl)

SIZE — ♀ 1.1-1.3 mm; ♂ 0.85 mm.

OCCURRENCE — M 283 (1), P 10 (Pr.), P 1 (3), IV 218 (20), IV 320 (5), III 320 (5), III 321 (44), III 322 (Pr.), E 39 (20)*, E 24 (20)*.

DISTRIBUTION — It had been registered before by Dahl (1894, p. 11) at the mouth of the Tocantins river in 11.8-12.8 ‰ salinity and 28°C temperature at the surface. Carvalho (1952, p. 146) recorded its presence in the bay of Santos. Sewell (1948, p. 452) considers it as apparently indigenous of the east coast of South America and as apparently "evolved in the brackish water of the great river estuaries". The water column where it occurred showed a salinity between 8.255 and 35.87 ‰. It was more abundant near the surface in samples taken at different depths. It seems to characterize the estuarine facies and inshore waters on the Brazilian coast together with *Labidocera fluviatilis* F. Dahl. Copepodites and nauplii of *P. acutus* were found in great numbers in the inshore waters of Cananéia but not in the offshore shelf waters, where the adults are occasionally found.

Pseudodiaptomus richardi (F. Dahl)

SIZE — ♀ 1.5 mm; ♂ 1.1 mm.

OCCURRENCE — M 269 (1).

DISTRIBUTION — It had been registered off the Amazon River's mouth by Dahl (1894, p. 4-5) and is again registered here in the same region. By Dahl's table (*loc. cit.*) this species is probably adapted to lower salinities than *P. acutus*.

Fam. Temoridae

Temora stylifera (Dana)

(Fig. 25)

SIZE — ♀ 1.05 mm; ♂ 1.7 to 1.55 mm.

OCCURRENCE — M 497 (Pr.), M 407 (12), M 400 (1), M 389 (560)*, M 368 (11), M 365 (400)*, M 364 (5), M 363 (3), M 314 (3), M 283 (21), M 265 (600)*, M 257 (18), M 246 (14), M 243 (2), M 242 (5), M 241 (19), M 240 (88), M 238 (14), M 236 (11), M 232 (1), M 208 (35), M 203 (12), M 190 (79), M 189 (226), M 188 (15), M 187 (97), M 186 (60), M 173 (17), M 162 (5), M 160 (3), M 114 (18), M 113 (1), M 112 (1), M 111 (2), M 107 (2), M 100 (19), M 99 (116), M 98 (108), M 97 (17), M 96 (8), M 95 (159), M 93 (119), M 88 (2), M 78 (20), M 76 (12), M 75 (37), M 74 (38), M 73 (30), M 39 (10), M 38 (127), M 37 (35), M 36 (44), M 35 (36), M 33 (30), M 32 (8), M 31 (12), M 30 (10), E 170 (20)*, E 164 (60), E 41 (40)*, E 39 (140)*, E 32 (20)*, E 30 (Pr.), E 24 (180)*, E 16 (1360)*, E 15 (680), E 14 (20)*, E 13 (900)*, E 12 (100), E 11 (700)*, E 9 (11), E 8 (32), E 7 (720)*, E 4 (4120)*, E 3 (12,720)*, E 2 (680)*, E 1 (1025)*, P 13 (90), P 12 (73), P 11 (154), P 10 (33), P 9 (104), P 8 (9), P 7 (7), P 6 (105), P 5 (29), P 4 (272), P 3 (210), P 2 (79), P 1 (52), V 13 (20)*, V 19 (510)*, V 3 (Pr.), V 1 (5), II 68 (20), III 321 (2), IV 244 (1), E 28 (Pr).

ECOLOGY — We find it to be the dominant species over other copepods in coastal waters with 33.00 °/₀₀ salinity or more and in samples of shelf waters with layers of salinity around 35.00 °/₀₀ and temperature above 20°C (Fig. 25). It is not usually found to be dominant in oceanic waters, thus, contrary to Deevey (1952b, p. 157) and Yamazi (1958, p. 150) it should be considered of

coastal or of shelf-water preferences off the Brazilian coast. In the Pacific, oceanic waters are of lower salinities than here and therefore in that ocean *T. stylifera* is oceanic.

The other authors mentioned register it in subtropical or in waters with temperatures between 15 and 18°C more or less (Yamazi 1958, p. 150; Deevey 1952b, p. 157). The most numerous occurrences, with many juvenile forms, examined here occurred in temperatures between 17 and 28.5°C in coastal and in shelf waters with salinities under 35.5 °/₀₀. It was absent or occurred in low percentages in inshore waters. Thus, *T. stylifera,* though very euryhaline, seems to have an environmental optimum between 33.00 and 35.50 °/₀₀. It has been found in the stomach contents of some fishes like "sardinha" (*Sardinella allecia* Raf.) and "oveva" (*Larimus breviceps* Cuv.) in dominant numbers.

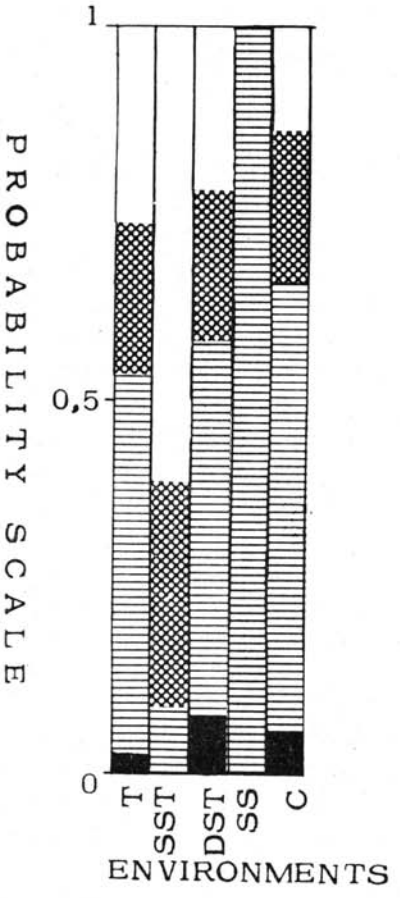

Fig. 25 — Probability of occurrence of *Temora stylifera* in different environments.

It is a very common cosmopolitan copepod. Although present in the northern hemisphere, it occurs there less frequently and in smaller numbers, as can be seen from station lists like Farran's (1929, p. 258). Wilson (1950, p. 343) registered it in the warm currents of the Pacific from 30° N down to 20° S and off Peru. The greatest number of specimens was recorded off Rio de Janeiro and Vitória, near the Tropic of Capricorn and it diminishes from latitude 15° S northwards. Bogorov (1958, p. 152) lits it in the mixing zone (temperatures from 15 to 18°C) and in tropical waters (temperatures from 18 to 27°C) in the northwestern Pacific epipelagial. Bainbridge (1960, tab. 1) lists it as one of the most numerous copepods "in hauls taken from 100 m to the surface along three sections of the shelf" in the Gulf of Guinea.

Temeropia mayumbaensis T. Scott

SIZE — ♀ 1.0 mm; ♂ 0.9 mm.

OCCURRENCE — M 78 (19), M 73 (4).

REMARKS — Registered here for the first time in Brazilian waters in two samples taken with closing-net from water layers between 54 and 108 m depth and in surface waters. It was also registered by Marques (1958, p. 214) off Angola. It is a deep-water copepod (Farran 1936, p. 110) and is probably part of the fauna of deep layers. Its presence in M 73 (a surface haul) can be explained through migrational movements. Heinrich (1961, p. 87) found it in large numbers in the North West Subtropical Pacific, where it was usually concentrated in the 50-100 m deep layer or near the surface during the day. At night it reached 500 m depth.

Fam. Metridiidae

The *Pleuromamma* of the Brazilian Coast

During the "Plankton" and the "Meteor" Expeditions the following *Pleuromamma* were registered in the Brazilian waters: *Pleuromamma xiphias* (Giesbr.) off the northern coast (the Tocantins mouth, Fortaleza, Cabo São Roque), off the eastern coast (Salvador) (Steuer 1932, p. 120, karte 1; 1937, p. 135-137), off the southern coast of Brazil (Rio Grande do Sul) (Steuer 1937, p. 134); *P. abdominalis* (Lubb.) off the northern coast of Brazil, Salvador, Rio (Steuer 1932, p. 120; 1937, p. 134, 137); *P. quadrungulata* (Dahl) off the northern coast of Brazil (Steuer 1932, karte 12; 1937, p. 137); *P. gracilis* (Claus) off the northern coast of Brazil, off the eastern and the southern coast (Steuer 1932, karte 14; 1937, p. 132-137); *P. borealis* (Dahl) off the northern coast of Brazil, off Rio Grande do Sul (Steuer 1937, p. 134-137). It seems that *P. gracilis* is the most common species of this genus off our coast. It is a deep-dwelling genus and not so common in our samples usually from the surface. The "Meteor" caught these animals frequently in the 0-100 m deep hauls in the south and from 600-400 m deep hauls off the Amazon in the north (see tables a-c in Steuer 1937, p. 134-137) off Brazil. *P. robusta* and *P. quadrungulata* were caught off the Brazilian coast only bet-

ween 600 and 400 m. That is perhaps the reason why they were not registered in any of the samples examined for this work, taken above 200 m.

Pleuromamma abdominalis (Lubbock)

(Fig. 26)

SIZE — ♀ 2.5-3.5 mm; ♂ 3.5-4 mm.

OCCURRENCE — M 510 (160)*, M 365 (5), M 232 (160)*, M 166 (30), M 114 (33), M 112 (2), M 111 (2), M 100 (3), M 76 (9), M 37 (1), M 36 (2).

ECOLOGY — All the specimens taken come from more than 35.00 ‰ salinity and 14-26.7°C temperature.

It was a very numerous species of copepod in two samples taken from waters of high salinity and temperatures between 21.44 and 26.70°C. So it seems to prefer warmer oceanic or shelf waters, but under oceanic influence. It is a deep water form with vertical migratory habits (Moore 1949, p. 53). According to Brodsky (1950, p. 308) it is a warm water surface copepod. Heinrich (1961, p. 88) collected it at the surface only at night. Generally it was found deeper than 50 m in the subtropical region of the North West Pacific.

Farran (1926, p. 259) registered it off the continental shelf of the northern coast of Brazil in oceanic tropical waters. According to Wiborg (1954, p. 69) and Yamazi (1958, p. 150) it is a southern warm-water oceanic form in the northern hemisphere. It indicates Atlantic water off Norway.

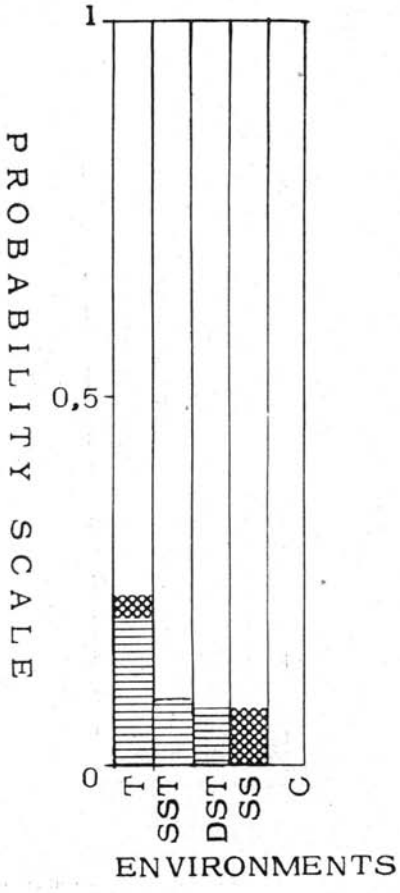

Fig. 26 — Probability of occurrence of *Pleuromamma abdominalis* in different environments.

Pleuromamma gracilis (Claus)

(Fig. 27)

SIZE — ♀ 2.0-1.9 mm; ♂ 1.8 mm.

OCCURRENCE — M 407 (1), M 403 (Pr.), M 395 (5), M 365 (5), M 232 (3), M 166 (2 f. *piseki*), M 162 (4), M 161 (70), M 114 (137), M 112 (2), M 111 (12), M 99 (18), M 78 (11), M 75 (14), M 74 (9), M 36 (3).

ECOLOGY — Here it occurred in samples of water of high salinities and temperatures under 24°C and it was more frequent in deep shelf water. Wilson (1950, p. 289) registered it in waters of lower salinity and Yamazi (1958, p. 150) registers it as a "Temperate Water species" off Japan. It is a cryophile species off Brazil. Brodsky (1950, p. 309) classifies it as oceanic, bathypelagic and a warm water form, whereas *P. abdominalis* is relatively thermophile.

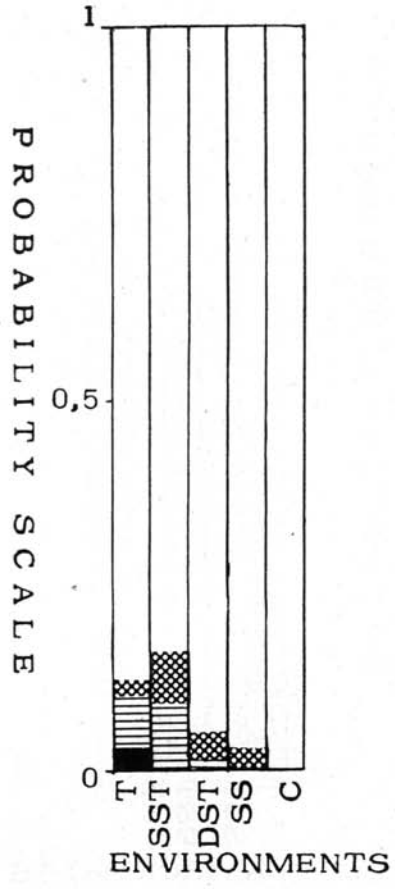

Fig. 27 — Probability of occurrence of *Pleuromamma gracilis* in different environments.

It was registered by Farran (1929, p. 260) and Wilson (1950, p. 353-354) off the Brazilian coast from Cabo Frio up to Fernando de Noronha. As *Pleuromamma abdominalis* it prefers deeper waters (Moore 1949, p. 54) and was caught only when surface samples were taken at night or early in the morning. According to Heinrich's (1961, p. 88) data it is found during the day concentrated at 500 m depth. It was caught in higher numbers (Farran 1929, p. 261) off New Zealand, in cooler waters, which it probably prefers. Kusmorskaya (1959) ranges it along with *P. borealis, P. xiphias, P. abdominalis* and *P. robusta* as characteristic of the transition zone between boreal and southern warm

water species in the Atlantic. Brodsky (1957, p. 60) registers it as a characteristic copepod of the association found in the subtropical North Pacific.

Pleuromamma borealis F. Dahl

SIZE — ♀ 1.9-2.0 mm.

OCCURRENCE — M 166 (9), M 162 (4).

REMARKS — It was thriving off the Brazilian coast in cooler waters (17.76 to 18.00°C) of high salinity. It was observed in samples off the South African coast in subtropical waters, during the night in surface hauls (Table XVI). An eurythermic cryophile species in the Atlantic. Our specimens are much smaller than those from the "Terra Nova" Expedition (Farran 1929, p. 262). It occurred there in cold waters of the sub-antarctic region (Sewell 1948, p. 513-515). It also occurs in the North Atlantic in the English Channel where waters are also cooler. Brodsky (1950, p. 310) classifies it as an oceanic bathypelagic species.

Pleuromamma xiphias (Giesbr.)

SIZE — ♂ 3.5 mm; ♀ 3.25-5.0 mm.

OCCURRENCE — M 166 (3), M 161 (Pr.), M 75 (3).

ECOLOGY — It occurred in samples taken during the night from waters of high salinity (over 35.00 ‰) and lower temperatures (under 20°C), thus corroborating Moore's (1949, p. 54) data on the migration of the species to the surface layers during the night. It is registered off Brazil with smaller size than elsewhere.

Fam. Lucicutiidae

Lucicutia flavicornis (Claus)

(Fig. 28)

SIZE — ♀ 1.9-1.7 mm; ♂ 1.25-1.5 mm.

OCCURRENCE — M 510 (20)*, M 409 (Pr.), M 407 (8), M 403 (Pr.), M 402 (Pr.), M 400 (Pr.), M 395 (29), M 389 (160)*,

M 368 (5), M 365 (280)*, M 364 (10), M 315 (Pr.), M 314 (2), M 304 (Pr.), M 283 (2), M 241 (1), M 240 (6), M 232 (8), M 166 (2), M 162 (5), M 161 (21), M 114 (8), M 112 (1), M 111 (19), M 100 (Pr.), M 99 (10), M 95 (Pr.), M 78 (10), M 76 (1), M 75 (18), M 74 (1), M 39 (2), M 38 (2), M 37 (11), M 36 (6), E 164 (1).

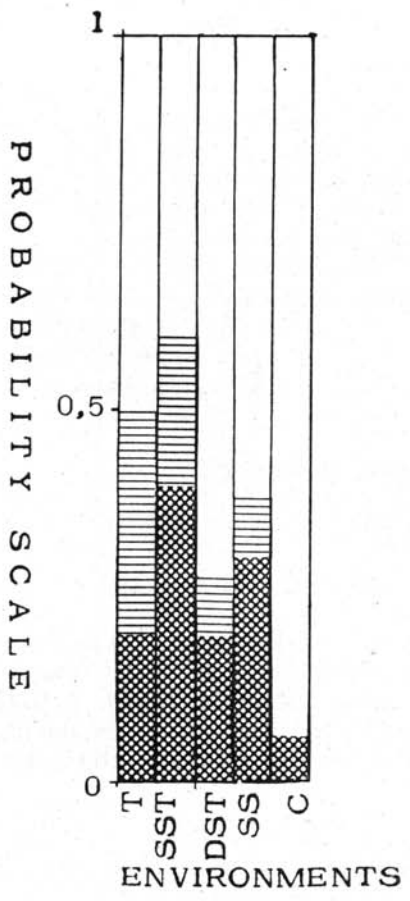

Fig. 28 — Probability of occurrence of *Lucicutia flavicornis* in different environments.

ECOLOGY — This species was found in 14 samples of water with high salinity (over 35.00 ‰) and temperatures below 21°C and in 10 samples from high salinity water and temperature from 24 to 21°C. It was found only in 5 samples of water of high salinity and temperature between 25.20 and 27°C. Thus it seems to prefer cooler waters. Of these it prefers the 25-50 m layers during the day (Heinrich 1961, p. 88). Moore (1949, p. 56) registers it under 50 m in larger quantities in the Bermuda area, and Heinrich (*loc. cit.*) in the subtropical North West Pacific. Farran (1929, p. 263) registers the largest numbers of this species in the "North Temperate Atlantic" and in the southern hemisphere between 30 and 40° S off New Zealand where the waters are also cooler. Although listed by Yamazi (1958, p. 150) as a warm-water oceanic form, it is perhaps better to consider it as oceanic but as preferring the transition zone between warm and cold waters. Kusmorskaya (1959) places it more correctly among the transition zones species between the warm and the boreal water species. It was also registered by Wilson (1950, p. 255) in the Bering Sea although Brodsky (1957, p. 113-121) did not mention it among the typical Bering Sea copepods.

Lucicutia ovalis Wolfenden

SIZE — ♀ 1.4 mm.

OCCURRENCE — M 489 (60)*, M 407 (4), M 403 (3), M 400 (Pr.), M 395 (2), M 240 (1).

REMARKS — It occurred in oceanic waters of salinities above 35.53 °/₀₀. It prefers deep waters (Sewell 1948, p. 521; Heinrich 1961, tab. 4). It is registered for the first time off Brazil.

Lucicutia clausi (Giesbrecht)

SIZE — ♀ 1.95 mm.

OCCURRENCE — M 407 (2), M 395 (1 ♂).

ECOLOGY — It was found in cool southern waters of high salinity for the first time off the Brazilian coast. According to Sewell (1948, p. 509) it is a deep-dwelling calanoid recorded from the deeper water of the Mediterranean Sea. Bogorov (1958, p. 152) registers it among the most eurythermal species of the tropical waters which inhabit the "zone of mixing" of boreal and tropical waters in the Northern Pacific and Brodsky (1957, p. 59) lists it among the copepods of the characteristic association of subtropical North Pacific waters.

Fam. Heterorhabdidae

Heterorhabdus spinifrons (Claus)

SIZE — ♂ 2.01 mm; ♀ 2.5 mm.

OCCURRENCE — M 407 (3), M 403 (4), M 402 (Pr.), M 395 (8), M 363 (1), M 315 (5), M 247 (3), M 166 (1), M 114 (1), M 100 (1), M 99 (1), M 78 (2), M 75 (4), M 74 (1).

ECOLOGY — It was found in surface off-shore and oceanic waters with more than 35.00 °/₀₀ salinity and temperatures under 23°C. According to Farran (1929, p. 264) it has a world-wide tropical and temperate distribution. Brodsky (1957, p. 55, 59) mentions it as one of the frequent species of the tropical and subtropical North Pacific. It is recorded here for the first time off Brazil.

Heterorhabdus papilliger (Claus)

SIZE — ♀ 1.9 mm; ♂ 1.6-1.7 mm.

OCCURRENCE — M 240 (1), M 111 (2), M 78 (4).

ECOLOGY — It was registered off the coast of Brazil (off Bahia and off Cabo São Roque) in oceanic tropical waters by Farran (1929, p. 265). Sewell (1948, p. 209) and Brodsky (1950, p. 353) list it among the deep-dwelling copepods. Farran (1926, p. 283) is of the opinion that it lives usually at 100 m depth and comes to the surface by night in the temperate Atlantic. This perhaps explains why it was so rarely present in our surface day time samples. The sample M 78 was taken from 108 to 54 m depth with a closing-net during the night, when the animal had probably migrated to the surface. M 111 was taken during the night and M 240 during the early morning hours. It is here recorded for the first time from Brazilian southern waters. It is among the most frequent species characteristic of subtropical waters in the North Pacific and it is also frequent in the tropical North Pacific (Brodsky 1957, p. 56, 59).

Fam. Augaptilidae

The following species of this family were represented in small numbers in a few samples: *Haloptilus acutifrons* (Giesbrecht) in samples M 368 (1 ♀ of 2.0 mm) and in M 409; *Haloptilus spiniceps* (Giesbrecht) in samples M 368 (Pr.), M 364 (1), M 360 (10), M 240 (1 ♀), M 372 (1 ♀ of 4.5 mm) and M 241 (1 ♀ of 3 mm); *Haloptilus fertilis* (Giesbrecht) in sample M 364 (91 ♂ of 3 mm); *Euaugaptilus hecticus* Giesbr. (1 ♀ of 2.8 mm) in sample M 365. These species are listed by Sewell (1948, p. 509) as deep-dwelling copepods. The Augaptilid which appeared in a larger number of samples was *Haloptilus longicornis* (Claus).

Haloptilus longicornis (Claus)

SIZE — ♀ 2.1 mm.

OCCURRENCE — M 403 (1), M 369 (2), M 365 (80)*, M 364 (2), M 362 (80)*, M 315 (30), M 314 (1), M 242 (1), M 241 (6), M 240 (2), M 78 (5), M 75 (1), M 74 (1).

ECOLOGY — It was only found in samples from oceanic, high salinity and usually high temperature waters. The samples were all taken from at least 50 m depth to the surface. The only exceptions are: M 78, in which only deep water layers were

sampled; M 409, M 75 and M 74, in which the salinity and temperature were low, although the layers sampled were at the surface. They were night samples and the presence of the animal may be due to vertical migration. In the North West Pacific, in subtropical waters, it was found in maximum numbers in the 100-200 m layer (Heinrich 1961, p. 91). It seems to be an indicator of very saline and usually warm oceanic water off the Brazilian coast, though Wilson (1950, p. 236) registered it in temperate waters of lower salinity in the Pacific Ocean. Heinrich (1960, p. 36) registered the highest numbers along the 174° W meridian between 10° and 30° S and near the Equator on the 154° E meridian. In the North Pacific it is listed among the most frequent species of the tropical waters and as one of the frequent species of the subtropical region (Brodsky 1957, p. 55, 59). It is registered here for the first time off the Brazilian coast.

Fam. Candaciidae

Candacia pachydactyla (Dana)

SIZE — ♀ 2.5 mm; ♂ 2.75 mm.

OCCURRENCE — M 510 (20)*, M 497 (4), M 489 (360)*, M 407 (3), M 368 (4), M 364 (160)*, M 315 (1), M 314 (1), M 247 (8), M 246 (6), M 245 (7), M 244 (4), M 243 (1), M 242 (2), M 241 (2), M 240 (4), M 114 (12), M 113 (Pr.), M 111 (4), M 98 (3), M 95 (2), M 39 (3), M 38 (2), M 37 (12), M 36 (6).

DISTRIBUTION — It was registered by Farran (1929, p. 272) off the Brazilian coast from Rio de Janeiro up to the Equator. The present findings have enlarged its distribution to 31°03' S and 04°57.0' N.

ECOLOGY — This species only occurred in samples taken from very saline (above 35.00 °/₀₀) and usually warm waters of the Brazil Current. It did not occur generally in samples taken from cooler water (under 21°C). It was the most numerous *Candacia* found in our samples, euryhaline, but preferring the higher salinities, and thermophile. Yamazi (1958, p. 151) classifies it as an oceanic, warm water species, which is partially confirmed by our data. It is among the frequent copepods found in the subtropical and tropical regions of the North Pacific (Brodsky 1957, p. 59).

Candacia bispinosa (Claus)

SIZE — ♀ 1.75-1.95 mm; ♂ 1.75-1.90 mm.

OCCURRENCE — M 403 (2), M 246 (1), M 243 (5), M 114 (5), M 113 (24).

REMARKS — It had been recorded by Farran (1929, p. 272) off the Brazilian coast (Bahia). The present findings enlarge this distribution to 07°28' S and 27°15' S in oceanic waters of the West South Atlantic. It is among the most frequent *Candacia* species of the tropical Pacific (Wilson 1950, p. 181; Brodsky 1957, p. 55) in maximum concentration between 30° and 40° S and above 30° N along the 174° W meridian (Heinrich 1960, p. 36) therefore of subtropical distribution. The same author (Heinrich 1961, p. 90) verified its concentration at night in the 50-100 m and during the day in the 25-50 m layer.

Candacia bipinnata (Giesbrecht)

SIZE — ♂ 2.2 mm; ♀ 2.3 mm.

OCCURRENCE — M 236 (10), M 173 (1), M 78 (50), M 37 (1).

REMARKS — Already known from Rio de Janeiro. Distribution here enlarged to 25°45' S. An eurythermic species preferring cooler waters. In tropical waters Brodsky (1957, p. 56) found it present in 25% of the samples of the East North Pacific, but in subtropical waters it was present in 60% of the samples from the North Pacific (Brodsky 1957, p. 59) and is recorded also from the Okotsk Sea (*op. cit.*, p. 86-90).

Candacia curta (Dana)

SIZE — ♂ 2.3 mm; ♀ 2.1 mm.

OCCURRENCE — M 407 (2), M 389 (Pr.), M 240 (2), M 78 (4), M 76 (4), M 75 (1), M 74 (15), M 73 (2), M 39 (1), M 38 (23), M 37 (18), M 36 (1), M 35 (12), M 33 (12).

REMARKS — Present only in high salinity (above 35.00 ‰) water and temperature lower than 22°C, with one exception (M 240). It had already been registered off Rio de Janeiro and up to the Equator, in small numbers. It seems to prefer cooler and very saline waters off our coast, though Farran (1926, p. 272) only registered it in tropical waters. In the Pacific it was among the less frequent *Candacia* species of tropical and subtropical regions (Wilson 1950, p. 181; Brodsky 1957, p. 55, 59). This speaks in favour of the fact that this animal prefers high salinities.

Candacia aethiopica (Dana)

(Fig. 29)

SIZE — ♂ 2.0-2.5 mm; ♀ 2.5-3.0 mm.

OCCURRENCE — M 497 (Pr.), M 451 (4), M 409 (1), M 407 (8), M 403 (77), M 402 (40)*, M 394 (600)*, M 365 (Pr.), M 364 (Pr.).

ECOLOGY — Registered off the coast of Brazil for the first time in Wilson's (1950, p. 180) paper, it is an eurythermic euryhaline warm water copepod but preferring the lower range of temperatures in these waters (see Farran 1926, p. 272). It is one of the frequent *Candacia* species in the tropical and temperate Pacific (Brodsky 1957, p. 56). Off Brazil it favours the surface subtropical waters (Fig. 29).

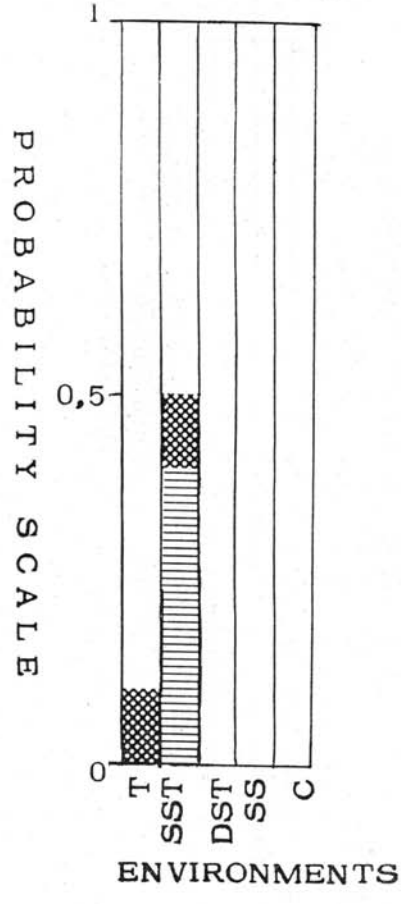

Fig. 29 — Probability of occurrence of *Candacia aethiopica* in different environments.

Candacia simplex (Giesbrecht)

SIZE — ♂ 2.3 mm; ♀ 1.7 mm.

OCCURRENCE — M 513 (1), M 510 (20)*, M 365 (Pr.), M 364 (80)*, M 363 (4), M 246 (3), M 244 (1), M 241 (3), M 232 (1), M 100 (1).

REMARKS — Already registered off Rio de Janeiro by Farran (1929, p. 151), its distribution is here enlarged to 03°33' S and to 25°00' S.

It seems to prefer very saline waters (over 36.00 ‰) of temperature above 22°C off the Brazilian coast. It is the most frequent *Candacia* in tropical and subtropical waters of the North Pacific (Wilson 1950, p. 182; Brodsky 1957, p. 55, 59).

Juvenile *Candacia*

OCCURRENCE — M 364 (Pr.), M 246 (3), M 242 (20), M 241 (12), M 240 (6), M 189 (1), M 187 (1), M 163 (2), M 112 (1), M 107 (1), M 100 (1)*, M 99 (6), M 98 (10), M 96 (1), M 75 (14), M 73 (2), M 36 (3).

ECOLOGY — In all these samples the juvenile *Candacia* always gave preference to layers of high salinity (above 35.00 ‰) and under influence of oceanic water, excepting in one sample taken from coastal waters. *Candacia* seems to be the characteristic genus of shelf or oceanic waters with usually high temperatures and salinities ranging from 33 to 35.5 ‰ (see Wilson 1950, p. 180-184; Brodsky 1957, p. 32) in the Pacific.

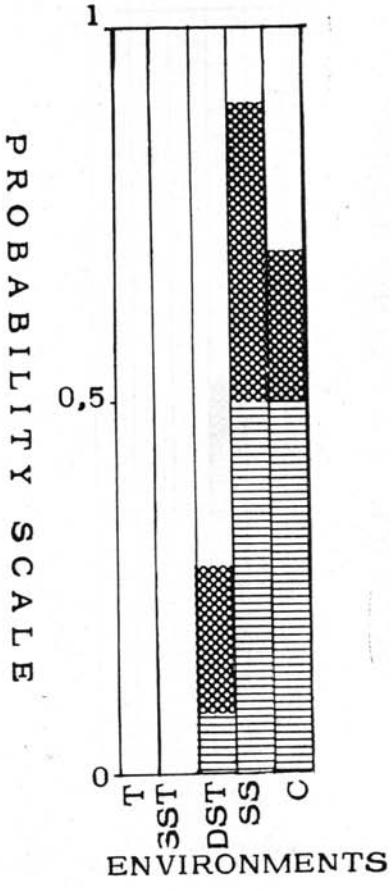

Fig. 30 — Probability of occurrence of *Calanopia americana* in different environments.

Fam. Pontellidae

Calanopia americana F. Dahl

(Fig. 30)

SIZE — ♂ 1.4 mm; ♀ 1.5 mm.

OCCURRENCE — M 265 (270)*, M 261 (12), M 257 (8), M 188 (2), M 107 (1), M 93 (1), M 76 (2), M 75 (4), M 74 (1), M 73 (8), M 39 (2), M 38 (21), M 36 (5), M 35 (4), M 33 (16), M 32 (2), M 31 (5), M 30 (4), E 164 (7), E 41 (20)*, E 39 (300)*, E 32 (20)*, E 30 (40)*, E 28 (660)*, E 24 (200)*, E 16 (36), E 15 (1640)*, E 14 (20)*, E 13 (340)*, E 12 (Pr.), E 9 (1), E 8 (29), E 7 (120)*, E 5 (560)*, E 4 (200)*, E 3 (1240)*, P 13 (1), P 12 (2), P 11 (1), P 10 (4), P 9 (11), P 8 (4), P 7 (4), P 5 (8), P 4 (5), P 3 (70), P 2 (11), P 1 (58), II 68 (1), IV 218 (6).

ECOLOGY — This species was described from waters taken off the mouth of the Amazon River (Dahl 1894, p. 12) with sur-

face salinity 11.8, 35.9 and 36.4 °/₀₀. Off the Brazilian coast it is among the characteristic copepods of shelf waters with salinities 35.00 to 36.00 °/₀₀ and it is found also in costal waters (Fig. 30). It is usually not numerous but frequent. According to Sewell (1948, p. 452) it appears to be indigenous of the East coast of America. It is euryhaline but with an optimum in the lower salinity of the marine environment.

Labidocera fluviatilis F. Dahl

(Fig. 31)

Syn. — *Labidocera fluviatilis* F. Dahl, 1894, p. 12-13, figs. 19-22.
Labidocera brasiliense Farran, 1929, p. 276-277.
Pontella resnautica L. Oliveira, 1946, p. 192-194, figs. 7-13.
Pontellina navalium L. Oliveira, 1947, p. 472-477, fig. 12.

SIZE — ♀ 2.5 mm; ♂ 2.5 mm.

OCCURRENCE — M 394 (120)*, M 283 (3), M 269 (3), M 265 (320)*, M 257 (12), M 95 (Pr.), M 88 (1), M 73 (1), E 41 (Pr.), E 28 (Pr.), E 3 (20)*, P 13 (8), P 12 (Pr.), P 11 (Pr.), P 10 (Pr.), P 1 (16), II 68 (3), IV 244 (60), III 321 (9), IV 218 (1).

SYSTEMATIC NOTES — *L. fluviatilis* was firstly described by Dahl (1894, p. 12) from samples of the "Plankton" Expedition taken at the Amazon River's mouth. Farran (1929, p. 276) registered it under the name of *L. brasiliense* from samples of the "Terra Nova" Expedition taken off Rio de Janeiro. The only difference between the animals described by Dahl and by Farran is the proportion between the length of the exopodite and the endopodite of the fifth legs of the female ("three times as

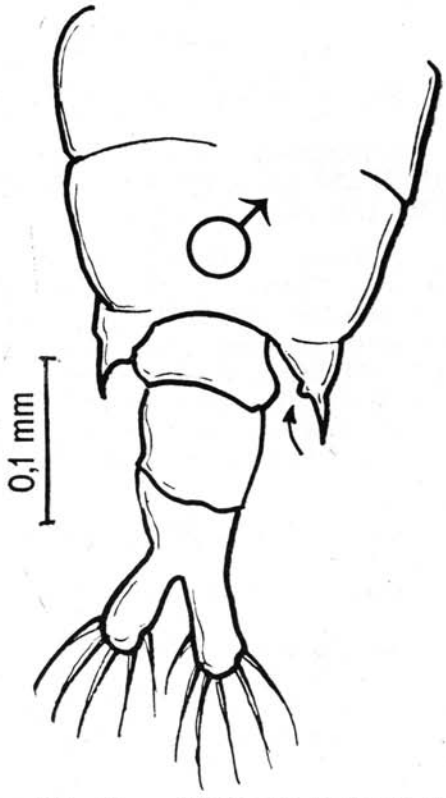

Fig. 31 — *Labidocera fluviatilis* F. Dahl: Posterior part of thorax.

long" as the endopodite in Farran's description; one and a half times as long, in Dahl's). In our samples all the intermediate lengths are found. Dahl did not register a little protuberance on the left point of the last thoracic segment of the adult male. The other acute point of the male's last thoracic joint has no such protuberance (Fig. 31). Oliveira described *Pontella resnautica* (1946, p. 192-194, figs. 7-13) and *Pontellina navalium* (1947, p. 472-474) from samples taken off Rio de Janeiro. The descriptions of these animals are identical to that of *L. fluviatilis*, leaving no doubt as to the synonymy of *P. resnautica* and P. *navalium* to the latter name.

ECOLOGY — It is a brackish water species, frequently found in fish stomachs (Table XII) and it occurs also in coastal waters. Although euryhaline, its optimum salinity is found in the brackish water environment.

Labidocera acutifrons (Dana)

SIZE — ♀ 4.1 mm; ♂ 4.0 mm.

OCCURRENCE — M 407 (3), M 403 (1), M 402 (1), M 394 (3), M 283 (3), M 269 (3), M 238 (2), M 236 (1), M 114 (19), M 95 (1), M 38 (1).

ECOLOGY — Recorded by Farran (1929, p. 274) off Rio de Janeiro. The author only found it in samples taken from waters with salinity above 36.00 °/₀₀ and temperatures under 25°C off the southern coast of Brazil. The actual findings confirm Yamazi's (1958, p. 151) statement that it is an oceanic species. In the Pacific it occurs in oceanic waters of lower salinity (see Wilson 1950, p. 242; Brodsky 1957, p. 55, 58). Its environmental optimum is thus the open-sea regardless of salinity.

Pontellopsis brevis (Giesbrecht)

SIZE — ♂ 1.98 mm.

OCCURRENCE — V 3 (Pr.), E 164 (1), E 41 (Pr.), E 7 (20)*, P 13 (8), P 12 (Pr.), P 11 (2), P 10 (Pr.), P 1 (1), M 190 (1), M 186 (1), M 107 (1), M 95 (Pr.), M 93 (1), M 74 (4), M 39 (2), M 38 (7), M 37 (1), M 36 (1), M 35 (1).

REMARKS — Farran (1929, p. 280) registered it off Rio de Janeiro. It is frequently found in small numbers in coastal waters and in shelf waters off Brazil.

Other *Pontellopsis*

Pontellopsis villosa Brady was first described from a specimen caught by the "Challenger" Expedition in the middle South Atlantic off Mar del Plata. It appeared in samples M 114 and M 75. The lengths of the specimens were ♂ 1.9 mm, ♀ 3.0-2.75 mm.

Pontellopsis perspicax (Dana) was described from the middle of the tropical South Atlantic. It was registered in samples M 247 (1 ♀ 1.85 mm) and M 244 (1 ♀ 2.8 mm) from oceanic, very saline waters (above 36.00 °/₀₀).

Pontellina plumata Dana

SIZE — ♀ 1.5-1.9 mm; ♂ 1.8 mm.

OCCURRENCE — M 497 (1), M 368 (1), M 364 (40)*, M 363 (1), M 247 (2), M 246 (2), M 245 (1), M 244 (6), M 242 (2), M 114 (1).

ECOLOGY — It seems to prefer very saline (above 36.00 °/₀₀) and warm waters (above 22°C) off the Brazilian coast.

Fam. Acartiidae

Acartia lilljeborghi Giesbrecht

Syn. *Acartia fariai* Lejeune de Oliveira, 1945

(Fig. 32)

SIZE — ♂ 1.15-1.2 mm; ♀ 1.4 mm.

OCCURRENCE — M 73 (1), M 38 (4), E 170 (1), E 164 (3), E 39 (120)*, E 28 (180)*, E 11 (Pr.), E 9 (1), E 8 (6), E 7 (20)*, E 2 (1), E 1 (675)*, P 13 (5), P 12 (11), P 11 (20), P 10 (6), P 9 (51), P 8 (37), P 7 (16), P 6 (59), P 5 (12), P 4 (1), P 3 (2), P 2 (7), P 1 (46), II 68 (9), III 322 (4), III 320 (72), IV 244 (4), IV 218 (1).

REMARKS — Already recorded in Brazilian waters by Dahl (1894, p. 2) off the Amazon River's mouth in waters of low salinity (11.8 and 12.8 °/₀₀) at the surface and by Carvalho (1952, p. 150) in Santos. Oliveira (1945, p. 459) also registered a juvenile form belonging to this species off Rio de Janeiro as *Acartia fariai*.

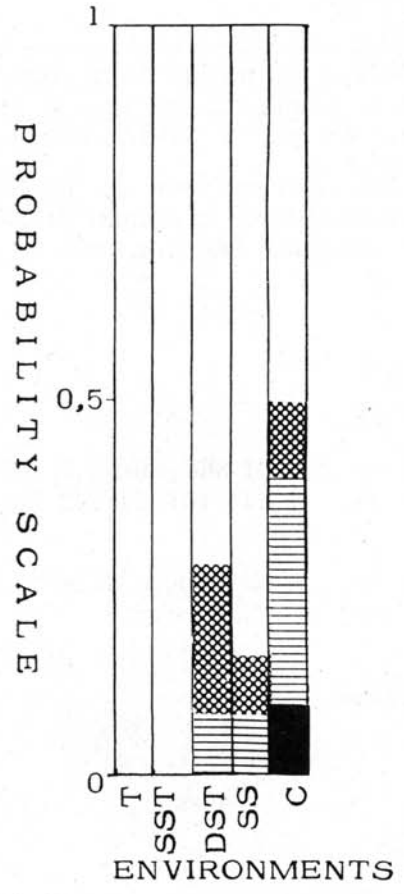

Fig. 32 — Probability of occurrence of *Acartia lilljeborghi* in different environments.

ECOLOGY — It is distinctly a copepod indicator of coastal waters (Fig. 32). Only few samples which also showed layers of shelf water contained specimens of *A. lilljeborghi*. All the other samples in which it appeared were taken in purely coastal sea water. It is frequently the dominant copepod in these and therefore also found in the gastric contents of littoral plankton feeders.

Steuer (in Sewell 1948, p. 405) refers to it as an inhabitant of the West Wind Drift which was swept up the east and west coasts of South America by the cold Falkland and Humboldt currents respectively. The known distribution and the present data favour Sewell's (1948, p. 405) doubts about the origin of the species. It is more probably a coastal water stenohaline, but strongly eurythermic species. It was present in the greatest number in inshore waters and waters very near to the coast. It is substituted by *A. tonsa* in the estuarine facies of the Gulf of Mexico (see Fleminger 1959, p. 154) and by a *A. giesbrechti* in the same facies in the mouth of the Amazon River.

Acartia danae Giesbrecht

(Fig. 33)

SIZE — ♀ 1.25 mm; ♂ 1.1 mm.

OCCURRENCE — M 497 (7), M 409 (Pr.), M 407 (1), M 403 (40), M 402 (40)*, M 400 (Pr.), M 395 (32), M 394 (Pr.), M 364 (1), M 314 (32), M 247 (8), M 242 (1), M 240 (1), M 208 (3), M 189 (2), M 166 (7), M 163 (184), M 162 (615), M 160 (246), M 113 (3), M 111 (1), M 100 (2), M 98 (1), M 88 (2), M 33 (1).

ECOLOGY AND DISTRIBUTION — Already known from Brazilian waters (Farran 1929, p. 282; Carvalho 1944, p. 98-99; 1952, p. 151-152). It occurred in greater numbers in the samples from high salinity waters (above 35.00 °/₀₀) and lower temperatures (approximately 18°C), thus preferring subtropical conditions, confirming Yamazi's (1958, p. 152) classification of the species as temperate. It did not occur in samples of coastal waters with one exception. It is an off-shore species, as stated by Deevey (1952a, p. 90). In the North Pacific it is one of the most abundant species in tropical, subtropical and intermediate waters (Brodsky 1957, p. 55, 59, 62) but was also frequent in the Bering Sea (Wilson 1950, p. 151) though these findings are not confirmed by Brodsky (1957). Heinrich (1961, p. 90) found large numbers of *A. danae* between 25° and 35° N in the West Pacific usually concentrated in the 25-50 m deep layer or in the 50-100 m layer, reaching down to 500 m. It is found in still deeper layers (580 to 1,040 m) near Japan (Furuhashi 1961, tab. 2) in temperatures about 4 to 5°C.

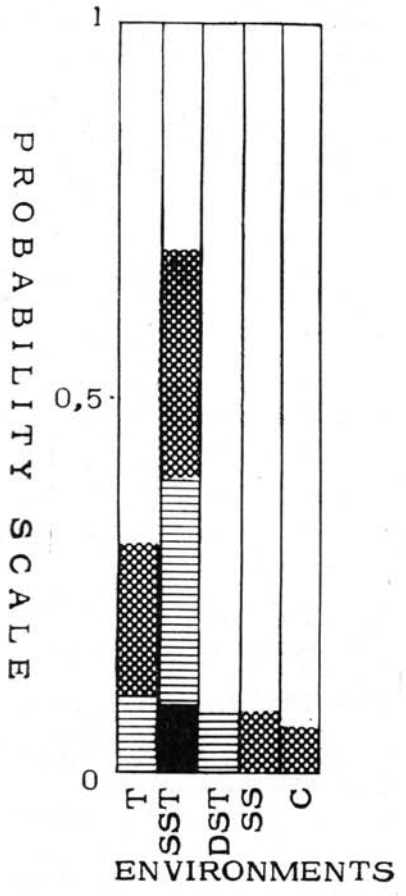

Fig. 33 — Probability of occurrence of *Acartia danae* in different environments.

Acartia negligens Dana

SIZE — ♀ 1.15 mm.

OCCURRENCE — M 489 (60), M 409 (12), M 400 (40), M 394 (600), M 315 (11), M 246 (4), M 243 (5), M 232 (24)*, M 161 (206), M 114 (6), M 97 (6), M 96 (1).

ECOLOGY — Already known from the Brazilian waters. The largest numbers were obtained from subtropical waters. Off South Africa it was abundant in waters of 35.3 °/₀₀ salinity and temperatures around 16.5°C, thus approximately of the same

characteristics as the Brazilian environment. It was also present in tropical waters and in one sample of coastal waters. Heinrich (1961, p. 90) found it usually concentrated in the surface, 0-25 m layer, excepting from 09:45 A.M. to 03:00 P.M. when it was concentrated in the 25-50 m layer or in the 50-100 m layer. Brodsky (1957, p. 55, 59) also recorded higher percentages of this species in the subtropical region than in the tropical and transition regions of the North West Pacific.

Acartia tonsa var. *cryophylla* var. nov.

(Fig. 34)

SIZE — ♀ 1.25 mm; ♂ 1.0 mm (measurements taken from ventral and dorsal view along the midsagittal plane from animals kept in formalin).

DESCRIPTION — It is very much like *A. tonsa* especially the male specimen, but shows slight differences in the following characters:

1 — The first abdominal segment in the male has a few thin spines (Fig. 34d).

2 — The abdomen of the female shows no spinulation along the margin of the abdominal segments (Fig. 34c).

3 — The female's fifth legs have a longer marginal seta on the basal segment than the typical *A. tonsa* (Fig. 34e).

All other characters are exactly the same as those described for the typical *A. tonsa* (Fig. 34a, b, f).

OCCURRENCE — M 88 (2), M 89 (52).

ECOLOGY — Already recorded from Brazil (Rose 1933, p. 276), it was only found in two samples from the south of Brazil, from coastal waters of low salinity (25.48-33.22 ‰) and relatively low temperatures (14.38-15.40°C).

Conover (1956, p. 156-233) studied the ecological requirements of *A. tonsa* in Long Island Sound (N. America). There *A. tonsa* is also a coastal copepod but indicator of warmer water. Though recorded in temperatures ranging from −0.65 to 32.0°C in the North West Atlantic (Deevey 1960, p. 25) in inshore waters, it reaches maximum numbers at the end of August (Deevey 1956, p. 126 and 131) in temperatures above 20°C (Riley 1956, p. 17,

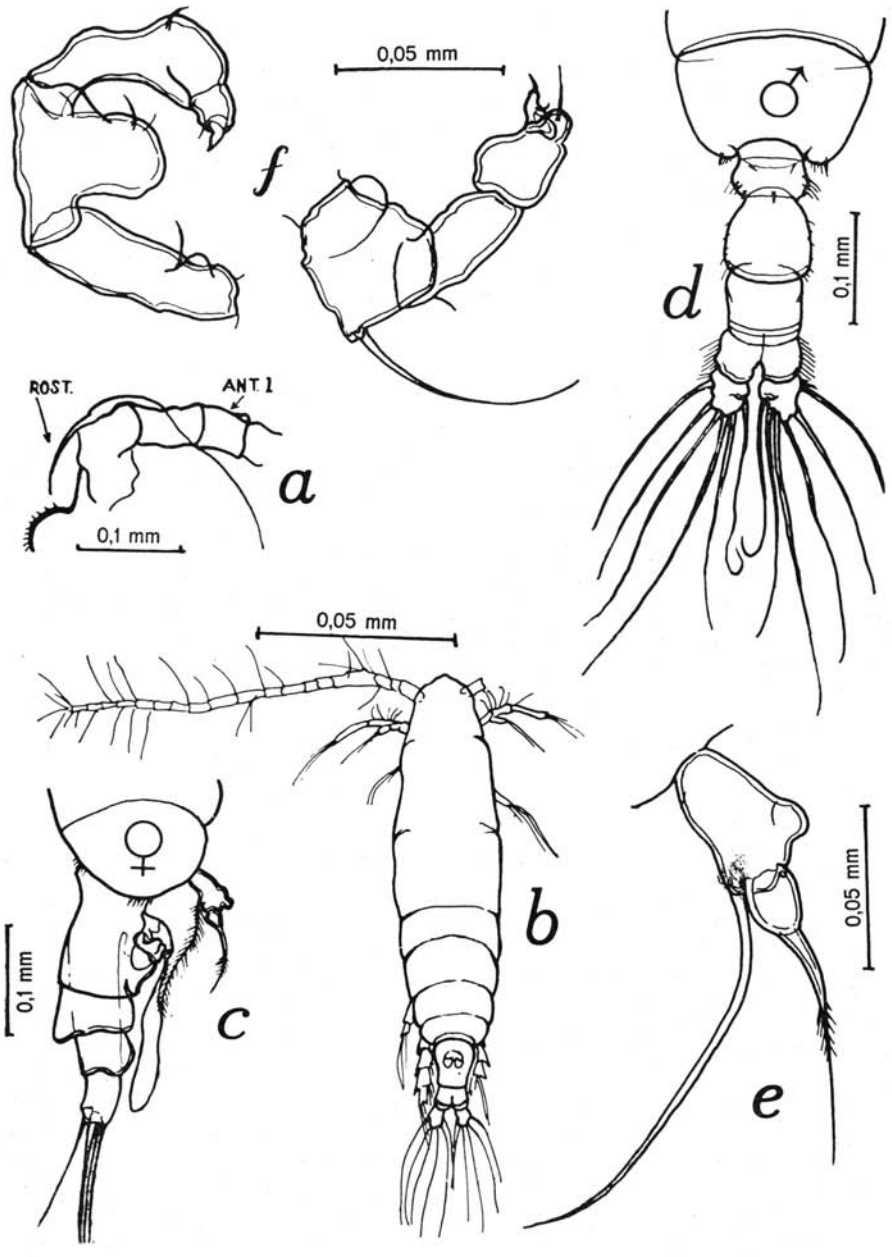

Fig. 34 — *Acartia tonsa* var. *cryophylla* nov.: a — Profile of head region, showing rostrum (ROST.) and first antenna (ANT. 1); b — Dorsal view of female; c — Lateral view of last thoracic segment and abdomen of female; d — dorsal view of last thoracic segment and abdomen of male; e — fifth leg of female; f — fifth legs of male.

fig. 1). In this habitat it is frequently dominant in numbers. It was also found to be strongly euryhaline, in salinities from 4.6-35.4 °/₀₀.

Here it is an indicator of cold southern water, therefore the name of the Brazilian new variety, *cryophilla*.

Conover (1956, p. 218-220) discovered that besides diatoms *A. tonsa* also feeds on dinoflagellates. In one Brazilian specimen the gastric contents were identified by Teixeira as of a dinoflagellate.

Acartia giesbrechti Dahl

SIZE — ♀ 1.1 mm; ♂ 0.9 mm.

OCCURRENCE — M 257 (1435), M 261 (293), M 265 (2670), M 269 (593), M 283 (24).

ECOLOGY — Described from plankton samples taken at the mouth of the Tocantins river (Dahl 1894, p. 13) it was one of the dominant copepods in this estuarine facies, in the lower salinities (5.69 to 34.5 °/₀₀) where it substitutes the *Acartia lilljeborghi* and the *A. tonsa* from the South of Brazil in the characteristic association for this environment. A good indicator of brackish or inshore waters in the area of the Amazon River's mouth.

Acartia clausi Giesbrecht

SIZE — ♀ 1 mm.

OCCURRENCE — E 170 (off Cananéia).

ECOLOGY — It is one of the most common coastal copepods of the North and South cold temperate regions and in the Mediterranean Sea. It was found in the largest numbers by Farran (1929, p. 281) off New Zealand in waters where the temperatures may range from 13°C to 21°C (Sverdrup *et al.*, 1942, charts II-VI) and the salinities are about 35 or 35.5 °/₀₀ and by Conover (1956, p. 177, 189) in temperatures from 12°-18°C and in estuarine conditions (Conover 1956, p. 227). Here it occurred at Station III off Cananéia in the winter and is probably a stray from southern cold waters. This should be expected for in the North Atlantic *A. clausi* is dominant in winter and spring and it is "definitely the more efficient organism at low temperatures" when compared to *A. tonsa* (Conover 1956, p. 221). In the inlet waters of Japan (Yamazi 1956, p. 165) and in the continental bays of the Sea of Japan (Brodsky 1957, p. 73-75) it is among the most frequent species in temperatures between 10 and 23°C and salinity between 10.00 and 32.00 °/₀₀.

Acartia longiremis Lilljeborgh

SIZE — ♀ 1.25 mm; ♂ 1.1 mm.

OCCURRENCE — E 28 (9), E 9 (1), M 403 (40), M 363 (5), M 37 (1), M 36 (2).

ECOLOGY — It is registered for the first time in our coastal and oceanic waters. It was more abundant in a sample from cold southern surface waters (21.09-15.41°C temperature and 35.17-36.88 °/₀₀ salinity). This was to be expected because it is mostly recorded in the northern temperate and boreal waters.

HARPACTICOIDA

Fam. Ectinosomidae

The Species of *Microsetella*

OCCURRENCE — M 513 (1), M 510 (2), M 497 (34), M 489 (3180)*, M 451 (47), M 407 (9), M 395 (3), M 365 (1680)*, M 364 (440)*, M 363 (28), M 315 (105), M 314 (24), M 208 (6), M 190 (3), M 189 (1), M 188 (1), M 186 (186), M 161 (Pr.), M 98 (1), M 97 (1), E 164 (2), E 41 (Pr.), E 39 (20)*, E 2 (20)*.

REMARKS — *Microsetella rosea* and *Microsetella norvegica* have been registered off the coast of Brazil. Many young *Microsetella* were doubtfully identified first as *M. norvegica* (Boeck) and afterwards as *M. rosea* (Dana). No separation was therefore made between the species in the tables. They were all considered as *Microsetella* spp. Adult *Microsetella rosea* and last copepodites of this species have been identified with certainty in the following occurrences. As can be seen from the occurrences above *Microsetella* generally prefers the open sea. It is known that it occurs in swarms, and it is frequently present in coastal waters and shelf waters as well, off the south of Brazil. Though very small its great numbers are responsible for the fact that it is, when present in the plankton, an important constituent of the food of plankton eaters.

Farran (1929, p. 297) registered the largest number of *M. rosea* in subtropical waters and of *M. norvegica* in the temperate North Atlantic and between 40° and 50° S Lat. in the Pacific where temperatures are cooler. Hensen (1911, p. 281) counted more *Microsetella* in the colder than in the warm waters.

Microsetella rosea (Dana)

SIZE — ♀ 0.60-0.65 mm.

OCCURRENCE — M 497 (2), M 489 (180)*, M 451 (2), M 407 (7), M 403 (480), M 402 (160)*, M 394 (3), M 368 (26), M 365 (1240)*, M 364 (920)*, M 363 (28), M 314 (10), M 238 (2), M 232 (460)*, M 208 (9), M 190 (1), M 189 (12), M 187 (3), E 164 (2), E 39 (1), E 32 (1), E 5 (100)*, E 1 (25)*.

ECOLOGY — This small copepod occurs usually in swarms and was found in great numbers in the gastric contents of some plankton-eating fishes (Table XII). It was found in very saline oceanic tropical and subtropical, in deeper and shallow shelf and in coastal waters. It may not have been more frequently found because it escaped from the zooplankton nets usually used (Almeida Prado, 1962) due to its small size. It reached the highest percentages in very saline and warm oceanic waters. The *Microsetella* were among the chief constituents of the copepod fauna during the "Meteor" Expedition (Hentschel 1933, p. 87), but Hensen (1911, p. 304) observed double as many *Microsetella* in the northern hemisphere than in the southern during the "Plankton" Expedition. As our samples were not always obtained with the phytoplankton nets, it is not advisable to draw conclusions from them. In the Pacific Heinrich (1961, p. 91) observed the greatest concentrations of *M. rosea* in the surface layers in the North West subtropical region.

Fam. Macrosetellidae

Macrosetella gracilis (Dana)

(Fig. 35)

SIZE — ♀ 1.8 mm; ♂ 1.25 mm.

OCCURRENCE — M 513 (60)*, M 497 (2), M 489 (60)* M 409 (2), M 403 (80), M 402 (Pr.), M 395 (3), M 394 (120)*, M 389 (80)*, M 368 (Pr.), M 365 (200)*, M 364 (9)*, M 363 (6)*, M 246 (1), M 241 (19), M 240 (94), M 238 (2), M 232 (1), M 208 (14), M 189 (2), M 188 (3), M 166 (4), M 162 (7), M 161 (2), M 160 (7), M 114 (4), M 112 (2), M 100 (1), M 99 (3), M 98 (28), M 97 (9), M 96 (2), M 95 (3), M 93 (1), M 75 (3), M 74 (1), M 39 (5), M 38 (7), M 37 (8), M 36 (3), M 35 (9), E 16 (20), E 15 (40), E 13 (100), E 11 (60), E 7 (100)*.

REMARKS — The "Challenger" Expedition recorded this species in the South Atlantic (Brady 1883, p. 23). Davis (1950, p. 101) lists this species as "confined to open waters" on East and West coasts of Florida. Yamazi (1958, p. 153-154) labels it as oceanic, tropical or subtropical in the Pacific. Wheeler (1900, p. 188) lists it among the species of the Gulf Stream. Bogorov (1958, p. 152) places it among the copepods of the zone of mixing (15-18°C) and of tropical (18-27°C) oceanic surface waters.

The data obtained from Brazilian waters corroborate Yamazi and Bogorov in what concerns the temperatures of the waters in which it is found (Fig. 35), but although oceanic, this species also occurs in coastal waters in large numbers (E 15, E 7). Heinrich (1961, p. 92) found it in very large numbers in the subtropical North West Pacific concentrated in the surface layer or in the 25-50 m layer in the morning and afternoon. At noon hours it migrates down to 50-100 m and at dusk and dawn it is concentrated in the 100-200 m layer.

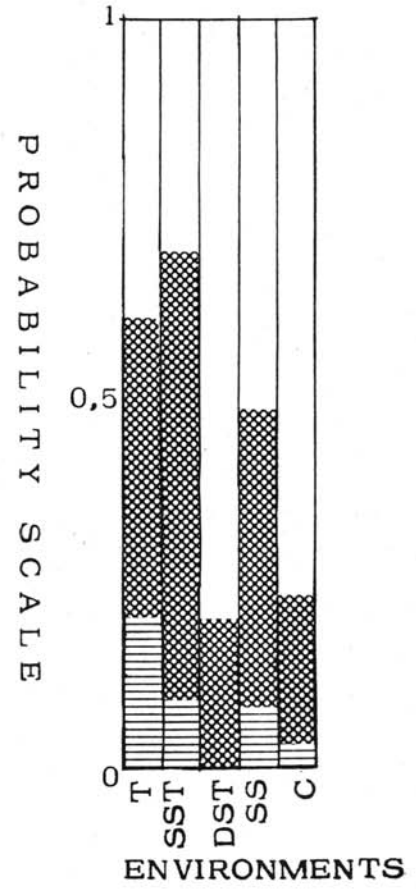

Fig. 35 — Probability of occurrence of *Macrosetella gracilis* in different environments.

Oculosetella gracilis (Dana)

Syn. *Setella gracilis* Sars

SIZE — ♂ 1.15 mm; ♀ 1.2 mm.

OCCURRENCE — M 409 (2), M 407 (Pr.), M 403 (Pr.), M 394 (3), M 364 (Pr.).

REMARKS — It occurred in samples of high salinity and lower temperatures, in subtropical waters. Moore has registered this species off the Bermudas also in the subtropical region (Moore 1949, p. 64).

SYSTEMATIC NOTE — But for its vivid coloration and big eye lenses it would easily be mistaken for *Macrosetella gracilis*. The males recorded here are slightly longer than those figured by Wilson (1932, p. 283).

Miracia efferata Dana

SIZE — ♀ 1.9 mm.

OCCURRENCE — M 489 (120)*, M 247 (1), M 246 (2).

REMARKS — Registered for the first time off Brazil in oceanic and tropical waters. Farran (1929, p. 298) registered its largest numbers in the tropical Atlantic.

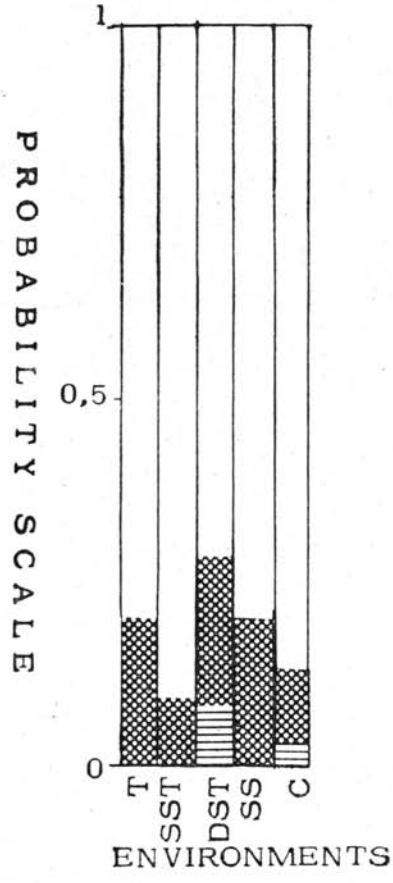

Fig. 36 — Probability of occurrence of *Clytemnestra rostrata* (Brady) in different environments.

Fam. Clytemnestridae

Clytemnestra scutellata Dana

(Fig. 36)

SIZE — ♀ 1.2 mm.

OCCURRENCE — M 497 (1), M 403 (1), M 368 (1), M 240 (1), M 232 (4), M 208 (5), M 203 (2), M 190 (1), M 189 (1), M 186 (4), M 98 (1), M 95 (Pr.), M 73 (1), M 38 (2), M 35 (1), P 17 (Pr.), P 15 (Pr.), P 13 (Pr.), P 12 (Pr.), P 11 (Pr.), P 10 (1), P 9 (Pr.), P 8 (Pr.), P 7 (Pr.), P 6 (Pr.), P 5 (Pr.), P 4 (Pr.), P 3 (Pr.), P 2 (Pr.), P 1 (Pr.), E 4 (Pr.), E 5 (1), E 14 (Pr.), E 24 (Pr.), E 32 (Pr.), E 120 (20)*, V 13 (20)*, V 19 (60)*.

REMARKS — It occurred sparingly in samples of nearly all the water masses examined. The highest percentages of this species appeared in coastal waters mixed with shelf waters and

with salinities from 33.73 to 35.49 °/₀₀ and in deeper shelf waters. Hensen (1911, p. 281) registered the highest percentage of this species in the warm rather than in the cold region during the "Plankton" Expedition.

Fam. Longipediidae

Longipedia mourei Jakobi

SIZE — ♀ 0.8 mm.

OCCURRENCE — IV 244 (8), III 320 (1), IV 218 (1).

REMARKS — Studied from the muddy sand in inshore waters of Paranaguá Bay (Jakobi 1954a, p. 210-211) it occurred in three samples in small numbers, taken further north, in Cananéia, from very shallow inshore waters (10 m deep) of low salinity (22.37 to 33.69 °/₀₀) and temperatures from 16 to 27.7°C. It is an euryhaline brackish water benthal copepod according to Remane's (1958, p. 101) classification.

Fam. Tachidiidae

Euterpina acutifrons

(Fig. 37)

SIZE — ♀ 0.85 mm.

OCCURRENCE — M 389 (40)*, M 208 (23), M 203 (52), M 190 (52), M 189 (2), M 188 (15), M 186 (3), M 78 (1), M 76 (1), M 73 (1), E 170 (60)*, E 164 (2), E 41 (60)*, E 39 (1540)*, E 32 (80)*, E 30 (Pr.), E 28 (4060)*, E 24 (140)*, E 16 (2080)*, E 15 (1), E 14 (20)*, E 12 (1720)*, E 10 (24), E 9 (Pr.), E 8 (13), E 4 (80)*, E 2 (660)*, P 13 (18), P 12 (6), P 10 (28), P 9 (6), P 7 (4), P 5 (2), P 4 (3), P 2 (1), IV 244 (26), IV 218 (47), III 322 (4), III 321 (201), III 320 (43), II 68 (153), V 13 (1).

REMARKS — Present in the samples from deeper very saline shelf waters. It reached the highest percentages among the copepods of coastal waters. It has a smaller form in waters of low

salinity. Though present in larger percentage in warm waters during the "Plankton" Expedition (Hensen 1911, p. 281) it showed preference for cooler waters off Brazil (Fig. 37).

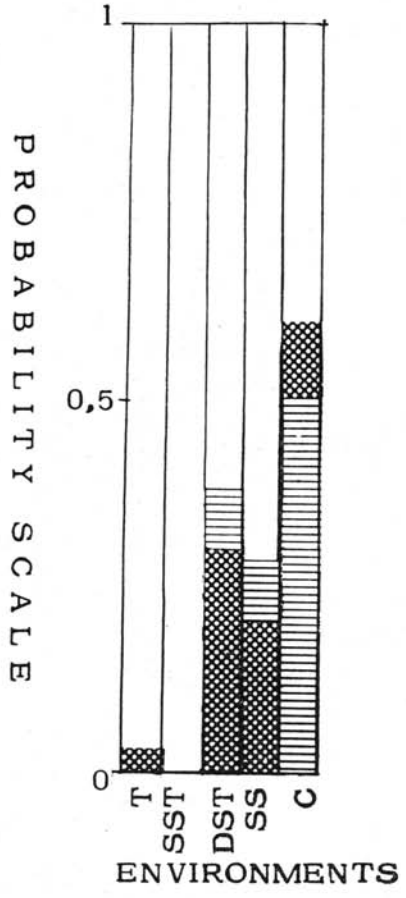

Fig. 37 — Probability of occurrence of *Euterpina acutifrons* in different environments.

Unknown Nauplius

SIZE — ♀ 1.6 mm.

OCCURRENCE — M 368 (Pr.), M 314 (1), M 240 (2), M 190 (2), M 114 (1), M 113 (1), M 107 (1), M 73 (2), M 39 (1), M 38 (4), M 37 (1), M 36 (5), M 33 (3), E 16 (40)*, E 15 (40)*, E 13 (1), E 12 (1), P 13 (4), P 11 (2), P 10 (3).

REMARKS — It reached the highest percentages relatively to other copepods in shelf waters (of higher salinity and higher temperature). It occurred also rarely in tropical waters and more frequently, but in small numbers, in coastal waters.

Fam. Clausidiidae

Sapphirella sp.

Syn. *Lanowia prowazeki* Lejeune de Oliveira, 1945

SIZE — 0.9 mm (young animal).

OCCURRENCE — E 28 (Pr.), E 24 (1), M 208 (10), M 203 (28), III 321 (1), III 322 (1), IV 218 (1), M 246 (1).

REMARKS — *"Sapphirella"* is probably a young copepod form in the first copepodite stage (Sewell 1928, p. 802-803). It has been registered off Rio de Janeiro under the name *Lanowia prowazeki* (Oliveira 1945, p. 465-468, est. 4, 7). It occurred in

southern coastal waters and in one sample of tropical water off the coast of Pernambuco. It fits the general description of *"Sapphirella" tropica* (Farran 1936, p. 139) and of *"Sapphirella" indica* (Sewell 1928, p. 800-803).

Other *Harpacticoida*

In some samples from coastal waters and also from inshore waters some unidentified benthal harpacticoida were present.

CYCLOPOIDA

Fam. Oithonidae

Genus OITHONA Baird

The small size and the delicacy of the animals which belong to this genus make it difficult to identify them with precision when in great numbers.

Reviewed in 1917 by Rosendorn (1917, p. 3-58), the following species of this genus were assigned to Brazilian waters: *O. plumifera, O. setigera* (= *O. challengeri*? Brady = *O. tropica* Wolf), *O. similis* Claus; *O. minuta* Scott (= *O hebes* Wolf) and *O. simplex* Farran (at the mouth of the Amazon River); *O. amazonica* Burkhardt from fresh water in the Aramá Grande River on the Marajó Island, and at the Amazon River's mouth.

O. nana and *O. brevicornis* were recorded in the Congo River's mouth; *O. plumifera* had its greatest relative numbers in the Guinea Gulf. *O. setigera, O. robusta, O. tenuis, O. fallax* and *O. pseudofrigida* had their maxima in the Indian Ocean.

O. atlantica, O. frigida, O. similis had their maxima in the cold southern and northern waters (West Wind Drift and Arctic). The remaining species apparently are typical of the tropical and subtropical regions.

O. plumifera seems to be the most widespread copepod in the Brazilian waters. *O. nana* is the next in frequency. *O. setigera* occurred in samples of very saline but usually cooler waters of the shelf or subtropical waters. *O. oculata* was registered for the first time off Brazil in very saline and warm waters. *O. ovalis, O. brevicornis, O. amazonica* occurred in samples of coastal or almost brackish waters in small numbers or in swarms. All were registered chiefly off the southern coast of Brazil.

O. robusta was registered in samples M 240 (4), and M 315 (13), in very saline and warm waters.

The cold water species, *O. atlantica* and *O. frigida* were not yet registered here and neither were *O. tenuis*, *O. fallax* and *O. pseudofrigida*, which seem to be restricted to the African region of the Atlantic and to the West Wind Drift. In many samples, young unidentifiable *Oithona* were found: M 244 (47), M 363 (28), M 395 (43), M 400 (110), M 513 (46).

Oithona plumifera Baird

(Fig. 38)

SIZE — ♀ 1.1-1.8-1.9 mm; ♂ 1.2 mm.

OCCURRENCE — M 510 (1020), M 497 (277), M 489 (27), M 451 (980), M 409 (15), M 407 (3), M 402 (240)*, M 394 (24), M 389 (560)*, M 368 (7), M 364 (2240)*, M 365 (29)*, M 315 (209), M 314 (107), M 283 (12), M 247 (289), M 246 (179), M 245 (33), M 244 (60), M 243 (45), M 242 (34), M 241 (110), M 240 (140), M 236 (1), M 232 (80)*, M 208 (17), M 190 (13), M 189 (102), M 187 (61), M 173 (1), M 163 (90), M 161 (3), M 114 (34), M 113 (27), M 112 (5), M 111 (1), M 107 (Pr.), M 100 (2), M 99 (90), M 98 (199), M 97 (10), M 96 (6), M 88 (3), M 76 (18), M 75 (30), M 74 (22), M 73 (8), M 39 (11), M 38 (28), M 37 (70), M 36 (113), M 35 (21), M 33 (19), M 32 (4), M 31 (2), M 30 (1), P 17 (Pr.), M 15 (Pr.), P 14 (Pr.), P 13 (3), P 12 (17), P 11 (38), P 10 (4), P 9 (41), P 8 (7), P 7 (47), P 6 (42), P 5 (8), P 4 (27), P 3 (10), P 2 (37), P 1 (15), E 170 (Pr.), E 164 (3), E 41 (280)*, E 39 (40)*, E 24 (Pr.), E 16 (400)*, E 15 (320)*, E 12 (Pr.), E 11 (360)*, E 10 (880)*, E 9 (6), E 8 (2), E 7 (260)*, E 4 (20)*,

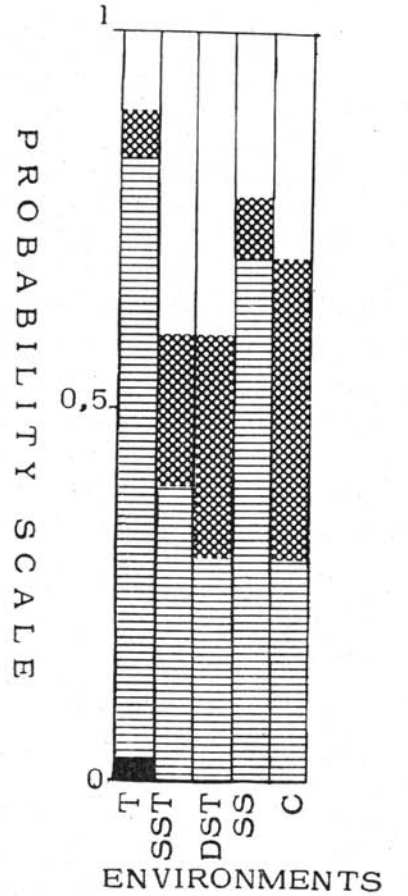

Fig. 38 — Probability of occurrence of *Oithona plumifera* in different environments.

E 3 (140)*, E 2 (Pr.), E 1 (75)*, V 19 (1140)*, V 13 (320)*, V 2 (Pr.), V 1 (540), III 320 (1), II 68 (1), IV 244 (1).

REMARKS — The absence of this species in some samples may be due to selectivity of the net used. Zooplankton nets usually do not catch the copepodites for they escape through the larger meshes (Almeida Prado, 1962).

It is one of the most common copepods. It is cosmopolitan and occurs in coastal and in oceanic waters. It was not usually present in the samples from brackish water and its largest numbers and frequencies occurred in oceanic and shelf waters with higher salinity (Fig. 38). Farran (1929, p. 282) registered the largest numbers in the tropical Atlantic.

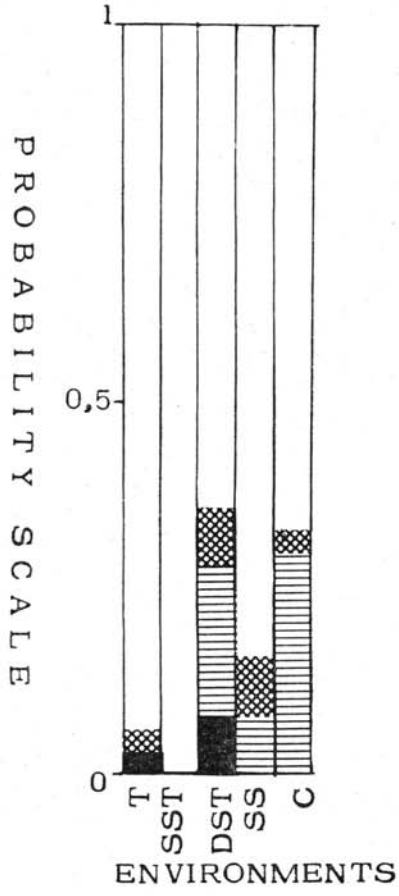

Fig. 39 — Probability of occurrence of *Oithona nana* in different environments.

Oithona nana Giesbrecht

(Fig. 39)

SIZE — ♀ 0.55-0.6 mm; ♂ 0.4 mm.

OCCURRENCE — M 510 (Pr.), M 395 (Pr.), M 236 (2004), M 208 (19), M 190 (Pr.), M 189 (531), M 188 (1), M 187 (11), M 186 (5), M 163 (Pr.), E 41 (Pr.), E 39 (980)*, E 32 (120)*, E 30 (Pr.), E 28 (Pr.), E 24 (280)*, E 14 (320)*, E 13 (500)*, E 12 (1280)*, E 10 (880)*, E 8 (2), E 5 (1960)*, E 4 (1980)*, E 2 (12,920)*, P 2 (496), P 9 (7), P 10 (7), P 11 (1), P 12 (2), P 13 (3), III 321 (151).

REMARKS — Labelled as "neritic or littoral, south-temperate" by Yamazi (1958, p. 153) for Japanese waters, it seems to prefer deeper shelf and coastal waters here also (Fig. 39). It sometimes forms very large patches. As the nets generally used for sampling were zooplankton nets its absence in many samples may be due to the mesh size.

Oithona setigera (Dana)

(Fig. 40)

SIZE — ♀ 1.80-2.0 mm; ♂ 0.93 mm.

OCCURRENCE — M 403 (280), M 400 (Pr.), M 395 (Pr.), M 394 (Pr.), M 389 (40), M 365 (80)*, M 364 (40)*, M 315 (57), M 314 (5), M 208 (2), M 190 (23), M 187 (3), M 162 (9), M 160 (16), M 113 (3), M 111 (3), M 78 (59), M 75 (11), M 74 (5), M 73 (4), M 36 (6), M 35 (2), V 19 (30)*.

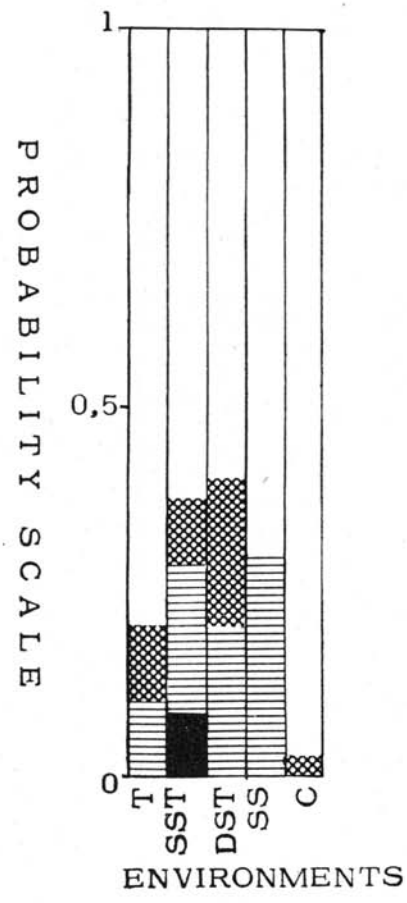

Fig. 40 — Probability of occurrence of *Oithona setigera* in different environments.

REMARKS — Dominant in surface subtropical waters. It occurred more frequently in samples taken from very saline deeper and surface shelf waters, in salinity above 35.00 ‰. Farran (1929, p. 283) found the largest numbers of this species in the tropical Atlantic.

Oithona oculata Farran

SIZE — 0.6 mm (juvenile).

OCCURRENCE — M 513 (Pr.).

REMARKS — Discovered in Samoan waters which belong to the tropical waters of the Pacific, it was registered in the warmest waters off Brazil in the South Equatorial Current. It is easily recognized by the eye lenses.

Oithona ovalis Herbst

SIZE — ♀ 0.55-0.6 mm; ♂ 0.50-0.55 mm.

OCCURRENCE — E 41 (300), E 28 (1140), E 8 (27), E 12 (Pr.), E 39 (Pr.), E 2 (Pr.), II 68 (2), III 320 (54), III 322 (161), IV 218 (91), IV 244 (8), P 13 (3).

ECOLOGY — Discovered in the brackish waters of the mangrove region of Southern Brazil (Herbst 1955, p. 215) it occurred in several samples taken from coastal waters apparently as a stray visitor from the mangrove region nearby and in several samples from the inshore waters near the mangrove region, where it was sometimes the dominant copepod (Tundisi)*.

SYSTEMATIC NOTE — It is very easily mistaken for *Oithona nana*, the difference being the pointed cephalon of *O. ovalis* and the flat cephalon, the mandibulae and maxillae of *O. nana*. It is also difficult to distinguish it from *O. minuta*, from which it differs only in the details of the mandibula and maxila (see Rosendorn 1917, p. 36).

Oithona similis Claus

OCCURRENCE — M 166 (1 juv.).

REMARKS — It was found in the cold southern waters off Brazil and in a sample of subtropical water off South Africa (Table XVI). This should be expected for in the North Atlantic it is a cold water form (Deevey 1960, p. 47).

Fam. Oncaeidae

Though sometimes in very large numbers, the representatives of this family do not generally influence the volume of plankton samples strikingly, because of their usually small size.

Lubbockia squillimana Claus

SIZE — ♂ 2.0 mm.

OCCURRENCE — M 409 (Pr.), M 407 (1), M 403 (4), M 402 (40)*, M 368 (Pr.), M 365 (200)*, M 315 (1), M 314 (1), M 241 (1), M 240 (3), M 113 (1), M 111 (1), M 78 (1), M 76 (2), M 75 (1), V 13 (1).

REMARKS — It is another usually scarce copepod, entirely absent from all the coastal water samples examined. It occurred in three samples of the deeper saline layers and in several samples of very saline water (above 36 ‰) and of temperatures ranging from 14.3 to 29.27°C. It is registered off Brazil for the first time. Heinrich (1961, p. 91) found it usually concentrated in the 25-50 m layer in the subtropical North West Pacific region.

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* Tundisi, J. — São Paulo, Inst. Ocean. Personal communication.

Oncaea media Giesbrecht

(Fig. 41)

SIZE — ♀ 0.85-0.95 mm; ♂ 0.7 mm.

OCCURRENCE — M 513 (360)*, M 510 (400)*, M 451 (120)*, M 497 (123), M 489 (3600)*, M 409 (16), M 407 (36), M 402 (800)*, M 400 (12), M 395 (97), M 394 (600)*, M 389 (4960)*, M 368 (67), M 365 (560)*, M 364 (3320)*, M 315 (188), M 314 (2), M 247 (84), M 246 (37), M 245 (1), M 244 (144), M 243 (6), M 242 (5), M 241 (18), M 240 (79), M 236 (16), M 238 (34), M 232 (360)*, M 208 (224), M 203 (80), M 190 (5000), M 189 (32), M 188 (21), M 187 (131), M 186 (31), M 173 (1), M 166 (25), M 162 (16), M 160 (1), M 114 (55), M 113 (24), M 112 (1), M 111 (17), M 99 (122), M 98 (177), M 97 (122), M 96 (93), M 95 (57), M 93 (7), M 89 (1), M 88 (2), M 78 (49), M 76 (55), M 75 (34), M 74 (21), M 73 (3), M 39 (15), M 38 (43), M 37 (204), M 35 (46), M 33 (125), M 32 (5), M 31 (2), M 30 (5), E 170 (3), E 164 (4), E 41 (500)*, E 39 (4400)*, E 32 (140)*, E 30 (360)*, E 28 (5780)*, E 24 (4820)*), E 16 (57,100)*, E 15 (1), E 14 (8420)*, E 13 (20)*, E 12 (7930)*, E 10 (1460)*, E 8 (1023), E 5 (3520)*, E 4 (40,220)*, E 2 (24,440)*, P 10 (44), P 9 (16), P 1 (1), V 1 (20), V 19 (270)*, II 68 (255), IV 244 (2), III 321 (1).

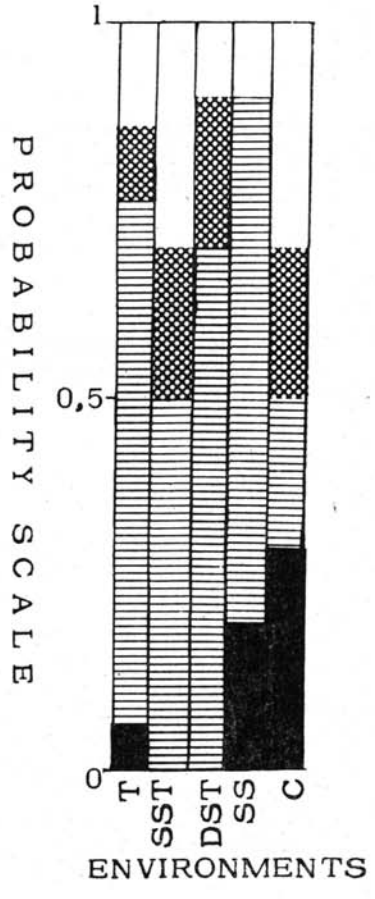

Fig. 41 — Probability of occurrence of *Oncaea media* in different environments.

REMARKS — The most common *Oncaea* in our collections. A smaller form (yellow) occurs in coastal waters and a larger (blueish or lilac when kept in formalin) in the more saline waters. It is frequently the dominant plankter in number of specimens present in the sample. It is small but since it is often present

in large swarms it occurs frequently in the gastric contents of plankton-feeding fish. It was found in the largest numbers in coastal and shelf waters. In coastal waters its number diminishes considerably as the salinity decreases. Farran (1929, p. 285) found the largest numbers of this species between 30° and 40° Lat. S in temperatures which vary between 15° and 21°C and in salinities around 35.00 °/₀₀.

Oncaea venusta Philippi

(Fig. 42)

SIZE — ♀ 1.01-1.40 mm; ♂ 0.95 mm.

OCCURRENCE — M 513 (1), M 497 (15), M 489 (900)*, M 409 (13), M 407 (105), M 403 (150), M 402 (320), M 400 (1), M 395 (22), M 394 (640)*, M 389 (120)*, M 368 (Pr.), M 365 (Pr.), M 364 (400)*, M 363 (31), M 315 (35), M 314 (27), M 247 (20), M 246 (39), M 243 (12), M 242 (3), M 232 (280), M 189 (21), M 187 (17), M 173 (1), M 166 (1), M 163 (3), M 161 (172), M 160 (21), M 114 (14), M 113 (3), M 112 (37), M 111 (50), M 107 (Pr.), M 100 (9), M 96 (1), M 78 (10), M 75 (5), M 74 (7), M 39 (4), M 37 (5), M 36 (11), M 35 (8), M 33 (1), M 31 (1), E 4 (20)*.

REMARKS — In larger numbers in oceanic tropical and subtropical surface waters and usually in smaller numbers or absent in coastal and shelf waters. A good indicator because of its colour and large numbers.

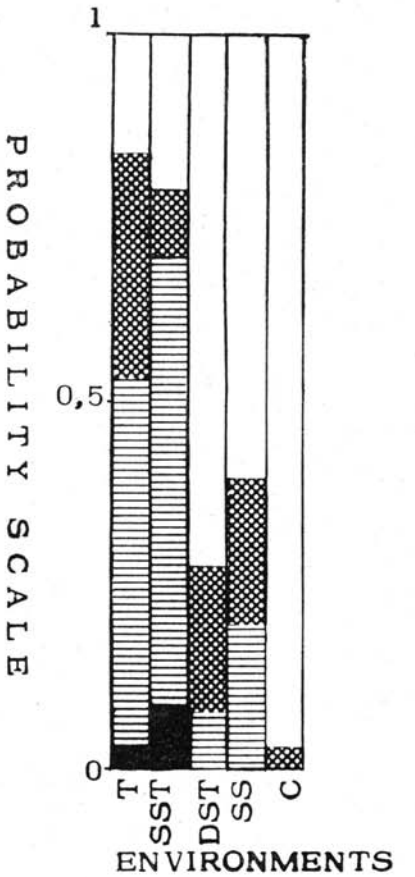

Fig. 42 — Probability of occurrence of *Oncaea venusta* in different environments.

Oncaea mediterranea Claus?

SIZE — ♂ 0.8 mm.

OCCURRENCE — M 403 (417), M 402 (840)*, M 400 (24), M 394 (40)*, M 389 (120)*, M 364 (440)*, M 315 (100), M 113 (2), M 78 (2), M 36 (106), E 30 (360)*, E 28 (5760)*, M 451 (40), M 497 (12), M 489 (1500)*, E 16 (100), E 12 (7930)*, E 8 (109), E 5 (20)*, V 13 (20).

REMARKS — An animal was usually found in coastal waters with the characteristics of *O. mediterranea* but it was never found in the adult stage, therefore it may be a juvenile form of some other *Oncaea*. *O. mediterranea* had not been recorded in Brazilian waters. The largest number of *O. mediterranea* was found in very saline, cold, southern, surface waters. It is eurythermic with its optimum environment in the temperate waters of the world (Mediterranean Sea, off New Zealand — Farran 1929, p. 285). Vervoort (1957, p. 147) registered it in deep layers off the Antarctic in 12.6°C down to 7.9°C.

Oncaea conifera Giesbrecht

SIZE — ♀ 1.05-1.3 mm; ♂ 0.7-1.0 mm.

OCCURRENCE — M 407 (20), M 403 (120), M 395 (2), M 389 (80)*, M 187 (4), M 111 (3), M 78 (17), M 76 (5), M 75 (10), M 74 (5), M 38 (4), M 36 (1), M 30 (1), E 2 (45,000)*, V 1 (20), V 13 (20).

REMARKS — Not previously recorded in Brazilian waters, this animal was frequently found in small numbers in coastal and in water masses where the temperature was below 22°C approximately. It is a species which prefers temperate waters (Farran 1929, p. 286; Vervoort 1957, p. 146-147). It was registered in deep layers (down to 750 m) in temperatures around 8 and 7°C and salinities about 34.00 °/₀₀ off the Antarctic Continent (Vervoort 1957, p. 147 and Johnston, 1937).

Oncaea subtilis Giesbrecht

SIZE — ♂ 0.4 mm; ♀ 0.5 mm.

OCCURRENCE — M 395 (2), M 389 (80)*, M 368 (Pr.), M 365 (5), M 363 (174), M 315 (64), M 236 (144), M 189 (89), M 161 (1), M 95 (5), M 76 (1), E 15 (1), E 10 (1460)*, E 5 (18,680)*, E 4 (3700)*, E 3 (40)*, E 2 (29,820)*.

REMARKS — Not yet found in the South Atlantic. It occurs in swarms chiefly in deep coastal waters and in shelf waters.

In more saline waters it was registered in lower temperatures (22°C or less). According to Farran (1929, p. 286) it occurred in largest numbers in waters with low temperatures (76-78° S Lat.), thus suggesting that this species is very eurythermic, but strongly cryophile.

Oncaea minuta Giesbrecht

SIZE — ♀ 4.5 mm.

OCCURRENCE — M 314 (8), M 365 (640)*, M 368 (?), M 513 (?).

REMARKS — Registered with certainty only in two samples, it is one of the species which may pass through the larger meshed plankton nets because of its small size.

Fam. Corycaeidae

Systematically and zoogeographically this is perhaps the best studied family of marine cyclopoid copepoda in the South Atlantic.

Dahl (1912, p. 129) classifies them as coastal subtropical and tropical for the Atlantic. When compared with Klevenhusen's (1933, p. 97) conclusions for the South Atlantic, we find that both authors agree for most *Corycaeus* species, classifying them as follows:

COASTAL	SUBTROPICAL	TROPICAL
C. africanus	*C. clausi*	*C. speciosus*
C. amazonicus	*C. flaccus*	*C. furcifer*
C. giesbrechti	*C. typicus*	*C. latus*
	C. limbatus	*C. gracilis*
	C. lautus	
	C. furcatus	
	C. rostratus	

The present study reveals why Klevenhusen and Dahl do not agree sometimes as to whether a copepod is coastal or oceanic. Preferentially coastal forms such as *C. giesbrechti* may occur in oceanic waters in small numbers and others, oceanic like *C. latus*, may occur in coastal waters too. Of the Corycaeidae registered here by Klevenhusen (1933) only *Ditrichocorycaeus minimus* was not found. *C. africanus* was registered here for the first time.

Genus CORYCAEUS Dana

C. Onychocorycaeus giesbrechti Dahl

(Fig. 43)

SIZE — ♂ 0.8-1.1 mm; ♀ 1.0 mm.

OCCURRENCE — M 394 (40)*, M 389 (880)*, M 365 (160), M 364 (40)*, M 315 (3), M 283 (37), M 265 (1140)*, M 261 (1), M 257 (9), M 243 (5), M 242 (1), M 241 (4), M 238 (2), M 236 (21), M 232 (40), M 208 (79), M 203 (31), M 190 (140), M 189 (9), M 188 (46), M 187 (70), M 186 (34), M 173 (51), M 166 (2), M 162 (1), M 112 (3), M 111 (16), M 107 (8), M 100 (4), M 99 (66), M 98 (58), M 97 (1), M 96 (6), M 95 (Pr.), M 93 (39), M 88 (1), M 78 (65), M 76 (1), M 75 (127), M 74 (137), M 73 (43), M 39 (2), M 38 (43), M 37 (4), M 36 (21), M 35 (176), M 32 (7), M 31 (12), M 30 (7), E 170 (140)*, E 164 (30), E 41 (Pr.), E 39 (320)*, E 32 (40)*, E 30 (1), E 28 (380)*, E 24 (100)*, E 16 (1060)*, E 15 (2120)*, E 14 (200)*, E 13 (1620)*, E 12 (1380)*, E 11 (2920)*, E 10 (240)*, E 9 (29), E 8 (11), E 7 (700)*, E 4 (340)*, E 3 (6520)*, E 2 (400)*, E 1 (1650)*, P 13 (22), P 12 (37), P 11 (18), P 10 (29), P 9 (17), P 8 (4), P 7 (21), P 6 (16), P 5 (3), P 4 (21), P 3 (10), P 2 (15), P 1 (8), III 320 (5), II 68 (41), IV 244 (27), III 321 (3), V 1 (800), V 2 (Pr.), V 3 (Pr.), V 13 (160)*, V 19 (1710)*.

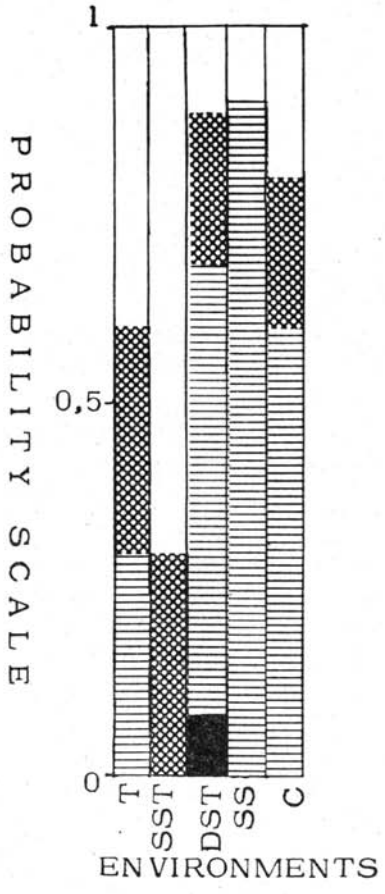

Fig. 43 — Probability of occurrence of *Corycaeus giesbrechti* in different environments.

ECOLOGY — *C. giesbrechti* is usually present and may occur in dominant or subdominant numbers in shelf and coastal waters (Fig. 43). It also occurs in the other waters, but in small per-

centages relatively to other copepods. In samples from water layers of very low salinity, under 20 °/₀₀, off the Amazon River's mouth and off Cananéia, the animal did not occur. It did not occur or appeared in very small numbers in two samples of coastal waters under 16°C of temperature taken from the surface. It seems to prefer waters of salinities ranging from more or less 30.00 to 35.00 °/₀₀ with temperatures above 15.4°C. This is corroborated by Dahl's (1894, p. 12) and Farran's (1929, p. 295) findings. It is an eurythermic thermophile, preferring shelf and coastal waters.

C. Ditrichocorycaeus amazonicus Dahl

SIZE — ♀ 0.9 mm; ♂ 0.82 mm.

OCCURRENCE — M 365 (Pr.), M 283 (42), M 265 (2370)*, M 208 (1), M 203 (3), M 173 (1), M 78 (11), M 76 (60), M 74 (6), M 73 (13), M 38 (4), M 30 (6), E 170 (7), E 28 (Pr.), E 24 (Pr.), E 13 (80)*, E 12 (1), E 9 (1), E 5 (40)*, E 4 (740)*, E 3 (3660)*, V 13 (40), V 1 (60) , II 68 (49), III 320 (1).

REMARKS — It occurs sparingly in the samples where *C. giesbrechti* is very numerous. The greatest percentage of this copepod occurred in waters where the salinity of some layers was under 34.00 °/₀₀. More samples should be examined to establish its preferential environment.

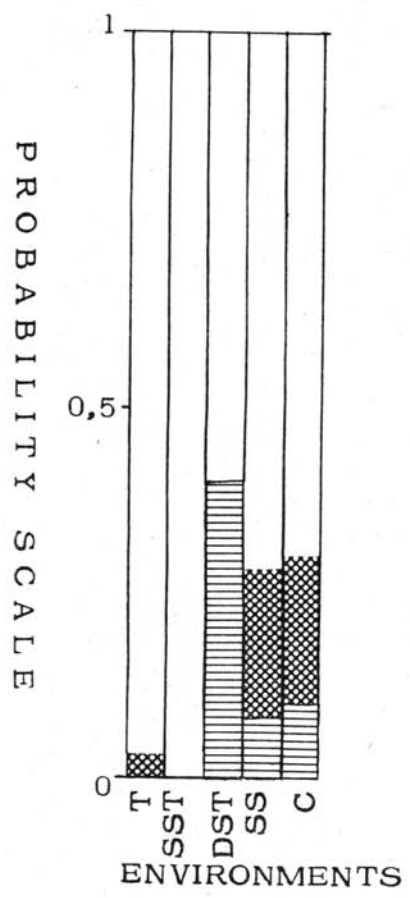

Fig. 44 — Probability of occurrence of *Corycaeus amazonicus* in different environments.

C. Ditrichocorycaeus africanus Dahl

SIZE — ♀ 1.2 mm; ♂ 0.95 mm.

OCCURRENCE — M 283 (12), M 265 (1200)*, M 163 (2), M 75 (9).

REMARKS — It occurred in samples off the northern coast in low salinities and high temperatures and in small numbers off the South of Brazil. Klevenhusen (1933, tab. 38) and Dahl (1912, p. 63-64) only registered it off the Atlantic coast of Africa.

C. Corycaeus speciosus Dana

(Fig. 45)

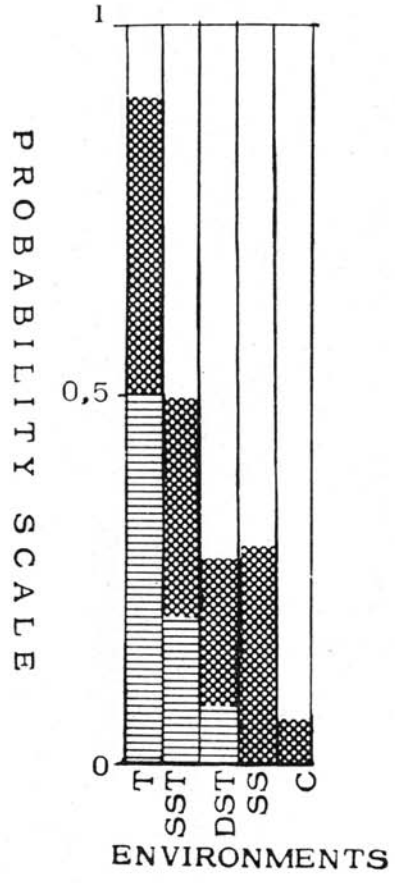

Fig. 45 — Probability of occurrence of *Corycaeus speciosus* in different environments.

SIZE — ♂ 1.95 mm; ♀ 2.5 mm.

OCCURRENCE — M 497 (7), M 489 (720)*, M 451 (40), M 409 (2), M 407 (4), M 403 (80), M 402 (160)*, M 394 (120)*, M 389 (40)*, M 368 (2), M 364 (80)*, M 363 (4), M 315 (27), M 314 (12), M 247 (6), M 246 (29), M 245 (16), M 244 (11), M 243 (20), M 242 (63), M 241 (34), M 240 (41), M 232 (42), M 238 (3), M 208 (1), M 144 (1), M 113 (1), M 111 (3), M 100 (1), M 99 (23), M 98 (11), M 97 (11), M 96 (4), M 95 (Pr.), M 76 (7), M 74 (1), M 39 (1), M 37 (8), M 36 (7), M 35 (1), M 33 (1), P 2 (1).

REMARKS — It occurred in nearly all samples of very saline waters (35.50 ‰ or more). The highest percentages were found in waters with temperatures above 26°C. It is therefore a typical indicator of warm tropical oceanic water when in larger numbers. Juvenile forms were also found in these waters.

Other *Corycaeus* species

Corycaeus (*Agetus*) *flaccus* Giesbr., *Corycaeus* (*Agetus*) *limbatus* Brady (♂ 1.4-1.3 mm); *Corycaeus* (*Agetus*) *typicus* Kröyer (♂ 1.5 mm); *C. Onychocorycaeus latus* Dana (♂ 1.15 mm; ♀ 1.12 mm); *C. Corycaeus clausi* F. Dahl (♀ 1.7 mm); *C. Urocorycaeus lautus* Dana, *C. Corycaeus crassiusculus* Dana occurred in samples of deep and of surface waters with salinity above 35.50 ‰ and temperatures above 15°C approximately. The most frequent of these was *C. latus* (Fig. 46). They were never numerous, usually under 10 specimens per sample. The concomitant presence of these species of *Corycaeus* is usually an index of open-sea waters off Brazil. Nearly all these forms are considered subtropical by Dahl (1912, p. 129) but are really thermophile and therefore tropical and subtropical as to temperature preferences, and according to Klevenhusen (1933, p. 81) indicators of oligotrophic regions in the South Atlantic.

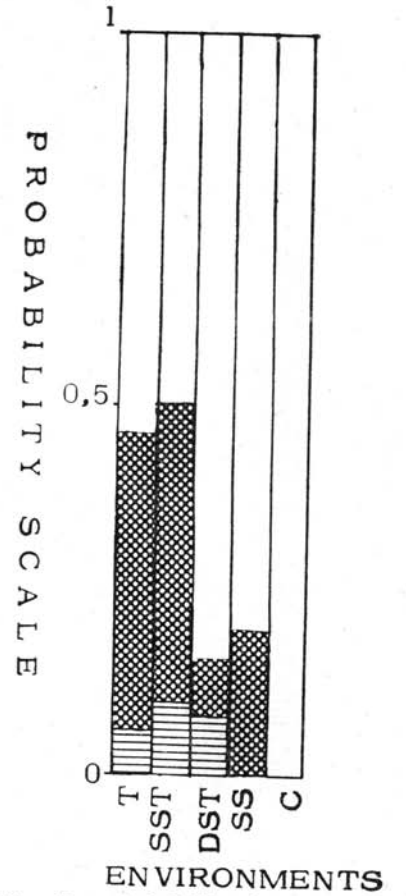

Fig. 46 — Probability of occurrence of *Corycaeus latus* in different environments.

Genus CORYCELLA Farran
(= *Farranula* Wilson)

Corycella gracilis (Dana)

(Fig. 47)

SIZE — ♂ 0.8-1.0 mm; ♀ 0.93-1.1 mm.

OCCURRENCE — M 513 (1), M 510 (26), M 497 (165), M 489 (5460)*, M 451 (160), M 409 (12), M 407 (9), M 402 (120)*, M 400 (1), M 394 (200)*, M 389 (80)*, M 368 (28), M 365 (920)*, M 364 (1920)*, M 363 (82), M 315 (116), M 314 (94), M 247 (83), M 246 (144), M 245 (39), M 244 (37), M 243 (16),

M 242 (40), M 241 (148), M 240 (326), M 238 (36), M 236 (1), M 232 (480)*, M 189 (86), M 188 (34), M 187 (15), M 186 (2), M 114 (1), M 113 (21), M 112 (8), M 111 (16), M 100 (28), M 99 (474), M 98 (312), M 97 (63), M 96 (43), M 95 (89), M 88 (3), M 78 (3), M 75 (6), M 74 (1), M 73 (2), M 39 (13), M 38 (70), M 37 (120), M 36 (107), M 35 (56), M 33 (32), M 32 (1), M 30 (2), E 41 (120)*, E 16 (20)*, E 4 (17), E 3 (26), E 2 (260)*, P 11 (1).

REMARKS — The most frequent Corycaeid, besides *C. giesbrechti*. It occurred in all water masses examined here, excepting in some of the coastal waters. It was numerically the first or second placed copepod species in warm and saline waters (above 35.5 ‰ and above 21°C) as was also observed by Farran (1929, p. 295). In cold very saline waters it diminished in number or disappeared completely. It was usually sparingly and rarely present in deep cold shelf waters. In coastal waters it was rare and appeared in small numbers. Although small, when in large numbers, it is a good indicator of very saline, warm waters, because of its bright colour (blue, when kept in formalin).

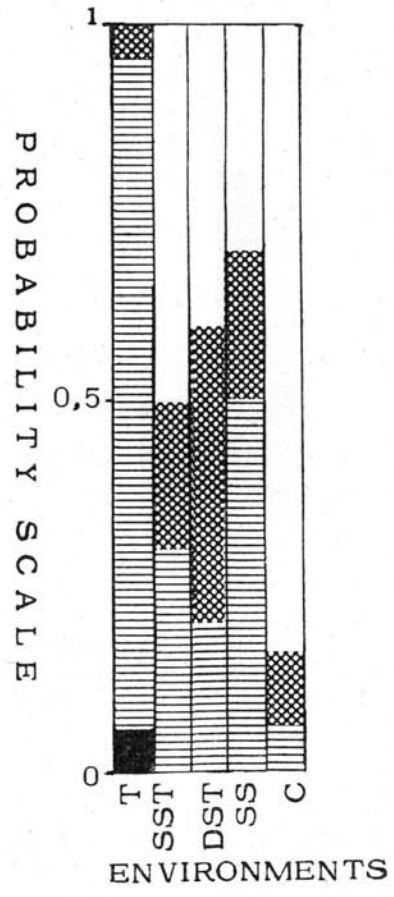

Fig. 47 — Probability of occurrence of *Corycella gracilis* in different environments.

Corycella rostrata (Claus)

(Fig. 48)

SIZE — ♀ 0.75-0.9 mm; ♂ 0.7-0.8 mm.

OCCURRENCE — M 409 (136), M 407 (Pr.), M 403 (640), M 402 (920)*, M 400 (34), M 395 (162), M 394 (4880)*, M 166 (19), M 163 (88), M 162 (69), M 161 (124), M 160 (160), M 76 (52).

REMARKS — Absent in samples from warm saline waters, this copepod replaces *C. gracilis* in the cool very saline surface subtropical waters (under 21°C and above 35.5 °/₀₀). It is rarely present in deep shelf water, or in tropical waters and not at all in the surface shelf and coastal waters. A good indicator of surface very saline waters of temperatures between 16 and 18° C approximately when in large numbers off the coast of Brazil and in other Atlantic waters (Table X) and off New Zealand (Farran 1929, p. 297).

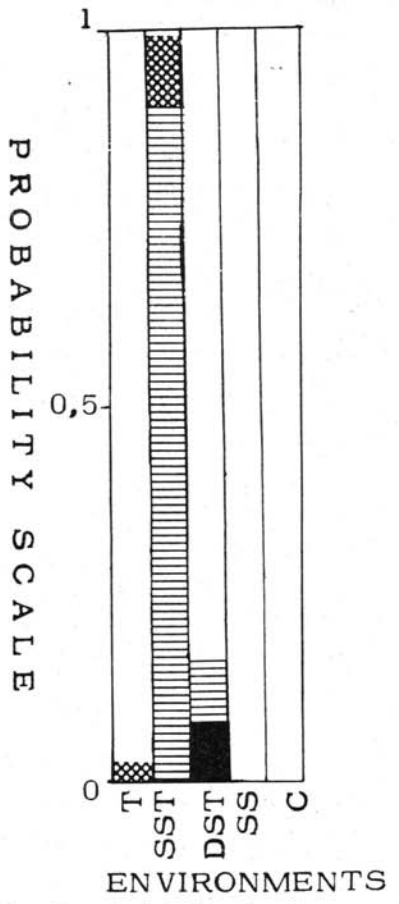

Fig. 48 — Probability of occurrence of *Corycella rostrata* in different environments.

Genus SAPPHIRINA
J. V. Thompson

This is another well studied genus for the Atlantic. The following species have been registered for the western South Atlantic (Sewell 1948, p. 452): *S. angusta* Dana; *S. auronitens* Claus *-sinuicauda* Brady; *S. intestinata* Giesbr.; *S. iris* Dana; *S. lactens* Giesbr.; *S. nigromaculata* Claus; *S. opalina* Dana *-darwini* Haeckel; *S. ovatolanceolata* Dana *-gemma* Dana.

The "Meteor" Expedition (Steuer 1937, p. 106) registered *Sapphirina* up to 40° S in the Atlantic and noticed a maximum of *Sapphirina* concentration off the La Plata river's mouth at the limit between the Brazil and the Falkland Currents. The same was observed for the *Corycaeidae* and for *Copilia*. Off the Brazilian coast the following *Sapphirina* were recorded during the expedition: *S. angusta* off the northern coast and off Rio Grande do Sul (4 specimens); *S. intestinata* (7) off Rio Grande do Sul, Florianópolis, Rio de Janeiro; *S. auronitens* (2), off Rio Grande do Sul; *S. ovatolanceolata* (5), off Rio Grande do Sul; *S. nigromaculata* (2 specimens) off Rio Grande do Sul and Rio de Janeiro (Steuer 1937, p. 104-105, tab. 22).

The following *Sapphirina* occurred in small numbers and not frequently in our samples:

S. maculosa (two in sample M 240);

S. auronitens — sinuicauda (one in each of the samples M 243 and M 98);

S. metallina (one in M 365 and one in M 368);

S. intestinata (in M 403 [2] and in M 78 [2]);

S. opalina — darwini (in sample M 395 [1], M 189 [1], M 403 [2] and M 240 [1]);

Sapphirina stellata in the samples M 243 (3), M 242 (2), M 75 (7), M 98 (4). Two species were more frequent though they were always present in small numbers: *S. angusta* and *S. nigromaculata.*

Thus three species registered for the western South Atlantic were not registered in our samples. In the samples studied, three *Sapphirina* were found which had not yet been registered off our coast.

Some occurred in colder very saline waters (*S. intestinata*), but mostly these animals seem to be thermophile, preferring high salinities.

Sapphirina angusta Dana

SIZE — ♂ 5.2 mm; ♀ 2.35 mm (juv.).

OCCURRENCE — M 402 (Pr.), M 368 (Pr.), M 364 (480)*, M 363 (Pr.), M 247 (7), M 113 (1), M 98 (1).

REMARKS — This species appeared in small numbers in six out of thirty-one samples of tropical water. It also occurred once in very saline, cold, surface water in the South.

Sapphirina nigromaculata-scarlata Claus

SIZE — ♀ 1.65 mm; ♂ 2.5 mm.

OCCURRENCE — M 407 (2), M 402 (Pr.), M 394 (80)*, M 364 (80)*, M 247 (1) ?, M 241 (1), M 240 (3), M 236 (1), M 189 (1), M 74 (1), M 35 (1), V 1 (1).

REMARKS — It occurred in five out of thirty-one samples of tropical water and in samples of very saline, cold surface southern water.

Genus COPILIA Dana

In a revision of this circumtropical genus, Lehnhofer (1926, p. 115-117) mentions that for the Brazil Current very little is known. *C. vitrea* Haeckel was registered off the northern coast of Brazil (in the South Equatorial Current and Gulf of Guinea); *C. mirabilis*, off the northern coast of Brazil, off Rio Grande do Sul (off the African coast in the South Equatorial Current; it was the commonest *Copilia* in the Indian Ocean); *C. quadrata*, off the North coast of Brazil (off the coast of Africa in the Gulf of Guinea) and *C. lata* off the North coast of Brazil and off Rio de Janeiro. *C. quadrata* and *C. lata* (Lehnhofer 1926, p. 170-171) occurred in salinities between 33.3 and 36.5 ‰. *C. mirabilis* occurred between temperatures of 23 and 29°C (only once at 16.3°C in the surface) during the "Valdivia" Expedition and was therefore considered as "almost warm-stenotherm" (Lehnhofer 1926, p. 458). It was the most numerous species caught by the "Valdivia" and here too. In our waters it occurred also in lower temperatures and all along the coast of Brazil.

Copilia is not mentioned in the reports of the "Plankton" Expedition samples. The "Meteor" Expedition collected several *Copilia* (Steuer 1937, p. 109-114), but very sparingly off the Brazilian coast. *Copilia mirabilis* Dana was registered off Rio Grande do Sul and *Copilia lata* Giesbrecht in the central South Atlantic and near the northern coast of Brazil, off Fernando de Noronha Island.

Copilia mirabilis Dana

SIZE — ♂ 6 mm; ♀ 5.8 mm.

OCCURRENCE — M 402 (Pr.), M 364 (160)*, M 363 (Pr.), M 315 (6), M 314 (1), M 247 (2), M 246 (7), M 245 (2), M 244 (1), M 243 (6), M 242 (3), M 241 (14), M 240 (9), M 189 (2), M 188 (3), M 187 (4), M 173 (Pr.), M 114 (2), M 112 (1), M 107 (12), M 100 (1), M 99 (3), M 97 (1), M 93 (13), M 78 (3), M 76 (1), M 75 (8), M 74 (4), M 39 (3), M 38 (5), M 37 (13), M 36 (17), M 35 (14), M 31 (1), E 164 (1), E 41 (Pr.), E 15 (20)*, E 13 (280), E 11 (60)*, V 19 (13), P 1 (Pr.).

REMARKS — Present in small percentages in 5 out of 31 samples of coastal waters; present in small percentages also in tropical and subtropical waters. It reached the highest numbers in the shelf waters. As can be seen from the general distribution, it prefers warmer waters. The samples with most specimens had temperatures between 22.97 and 21°C. Lehnhofer (1926, p. 458)

registered it chiefly in higher temperatures and so did Dahl (1892, p. 514).

Copilia quadrata Dana

SIZE — ♀ 1.7 mm (juvenile).

OCCURRENCE — M 403 (3), M 246 (1), M 240 (6).

REMARKS — It occurred rarely in small numbers in samples of tropical water (M 246 and M 240) and in a single sample of subtropical water. Dahl (1892, p. 516) mentions it as a subtropical southern Atlantic form.

Copilia lata Giesbr.

SIZE — ♀ 5.6 mm.

OCCURRENCE — M 242 (1).

REMARKS — Supposed to occur over all the Atlantic (Dahl 1892, p. 512) it was observed only once in a sample taken off the northern coast of Brazil in warm and very saline waters. The "Meteor" Expedition also registered it off the northern coast of Brazil (Steuer 1937, p. 112-113).

Copilia vitrea (Haeckel)

SIZE — ♂ 8.01 mm.

OCCURRENCE — M 365 (1 ♂).

REMARKS — Only one specimen, a male, was found in one sample taken between the latitudes of Rio de Janeiro and Santos in tropical water of the Brazil Current.

Copilia mediterranea (Claus)

SIZE — ♀ 4 mm; ♂ 5.5 mm.

OCCURRENCE — M 402 (1 ♀), M 114 (1 ♂).

REMARKS — Only two specimens were registered in very saline, under 21.3°C surface waters. It had not been registered before in Brazilian or South American waters.

THE ENVIRONMENTS

COASTAL WATERS

If the plankton volume is compared in Brazilian coastal waters, an average of 1.49 ml/m³ is found, ranging from 0.09 ml/m³ (in sample M 283) to 8.6 ml/m³ (in sample E 41). These are undoubtedly the richest of Brazilian waters (Table II). Hentschel (1933, p. 146) showed that the highest number of plankters in the western South Atlantic in the surface layer of sea water lived in a narrow band, a hundred kilometers wide along the South American coast. Thus our data support Hentschel's.

Hentschel (1933, p. 149) also found higher numbers of plankters in the southern colder waters off the coast of South America, from 25° S Lat. to 55° S Lat.

Plankton volumes obtained by settlement were the largest, 0.4 to 8.6 ml/m³, at the stations off Cananéia (about 28°8.4' S-47°44.2' W). Volumes 0.3 to 0.8 ml/m³ were obtained in samples from 25° S to 23° N. The same volume occurred in the South (32°23.5' S) off the outlet of the Lagoa dos Patos. In the North near the mouth of the Amazon River there were also larger volumes 0.34 to 0.8 ml/m³ for total plankton collected by zooplankton nets. This had also been verified by Hensen (1911, tab. III-IV-V) who found the largest number of copepods and diatoms in the north coast of Brazil off the mouth of the Tocantins River.

The poorest coastal water samples were M 283 from the north (02°46.0' N-49°35.0' W) and M 203 from the south (30°48.7' S-50°28.3' W) both from regions far away from river mouths or sound outlets.

Relatively to the volume of phytoplankton in these waters, the volume of copepods is frequently small, whereas in other waters it may even exceed that of the phytoplankton. In our coastal waters the copepods usually dominant in volume are *Centropages furcatus, Temora stylifera, Oncaea media* and *Acartia* spp.. In our colder waters *Ctenocalanus vanus* is dominant in volume. Occasionally *Oithona* and *Pseudodiaptomus* may be the dominant species in lower salinity.

Forty-five samples of coastal water were examined, 31 of which were separated as representatives of different seasons, different regions, different temperature and salinity (Tables I and III). The great majority of samples was taken off the southern coast of Brazil and the conclusions are usually valid for that region.

TABLE I — List of stations and hydrographical conditions of coastal and inshore waters

Sample Number	Position	Salinity (‰)	Temperature (°C)	Local Depth (m)	Depth of haul (m)	Date	Time (h)	Net	Haul	Plankton volume (cc/m³)
M 30	24°06'S 46°14'W	33.48 33.77	21.7 21.4	14	12-0	26/ 6/54	23:00	S	V	0.8
P 1 Guarujá	24°03'S 46°11'W	33.86	22.0	23	20	17/ 7/59	10:20	C.B.	H	0.3
P 10	23°31.9'S 45°06.0'W	34.54	22.9 23.2	16	10	20/ 7/59	08:10	C.B.	H	0.5
E 164	25°8.4'S 47°44.2'W	33.85 34.09	20.6	20	15	25/ 6/59	12:55 13:10	C.B.	H	54
IV 244	25°15'S 47°55'W	33.69	20.0	10	surface	20/ 9/55	08:20	3	H	—
E 170	25°8.4'S 47°44.2'W	33.39 33.78	20.5 20.3	20	15	10/ 7/59	13:01 13:11	C.B.	H	0.44
IV 248	25°15'S 47°55'W	22.37	16.9	12	9-10	6/ 8/55	12:03	1	H	—
M 88	32°23.5'S 52°03.3'W	25.48 33.22	15.40 15.18	20	12-0	5/10/55	19:30	S	O	0.7
II 68	25°8'S 47°51'W	34.57	19.7	19	17-18	30/ 6/55	—	2	H	—
M 89	32°36.0'S 51°58.5'W	31.78 32.57	14.38 15.06	27	22-0	6/10/55	00:05	S	O	—
P 9	23°35.5'S 45°12.6'W	34.67	23.0	17	10	20/ 7/59	16:00 17:00	C.B.	H	0.12
E 41	25°9.5'S 47°35.7'W	30.30 34.40	24.86 23.68	30	25	11/ 5/58	11:18 11:35	C.B.	H	8.6
E 39	25°79'S 47°48.4'W	27.64 33.84	24.69 24.08	20	15	11/ 5/58	08:36 08:51	C.B.	H	4.5
E 32	25°9.5'S 47°35.7'W	33.84 34.38	25.40 25.20	29	25	27/ 3/58	12:08 12:23	C.B.	H	1.0
E 28	25°7.9'S 47°48.4'W	31.67 33.65	25.1 25.5	20	15	27/ 3/58	08:33 08:48	C.B.	H	1.7

M 203	30°48.7'S 50°28.3'W	34.56 34.99	23.40 21.28	19	18,4	22/ 1/57	05:55	KK	O	—
E 7	25°7.9'S 47°48.4'W	34.67 34.72	25.95 26.00	20	15-0	28/ 1/58	10:22 10:25	H	V	0.6
E 8	25°7.9'S 47°48.4'W	34.67 34.72	25.95 26.00	20	15	28/ 1/58	10:35 10:50	C.B.	H	4.3
M 107	23°58.5'S 45°30.0'W	33.78 34.78	27.22 26.50	42	1-10	7/ 3/56	04:10	C.B.	H	0.7
E 24	25°8.4'S 47°44.2'W	32.22 33.41	27.34 26.4	20	15	12/ 3/58	13:07 13:22	C.B.	H	1.3
E 15	25°7.9'S 47°48.4'W	33.83 34.83	28.18 27.50	20	17-0	25/ 2/58	07:35 07:54	H	V	1.2
E 16	25°7.9'S 47°48.4'W	33.83 34.83	28.18 27.50	20	18	25/ 2/58	08:10 08:22	C.B.	H	1.6
M 257	0°01.0'S 46°37.08W	11.347 34.343	26.03 27.63	27	16.18-0	10/ 4/57	07:30 08:10	KO	O	0.34
M 261	0°10.08'S 47°09.0'W	12.25 30.96	27.18 27.90	30	14.6-0	10/ 4/57	19:05 19:30	KO	O	0.8
M 265	0°54.4'N 47°18.7'W	20.57 33.71	27.28 27.41	38	17.80-0	19/ 4/57	23:45 00:20	KO	O	0.7
M 283	02°46.0'N 49°35.0'W	8.225 35.87	26.41 27.13	30	13.8-0	23/ 4/57	08:40 09:15	KO	O	0.09
M 269	01°07.5'N 48°18.8'W	5.698 34.993	27.34 27.23	30	11.18-0	20/ 4/57	18:10 18:40	KO	O	—
III 320	25°35'S 47°54'W	28.03	29.7	17	surface	1/ 2/57	14:10	3	H	—
III 321	25°3.5'S 47°54'W	31.01	29.6	17	16-0	1/ 2/57	14:13	3	O	—
III 322	25°3.5'S 47°54'W	9.29	27.90	16.50	surface	8/ 2/57	13:25	3	H	—
IV 218	25°1.5'S 47°55'W	22.370	16.9	12	surface	6/ 8/55	12:03	2	H	—

Note — Nets: Standard net (Nansen type); Net C.B. = Clarke- Bumpus sampler; Net 1, 2 and 3 = nets of 1 m length and 25 cm diameter of aperture made of 60GG bolting silk; H net = Hensen net; KK net = Kitahara K net; KO net = Kitahara O net for zooplankton.

Hauls: V = vertical; O = oblique; H = horizontal.

TABLE III — Frequency of copepods in coastal waters of Brazil

Sample number	II 68	M 30	P 1	P 10	E 164	E 170	M 88	M 89	IV 244	E 41	E 39	E 32	E 28	M 203	M 208	E 7
Copepods	Percentages of copepods from total number of copepods per sample															
Corycaeus giesbrechti	4.1	7.7	2.03	9.2	10.3	13.4	0.1	—	10.8	x	1.7	7.1	1.3	7.4	12.4	11.1
Temora stylifera	2.0	10.8	13.1	10.5	20.6	1.9	0.3	—	0.4	1.9	0.8	3.5	x	28.7	5.5	20.3
Paracalanus aculeatus	6.2	10.8	2.7	19.9	24.8	19.5	1.4	—	—	2.8	9.5	7.1	15.6	—	0.1	14.3
Paracalanus parvus	11.3	5.4	2.5	3.2	8.1	13.3	9.7	28.6	21.3	—	39.2	—	0.1	0.2	11.1	0.8
Oncaea media	25.5	5.4	0.2	14.1	1.3	5.7	0.3	0.2	0.8	24.7	25.4	25.0	20.5	19.3	35.2	—
Centropages furcatus	1.8	18.1	20.05	5.4	6.2	9.6	0.3	—	—	—	1.5	x	0.1	0.2	0.9	1.2
Calanopia americana	0.1	4.3	14.7	1.2	2.4	—	—	—	—	0.9	1.7	3.5	2.3	—	—	1.9
Euterpina	15.3	—	—	8.9	0.6	5.7	—	—	10.4	2.9	8.8	14.2	14.4	22.2	3.6	—
Oithona plumifera	0.1	1.0	3.8	1.2	1.03	x	0.4	—	0.4	13.8	0.2	—	—	—	2.6	4.1
Clausocalanus furcatus	3.1	16.2	—	4.4	10.3	1.9	—	—	—	0.9	—	—	—	—	12.5	30.8
Eucalanus monachus	—	8.63	—	23.8	3.2	14.1	23.0	—	—	—	0.9	x	1.2	0.2	0.1	2.5
Acartia lilljeborghii	0.9	—	11.6	1.9	1.03	4.9	—	—	1.6	—	0.6	—	5.7	—	—	1.2
Paracalanus crassirostris	19.1	—	—	—	—	—	—	—	14.5	—	26.2	10.7	4.7	25.8	1.5	—
Labidocera fluviatilis	0.3	—	4.06	x	—	—	0.4	—	24.1	x	—	—	x	—	—	—
Eucalanus subcrassus	3.3	—	—	—	—	0.5	2.9	—	—	—	0.8	—	—	—	—	8.5
Oithona minuta	0.2	—	—	—	—	—	—	7.3	—	14.8	—	—	4.06	—	—	—
Corycaeus amazonicus	4.9	6.5	—	—	—	x	—	—	—	—	—	—	x	0.7	0.1	—
Oithona nana	—	—	—	4.7	—	—	—	—	3.2	—	5.6	21.4	—	—	2.9	—
Pseudodiaptomus	—	—	0.7	x	—	—	—	—	10.4	—	—	—	—	—	—	—
Sapphirella	—	—	—	—	—	—	—	—	—	—	—	—	x	6.6	1.5	—
Clytemnestra	—	—	—	0.3	—	1.9	—	—	—	—	—	x	—	0.4	0.7	—
Pontelopsis brevis	—	—	0.2	x	0.3	—	—	—	—	x	—	—	—	—	—	0.3
Macrosetella	—	—	—	—	—	—	—	—	—	x	—	x	—	0.2	2.2	1.5
Young *calanids*	—	1.0	—	—	—	—	0.8	—	—	5.9	8.6	3.5	12.5	—	—	—
Acartia giesbrechti	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Copilia mirabilis	—	—	x	—	0.3	—	—	—	—	x	—	—	—	—	—	—
Corycella gracilis	—	2.1	—	—	—	—	0.4	—	—	5.8	—	—	—	—	—	—
Ctenocalanus vanus	—	—	—	—	—	1.9	62.0	31.4	—	—	0.1	—	—	—	3.1	—
Mecynocera clausi	—	—	x	1.2	—	—	—	—	—	—	—	—	—	—	0.1	—
Calocalanus styliremis	—	—	—	—	—	—	—	—	—	1.9	—	—	—	—	0.7	—
Microsetella spp.	—	—	—	—	0.6	—	—	—	—	x	0.1	3.5	—	—	0.9	—
Unknown Nauplius	—	—	—	0.9	—	—	—	—	—	—	—	—	—	—	—	—
Calocalanus plumulosus	0.5	—	—	—	—	—	0.1	—	—	—	—	—	—	0.2	0.1	—
Nannocalanus minor	—	x	—	0.3	0.6	—	0.9	0.2	—	—	—	—	—	—	0.1	—
Acrocalanus	—	—	—	18.2	—	—	—	2.2	—	—	—	—	—	—	—	—
Longipedia mourei	—	—	—	—	—	—	—	—	2.4	—	—	—	—	—	—	—
Centropages brachiatus	—	—	—	—	—	—	5.8	8.4	—	—	—	—	—	—	—	—
Oithona setigera	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.3	—
Calanoides carinatus	—	—	—	—	—	—	16.2	8.1	—	—	—	—	—	—	—	—
Oncaea mediterranea?	—	—	—	—	—	—	—	—	—	—	—	—	20.5	—	—	—
Acartia danae	—	—	—	—	—	—	0.6	—	—	—	—	—	—	—	0.4	—
Eucalanus attenuatus	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—
Euaetideus giesbrechti	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—
Sapphirina	—	—	—	0.3	0.3	—	—	—	—	—	—	—	—	—	—	—
Corycaeus africanus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eucalanus subtenuis	—	—	—	—	—	—	—	0.8	—	—	0.2	—	—	—	—	—
Oithona brevicornis	—	—	—	—	—	—	—	—	—	—	—	—	—	13.3	—	—
Corycaeus speciosus	—	—	—	x	—	—	—	—	—	—	—	—	—	—	0.1	—
Acartia sp.	—	—	—	—	—	—	—	14.6	—	—	—	—	—	—	—	—
Lucicutia flavicornis	—	—	—	—	0.3	—	—	—	—	—	—	—	—	—	—	—
Undinula vulgaris	—	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhincalanus cornutus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oncaea subtilis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oncaea conifera	—	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oncaea venusta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

x = present.

TABLE III — Frequency of copepods in coastal waters of Brazil (contd.)

Sample number	E 8	P 9	III 320	E 16	E 15	M 257	M 261	M 265	M 283	M 269	M 107	E 24	III 321	III 322	IV 218
Copepods	Percentages of total number of copepods counted per sample														
Corycaeus giesbrechti	0.8	4.0	2.5	1.5	0.5	0.5	0.3	10.8	15.1	—	6.8	1.1	0.3	—	—
Temora stylifera	2.4	24.5	—	1.9	4.1	1.1	—	6.2	7.9	—	1.7	2.1	0.2	—	—
Paracalanus aculeatus	0.3	10.5	1.0	4.9	34.4	0.1	—	0.8	2.6	—	13.8	19.7	0.4	—	0.5
Paracalanus parvus	—	13.9	4.1	—	0.9	—	—	1.7	3.5	—	3.4	—	3.1	—	—
Oncaea media	78.03	3.7	—	83.7	—	—	—	—	—	—	—	58.07	0.1	—	—
Centropages furcatus	—	7.0	—	0.2	3.2	3.3	0.6	9.6	4.1	—	4.2	0.4	—	—	—
Calanopia americana	0.6	2.6	—	1.05	11.6	0.5	3.8	2.5	—	—	0.8	2.4	—	—	1.6
Euterpina	0.9	1.4	22.1	3.04	0.1	—	—	—	—	—	—	1.6	20.1	2.0	12.5
Oithona plumifera	0.1	9.6	0.5	0.7	2.2	—	—	—	4.5	—	x	x	—	—	—
Clausocalanus furcatus	0.2	0.9	—	1.7	20.4	—	—	—	—	—	44.0	0.2	—	—	—
Eucalanus monachus	0.1	4.2	—	—	—	2.0	4.5	—	—	—	13.0	—	—	—	—
Acartia lilljeborghi	0.4	12.0	37.1	—	—	—	—	—	—	—	—	—	43.4	2.0	34.1
Paracalanus crassirostris	1.6	—	x	—	—	—	—	—	3.0	—	—	—	11.7	14.6	22.1
Labidocera fluviatilis	—	—	—	—	—	0.7	—	2.2	1.1	1.2	—	—	0.9	—	0.2
Eucalanus subcrassus	0.1	—	—	0.4	6.5	—	—	6.5	26.6	—	x	1.6	—	—	—
Oithona minuta	2.05	—	27.8	—	—	—	—	—	—	—	—	x	—	80.9	24.3
Corycaeus amazonicus	—	—	0.5	—	—	—	—	22.5	15.9	—	—	—	—	—	—
Oithona nana	0.1	1.6	—	—	—	—	—	—	—	—	—	3.3	15.1	—	—
Pseudodiaptomus	—	—	2.0	—	—	—	—	—	0.3	x	—	—	4.4	x	4.0
Sapphirella	—	—	—	—	—	—	—	—	—	—	—	x	0.1	0.5	—
Clytemnestra	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—
Pontellopsis brevis	—	—	1.0	—	—	—	—	—	—	—	—	—	—	—	—
Macrosetella	—	—	—	0.02	0.2	—	—	—	—	—	—	—	—	—	—
Young calanids	—	—	—	1.3	—	—	—	—	—	—	—	—	—	—	—
Acartia giesbrechti	—	—	—	—	—	92.1	94.2	25.7	7.2	99.3	—	—	—	—	—

Mecynocera clausi	—	1.4	—	—	—	—	—	—	—	—	—	—	—	—	—
Calocalanus styliremis	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—
Microsetella spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unknown Nauplius	—	—	—	0.05	0.2	—	—	—	—	—	0.8	—	—	—	—
Calocalanus plumulosus	2.2	—	0.5	—	—	—	—	—	—	—	—	—	—	—	—
Nannocalanus minor	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Acrocalanus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Longipedia mourei	—	—	0.5	—	—	—	—	—	—	—	—	—	—	—	0.2
Centropages brachiatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oithona setigera	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Calanoides carinatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oncaea mediterranea	8.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Acartia danae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eucalanus attenuatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Euaetideus giesbrechti	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapphirina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus africanus	—	—	—	—	—	—	—	11.3	4.5	—	—	—	—	—	—
Eucalanus subtenuis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oithona brevicornis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus speciosus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Acartia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lucicutia flavicornis	—	—	—	—	—	—	—	—	0.7	—	—	—	—	—	—
Undinula vulgaris	—	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—
Rhincalanus cornutus	—	—	—	—	—	—	—	—	0.3	—	—	—	—	—	—
Oncaea subtilis	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—
Oncaea conifera	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oncaea venusta	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—

x = present.

TABLE II — Plankton volume in different marine environments off Brazil

Environments	Coastal water	Surface shelf water	Deeper shelf water	Surface subtropical water	Tropical water
Salinity (‰)	8.2-34.8	34.8-35.9	35.1-35.9	35.9-36.9	35.8-37.2
Temperature (°C)	14.3-28.1	20.0-28.8	15.2-20.5	17.0-23.0	21.0-28.0
Plankton volume (cc/m³)	0.09-8.9	0.09-1.5	0.03-4.0	0.03-0.16	0.03-1.2
Average (cc/m³)	1.49	0.57	1.10	0.08	0.23
$\frac{\text{Average}}{4}$	0.37 cc/m³	0.11 cc/m³	0.27 cc/m³	0.02 cc/m³	0.05 cc/m³

The largest number of copepod species in coastal waters respectively 25 and 23 were found in samples M 208 and M 88 off the very south of Brazil, in temperatures ranging from 15, 18 to 23.9°C and in low salinity, 25.48 to 33.00 ‰. The samples listed in Table III show an average of 14 to 15 different copepod species. The smallest number of species found was 3 and 5 in a sample taken off the Amazon River's mouth and at Cananéia. In both instances the waters sampled had very low salinities (below 20 ‰) at the surface, due to the discharge of the river or sound. The great local variability of environmental conditions was probably the cause of the small number of species in these two samples.

When horizontal and vertical hauls were made at the same station the largest number of species was always in the sample collected vertically, because more layers of water were sampled. The coastal waters show the greatest variety of copepod associations, corresponding to the variable characteristics of the environment which presents many biotopes.

As Jakobi (1953, p. 14) pointed out the greater abundance of *Pseudodiaptomus* in relation to *Oithona* is an index of lower salinity of coastal waters. The same may be said here concerning the abundance of *Labidocera fluviatilis* and certain harpacticids (*Longipedia*) in relation to *Acartia lilljeborghi* and to *Temora stylifera*.

Table III also shows that the association of species characteristic of Brazilian coastal waters is:

Corycaeus giesbrechti, Paracalanus aculeatus and *P. parvus, Temora stylifera, Oncaea media, Centropages furcatus* all of which

with a probability of occurring usually in the highest percentage of the total number of copepods counted per sample and in more than 20 samples in every 31 examined; *Clausocalanus furcatus* in high percentages of the total number of copepods counted per sample; *Oithona plumifera, Eucalanus monachus* and *E. subcrassus, Oithona nana, Acartia lilljeborghi, Calanopia americana, Euterpina acutifrons, Paracalanus crassirostris* with a probability of occurring in more than 10 in every 31 samples examined. Some of these may represent 30% of the total number of copepods present. Some species are found only in coastal waters, though in only one or a few samples and usually in small numbers. As they did not appear in more saline waters it is probable that they thrive in brackish water or in other types of water and are "visitors" of coastal waters: *Pseudodiaptomus acutus* and *P. richardi, Sapphirella* sp., *Labidocera fluviatilis, Oithona minuta, O. ovalis, Pontellopsis brevis, Centropages brachiatus, Longipedia mourei, Corycaeus africanus, Acartia giesbrechti, Parathalestris.*

Pseudodiaptomus acutus was very numerous in two samples taken from inshore waters at Cananéia. *Centropages brachiatus* seems to substitute *Centropages furcatus* in very cold southern coastal waters. *Corycaeus amazonicus* and *C. africanus* may partly substitute *C. giesbrechti.* The second only appeared in the northern warm waters off Brazil and the first also in the south. *Acartia lilljeborghi* is substituted by *A. tonsa* in the cold southern coastal waters and by *A. giesbrechti* in the warm coastal waters of the north. *Pseudodiaptomus richardi* is the substitute of *P. acutus* in less saline northern coastal waters. *Labidocera fluviatilis* and *Oithona ovalis* also seem to be strays from brackish waters.

Ctenocalanus vanus, Nannocalanus minor, Acartia danae, Corycaeus gracilis, Mecynocera clausi, Calocalanus pavo, Microsetella sp., *Euaetideus giesbrechti, Oncaea subtilis, O. conifera, O. venusta, O. mediterranea, Clytemnestra* sp., *Acrocalanus* sp., *Saphirina* sp., *Copilia mirabilis, Macrosetella* sp., *Oithona setigera* and *O. brevicornis, Corycaeus speciosus, Calocalanus tenuis, Calanoides brevicornis, Undinula vulgaris, Rhincalanus cornutus* are visitors in this environment from other waters.

Longipedia mourei is known to live in the muddy sand covered by shallow brackish water in the bay of Paranaguá. According to Hensen's (1911, p. 316) observations of harpacticids it can be considered an indicator of inshore waters, as it was also found in the Mar de Cananéia, under strong influence of alternating salty coastal waters and almost fresh waters from the Ribeira River. Bottom harpacticids were numerous in the Tocantins River and banks (Hensen 1911, p. 316).

The following table grossly summarizes the data on coastal waters from divers parts of the world, where hydrographical conditions were also observed. We find that the characteristic genera for these waters are *Centropages, Temora, Acartia, Labidocera, Paracalanus, Oithona, Oncaea, Corycaeus, Pseudodiaptomus, Euterpina* and *Microsetella.* The first six genera are present in nearly all lists of coastal copepoda (Table IV). These are also the waters visited by tychopelagic copepods mostly living on or near the bottom or on algae, such as *Bradya limicola, Harpacticus chelifer* and other representatives of the genera Harpacticoida. These are absent from open-sea waters and shelf waters.

If we compare the characteristic copepod fauna of coastal waters (Table IV), we notice that they can be roughly divided into three groups: the thermophile *Centropages furcatus* group, characteristic of warm coastal waters; the cryophile *Centropages hamatus* group from cold waters; and waters with different species or without *Centropages. Oithona similis* and *Calanus finmarchicus* are also cryophiles of the northern hemisphere. *Calanus finmarchicus* is substituted in coastal Antarctic and in the Bering Sea (Brodsky 1957, p. 99) waters by *Calanus tonsus* (Farran 1936, p. 77) and *C. hyperboreus,* stenothermic cryophiles, and in some of the warm waters by *C. pauper. Ctenocalanus vanus,* usually characteristic of cold deep shelf waters off our coasts, shows its maxima in numbers in the cold coastal Antarctic waters. It also appears in other cold coastal waters, for instance in California (Table IV) and in coastal waters off the very south of Brazil. The following species, *Eucalanus subcrassus, E. monachus, E. subtenuis* and *Clausocalanus furcatus,* although usually shelf water copepods, also appear in large numbers in warm coastal waters. They are restricted to tropical and subtropical areas. *Pseudocalanus elongatus* is a cold water boreal species. Coastal water copepods are usually more euryhaline than eurythermic. *Calanopia,* with its various species, is characteristic of warm coastal waters. *Corycaeus* with several species in warm waters, has only a few adapted to cold environments, such as *C. anglicus* in the North Sea and *C. inuncus* in New Zealand waters.

Of the *Paracalanus, P. aculeatus* is thermophile; *P. parvus* is the most eurythermic, but standing colder environments, better than *P. aculeatus. P. crassirostris* seems to be a stenoecius copepod. It usually occurs in coastal waters all over the world.

Coastal copepods are sometimes also good geographical indicators, as has already been pointed out and is emphasized when studying the *Acartia* species and the Diaptomidae (Table IV). They are usually very stenoecius.

TROPICAL WATERS

Tropical waters are here considered as the surface waters (the upper layer of 150 m) which show temperatures above 20°C and salinities above 36 °/₀₀ (Emilsson 1959, p. 45). These waters are brought in direction to the easternmost part of the Brazilian coast by the South Equatorial Current (*op. cit.*, p. 44) a part of which is deviated to the South, giving rise to the Brazil Current, while the other part continues in a NW direction along the N coast of Brazil.

The thirty-one samples examined from these waters (Table V) showed salinities between 35.84 and 37.25 °/₀₀ and temperatures between 20.33° and 28.00°C. They were taken mostly off the Brazilian continental shelf at stations located from 04°57' N to 27°43.5' S, up to where this kind of environment is found all the year round. Two samples (M 314, M 315) taken near Trindade Island were also examined because their salinities and temperatures were within the limits mentioned above. These waters show a variability of plankton volume from 0.06 to 0.50 ml/m³ (Kanaeva 1960, p. 184) along the 30° W meridian down to 20° S in the Atlantic. The samples examined for this work showed values which ranged from 0.077 ml/m³ (observed in southern waters and the farthest away from the coast) to 1.4 ml/m³ off the mouth of the Amazon River. The plankton volume per cubic meter of water off the Brazilian coast showed also larger values in the vicinities of Fernando de Noronha Island, in the South Equatorial Current, off Rio de Janeiro and Santos, and off Santa Catarina. Generally the plankton volume was very low. According to Hentschel (1933, p. 146) the decrease of plankton volume is proportional to the distance from the coast in the South Atlantic. This is confirmed in this paper: the average volume for a band of coastal water nearest the coast is 1.49 ml/m³, that for a band of shelf water next nearest is 0.57 ml/m³, and the smallest volume is observed in the Brazil Current waters, which are the farthest away from the coast (0.23 ml/m³). It shows the rise in plankton volume in the stations nearing the slope and its decrease in stations away from the slope (M 314, M 315). The increase in the Fernando de Noronha area and off the mouth of the Amazon River had also been noticed by Hentschel (1933, beil. 1 & 2) and by Hensen (1911, p. 52-53, p. 186-187). In volume the dominant copepods in this environment are usually *Nannocalanus minor* and *Clausocalanus furcatus*, which although small is usually so numerours that it accounts for large portions of the total plankton. *Euchaeta marina, Copilia mirabilis, Neocalanus gracilis, Candacia*

TABLE V — List of samples from tropical waters

Sample number	Position	Date	Time (h)	Salinity (‰)	Temperature (°C)	Local depth (m)	Depth of haul (m)	Net *	Haul *	Plancton vol. (cc/m³)
M 451	04°57' N 46°55.5' W	30/11/58	07:00	36.15	27.39- 0 m 22.66- 84 m	3292	91	20	V	0.22
M 489	00°25' N 44°18' W	18/12/58	18:00	36.17 36.22	27.27- 0 m 27.01- 86 m	> 1800	91	20	V	1.1
M 497	01°46' S 40°36' W	21/12/58	09:00	36.40 36.92	26.90- 25 m 23.91-110 m	≅ 2000	91	20	V	0.50
M 247	01°30' S 34°16' W	28/ 3/57	05:25-07:30	35.82 36.07	27.5 - 0 m 24.77- 58 m	> 5000	—	KO	O	0.14
M 244	03°33' S 33°32' W	18/ 3/57	05:15-07:30	35.98 36.23	27.7 - 0 m 26.52- 68 m	4732	85-0	KO	O	0.08
M 510	03°47' S 33°23' W	29/12/58	18:00	36.20 36.26	26.70- 0 m 21.44-122 m	1080	99-0	20	V	1.2
M 513	03°49.4' S 32°27.2' W	30/12/58	07:00	36.42 36.40	26.48- 0 m 26.44- 58 m	58	55-0	20	V	0.9
M 245	05°29.5' S 33°42.9' W	19/ 3/57	05:10-07:30	36.32 36.88	27.9 - 0 m 24.98-100 m	> 1018	87-0	KO	O	0.035
M 246	07°28.5' S 34°17.0' W	20/ 3/57	05:15-06:45	36.74 37.14	28.00- 2 m 25.24- 90 m	> 876	88-0	KO	O	0.05
M 243	09°29.5' S 33°35.7' W	16/ 3/57	05:10-07:25	36.76 36.92	27.59- 2 m 24.07- 99 m	> 1005	84-0	KO	O	—
M 242	11°24.0' S 33°19.0' W	15/ 3/57	05:40-07:30	36.65 36.81	27.63- 2 m 24.89- 95 m	> 994	—	KO	O	0.06
M 241	15°27.0' S 36°02.0' W	9/ 3/57	05:25-07:25	37.14 37.05	27.44- 2 m 22.65- 99 m	> 1019	85-0	KO	O	0.03
M 240	17°26' S 35°55' W	8/ 3/57	05:20-08:00	36.99 37.14	27.42- 2 m 23.46-104 m	> 2000	90-0	KO	O	0.14
M 314	19°16' S 29°49' W	29/ 5/57	08:00	37.25 —	25.20- 0 m 25.08-104 m	200/2000	183-0	20	V	0.08
M 315	20°28' S 30°45' W	30/ 5/57	08:00	37.07 37.03	25.50- 0 m 24.27- 25 m	—	10-0	20	H	0.07

M 232	22°00' S 37°36' W	25/ 2/57	21:00	36.51 36.55	26.10- 0 m 21.44-100 m	4000	183-0	20	V	0.077
M 100	24°10' S 43°03' W	28/ 2/56	21:57	36.06 36.07	22.78- 0 m 22.36- 20 m	410	0-10	S	H	—
M 365	24°14' S 43°20' W	16/10/57	08:30	36.69 36.65	24.00- 0 m 21.60-100 m	625	183-0	20	V	0.3
M 99	24°22' S 43°04' W	28/ 2/56	19:12	36.49 36.45	24.89- 0 m 24.74- 20 m	> 1000	0-10	S	H	—
M 98	24°51' S 42°59' W	28/ 2/56	16:05	36.47 36.47	25.43- 0 m 25.14- 10 m	2000	0-10	S	H	—
M 364	24°59' S 43°12.1' W	15/10/57	08:00	36.85 36.77	23.20- 0 m 21.80-100 m	> 1000	183-0	20	V	0.25
M 363	25°00' S 44°15' W	14/10/57	17:00	36.56 36.67	22.80- 0 m 21.20-100 m	> 1000	183-0	20	V	0.47
M 37	25°02' S 44°42' W	27/ 6/54	23:55	36.40 36.44	23.3 - 0 m 23.3 - 30 m	136	30-0	S	V	0.25
M 95	25°19' S 45°21' W	26/ 2/56	20:10	35.84 36.94	25.80- 0 m 25.24- 20 m	135	0-10	S	H	—
M 97	25°39' S 42°52' W	28/ 2/56	10:45	36.86 36.82	26.46- 0 m 26.21- 10 m	2250	0-10	S	H	—
M 111	25°48' S 44°31' W	14/ 6/56	01:30	36.87 36.79	22.52- 0 m 22.59- 19 m	> 1000	0-10	C.B.	H	—
M 113	26°45' S 43°21' W	15/ 6/56	12:00	36.48 36.44	21.60- 0 m 21.54- 10 m	> 2000	0-10	C.B.	H	—
M 96	26°48' S 43°19' W	27/ 2/56	11:07	36.52 36.51	25.93- 0 m 25.90- 10 m	2571	0-10	S	H	—
M 189	26°48' S 46°59' W	11/ 1/57	11:25	36.00 35.80	25.31- 0 m 20.33- 50 m	145	49-0	KK	O	0.04
M 114	27°15' S 43°51' W	15/ 6/56	21:39-23:19	36.15 36.43	21.00- 0 m 21.30- 19 m	> 2000	0-5	S	H	—
M 368	27°43,5' S 41°56' W	2/ 4/58	16:00	36.56 36.53	25.21- 0 m 25.30- 25 m	> 2380	0-10	20	H	0.365

* Net: 20 (American nº 20); KO = Kitahara O net for zooplankton; KK = Kitahara K net for phytoplankton; S = Standard (Nansen type); C.B. = Clarke-Bumpus plankton sampler.

* Haul: V = vertical; O = oblique; H = horizontal.

spp. and *Scolecithrix* sp. may also constitute the dominant volume. When there is a nycthemeral migration from deeper layers and large copepods like *Undeuchaeta major* reach the surface (M 114) this species is the dominant in size and volume.

Although poor in plankton volume, tropical waters are extremely rich in species (97 recorded in this paper) as is known from other papers. The following copepods were found in all samples (Table VI) but one: *Clausocalanus furcatus, Corycella gracilis* (or *C. carinata*), *Scolecithrix danae* in all stages of development and usually in high percentages. The *genus Oithona* (with *O. plumifera* and *O. setigera*), *Undinula vulgaris, Nannocalanus minor, Calocalanus pavo, Euchaeta marina, Acrocalanus longicornis, Corycaeus speciosus, Temora stylifera* (usually in low percentages), *Mecynocera clausi, Candacia pachydactyla* and the genus *Oncaea* (*O. media, O. venusta, O. conifera,* the most frequent) were present in 20 or more of the samples taken in the tropical water. The copepods mentioned above seem to constitute a characteristic association for tropical waters in the western South Atlantic. The other copepods usually present are *Neocalanus gracilis, Centropages violaceus, Copilia mirabilis, Paracalanus aculeatus, Acartia danae* or *A. negligens* and *Corycaeus* represented by several species (*C. clausi, C. latus, C. furcifer, C. typicus, C. flaccus*).

When different lists of open sea copepods from "tropical water" or "warm water" are compared the great number of species of *Corycaeidae* (*Corycaeus* and *Corycella*) may be noticed. In smaller number *Sapphirina* spp. are also common in warm oceanic waters (Lehnhofer 1929, p. 308). Some species appear in tropical waters but usually in very reduced numbers: *Rhincalanus cornutus* (or *nasutus*), *Eucalanus attenuatus, Haloptilus acutifrons* (or another *Haloptilus* species), *Heterorhabdus papilliger* (or another *Heterorhabdus* species), *Temeropia mayumbaensis, Pleuromamma abdominalis* (or *gracilis*), *Undeuchaeta* (*major* or *minor*). These usually appear in tropical surface layers during their nycthemeral migrations from deeper layers.

Table VII compares the general data in the literature and those obtained here. So as to be sure that the same environments are being compared only data were used from regions where the salinities and temperatures could be established as well as the species and when possible, the number of specimens of each species.

Two conclusions may be drawn from Table VII: 1 — the association found in Brazilian waters could be expected, as it confirms earlier data obtained by other authors (Dahl, 1894; Farran,

TABLE Xa — Colder subtropical waters

	REGION	South Atlantic off Southern Brazil	South Africa South Atlantic	New Zealand South Pacific	North Atlantic West & Middle	Western North Pacific
	AUTHOR	Björnberg	Tanaka, 1960 Björnberg	Farran, 1929	Kanaeva, 1959	Brodsky, 1957
	SALINITY	35.00 ‰	35.5-35.9 ‰	35.5 ‰	35.5-35.0 ‰	33.7-34.6 ‰
	TEMPERATURE	18°-10°C	20°-15°C	15°C	10°-20°C	6.7°-23.7°C
COPEPODS USUALLY RECORDED	*Ctenocalanus*	*vanus* *	*vanus*	*vanus* *	*vanus* *	—
	Clausocalanus	*arcuicornis*	*arcuicornis* *	*arcuicornis* *	*arcuicornis* *	*arcuicornis*
	Mecynocera	*clausi* *	*clausi* *	*clausi* *	*clausi* *	*clausi*
	Nannocalanus	*minor*	*minor*	*minor*	*minor*	*minor*
	Corycella	*rostrata*	*rostrata* *	*rostrata* *	spp.	?
	Corycella	*gracilis*	*concinnus*	—	—	?
	Corycaeus	*giesbrechti* *	*agilis* + *giesbrechti*	*flaccus* + *inuncus*	—	?
	Corycaeus	—	*dahli* *	*crassiusculus* *	—	?
	Corycaeus	—	*asiaticus*	*longistylis*	—	?
	Calocalanus	*styliremis*	*subtilis* + *pavo*	*pavo* + *styliremis*	*contractus* + *styliremis*	*pavo* + *plumulosus* + *styliremis*
	Calanus	*tenuicornis*	*tenuicornis*	*tenuicornis*	*tenuicornis* *	*tenuicornis* *
	Calanus	*carinatus*	*carinatus* + *tonsus*	*carinatus* + *tonsus*	*helgolandicus*	*propinquus* + *pauper*
	Acrocalanus	sp.	*gracilis*	—	—	*gracilis* *
	Euchaeta	*marina*	*marina* + *acuta*	*acuta* * + *media* + *pubera*	*acuta*	*acuta* + *marina*
	Clausocalanus	*furcatus*	*furcatus* + *laticeps*	*pergens* + *paululus*	—	—
	Neocalanus	*gracilis*	*gracilis*	—	*gracilis*	*gracilis* *
	Paracalanus	*parvus* * + *aculeatus*	*aculeatus* + *parvus* + *crassirostris*	*parvus*	—	*parvus* + *pygmaeus* *
	Candacia	*curta* + *bipinnata*	*aethiopica* + *pachydactyla*	*aethiopica* + *longimana*	*armata* + *bipinnata*	*simplex* * + *armata* + *bipinnata* + *varicans*
	Acartia	*danae* + *lilljeborghii*	*danae* * + *negligens*	*danae* * + *clausi*	—	*danae* + *negligens*
	Macrosetella	*gracilis*	*oculata* + *gracilis*	—	*gracilis* + *oculata*	?
	Oncaea	*venusta* + *media* *	*media* * + *venusta*	*venusta* *	*venusta* *	?
	Lucicutia	*flavicornis* + *ovalis* + *clausi*	*flavicornis*	*flavicornis* * + *ovalis*	*flavicornis* * + *gemina*	*flavicornis* * + *clausi*
	Pleuromamma	*gracilis* + *abdominalis*	*gracilis* + *borealis* + *piseki*	*abdominalis* + *xiphias* + *gracilis* + *piseki*	*abdominalis* + *xiphias* + *gracilis* + *piseki* + *borealis*	*gracilis*
	Oithona	*plumifera* + *setigera*	*plumifera* + *fallax* + *oculata*	*plumifera*	*similis* + *spinifrons*	?
	Oithona	*nana* + *minuta*	+ *nana* + *similis*	*similis*	*nana* + *setigera*	?
	Oncaea	*conifera* + *subtilis*	*clevei*	—	*mediterranea* * + *conifera*	?
	Centropages	*furcatus*	*typicus* + *violaceus*	*bradyi* + *aucklandicus*	—	*calaninus*
	Euchirella	*rostrata*	—	*rostrata* + *brevis*	*rostrata*	*curticauda* + *intermedia*
	Microsetella	—	*rosea*	—	*rosea*	?
	Temora	*stylifera* *	—	*turbinata* *	—	*discaudata* + *stylifera*
	Scolecithrix	*danae*	*danae*	*danae* + *bradyi*	*bradyi*	*danae* + *bradyi*
	Scolecithricella	—	*tenuiserrata*	*dentata* + *vittata*	*ovata*	*marginata*
	Heterorhabdus	*spinifrons*	—	*spinifrons* + *papilliger*	*papilliger* + *spinifrons*	*papilliger* * + *spinifrons*
	Haloptilus	*longicornis*	—	*acutifrons*	*longicornis* + *oxycephalus*	*spiniceps* + *longicornis* + *ornatus*
	Pontellopsis	sp.	*regalis*	—	—	—

* Species usually found in large numbers.

TABLE VI — List and percentages of copepods found in tropical waters (contd.)

STATION NUMBER	M 100	M 365	M 99	M 98	M 364	M 363	M 37	M 95	M 97	M 111	M 113	M 96	M 189	M 114	M 368
COPEPODS	Percentages of copepods in total number of copepods counted per sample														
Corycaeus crassiusculus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Copilia vitrea	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus robustus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Candacia sp.	—	—	0.46	—	—	—	x	—	—	—	0.8	—	0.03	—	—
Sapphirina gastrica	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—
Candacia bispinosa	—	—	—	—	—	—	—	—	—	—	11.2	—	—	1.6	—
Sapphirina spp. { *maculosa* / *sinuicauda* / *metallina*	—	x	0.06	—	—	—	—	—	0.2	—	—	—	—	—	—
Sapphirina opalina	—	—	—	—	—	—	—	x	—	—	—	—	0.03	—	—
Euchaeta acuta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Undeuchaeta major	—	—	—	—	—	—	—	—	—	—	—	—	—	1.9	—
Euchirella brevis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus limbatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus flaccus	—	—	—	0.07	—	—	—	—	—	—	—	—	—	—	—
Corycaeus clausi	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Copilia lata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miracia efferata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapphirella tropica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Copilia quadrata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Urocorycaeus lautus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Labidocera acutifrons	—	—	—	—	—	—	—	—	—	—	—	—	—	3.4	—
Haloptilus longicornis	—	0.6	—	—	0.4	—	—	—	—	—	—	—	—	—	—
Haloptilus spiniceps	—	—	—	—	0.2	—	—	—	—	—	—	—	—	—	x
Pontellina plumata	—	—	—	—	0.2	—	—	—	—	—	—	—	—	0.1	—
Pontellopsis perspicax	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pontellopsis villosa	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—
Candacia simplex	0.5	x	—	—	0.4	0.5	—	—	—	—	—	—	—	—	—
Candacia aethiopica	—	x	—	—	x	—	—	—	—	—	—	—	—	—	—
Euaugaptilus filiger	—	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—
Calanoides carinatus	1.6	—	—	—	—	—	—	x	—	—	—	—	—	—	—
Eucalanus attenuatus	—	—	—	—	x	0.7	—	—	—	—	0.4	—	—	—	x
Sapphirina ovato-lanceolata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapphirina nigromaculata	—	—	—	—	0.4	—	—	—	—	—	—	—	0.03	—	—
Rhincalanus cornutus	—	0.6	—	—	—	—	—	0.2	—	—	0.4	—	—	—	x
Centropages violaceus	—	—	0.2	0.7	—	—	0.7	—	1.1	—	—	—	—	1.08	1.0
Neocalanus robustior	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapphirina stellata	—	—	—	0.13	0.4	—	—	—	0.2	—	—	—	—	—	—
Lubbockia squillimana	—	1.6	—	—	—	—	—	—	—	0.6	0.4	—	—	—	x
Corycaeus furcifer	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus typicus	—	0.3	—	—	1.3	1.9	0.2	—	2.2	—	4.2	—	—	—	—
Heterorhabdus spinifrons	0.5	—	0.05	—	—	0.1	—	—	—	—	—	—	—	0.1	—
Candacia pachydactyla	—	—	—	0.4	0.7	—	1.2	0.4	—	2.5	x	—	—	2.1	2.0
Euchaeta marina	—	—	0.1	—	x	0.5	3.4	—	—	1.2	1.8	—	—	5.9	x
Neocalanus gracilis	—	—	—	—	1.4	—	—	—	—	—	—	—	—	0.3	—
Scolecithrix	0.5	0.3	0.6	0.03	0.2	x	1.8	1.2	0.2	2.4	2.8	—	—	1.3	3.0
Corycaeus speciosus	2.2	—	2.0	0.5	0.4	0.7	0.8	x	3.1	1.8	0.4	1.6	—	0.1	1.0
Acrocalanus	1.1	0.3	1.4	1.0	0.4	0.1	1.5	x	2.7	—	1.4	—	—	0.1	1.5
Calocalanus pavo	—	—	—	0.4	—	—	2.6	x	—	0.6	0.4	—	—	—	1.0
Mecynocera clausi	—	3.2	0.9	—	1.3	x	—	—	0.2	—	2.8	0.4	0.9	1.9	1.5
Acartia danae	1.1	—	—	0.03	0.2	—	—	—	—	0.6	1.4	—	0.06	—	1.0
Corycaeus ovalis or *latus*	—	—	0.1	0.1	0.4	—	1.4	—	—	—	—	—	—	—	—
Nannocalanus minor	2.2	—	1.1	0.2	1.1	2.1	4.1	3.7	x	3.1	1.4	1.6	0.31	8.8	1.5
Undinula vulgaris	x	1.2	1.7	2.1	1.4	0.1	0.4	1.9	6.7	—	—	1.2	0.03	0.3	2.0
Copilia mirabilis	0.5	x	0.2	—	0.7	—	1.4	—	0.2	—	—	—	0.06	0.3	—
Lucicutia flavicornis	—	2.2	0.6	—	2.2	—	1.1	—	—	11.8	—	—	—	1.4	2.5
Macrosetella	0.5	1.6	0.2	1.03	2.01	1.1	0.8	0.7	2.0	—	—	0.8	0.06	0.7	x
Paracalanus aculeatus	—	—	0.4	2.3	—	—	1.6	4.2	1.3	—	—	0.8	8.6	1.9	—
Clausocalanus arcuicornis	—	x	—	0.07	—	0.1	0.1	—	—	—	—	—	—	—	—
Corycella gracilis	15.71	7.4	31.0	11.6	10.7	16.2	12.8	22.1	14.1	9.9	11.2	18.1	3.3	0.3	14.0
Clausocalanus furcatus	52.2	22.6	31.0	59.2	25.9	21.5	33.7	9.4	29.4	—	31.3	24.1	8.5	2.3	10.5
Oithona setigera	—	0.6	—	—	0.2	—	—	—	—	1.8	1.4	—	—	—	—
Oncaea media	—	4.5	7.9	4.4	18.5	—	21.8	10.1	27.0	9.9	11.2	39.4	1.2	9.9	33.5
Oncaea subtilis	—	1.6	—	—	—	34.3	—	12.8	—	—	—	—	3.7	—	—
Oncaea venusta	0.05	1.2	0.1	—	2.2	6.1	0.5	2.8	0.6	31.6	1.4	0.4	0.8	2.5	x
Oithona plumifera	1.1	9.3	5.9	7.5	12.5	—	7.5	—	2.2	0.6	12.6	2.5	1.3	6.1	3.5
Temora stylifera	10.6	3.2	7.5	4.1	1.1	0.5	3.9	39.3	3.8	1.2	0.4	3.3	10.0	3.2	5.5
Corycaeus giesbrechti	2.2	1.2	4.3	2.2	0.2	—	0.4	—	0.2	9.9	—	2.5	0.03	—	—
Clytemnestra sp.	—	—	—	0.03	—	—	—	x	—	—	—	—	0.03	—	0.5
Microsetella sp.	—	13.53	—	0.03	5.1	5.5	—	—	0.2	—	—	—	0.01	—	13.0
Centropages furcatus	x	—	—	—	—	—	—	0.2	—	—	—	—	—	0.3	—
Calocalanus plumulosus	—	1.8	—	—	2.01	—	—	—	—	—	—	—	0.8	0.1	—
Acartia negligens	—	—	—	—	—	—	—	—	0.2	—	—	0.4	—	1.0	—
Calocalanus styliremis	x	—	—	—	1.3	—	—	—	—	—	0.2	—	—	—	—
Corycella rostrata	—	—	—	—	0.7	—	—	—	—	—	—	—	—	—	—
Pleuromamma abdominalis	1.6	1.6	—	—	—	—	0.1	—	—	1.2	—	—	—	5.9	—
Pleuromamma xiphias	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Paracalanus parvus	—	6.7	—	—	—	—	0.1	—	—	—	—	—	—	—	—
Pleuromamma gracilis	—	—	1.1	—	—	—	—	—	—	7.4	—	—	—	24.8	—
Oithona nana	—	—	—	—	—	—	—	—	—	—	—	—	26.6	—	—
Euaetideus giesbrechti	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Candacia curta	—	—	—	—	—	—	1.9	—	—	—	—	—	—	—	—
Sapphirina angusta	—	—	—	0.03	2.6	x	—	—	—	—	0.4	—	—	—	x
Heterorhabdus papilliger	—	—	—	—	—	—	—	—	—	1.2	—	—	—	—	—
Lucicutia ovalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aeghistus mucronatus?	—	—	—	—	—	—	0.1	—	—	—	0.4	—	—	0.1	x
Eucalanus monachus	—	—	—	—	—	—	1.7	—	—	—	—	—	—	—	—
Eucalanus subcrassus	—	x	—	—	—	—	—	1.2	—	1.2	—	—	—	0.1	—
Acartia longiremis	—	—	—	—	—	0.9	0.1	—	—	—	—	—	—	—	—
Euterpina acutifrons	—	—	—	—	—	—	—	—	—	—	—	—	0.05	—	—
Pontellopsis brevis	—	—	—	—	—	—	0.1	0.9	—	—	—	—	—	—	—
Corycaeus amazonicus	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—
Ctenocalanus vanus	—	—	—	—	—	—	—	—	—	—	—	—	0.03	0.3	—
Oncaea conifera	—	—	0.05	—	—	—	—	—	—	1.8	—	—	—	—	—
Oithona robusta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Young calanids (unidentified)	—	1.2	—	—	—	—	—	—	—	—	—	—	32.8	—	—
Oncaea mediterranea	—	—	—	—	2.4	—	—	—	—	—	—	—	—	—	—
Oncaea minuta	—	5.1	—	—	—	—	—	—	—	—	—	—	—	—	—
Young *Oithona*	—	—	—	—	—	5.5	—	—	—	—	—	—	—	—	—
Oculosetella	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—

x = Presence of the species in the total sample but not in the sub-sample.

TABLE IV — Copepods usually present in coastal waters of different parts of the world

SITUATION	Block Is. Sound and Woods Hole	Alaska	North Sea & Kattegat	Florida Gulf & Mexico Gulf	Amazon's mouth area	South of Brazil	South of Brazil	Portuguese Guinea, Angola (Africa)	Sesimbra (Portugal)	California	McMurdo Sound (Antarctica)	Australia	Japan	Suez Canal	Persian Gulf	Indian Sea	Burma Sea	Bering Sea (coastal region)
AUTHOR	Sharpe Deevey (1952)	Johnson (1957)	Colebrook (1961) Bremen (1936) Ostenfeld (1929)	Grice (1956) Davis (1950)	Dahl (1894) Björnberg (—)	Björnberg (1959) Carvalho (1952)	Björnberg (1959)	Marques (1948-58)	Candeias (1930)	Esterly (1926)	Farran (1929)	Farran (1936, 1949)	Yamada (1956) Tamaki (1957)	Gurney (1927)	Pesta (1912)	Devasundaram & Roy (1954); Sewell (1948); Dutta, Malhotra, Bose (1954)	Sewell (1948)	Brodsky (1957)
SALINITY (‰)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Under 34.0	[illegible]	[illegible]	34.5 approx.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—
TEMPERATURE (°C)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Under −2°	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—
GENUS	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES
Centropages	typicus* hamatus (Brady)	mcmurrichi	typicus hamatus*	furcatus hamatus	furcatus	furcatus	brachiatus	furcatus	chierchiai	—	—	furcatus gracilis*	abdominalis	furcatus* typicus ponticus	furcatus orsinii	elongatus, alcocki, trispinosus, etc.	furcatus	mcmurrichi
Temora or Eurytemora	longicornis herdmani, hirundoides	herdmani	longicornis affinis	turbinata (stylifera)	stylifera	stylifera	stylifera	longicornis	—	—	—	discaudata	discaudata	stylifera discaudata	turbinata discaudata	discaudata	turbinata	kieferi herdmani
Acartia	clausi tonsa	longiremis* clausi	bifilosa longiremis clausi	tonsa floridana spinata	giesbrechti lilljeborgi	lilljeborgi	tonsa	clausi longiremis	—	clausi tonsa	—	pacifica negligens pietschmanni	erythraea clausi	fossae clausi centrura latisetosa	bispinosa erythraea pietschmanni	plumosa, major centrura chilkaensis danae, etc. (Acartiella)	erythraea	longiremis* clausi tumida
Labidocera	aestiva	(Epilabidocera amphitrites)	wollastoni	aestiva scotti	fluviatilis	fluviatilis (aestiva)	—	detruncata	—	—	(Paralabidocera antarctica)	acuta, laevidentata, detruncata	pavo, japonica, pacifica, spinicauda	pavo minuta	acuta, minuta	bataviae, laevidentata, pavo, pectinata, etc.	minuta	(Epilabidocera amphitrites)
Paracalanus	parvus crassirostris	—	parvus	parvus crassirostris	parvus crassirostris	parvus crassirostris	parvus aculeatus crassirostris	crassirostris	parvus	—	—	parvus* aculeatus	parvus	parvus, crassirostris	aculeatus	crassirostris, dubius, indicus, nanus, serratipes	parvus aculeatus	—
Oithona	plumifera setigera similis* brevicornis	similis*	nana plumifera similis	nana, brevicornis, simplex	plumifera setigera	nana, plumifera, brevicornis, ovalis	plumifera similis rigida	brevicornis, nana	nana*	nana similis	similis frigida	plumifera*	nana similis rigida	plumifera nana simplex	plumifera	brevicornis nana	—	?
Oncaea	minuta	—	—	—	—	media	media	—	media*	—	curvata conifera	clausi* conifera	media	media	minuta conifera media	?	?	?
Corycaeus	giesbrechti	—	anglicus	amazonicus americanus	africanus giesbrechti amazonicus	giesbrechti	—	africanus	—	sp.	[illegible]	erythraeus* asiaticus, catus lubbocki	affinis	erythraeus asiaticus brehmi medius	[illegible] gracilicaudatus ovalis?	—	—	?
Pseudocalanus	minutus*	minutus*	elongatus	—	—	—	—	—	elongatus	—	—	—	elongatus	—	—	—	—	elongatus and sp.
Eucalanus	—	—	—	—	monachus subcrassus	monachus subcrassus subtenuis	subtenuis	monachus	—	—	—	subcrassus*	subcrassus	—	subcrassus	—	subcrassus monachus	bungii
Calanus and Related Genera	finmarchicus	finmarchicus hyperboreus	finmarchicus	— Microcalanus [illegible]	—	—	tenuicornis	—	—	—	acutus Microcalanus sp.	pauper*	Sinocalanus tenellus	pauper	—	—	Metacalanus aurivillii	finmarchicus, tonsus cristatus
Pontella-Pontellopsis Parapontella	lobiancoi meadii	—	brevicornis	pennata	—	brevis	—	lobiancoi	—	—	—	krameri macronyx	[illegible]	—	—	andersoni 10 spp.	—	—
Calanopia	—	—	—	americana	americana	americana	—	—	—	—	—	elliptica aurivillii	thompsoni	media elliptica	elliptica, minor	aurivillii herdmani thompsoni	elliptica	—
Pseudodiaptomus	coronatus	—	—	coronatus	acutus richardi	acutus cristobalensis	—	serricaudatus	—	—	—	—	marinus inopinus	salinus	—	annandalei, lobipes, aurivillii, tollingeri, binghami, salinus, etc.	—	—
Tortanus	discaudatus setacaudatus	discaudatus	—	—	—	—	—	—	—	—	—	gracilis	forcipatus	gracilis	—	barbatus, tropicus, forcipatus, gracilis	—	discaudatus
Euterpina	—	—	acutifrons	—	acutifrons	acutifrons	—	acutifrons	acutifrons	acutifrons	—	acutifrons	acutifrons	acutifrons	—	—	—	?
Microsetella	norvegica	—	atlantica	—	norvegica rosea	rosea, norvegica	—	—	norvegica	—	—	—	norvegica, rosea	norvegica	rosea	—	—	?
Clausocalanus	—	—	—	furcatus	furcatus	furcatus	—	—	arcuicornis	arcuicornis	—	furcatus arcuicornis	—	arcuicornis	—	—	—	—
Ctenocalanus	—	—	—	—	—	—	vanus	—	—	vanus	vanus	—	—	—	—	—	—	—

NOTE — Many of the copepods in this list are characteristic of brackish environments, but live also in coastal waters.

Only the genera common to most of the waters studied were registered here, excepting the Harpacticoida.

* = More numerous in the samples.

TABLE VII — Copepods found in tropical waters in different regions of the world •

REGION	South Equatorial & Brazil Currents	Tropical Atlantic	North Equatorial Current (Atlantic)	Gulf Stream	Indian Ocean	Tropical North Pacific	Japan	Tropical East Pacific (Ecuador)	Tropical West Pacific	Tropical North Pacific	Indo-Pacific Ceram & Banda Seas
AUTHOR	Björnberg	Dahl, 1894; Farran, 1929	Evans, 1961	Wheeler, 1900 Wilson, 1932; Moore, 1949 Deevey, 1952	Tanaka, 1960	Sugonov, 1958	Yamazi, 1958	Wilson, 1950	Wilson, 1950 Brodsky, 1957	Wilson, 1950	Scott, 1909; Vervoort, 1946
SALINITY (‰)	more than 36.00	35.00-37.00	34.9-36.3 average = 35.6	36.00-35.00	35.00	34.5-34.7	34.5	32.00-33.00	32.00-35.00 average = 34.8	34.00-35.50	32.08-34.7
TEMPERATURE (°C)	above 20.0	20-29	24.72-26.53	29-6	27-20	18-27	25-27	25-27	29-17.9 average = 27.8	25-28	29.2-25.1
COPEPODS											
Clausocalanus	*furcatus* *	*furcatus* *	*furcatus* *	*furcatus*	*furcatus, pergens*	*furcatus*	—	—	*furcatus*	—	*furcatus*
Corycella	*gracilis* *	*gracilis* *	*carinata* *	*carinata*	—	spp.	—	—	*rostrata, carinata*	*rostrata*	—
Nannocalanus	*minor* *	*minor* *	*minor* *	*minor*	*minor*	*minor*	*minor*	*minor*	*minor*	*minor*	*minor*
Scolecithrix	*danae* *	*danae* *	*danae* *	*danae*	*danae*	—	*danae*	*danae*	*danae*	*danae*	*danae*
Oncaea	*media* *	*media* *	*media* *	—	*media*	*media*	*media*	—	*minuta*	*minuta*	*minuta*
Undinula	*vulgaris* *	*vulgaris* *	*vulgaris*	*vulgaris*	*vulgaris*	*vulgaris*	*vulgaris*	*vulgaris*	*vulgaris*	*vulgaris*	*darwini*
									darwini	*darwini*	*vulgaris*
Corycaeus	*speciosus*	*speciosus*	*speciosus* *	*speciosus*	*speciosus*	*speciosus*	*longistylis*	—	*speciosus*	*latus*	*speciosus, furcifer*
					crassiusculus						
Arrocalanus	*longicornis* *	*longicornis* *	*longicornis*	—	*gracilis* *	*gibber*	*gracilis*	*longicornis*	*gracilis*	*longicornis*	*longicornis, gibber, gracilis, monachus*
							longicornis		*gibber*		
Euchaeta	*marina* *	*marina* *	*marina* *	*marina*	*marina, wolfendeni*	*marina*	*marina*	*marina*	*marina, spinosa*	*marina, spinosa*	*marina, wolfendeni cuspidata*
Gidkosa	*plumifera* *	*plumifera* *	*kofoidandira*	*plumifera*	*plumifera, simplex* *	*plumifera*	*plumifera*	—	—	—	*plumifera*
Candacia	*pachydactyla*	*pachydactyla*	*pachydactyla*	*pachydactyla*	*pachydactyla*	*curvicauda*	*spp.*	*longicauda, curta*	*longicauda, simplex*	—	*curta, pachydactyla simplex*
Calocalanus	*pavo* *	*pavo* *	*pavo* *	*pavo*	*pavo*	*pavo*	*pavo*	—	*pavo*	—	*pavo*
Macrosetella	*x* *	*x* *	*gracilis* *	*x*	*x*	*x*	*x*	—	—	—	*x*
Oncaea	*venusta* *	*venusta* *	*venusta* *	*venusta*	*venusta*	*venusta*	*venusta*	*venusta*	*venusta*	—	*venusta*
Mecynocera	*clausi*	*clausi*	—	*clausi*	—	*clausi*	*clausi*	—	—	—	*clausi*
Temora	*stylifera*	*stylifera*	*stylifera*	*stylifera*	*discaudata*	*stylifera*	*stylifera*	*stylifera, discaudata*	*stylifera, discaudata*	*stylifera*	*discaudata, turbinata*
Centropages	*violaceus*	*violaceus* *	*violaceus*	*brady, typicus*	*violaceus*	—	*spp.*	*furcatus*	*furcatus, calaminus*	*violaceus, kröyeri*	*furcatus*
Paracalanus	*aculeatus*	*aculeatus* *	*aculeatus* *	—	*aculeatus, nudus*	*aculeatus*	*aculeatus*	*parvus*	*parvus*	*parvus*	*parvus, aculeatus*
Copilia	*mirabilis*	*mirabilis*	*mirabilis*	*sp.*	*headorffi*	*mirabilis*	*mirabilis*	*denticulata*	*quadrata*	*mirabilis*	*mirabilis, quadrata*
Neocalanus	*gracilis*	*gracilis*	*gracilis, robustior*	*gracilis*	—	—	—	*gracilis*	*gracilis, robustior*	*gracilis*	—
Candacia	—	—	—	—	*pauper*	—	*pauper*	—	*pauper*	—	*pauper*
Corycaeus	*typicus*	*typicus*	—	*typicus*	*andrewsi*	*typicus*	*flaccus*	—	—	*clausi*	*flaccus*
Corycaeus	*latus*	*latus* *	*latus*	*latus*	*asiaticus, pacificus*	*pumilus*	*crassiusculus*	—	*longistylis*	—	—
Lucicutia	*flaccicornis*	*flaccicornis*	*flaccicornis*	*spp.*	*flaccicornis*	*flaccicornis*	*flaccicornis, ovalis*	*flaccicornis, curta*	*flaccicornis*	—	*flaccicornis, clausi*
Clausocalanus	*arcuicornis*	*arcuicornis* *	—	*arcuicornis*	*arcuicornis*, *pavolleti*	*arcuicornis*	*arcuicornis*	—	*arcuicornis*	—	*arcuicornis*
Candacia	*simplex*	*simplex*	—	*armata*	*catula aethiopica*	*simplex*	*truncata*	*simplex, armata*	*simplex*	—	*curta, catula*
Acartia	*danae*	*danae*	*danae*	*danae, tonsa*	*danae*	*danae*	*danae*	*danae*	*danae*		*danae, erythraea*
Microsetella	*rosea*	*rosea*	*norvegica*	—	*rosea* *	*rosea*	*rosea, norvegica*	—	*rosea*	*rosea*	—
Corycaeus	*giesbrechti*	*giesbrechti*	—	—	*coriaceus* *, *agilis*	*anglicus*?	*asiaticus, lautus, gibbulus*	—	*gibbulus*	—	*gibbulus, ovalis, robustus, giesbrechti, lubbocki, flaccus*
Calocalanus	*plumulosus*	*plumulosus*	—	*plumulosus*	*plumulosus*	*plumulosus*	*plumulosus*	—	*plumulosus*	—	*plumulosus*
Rhincalanus	*cornutus*	*cornutus*	*cornutus*	*cornutus*	—	*nasutus*	*cornutus*	*cornutus*	*cornutus*	—	*cornutus*
Euchaeta	*attenuatus*	*attenuatus*	*attenuatus*	*attenuatus, monachus*	—	*attenuatus*	*attenuatus*	*attenuatus*	*attenuatus, elongatus, rostrus, etc.*	*attenuatus*	*subtenuis, macronatus, subcornuta, monachus*
Sapphirina	*stellata*	*stellata*	*stellata*	*gemma*	—	*stellata*	*stellata*	—	—	*nigromaculata*	*nigromaculata, opalina, ovatolanceolata*
Haloptilus	*longicornis*	*longicornis*	—	*longicornis*	—	*angusticeps*	*longicornis, ornatifrons*	*ornatifrons, ornatus*	*longicornis*	*longicornis*	*longicornis*
Gidkosa	*setigera*	*setigera*	*setigera*	—	*nana*	*setigera*	*setigera*	*similis*	*similis*	—	—
Clytemnestra	*rostrata*	*scutellata*	*scutellata*	*rostrata*	—	*rostrata*	*scutellata*	—	—	—	—
Acartia	*negligens*	*negligens*	*negligens*	—	*negligens*	*negligens*	*negligens*	—	—	—	*negligens*
Pleuromamma	*abdominalis, gracilis*	*xiphias*	*abdominalis, gracilis, gracili, borealis, xiphias*	*abdominalis*	*abdominalis, gracilis*	*gracilis*	*abdominalis, gracilis, xiphias*	*abdominalis, xiphias*	*abdominalis, gracilis*	*robusta, abdominalis*	*gracilis, abdominalis, xiphias*

x = occurrence of genus or species; * = numerous

• = The data published by Grice (1962) and Brodsky (1957) were not always obtained from waters with temperatures only above 2°C, and therefore all or nearly all were not included.

1929); 2 — the same characteristic association with minor variations on the species level can be expected in waters from other parts of the world where the same temperature and salinity ranges as in Brazilian tropical waters are observed.

Subtropical surface waters

As the Brazil Current advances southwards it diminishes in strength and in winter its southern boundary is not always clearly discernible (Emilsson 1959, p. 49). The tropical water gradually looses its high temperature in the subtropical region by admixture with surrounding water and contributes in the south of Brazil to the formation of water with salinities around 36.00 ‰ and temperatures of 18°C or less, in the surface layer (Table IX). Plankton volumes of samples from this water averaged 0.08 ml/m³, the poorest of the waters studied. Dominant in volume in these waters are *Pleuromamma, Nannocalanus minor* and *Clausocalanus furcatus* or *C. arcuicornis, Oncaea venusta* and *Acartia*. In these impoverished waters, *Corycella rostrata* sometimes in high percentages, substitutes *Corycella gracilis* or *Corycaeus giesbrechti* of other waters. The following copepods were present in the 11 samples examined from these waters: *Mecynocera clausi* (in higher percentages) and *Scolecithrix* sp., in lower percentages than in tropical waters. *Clausocalanus furcatus* was present in high percentages in 9 out of 11 samples. *Clausocalanus arcuicornis,* in 6 out of 11 samples, in higher percentages sometimes than *C. furcatus. Nannocalanus minor, Calocalanus pavo, Euchaeta marina, Macrosetella* were also frequent. *Nannocalanus minor* appears in percentages as high as 16.7 of the total number of copepods per sample.

In the surface subtropical waters only 68 species were recorded off Brazil (Table VIII). Some species of the same genus prefer the warmer and others these colder waters as already pointed out for *Corycella* and *Clausocalanus. Candacia aethiopica* is found more frequently than *C. pachydactyla* in this environment, *Euchaeta acuta* is also found sometimes, instead of *E. marina.* The genus best represented in this water is *Pleuromamma* with its four species, *P. gracilis* (and its variety *P. piseki*), *P. abdominalis, P. xiphias* and *P. borealis.* The study of waters from other regions with salinities above 35.5 ‰ and temperatures between 20° and 16°C show a similar composition of copepod species. In all these regions the great number of *Mecynocera clausi,* of *Clausocalanus arcuicornis, Nannocalanus* sp. and *Pleuromamma* spp. was directly observed (Table X).

TABLE VIII — Percentages of copepod species in samples of surface subtropical waters

SAMPLE NUMBER	M 166	M 394	M 402	M 400	M 163	M 403	M 162	M 161	M 407	M 160	M 409
COPEPODS	Percentages of copepods from total number of copepods per sample										
Mecynocera clausi	0.1	4.5	2.1	5.9	20.7	2.2	4.3	15.8	0.9	8.6	8.08
Scolecithrix	0.3	0.8	0.5	x	0.8	0.2	0.1	0.1	5.4	0.4	0.9
Corycaeus rostratus	2.6	20.7	12.1	8.7	15.7	8.9	3.9	5.9	x	18.6	26.8
Oncaea venusta	1.0	2.7	4.5	—	0.5	2.08	—	8.3	24.7	2.4	2.5
Clausocalanus furcatus	1.2	50.7	32.1	2.05	1.0	25.6	—	—	8.01	31.8	44.7
Nannocalanus minor	9.3	2.7	3.0	4.3	0.7	1.7	0.6	9.9	16.7	2.9	2.9
Euchaeta marina	—	—	1.6	—	0.8	0.08	0.1	0.2	0.9	0.1	x
Calocalanus pavo	—	0.1	—	2.8	1.07	0.5	0.3	0.4	—	1.6	0.1
Macrosetella	0.5	—	x	—	—	1.1	0.3	0.09	x	0.8	0.2
Clausocalanus arcuicornis	69.6	—	1.0	—	3.4	34.5	—	43.05	x	—	0.1
Corycaeus speciosus	—	0.5	2.1	—	—	1.1	—	—	0.9	—	0.3
Pleuromamma gracilis	0.2	—	—	—	—	0.01	0.1	3.3	0.2	—	x
Oncaea media	3.3	2.5	10.5	—	—	—	0.9	—	8.4	0.1	3.1
Oithona plumifera	—	4.08	3.2	—	16.1	—	—	0.1	0.6	—	2.9
Undinula vulgaris	—	1.1	2.5	—	—	0.1	—	—	3.7	—	0.7
Neocalanus gracilis	1.5	—	—	1.2	—	0.1	—	0.3	1.6	—	—
Candacia aethiopica	—	2.5	1.0	—	—	1.07	—	—	1.8	—	0.1
Acartia negligens	—	2.5	—	1.02	—	—	—	9.9	—	—	2.2
Calanus tenuicornis	—	—	—	—	1.6	—	0.5	0.04	—	x	0.1
Acartia danae	0.8	—	1.5	—	32.9	0.5	34.9	—	0.2	28.6	—
Lucicutia flavicornis	0.2	—	x	—	—	0.08	0.1	1.01	1.8	—	—
Corycella gracilis	—	0.8	1.6	0.2	—	—	—	—	2.1	—	2.3
Corycaeus giesbrechti	0.2	0.1	—	—	—	—	0.05	—	—	—	—
Temora stylifera	—	—	—	0.2	—	—	0.1	—	2.8	0.3	—
Corycaeus latus	—	0.6	1.0	—	—	0.06	—	—	—	x	0.3
Calocalanus styliremis	—	0.1	0.5	4.1	—	—	—	—	0.2	—	—
Centropages violaceus	—	x	0.5	—	—	0.04	—	—	—	—	x
Heterorhabdus spinifrons	0.1	—	x	—	—	0.05	—	—	0.7	—	—
Lubbockia squillimana	—	—	0.5	—	—	0.05	—	—	0.2	—	x
Labidocera acutifrons	—	0.5	3.2	—	—	0.02	—	—	0.7	—	—
Lucicutia ovalis	—	—	—	x	—	0.04	—	—	0.8	—	—
Microsetella sp.	—	—	2.1	—	—	6.6	—	x	2.4	—	—
Oithona setigera	—	—	—	28.2	—	3.8	0.5	—	—	1.8	—
Oncaea mediterranea	—	0.1	1.1	—	—	5.8	—	—	—	—	—
Paracalanus parvus	—	—	—	—	4.8	—	50.1	0.04	—	—	—

Acrocalanus longicornis	—	—	—	—	—	—	—	—	1.1	—	—
Corycaeus typicus	—	—	—	—	—	0.04	—	—	0.4	—	—
Young calanids	—	—	—	—	—	—	3.01	—	7.5	—	—
Calocalanus plumulosus	—	—	2.1	4.6	0.3	—	—	—	—	—	—
Corycaeus crassiusculus	—	—	0.5	—	—	—	—	0.09	—	—	—
Corycaeus limbatus	—	0.5	—	—	—	—	—	—	—	—	0.1
Euchaeta acuta	1.8	—	—	—	—	—	—	0.7	—	—	—
Pleuromamma borealis	1.2	—	—	—	—	—	0.1	—	—	—	—
Sapphirina nigromaculata	—	0.3	x	—	—	—	—	—	0.4	—	—
Pleuromamma xiphias	0.4	—	—	—	—	—	—	2.5	—	—	—
Paracalanus aculeatus	—	—	—	22.8	—	—	—	—	—	0.6	—
Copilia quadrata	—	—	—	—	—	0.04	—	—	—	—	—
Haloptilus spp.	—	—	—	—	—	0.02	—	—	—	—	x
Ctenocalanus vanus	0.5	—	—	—	—	—	—	—	—	—	—
Oncaea conifera	—	—	—	—	—	1.6	—	—	4.4	—	—
Candacia bispinosa	—	—	—	—	—	0.02	—	—	—	—	—
Candacia pachydactyla	—	—	—	—	—	—	—	—	0.7	—	—
Candacia curta	—	—	—	—	—	—	—	—	0.4	—	—
Corycaeus clausi	—	—	—	—	—	0.5	—	—	—	—	—
Clytemnestra	—	—	—	—	—	0.01	—	—	—	—	—
Copilia mediterranea	—	—	0.5	—	—	—	—	—	—	—	—
Corycaeus furcifer	—	—	—	—	0.3	—	—	—	—	—	—
Eucalanus attenuatus	—	x	0.5	—	—	0.01	—	—	—	—	—
Oncaea subtilis	—	—	—	—	—	—	—	0.04	—	—	—
Pleuromamma abdominalis	4.08	—	—	—	—	—	—	—	—	—	—
Sapphirina scarlata	—	x	—	—	—	—	—	—	—	—	—
Sapphirina intestinata	—	—	—	0.2	—	0.02	—	—	—	—	—
Oculosetella gracilis	—	0.5	—	—	—	x	—	—	x	—	0.2
Corycaeus africanus	—	—	—	—	0.3	—	—	—	—	—	—
Acartia longiremis	—	—	—	—	—	0.5	—	—	—	—	—
Sapphirina opalina	—	—	—	—	—	0.02	—	—	—	—	—
Euchirella rostrata	2.1	—	—	—	—	—	—	—	—	—	—
Lucicutia clausi	—	—	—	—	—	—	—	—	x	—	—
Undeuchaeta major	—	—	—	—	—	—	—	x	—	—	—

x = species present in total sample, but not in sub-sample.

TABLE IX — List of stations of subtropical surface waters (SST)

Sample Number	Position	Date	Time (h)	Salinity (‰)	Temperature (°C)	Local depth (m)	Haul	Net	Plankton vol. (cc/m³)
M 166	34°42' S 46°45' W	7/11/56	23:20	36.23 36.29 36.24	18.44- 0 m 18.18- 9 m 18.19- 27 m	≅ 4500	25-0 O	S	—
M 394	33°02' S 48°28' W	16/ 4/58	16:00	35.78 36.76	20.52- 0 m 20.47- 29 m	3180	H Surf.	20	0.16
M 401	32°55' S 46°02' W	18/ 4/58	—	36.21 36.17 36.21 36.49 36.36 35.87	21.36- 0 m 21.38- 25 m 21.50- 50 m 21.21- 80 m 19.48-100 m 16.19-200 m	4035	V 274-0 m	20	0.03
M 400	32°55' S 46°02' W	18/ 4/58	—	36.21 36.17 36.21	21.36- 0 m 21.38- 25 m 21.50- 50 m	4030	H Surf.	20	0.03
M 163	32°24' S 44°54' W	7/11/56	04:40	36.27 36.28 36.32 36.20	18.90- 0 m 18.63- 10 m 18.42- 30 m 18.38- 50 m	≅ 3800	0-50 m O	S	—
M 403	32°17' S 45°55' W	18/ 4/58	—	35.17 35.88 36.02 36.33 36.88 36.66	21.05- 0 m 21.09- 25 m 21.07- 50 m 19.80- 75 m 17.30-108 m 15.41-210 m	4035	V 274-0 m	20	0.102

M 162	31°31' S 45°45' W	7/11/56	04:40	36.19 36.08 36.19	18.10- 0 m 18.02- 10 m 17.76- 30 m	≅ 3800	0-50 m O	S	—
M 161	31°31' S 46°33' W	6/11/56	23:50	36.21 36.26 36.10 36.10	18.18- 0 m 18.18- 10 m 17.82- 30 m 17.56- 50 m	≅ 3000	0-50 m O	S	—
M 407	31°03' S 45°00' W	19/ 4/58	—	36.21 36.24 36.31 36.20 35.97 35.69	22.35- 0 m 22.37- 25 m 22.50- 55 m 19.41- 85 m 17.61-115 m 15.40-300 m	3660	V 274-0 m	20	0.11
M 160	30°55' S 47°25' W	6/11/56	19:15	36.46 36.39 36.48 36.44 36.42	19.73- 0 m 19.64- 10 m 19.64- 20 m 19.48- 30 m 19.52- 48 m	≅ 1600	0-50 m O	S	—
M 409	30°17' S 43°59' W	20/ 4/58	—	36.15 36.20 36.31 36.16 36.11 35.49	22.33- 0 m 22.28- 25 m 22.45- 55 m 19.28- 83 m 18.07-111 m 14.40-300 m	3669	V 274-0 m	20	0.02

Haul: H = horizontal; V = vertical; O = oblique.
Net: S = Standard (Nansen type); 20 = American nº 20.

TABLE Xb — Surface subtropical waters (warmer)

REGION	South Atlantic off Brazil	South Atlantic Middle	North Atlantic Eastern (Temperate)	Ligurian Sea (Mediterranean)
AUTHOR	Björnberg Farran, 1929	Björnberg	Farran, 1929	Della Croce, 1959
SALINITY	36.00-35.5 °/₀₀	36.0-35.6 °/₀₀	37.0-35.5 °/₀₀	38.33-38.26 °/₀₀
TEMPERATURE	21°-18°C	20.9°-19.5°C	20°-18°C	21.53°-18.70°C
SPECIES USUALLY REGISTERED	*Mecynocera clausi* *	*Mecynocera clausi* *	*Mecynocera clausi*	*Mecynocera clausi*
	Scolecithrix danae	—	—	—
	Corycella rostrata	*Corycella rostrata*	*Corycella rostrata*	*Corycella rostrata*
	Oncaea venusta	*Oncaea venusta*	—	—
	Clausocalanus furcatus	*Clausocalanus furcatus* *	*Clausocalanus furcatus*	*Clausocalanus furcatus*
	Nannocalanus minor	*Nannocalanus minor* *	*Nannocalanus minor*	*Nannocalanus minor*
	Calocalanus pavo	*Calocalanus styliremis*	*Calocalanus pavo; styliremis*	*Calocalanus pavo; styliremis*
	Eucalanus monachus; attenuatus	—	*Eucalanus crassus; elongatus*	—
	Euchaeta marina	*Euchaeta marina*	*Euchaeta marina*	*Euchaeta marina*
	Macrosetella gracilis	*Macrosetella oculata*	*Macrosetella gracilis*	*Macrosetella gracilis*
	Oithona plumifera	*Oithona plumifera; setigera*	*Oithona plumifera*	*Oithona plumifera*
	Oncaea media	*Oncaea media* *	*Oncaea media* *	*Oncaea media*
	Clausocalanus arcuicornis *	*Clausocalanus arcuicornis* *	*Clausocalanus arcuicornis* *	*Clausocalanus arcuicornis*
	Corycaeus speciosus	*Corycaeus speciosus*	*Acartia danae; clausi*	*Corycaeus ovalis*
	Corycella gracilis	*Corycella gracilis*	*Lacicutia flavicornis; ovalis*	—
	Acartia danae; negligens	*Acartia negligens*	*Corycaeus speciosus*	*Acartia clausi; negligens*
	Lucicutia flavicornis	*Lucicutia flavicornis*	—	—
	Calanus tenuicornis	*Calanus tenuicornis*	*Calanus tenuicornis*	—
	Candacia aethiopica	*Candacia aethiopica*	*Candacia aethiopica; bispinosa*	*Candacia simplex*
	Neocalanus gracilis	*Neocalanus gracilis*	*Neocalanus gracilis*	—
	Undinulla vulgaris	*Undinulla vulgaris*	—	—
	Heterorhabdus spinifrons	*Heterorhabdus spinifrons*	*Heterorhabdus papilliger*	—
	Haloptilus longicornis	*Euaetideus giesbrechti*	—	—
	Centropages violaceus	*Centropages violaceus*	*Centropages violaceus*	*Centropages typicus; violaceus*
	Paracalanus parvus	*Paracalanus parvus*	*Paracalanus parvus*	*Paracalanus parvus*
	Microsetella rosea; norvegica	*Microsetella rosea*	*Microsetella norvegica*	*Microsetella rosea; norvegica*
	Sapphirina salpae	*Sapphirina stellata*	*Sapphirina ovatolanceolata*	*Sapphirina angusta*
	Pleuromamma spp.	*Pleuromamma* spp.	*Pleuromamma* spp.	*Pleuromamma gracilis*
	Corycaeus giesbrechti	*Corycaeus lautus*	*Corycaeus flaccus; latus* *	*Corycaeus giesbrechti*
	—	—	—	*Temora stylifera*
	—	—	—	*Pontella mediterranea*
	—	—	—	*Isias clavipes*

* Copepods found usually in large numbers.

SHELF WATERS

Surface shelf waters — Over the continental shelf, in a parallel band along the coast from 24°S to 27°S there is a layer of water which is the result of mixture of subtropical or deep shelf water and coastal water. It is heated locally and also suffers the influence of the surface tropical water (Emilsson 1959, p. 49-53). This water is here called "surface shelf water" or "warm shelf water" because its temperature is usually above 20°C, while the temperature of the "deeper shelf water" is usually under 20°C. Thirteen samples (Table XI) taken in layers chiefly of this water contained the following copepods in more than 6 samples: *Temora stylifera, Centropages furcatus, Corycaeus giesbrechti, Oncaea media, Calanopia americana, Paracalanus aculeatus, Clausocalanus furcatus, Copilia mirabilis, Oithona plumifera, Eucalanus subcrassus* in a decreasing order of frequency. *Nannocalanus minor, Undinula vulgaris, Pontellopsis brevis* and *Macrosetella* occurred in five of the examined samples. Any of the species characteristic of other water masses may occur in these waters because this is the result of mixture of the other waters (Table XIII). Seventy species were found in these waters, 39 of which appeared in one of the samples.

Table XVII compares our copepod list for shelf waters with those of other areas in the Atlantic and in the Pacific where approximately the same conditions of temperature and salinity occur. Fleminger (1959, p. 154) finds three different facies on the North American shelf, which are named and characterized as follows: 1 — coastal-neritic, where *Centropages furcatus* and *Temora turbinata* dominate; 2 — neritic-slope, characterized by *Eucalanus pileatus* and *Paracalanus parvus;* 3 — oceanic-shelf with *Clausocalanus furcatus* and *Undinula vulgaris.*

Bainbridge (1960, tab. 1) off Africa (from River Volta to Lagos) found the following association in waters over the continental shelf with salinity usually over 35.00 °/₀₀ and temperatures usually over 23°C (personal information): *Temora turbinata, Oncaea venusta, Corycaeus giesbrechti, Temora stylifera, Centropages furcatus, Euchaeta marina, Eucalanus monachus, Centropages chierchiai, E. pileatus, Paracalanus parvus,* etc., in a decreasing order of numbers.

The same facies could be pointed out for our shelf waters, according to the greater influence which they may suffer from coastal deep shelf or from oceanic (Brazil Current) waters. *Te-*

TABLE XI — List of station in surface shelf waters

Sample Number	Position	Date	Time (h)	Salinity (°/₀₀)	Temperature (°C)	Local depth (m)	Haul	Net	Plankton vol. (cc/m³)
M 31	24°18' S 46°06' W	27/6/54	01:08	34.84- 0 m 34.87- 6 m 35.27-12 m	21.4 21.5 21.2	39	0-12 m H	S	0.1
M 93	24°29' S 45°48.2' W	26/2/56	13:45	35.18- 0 m 35.18-10 m 35.96-20 m	26.34 25.21 21.26	60	0-10 m H	S	—
M 39	24°33' S 45°27' W	28/6/54	09:15	35.01- 0 m 35.01- 6 m 35.48-12 m 35.86-18 m 35.90-30 m	21.7 21.4 21.3 21.6 17.8	69	30-0 m V	S	4.5
M 32	24°33' S 45°57' W	27/6/54	04:00	35.58- 0 m 35.62- 6 m 35.61-12 m	21.6 21.4 21.4	56	12-0 m S	S	0.09
M 74	24°44.8' S 45°59' W	25/9/55	16:05	33.23- 0 m 33.30-10 m 35.70-20 m	20.7 20.2 20.14	70	0-10 m H	S	—
M 38	24°50' S 45°12' W	28/6/54	04:55	34.99- 0 m 34.99- 6 m 35.70-12 m 35.64-18 m 35.40-30 m	21.8 21.7 21.3 21.4 21.2	82	30-0 m V	S	0.3

M 33	24°57' S 45°42' W	27/6/54	08:15	35.81- 0 m 35.92- 6 m — -12 m	21.6 21.5 21.6	73	12-0 m V	S	0.6
M 36	25°09' S 44°55' W	27/6/54	20:35	35.93 - 0 m 35.925- 6 m 35.965-12 m 35.96 -18 m 35.405-30 m	22.97 22.80 22.80 22.80 22.90	121	30-0 m V	S	0.5
E 9	25°7.9' S 47°48.4' W	12/2/58	10:15	33.73- 0 m 35.40- 7 m 35.49-18 m	28.80 27.8 27.4	20	17-0 m V	S	0.19
M 75	25°15' S 46°18' W	25/9/55	21:05	33.36- 0 m 35.86-50 m	18.72 20.48	113	50-10 m V	S	—
M 187	25°31'.8' S 46°39' W	9/1/57	15:50	35.8-26 m 35.4-83 m	24.6 24.1	98	30.5-0 m O	KK	—
M 188	25°49.3' S 48°4.8' W	10/1/57	12:50	35.11- 0 m 35.11-12 m 35.20-27 m	25.8 25.1 20.1	30	12-0 m O	KK	1.5
M 190	26°44.3' S 48°31.3' W	12/1/57	06:00	34.830- 2 m 35.318-18 m	22.93 25.14	20	20-0 m O	KK	1.0

Plankton volumes were grossly calculated by dividing the settling volume by the approximate water column sifted through net.

Net: S = Standard (Nansen type); KK = Kitahara K net for phytoplankton (Japanese).

Haul: H = horizontal; V = vertical; O = oblique.

TABLE XIII — Percentages of copepod species in samples of shelf water layers

SAMPLE NUMBER	M 31	M 93	M 39	M 32	M 74	M 38	M 33	M 36	E 9	M 75	M 187	M 188	M 190
COPEPODS	Percentages of copepods from total number of copepods per sample												
Corycaeus giesbrechti	14.1	7.4	10.9	15.3	11.8	3.5	—	2.2	29.0	9.6	8.07	3.4	2.2
Clausocalanus furcatus	7.0	60.0	21.9	25.0	43.2	27.9	8.8	30.3	x	35.8	38.7	78.05	7.3
Temora stylifera	14.1	22.6	5.4	15.3	3.2	10.5	7.0	4.7	11.0	2.0	11.1	1.1	1.2
Centropages furcatus	18.8	—	4.9	3.8	0.6	9.5	1.8	0.9	9.0	1.0	0.1	0.1	0.6
Oncaea media	3.5	1.3	18.1	9.6	1.7	3.5	32.6	—	—	2.5	15.1	1.5	81.5
Paracalanus aculeatus	7.0	1.1	3.2	—	1.7	4.7	1.8	5.6	35.0	5.5	—	0.7	2.5
Calanopia americana	5.8	0.1	10.9	3.8	0.08	1.7	3.8	0.5	1.0	0.3	—	0.1	—
Corycella gracilis	—	—	6.9	1.9	0,08	5.8	7.5	11.6	—	0.5	1.7	2.5	—
Oithona plumifera	2.3	—	6.04	7.6	1.8	2.3	4.9	12.2	—	2.2	7.03	—	0.5
Copilia mirabilis	1.1	2.4	1.6	—	0.4	0.4	—	1.8	—	0.6	0.4	0.2	—
Nannocalanus minor	—	0.1	1.6	7,6	2.2	1.6	15.1	3.1	—	3.9	x	—	—
Eucalanus subcrassus	12.9	4.0	9.8	9.6	4.5	2.5	4.2	3.2	—	—	—	—	—
Calocalanus styliremis	—	—	3.2	—	0.5	1.7	0.7	0.3	—	0.5	x	—	0.07
Paracalanus parvus	5.8	—	—	—	6.6	2.08	—	—	12.0	—	0.2	10.1	0.01
Macrosetella	—	—	2.7	—	0.08	0.5	—	0.3	—	0.2	—	0.2	—
Candacia curta	—	—	0.5	—	1.2	1.9	3.3	0.1	—	0.07	—	—	—
Pontellopsis brevis	—	0.1	1.09	—	0.3	0.5	—	0.1	—	—	—	—	0.01
Oncaea venusta	—	—	2.1	—	0.6	—	0.2	1.1	—	0.3	1.9	—	—
Lucicutia flavicornis	—	—	1.09	—	0.08	0.1	—	0.6	—	0.7	—	—	—
Unknown Nauplius	—	—	0.5	—	—	0.3	0.7	0.5	—	—	—	—	0.03
Scolecithrix	—	0.1	1.09	—	0.7	0.08	—	0.7	—	0.07	—	—	—
Eucalanus monachus	—	—	1.09	—	—	13.6	—	—	1.0	9.2	—	—	1.8
Mecynocera clausi	3.5	—	1.09	—	0.08	—	—	—	—	—	0.1	—	—
Undinula vulgaris	—	—	1.6	—	—	0.4	1.5	0.2	—	0.2	—	—	—
Acrocalanus longicornis	3.5	—	—	1.9	—	—	0.5	0.8	—	0.5	—	—	—
Corycaeus speciosus	—	—	0.5	—	0.08	—	0.2	0.7	—	—	—	—	—
Calanoides carinatus	—	—	—	—	—	0.5	0.2	0.1	—	0.5	—	—	—
Corycaeus limbatus	—	—	—	—	0.3	—	—	0.4	—	0.3	—	—	—
Oithona setigera	—	—	—	—	0.4	—	—	0.6	—	0.8	0.3	—	—
Oncaea conifera	—	—	—	—	0.4	0.3	—	0.1	—	1.0	0.4	—	—
Euchaeta marina	—	—	—	—	—	0.08	0.7	1.4	—	0.3	—	—	—
Calocalanus tenuis	—	—	—	—	0.1	0.1	—	—	—	0.3	—	—	—

Pleuromamma gracilis	—	—	—	—	0.8	—	—	0.3	—	0.9	—	—	—
Centropages violaceus	—	—	—	—	—	0.08	0.5	0.1	—	—	—	—	—
Ctenocalanus vanus	—	—	—	—	10.6	1.5	—	—	—	12.1	—	—	—
Corycaeus latus	—	—	—	—	0.1	0.08	—	0.9	—	—	—	—	—
Candacia pachydactyla	—	—	1.6	—	—	0.1	—	—	—	—	—	—	—
Calanus tenuicornis	—	—	—	—	1.03	—	—	0.3	—	3.0	—	—	—
Clausocalanus arcuicornis	—	—	—	—	—	—	—	—	—	0.3	—	—	—
Clytemnestra	—	—	—	—	—	0.1	—	—	—	—	—	—	0.01
Euaetideus giesbrechti	—	—	—	—	0.08	—	—	—	—	0.07	—	—	—
Heterorhabdus spinifrons	—	—	—	—	0.08	—	—	—	—	0.3	—	—	—
Haloptilus longicornis	—	—	—	—	0.08	—	—	—	—	0.07	—	—	—
Microsetella spp.	—	—	—	—	—	—	—	—	—	—	—	0.07	0.04
Oithona nana	—	—	—	—	—	—	—	—	—	—	1.2	0.07	—
Euterpina	—	—	—	—	—	—	—	—	x	—	—	1.0	0.8
Eucalanus crassus	—	—	—	—	—	—	0.5	—	—	—	0.4	—	—
Acartia lilljeborghi	—	—	—	—	—	0.3	—	—	1.0	—	—	—	—
Acartia danae	—	—	—	—	—	—	0.2	—	—	—	—	—	—
Corycaeus amazonicus	—	—	—	—	0.5	0.3	—	—	1.0	—	—	—	—
Young calanidae	—	—	—	—	—	—	—	—	—	0.6	—	—	—
Eucalanus attenuatus	—	—	—	—	—	—	—	—	—	—	0.1	—	—
Lubbockia squillimana	—	—	—	—	—	—	—	—	—	0.07	—	—	—
Labidocera acutifrons	—	—	—	—	—	0.08	—	11.5	—	—	—	—	—
Oncaea mediterranea	—	—	—	—	—	—	—	0.3	—	—	—	—	—
Pleuromamma abdominalis	—	—	—	—	—	—	—	—	—	—	—	—	—
Sapphirina scarlata	—	—	—	—	0.2	—	—	0.2	—	—	—	—	—
Acartia longiremis	—	—	—	—	—	—	—	—	—	—	—	—	—
Pleuromamma xiphias	—	—	—	—	—	—	—	—	—	0.2	—	—	—
Candacia sp.	—	—	—	—	—	—	—	—	—	1.4	0.1	—	—
Aetidiid sp.	—	—	—	—	—	—	—	0.1	—	0.5	—	—	—
Eucalanus elongatus	—	—	—	—	—	—	—	—	—	—	—	—	—
Corycaeus africanus	—	—	—	—	—	—	—	—	—	0.6	—	—	—
Corycaeus flaccus	—	—	—	—	—	—	—	—	—	0.3	—	—	—
Sapphirina stellata	—	—	—	—	—	—	—	—	—	0.5	—	—	—
Eucalanus subtenuis	—	—	—	—	—	—	—	—	—	—	—	0.2	—

x = Species present in total sample, but not in sub-sample.

TABLE XII — Copepods found in the gastric contents of fishes caught off Cananéia and off Santos

COPEPOD SPECIES	SPECIES OF FISHES	*Larimus breviceps* (Cuv.)	*Sardinella allecia* (Rafin.)	*Brevoortia aurea* (Agassiz)	*Chloroscombrus chrysurus* (L.)	*Micropogon furnieri* (Desm.)	*Xenomelaniris brasiliensis* *	Young *Anchoviella* sp.*	Total number of copepods counted excluding those found in the fishes marked with *
	Nº of fishes examined	15	4	1	1	1	50	?	
		Nº of fishes in which the copepod was found							
	Acartia lilljeborghi	2	—	—	—	—	18	x	23
	Calanid	—	1	—	1	—	7	x	5
	Calanopia	2	1	—	—	—	—	—	26
	Centropages furcatus	4	—	—	—	—	—	—	17
	Clausocalanus	1	—	—	—	—	—	—	1
	Diaptomus	—	—	—	—	—	—	x	1
	Corycaeus	—	1	—	—	—	6	x	5
	Eucalanus	15	—	—	—	1	31	—	190
	Euterpina	—	2	—	—	—	14	x	5
	Harpacticoida	—	—	—	—	—	—	x	—
	Labidocera fluviatilis	2	—	—	1	1	38	—	148
	Macrosetella	—	1	—	—	—	—	—	3
	Microsetella	—	2	—	—	—	—	—	13
	Oithona (small)	—	1	—	—	—	3	x	8
	Oncaea subtilis	—	3	1	—	—	—	—	53
	Oncaea media	—	1	—	—	—	—	—	3
	Paracalanus sp.	1	—	—	—	—	38	—	2
	Pseudodiaptomus	—	—	—	—	—	—	x	—
	Temora stylifera	14	—	—	—	—	11	—	255

* These data were taken from unpublished notes by J. Paiva Carvalho.

x = Number of fishes unknown.

mora stylifera, Eucalanus subcrassus or *monachus* and *Paracalanus aculeatus* are the species which occur off Brazil instead of *Temora turbinata, Eucalanus pileatus* and *Paracalanus parvus.* Our data may also be compared to those of Pierce (1953, p. 88) and of Moore (1958, p. 165, figs. 5, 39) who also found a shelf water environment off the northwestern Atlantic coast where there are an "inner shelf zone" or "coastal water", an "outer shelf zone" or "slope water". These authors do not mention the deeper shelf water environment which is present off the Brazilian and African coasts.

Deeper shelf waters — The deep waters (Table XIV) on the shelf are probably derived from deep subtropical water which, because of its greater density sinks and moves slowly underneath the Brazil Current in opposite direction along the border of the shelf (Emilsson 1959, p. 46, 49-50). In these waters *Ctenocalanus vanus* is the characteristic copepod, usually occurring in dominant numbers and volume (Table XV). This widespread species is found in largest number in the cold Antarctic surface coastal waters (Farran 1929, p. 226) but it occurs even in tropical regions, though in deeper layers (Vervoort 1951, p. 51-61) which makes it probable that it was introduced in this region by the cold Falkland Current mixed with the subtropical water. *Ctenocalanus vanus* is found in surface waters of temperatures under 16°C and in salinities between 34.00 and 35.5 °/₀₀. In deeper waters it is found in temperatures up to 20°C. *Calanoides carinatus* may also appear in large numbers and volume in these samples. The neritic influence on this water is indicated by the presence of *Corycaeus giesbrechti* and *Oncaea media,* in 12 out of 13 samples examined; of *Centropages furcatus* in 8 out of 13 samples; of *Temora stylifera,* in 11 out of 13 samples. *Oithona plumifera, Paracalanus parvus* (in large numbers) and *Eucalanus subcrassus* occurred in 8 or 9 out of 13 samples. *Clausocalanus furcatus, Corycaeus gracilis, Mecynocera clausi, Calanus tenuicornis* and *Paracalanus aculeatus* occurred less frequently (in 7 to 5 samples out of 13). Their presence is perhaps due to the origin of these waters by ressurgence from deeper layers. The neritic influence is strong here too as is also shown by its richness in plankton volume (more than 1.0 ml/m³). Along and off the slope of the continental shelf the deep subtropical waters are poorer (Vannucci & Almeida Prado 1959, tab. II; Vannucci, unpublished data). Waters with salinities ranging between 35.00 and 36.00 °/₀₀ in the North Atlantic and with temperatures between 10 and 17°C are called "intermediate" or "mixed" waters (Kusmorskaya 1960, p. 147; Kanaeva

TABLE XIV — List of stations in deep shelf waters and slope waters

Sample Number	Position	Date	Time (h)	Salinities (‰)	Temperature (°C)	Local depth (m)	Type of haul	Net	Plankton vol. (cc/m³)
M 236	22°53' S 41°34' W	27/2/57	—	(0 m) 35.79 (47 m) 35.59 (72 m) 35.53	25.20 15.24 15.26	Approximately 70	Surface and vertical 70-0 m	Standard Nº 20 (American)	0.561
M 238	23°01' S 41°35' W	27/2/57	—	(0 m) 35.93 (49 m) 35.66 (74 m) 35.55	23.40 18.18 15.36	89	Surface and vertical (70-0 m)	Standard Nº 20 (American)	0.031
M 73	24°11.8' S 45°38.5' W	25/9/55	09:15	(0 m) 34.52 (10 m) 34.52 (20 m) 35.41	19.79 19.20 15.38	47	Horizontal at Surface	Standard Nansen closing	—
V 1	24°16.8' S 46°00.4' W	8/4/60	—	(35 m) 35.50 (47 m) 35.52	16.4 16.4	50	Horizontal at 45 m depth	Standard Nansen closing	—
V 19	24°11.8' S 45°38.5' W	22/3/61	12:22 12:37	(47 m) 35.76	16.6	47	Horizontal at 45 m depth	Standard Nansen closing	4.0
M 186	25°10' S 47°11.3' W	9/1/57	06:20	(?) 35.462 (?) 35.552	25.00 17.07	40	Oblique from 36-0 m	Kitahara K Net	0.01

M 76	25°15' S 46°18' W	25/9/55	20:50	(50 m) 35.86 (60 m) 35.77 (85 m) 35.59 (110 m) 35.14	18.72 16.82 16.00 13.30	113	Vertical from 95-50 m	Standard Nansen closing Net	0.17
M 35	25°26' S 45°25' W	27/6/54	14:52	(0 m) 35.09 (6 m) 35.02 (12 m) 35.17 (18 m) 36.36 (30 m) 36.60 (45 m) 37.54	21.9 21.8 21.6 21.4 20.6 16.9	106	Vertical from 48-0 m	Standard Nansen closing Net	0.18
M 78	25°45.5' S 46°36.9' W	26/9/55	01:40	(50 m) 35.72 (75 m) 35.59 (110 m) 35.10	17.35 15.76 12.48	125	Vertical from 103-54 m	Standard Nansen closing	0.27
M 173	32°30' S 51°23' W	9/11/56	08:58	(0 m) 35.15 (9 m) 33.06 (19 m) 34.04 (28 m) 34.91 (52 m) 35.23	19.25 19.02 18.28 18.32 16.16	58	Vertical from approximately 50-0 m	Standard Nansen closing	—
M 395	33°02' S 48°28' W	16/4/58	—	(0 m) 35.78 (29 m) 35.76 (61 m) 35.75 (92 m) 36.04 (124 m) 35.97 (232 m) 35.70	20.52 20.47 20.15 19.91 17.82 15.75	3,180	Vertical from 174-0 m	Standard Nansen closing	0.04
E 1	25°7.9' S 47°48.4' W	10/1/58	13:50	(0 m) 34.47 (7 m) 35.43 (18 m) 35.44	27.51 19.70 19.46	19	Vertical from 15-0 m	Hensen	1.2
E 2	25°7.9' S 47°48.4' W	10/1/58	14:00 14:15	35.44	19.46	19	Horizontal at 18 m depth	Clarke-Bumpus	1.2

TABLE XV — Percentages of copepod species in samples of deeper shelf waters

SAMPLE NUMBER	M 236	M 238	M 73	V 1	V 19	M 186	M 76	M 35	M 78	M 173	M 395	E 1	E 2
COPEPODS	Percentages of species from total number of copepods in each sample												
Corycaeus giesbrechti	7.5	0.7	13.6	15.7	16.7	10.04	0.1	8.9	7.9	23.07	—	16.6	0.2
Temora stylifera	0.5	5.4	9.5	0.09	5.0	26.2	—	1.6	2.4	7.6	—	8.8	0.4
Ctenocalanus vanus	1.2	6.6	15.2	49.7	24.3	3.9	30.4	41.2	28.9	11.3	—	21.7	6.1
Oncaea media	0.5	13.3	0.9	0.3	2.6	13.5	5.6	2.7	6.02	7.6	12.5	—	16.1
Centropages furcatus	0.03	—	4.1	0.01	—	—	1.6	2.1	0.5	3.1	—	4.2	0.01
Eucalanus subcrassus	—	—	3.5	11.8	—	1.7	8.06	6.6	6.5	6.3	—	3.7	0.1
Oithona plumifera	0.03	—	3.4	10.6	10.8	—	2.5	0.8	—	0.4	—	0.7	—
Paracalanus parvus	—	—	18.3	6.7	30.4	3.9	0.8	0.7	—	20.3	—	34.8	17.6
Clausocalanus furcatus	—	—	3.1	—	—	9.6	15.3	14.4	13.1	10.4	6.6	—	—
Corycella gracilis	0.03	14.1	0.6	—	—	0.8	—	3.2	0.3	—	—	—	0.1
Mecynocera clausi	0.03	—	—	—	—	0.4	0.4	0.2	0.8	0.4	13.9	—	—
Oncaea conifera	—	—	—	0.3	—	—	0.7	0.1	2.09	—	0.2	—	29.8
Paracalanus aculeatus	6.5	—	1.5	x	—	—	—	9.5	6.1	2.7	—	—	0.1
Calanus tenuicornis	—	—	10.7	—	—	—	6.3	—	0.3	—	0.1	—	—
Oithona setigera	—	—	1.2	—	0.3	—	—	0.1	7.2	—	x	—	—
Corycaeus amazonicus	—	—	4.1	1.1	—	—	8.4	—	1.2	1.8	—	—	—
Microsetella spp.	—	0.7	—	—	—	4.8	—	—	—	—	0.3	0.2	0.01
Nannocalanus minor	—	—	—	—	—	14.8	0.9	0.8	0.2	—	14.8	—	—
Oncaea subtilis	5.2	—	—	—	—	—	0.1	—	—	—	0.2	—	19.7
Euchaeta marina	—	—	—	—	—	—	3.1	0.05	0.1	—	2.5	—	—
Clytemnestra sp.	—	—	0.3	—	0.6	1.7	—	0.05	—	—	—	—	—
Oncaea venusta	—	—	—	—	—	—	0.9	0.4	—	0.4	2.8	—	—
Euterpina acutifrons	—	—	0.3	—	—	1.3	0.1	—	0.1	—	—	—	0.4
Copilia mirabilis	—	—	—	—	0.3	—	0.1	6.6	0.3	x	—	—	—
Calanoides carinatus	12.08	54.9	—	1.1	3.5	—	—	—	0.2	—	—	—	—
Scolecithrix sp.	—	—	—	—	—	—	0.1	0.1	1.0	—	2.2	—	—
Eucalanus monachus	—	—	—	1.9	5.0	—	—	6.2	—	—	—	0.7	—
Macrosetella sp.	—	—	0.03	—	—	—	—	0.5	—	—	0.3	—	—
Lucicutia flavicornis	—	—	—	—	—	—	0.1	—	1.2	—	0.3	—	—
Euaetideus giesbrechti	—	—	—	—	—	—	0.7	—	0.2	—	0.1	—	—
Calanopia americana	—	—	2.5	—	—	—	0.2	0.1	—	—	—	—	—
Corycaeus speciosus	—	1.1	—	—	—	—	0.9	0.05	—	—	—	—	—
Candacia curta	—	—	—	—	—	—	0.5	0.5	0.4	—	—	—	—
Candacia bipinata	0.3	—	—	—	—	—	—	—	0.5	0.4	—	—	—
Oithona nana	72.5	—	—	—	—	2.1	—	—	—	—	x	—	8.5

Pleuromamma gracilis	—	—	—	—	—	—	—	—	1.3	—	0.6	—	—	
Corycella rostrata	—	—	—	—	—	—	7.3	—	—	—	20.9	—	—	
Acartia danae	—	—	—	—	—	—	—	—	—	—	4.1	—	—	
Acrocalanus sp.	—	—	—	—	—	—	0.8	—	0.4	—	—	—	—	
Corycaeus latus	0.03	—	—	—	—	—	—	—	2.4	—	—	—	—	
Corycaeus typicus	—	—	—	—	—	—	0.7	—	—	—	—	—	—	
Clausocalanus arcuicornis	—	—	—	—	—	—	—	—	0.9	—	—	0.5	—	
Calocalanus styliremis	—	—	—	—	—	—	—	0.8	0.3	—	—	—	—	
Juvenile Calanids	—	—	—	—	—	—	—	—	—	—	—	0.7	—	
Calocalanus plumulosus	—	0.3	—	—	—	—	—	—	—	—	—	—	—	
Corycaeus clausi	—	—	—	0.01	—	—	—	—	—	—	0.5	—	—	
Corycaeus limbatus	—	—	—	—	—	—	—	—	0.9	—	—	—	—	
Corycaeus furcifer	—	—	—	—	—	—	0.7	—	0.3	—	—	—	—	
Eucalanus attenuatus	—	—	—	—	—	—	—	—	0.1	0.4	—	—	—	
Heterorhabdus spinifrons	—	—	—	—	—	—	—	—	0.2	—	1.03	—	—	
Haloptilus longicornis	—	—	—	—	—	—	—	—	0.5	—	—	—	—	
Lubbockia squillimana	—	—	—	—	—	—	0.2	—	0.1	—	—	—	—	
Labidocera acutifrons	x	0.7	—	—	—	—	—	—	—	—	—	—	—	
Lucicutia ovalis	—	—	—	—	—	—	—	—	—	—	0.2	—	—	
Neocalanus gracilis	—	—	—	—	—	—	—	—	—	—	5.1	—	—	
Oncaea conifera	—	—	—	—	—	—	—	—	2.09	—	—	—	—	
Pleuromamma abdominalis	—	—	—	—	—	—	1.2	—	—	—	—	—	—	
Sapphirina nigromaculata	0.03	—	—	0.01	—	—	—	0.05	—	—	—	—	—	
Sapphirina intestinata	—	—	—	—	—	—	0.1	—	0.2	—	—	—	—	
Undinula vulgaris	—	—	—	—	—	—	—	0.4	4.1	—	—	—	—	
Sapphirina opalina	—	—	—	—	—	—	—	—	—	—	0.1	—	—	
Euchirella rostrata	—	—	—	—	—	—	0.2	—	—	—	—	—	—	
Temeropia mayumbaensis	—	—	1.2	—	—	—	—	—	2.3	—	—	—	—	
Candacia sp.	—	—	0.6	—	—	—	—	—	—	—	—	—	—	
Labidocera fluviatilis	—	—	0.3	—	—	—	—	—	—	—	—	—	—	
Pontellopsis sp.	—	—	—	—	—	0.4	—	0.05	—	—	—	—	—	
Eucalanus crassus	—	—	—	—	—	—	—	0.05	1.5	—	—	—	—	
Aetidiid sp.	—	—	—	—	—	—	—	—	1.5	—	—	—	—	
Neocalanus robustior	—	—	—	—	—	—	—	—	0.1	—	—	—	—	
Heterorhabdus papilliger	—	—	—	—	—	—	—	—	0.9	—	—	—	—	
Scaphocalanus curtus	—	—	—	—	—	—	0.2	—	0.4	—	0.1	—	—	
Acartia lilljeborghi	—	—	0.3	—	—	—	—	—	—	—	—	6.8	0.01	
Lucicutia clausi	—	—	—	—	—	—	—	—	—	—	0.1	—	—	
Oithona minuta	—	—	—	—	—	—	—	—	—	—	—	—	0.1	
Paracalanus crassirostris	—	0.7	—	—	—	—	—	—	—	—	—	—	—	
Paracalanus attenuatus	—	—	—	—	—	—	—	—	—	—	—	—	0.05	
Unknown Nauplius	—	—	0.6	—	—	—	—	—	—	—	—	—	—	

TABLE XVI — Copepods found in six samples collected during the cruise No. 247 of the Oc/Ship "Atlantis" in the South Atlantic *

SAMPLE NUMBER STATION NUMBER	M 721 5828	M 722 5826	M 723 5827	M 728 5833	M 729 5834	M 731 5839
POSITION	32°31' S 13°00' W	32°35' S 11°02' W	32°31' S 08°56' E	32°48' S 17°39' E	32°49' S 16°56' E	32°19' S 11°03.5' E
TEMPERATURE (°C)	(1 m)-20.95 (45 m)-20.49	(1 m)-19.52 (45 m)-19.54	(1 m)-14.49 (45 m)-19.60	(1 m)-14.49 (15 m)-13.40 (40 m)-12.61	(1 m)-16.51 (25 m)-16.54 (50 m)-15.90	(1 m)-17.82 (45 m)-17.87
SALINITY (‰)	(1 m)-36.021 (45 m)-36.012	(1 m)-35.635 (45 m)-35.724	(1 m)-35.636 (45 m)-35.640	(1 m)-35.057 (15 m)-34.913 (40 m)-34.911	(1 m)-35.373 (25 m)-35.368 (50 m)-35.322	(1 m)-35.58 (45 m)-35.60
NET	Hensen	Hensen	Hensen	Hensen	Hensen	Hensen
DEPTH OF HAUL	Surface	Surface	Surface	Surface	Surface	Surface
TIME (h)	15:45-17:45	09:00-11:00	02:20-04:20	20:35-22:35	01:30-02:00	02:00-05:00
DATE	10/5/59	11/5/59	12/5/59	27/5/59	28/5/59	31/5/59
COPEPOD SPECIES						
Acartia danae	—	—	x	—	x	x
Acartia negligens	x	x	x	x	x	x
Calanus tenuicornis	—	x	x	x	—	x
Calocalanus pavo	—	x	—	—	x	—
Calocalanus plumulosus	—	—	—	—	—	x
Calocalanus styliremis	x	x	x	x	x	x
Clausocalanus arcuicornis	x	x	x	x	x	x
Clausocalanus furcatus	—	x	x	x	x	x
Clausocalanus paululus	—	x	x	—	x	x
Candacia aethiopica	x	x	x	x	x	x
Candacia bipinnata	—	—	—	x	—	—
Calocalanus contractus	—	—	—	—	—	x
Centropages violaceus	x	x	x	x	—	—
Copilia mediterranea	—	x	—	—	—	—
Corycaeus clausi	—	—	x	x	—	—
Corycaeus longistylis	—	x	—	—	—	—

Corycaeus speciosus	x	x	x	—	—	—
Corycaeus typicus	x	x	x	—	—	—
Corycella gracilis	x	x	x	x	—	x
Corycella rostrata	x	x	x	x	—	x
Euaetideus giesbrechti	x	x	x	—	—	x
Eucalanus attenuatus	—	—	—	—	—	x
Euchaeta marina	—	x	x	x	x	—
Euchirella sp.	—	—	x	—	—	—
Heterorhabdus spinifrons	x	—	—	—	—	—
Lucicutia flavicornis	—	—	x	x	—	x
Lucicutia ovalis	—	—	—	—	—	x
Mecynocera clausi	x	x	x	x	x	x
Metridea lucens	—	—	—	—	x?	—
Metridea gerlachei ?	—	—	—	—	x?	—
Microsetella rosea	—	—	x	x	—	x
Nannocalanus minor	—	x	x	x	x	x
Neocalanus gracilis	x	x	x	x	—	x
Oculosetella gracilis	x	—	—	x	—	x
Oithona plumifera	x	x?	—	—	—	x?
Oithona pseudofrigida	—	x	x	?	?	x
Oithona similis	—	—	?	—	x	?
Oncaea conifera	—	—	x	x	—	x
Oncaea media	x	x	x	x	—	x
Oncaea mediterranea ?	x	—	?	—	—	?
Oncaea venusta	x	x	x	—	x	x
Pachos punctatum	—	—	x	—	—	—
Paracalanus parvus	—	—	x	x	x?	x
Plâeuromamma borealis	—	—	x	—	x	x
Pleuromamma piseki	—	—	—	—	—	x
Pleuromamma xiphias	—	—	—	—	—	x
Pontellina plumata	—	—	x	x	—	—
Sapphirina auronitens-sinuicauda	—	x	—	—	—	—
Scolecithrix danae	—	—	—	—	x	—
Scolecithricella tenuiserrata	—	—	—	x	—	—
Undeuchaeta plumosa	—	—	—	—	—	x
Undinulla vulgaris	x	x	x	—	—	—

x = present; — = absent; x? = doubtfully determined.

* The animals were registered in ¼ of each total sample kindly donated to the author by Dr. J. Miller of Woods Hole Institution (USA).

1960, p. 180). They are rich waters where plankton volumes average 1.62 ml/m³ along the 30° meridian in the Atlantic (Kanaeva 1960, p. 117). When copepod lists for these waters are compared (Tanaka 1960, p. 7-8; Farran 1929, p. 207-211; Kusmorskaya 1959, tab. 5, p. 147) we find our data confirmed. Samples of the middle South Atlantic (Stations 5827, 5826, 5825 of the "Atlantis" cruise 247) and of waters probably belonging to the Benguela Current (Stations 5833, 5834, 5839 of the "Atlantis" cruise 247) have approximately the same species composition (Table XVI). Vervoort (1946) recorded the following species in deep cool waters sampled by the "Snellius" Expedition in the Indo-Pacific waters: *Calanus tenuicornis, Nannocalanus minor, Neocalanus gracilis, Undinula darwini, Eucalanus mucronatus, Eucalanus subtenuis, E. crassus, Rhincalanus cornutus, Paracalanus aculeatus, Clausocalanus arcuicornis* and *C. furcatus.* Della Croce (1959, p. 40-41) recorded approximately the same species in the subtropical waters of the Tyrrhenian and Ligurian Seas as those found here. Bainbridge (1960, tab. 1) recorded off Ghana the following species in decreasing numbers in samples collected in water layers with temperatures usually under 21.5°C and salinity around 35.7 °/₀₀ (Bainbridge, *in lit.*) : *Calanoides carinatus, Temora turbinata, T. stylifera, Paracalanus parvus, Corycaeus giesbrechti, Centropages chierchiai, Eucalanus monachus, Clausocalanus arcuicornis, Eucalanus pileatus, Paracalanus aculeatus.*

Deep subtropical waters

The association of species in subtropical waters below the Brazil Current was not studied in this paper because no plankton samples from that habitat were available. The deepest samples examined were those collected near the edge of the shelf (Table XIV) as well as samples from the Brazil Current which were sampled by hauling the net from 200 m depth up to the surface. Copepods which appeared only in samples from stations occupied during the night in tropical water are probably the result of migration from this deeper layer. Samples M 76 and M 78 show some of the species which belong to this environment and which did not appear in the other samples.

The species which belong to this environment are probably *Undeuchaeta major, Neocalanus gracilis, Ctenocalanus vanus, Euaetideus giesbrechti, Scolecithricella dentata, Centropages violaceus, Eucalanus attenuatus, Euchirella brevis, E. rostrata, Calanoides carinatus, Scaphocalanus curtus, Pleuromamma* spp., *Heterorhabdus* spp., *Haloptilus* spp., *Rhincalanus cornutus* and *R. nasutus, Temeropia mayumbaensis, Lophothrix latipes, Euaugaptilus hecticus.*

TABLE XVII — Copepods usually found in the shelf waters of the world

REGION	North Sea	Africa	Australia	North America	Sulu Archipelago	Gulf of Mexico Lat. 28°34' N — 86°48' W	Coast of Mexico Lat. 19°52' N — 102°07' W	Central America Lat. 10°32' N — 88°25' W	Brazil	Mediterranean Sea
AUTHOR	Colebrook	Bainbridge	Farran	Grice & Hart	Scott	Wilson	Wilson	Wilson	Björnberg	Della Croce
DATE	1961	1960	1949	1961	1909	1950	1950	1950	1959	1959
SALINITY (‰)	—	34.5-35.00	36.5-32.5	32.0-35.5	—	—	34.0-35.5	33.0-34.0	35.00-36.90	37.86-38.01
TEMPERATURE (°C)	—	22.5-27.8	21.26-29.43	23.0-26.5	—	—	25.0-28.0	25.0-27.0	above 20.0	12.82-15.98
GENUS	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES
Acartia	*clausi*	—	*pacifica, australis*	*danae, clausi, longiremis*	*erythraea, spinicauda*	—	—	—	—	*clausi*
Acrocalanus	—	—	*longicornis, gibber, gracilis*	—	*gracilis, monachus*	—	*longicornis*	—	—	—
Anomalocera	*patersoni*	—	—	—	—	*mexicanda*	—	—	—	*patersoni*
Calanopia	—	—	*elliptica, auricilli*	—	*elliptica, minor*	—	—	—	*americana*	—
Calocalanus	—	—	—	*pavo, styliremis, tenuis*	*pavo*	—	—	—	*styliremis*	*pavo*
Candacia	*armata*	—	*discaudata*	—	*bradyi, catula, simplex, discaudata, truncata*	—	—	*aethiopica, armata, longimana, simplex, bispinosa, norvegica*	*curta*	—
Centropages	*typicus, armatus*	*chierchiai, furcatus*	*orsinii, furcatus*	*typicus*	*furcatus*	—	*kroyeri, violaceus*	—	*furcatus*	*typicus*
Clausocalanus	—	*arcuicornis, furcatus*	*arcuicornis, furcatus*	*arcuicornis*	*furcatus*	—	—	—	*furcatus*	*arcuicornis, furcatus*
Copilia	—	—	—	—	*mirabilis*	—	*mirabilis*	*denticaudata*	*mirabilis*	—
Corycaeus	*anglicus*	*africanus, giesbrechti*	*orientus, erythraeus, cutus, australis*	—	*danae, gibbulus, obtusus, robustus*	—	*clausi, latus*	—	*giesbrechti*	*limbatus, latus, brevirostris, furciler*
Eucalanus	—	*pileatus, monachus*	*subcrassus*	—	*crassus, monachus, macronatus, pileatus*	*attenuatus*	*attenuatus*	*attenuatus, monachus, subtenuis*	*subcrassus*	—
Euchaeta	*hebes, acuta*	*marina*	*concinna*	—	*marina*	*marina*	*marina, spinosa*	*acuta, marina*	—	—
Corycella	—	—	—	—	—	—	*rostrata*	—	*gracilis*	*rostrata*
Labidocera	—	—	*acuta, minuta*	*acuticrura*	*acuta, kroyeri*	—	*acuta, kroyeri*	—	—	—
Lucicutia	—	*flavicornis*	—	—	—	—	—	—	*flavicornis*	*flavicornis*
Microsetella	—	—	*gracilis*	—	*norvegica*	—	*rosea*	—	—	—
Nannocalanus	—	*minor*	*minor*	—	—	—	*minor*	*minor*	*minor*	*minor*
Neocalanus	*gracilis*	—	—	—	—	—	*gracilis*	—	—	*gracilis*
Oithona	—	—	*plumifera*	—	*plumifera*	—	—	—	*plumifera*	*helgolandica, plumifera*
Oncaea	—	*venusta*	*clevei*	—	*venusta*	—	*minuta*	*venusta*	*media, venusta*	*venusta, mediterranea, conifera*
Paracalanus	—	*aculeatus, parvus*	*aculeatus, parvus*	*parvus*	*parvus*	—	*parvus*	—	*aculeatus, parvus*	*parvus*
Pleuromamma	*gracilis, xiphias, borealis*	—	—	—	—	—	—	*xiphias*	—	*abdominalis, gracilis, brevicornis*
Postella or *Parapostella*	—	—	—	—	*dendicaudata*	*lubbocki, meradii*	*atlantica*	*atlantica, danae*	—	—
Postellina	—	—	—	—	—	—	*plumata*	—	—	—
Postellopsis	—	—	—	—	—	—	*regalis*	—	*brevis*	—
Sapphirina	—	—	—	—	*metallina, stellata*	*lactens, opalina*	*nigromaculata*	*nigromaculata, opalina*	—	—
Scolecithricella	—	—	—	*minor*	—	—	—	*bradyi*	—	*dentata*
Scolecithrix	—	—	—	—	—	*danae*	*danae*	*danae*	—	—
Temora	*longicornis*	*stylifera, turbinata*	*turbinata, discaudata*	*stylifera, longicornis*	*discaudata*	*longicornis, discaudata*	*stylifera*	*discaudata, stylifera*	*stylifera*	*stylifera*
Undinula	—	*vulgaris*	*vulgaris*	—	*darwini, vulgaris*	—	*darwini, vulgaris*	*vulgaris*	—	—
Xanthocalanus	—	—	*pauper*	—	*pauper*	—	—	—	—	—
Macrosetella	—	—	*gracilis*	*gracilis*	*gracilis*	—	—	—	*gracilis*	—
Calanus	*finmarchicus*	—	—	*tenuicornis, finmarchicus*	—	—	—	—	—	—
Clausocalanus	—	—	—	*venus*	—	—	—	—	—	*venus*

CONCLUSIONS

I — A comparison of the different graphs of the most numerous and frequent copepods show that the two fundamental habitats of copepods off the coast of Brazil are the TROPICAL WATERS (T) with the greatest number of species and the COASTAL WATERS (C), the next most numerous in species.

These two habitats mix over the shelf with others and produce several intermediate habitats like what is here called SURFACE SHELF WATER (SS), where some species do not find living conditions and die. The want of sufficient depth of layers and the higher temperature or the lower salinity may be among the causes of this change. In the South the tropical waters gradually loose heat and form another intermediate habitat — the SURFACE SUBTROPICAL (SST) water where many tropical copepods do not survive because of the lower temperature.

There are indications of the existence of another typical habitat — the DEEP SUBTROPICAL WATER. This mixes with the tropical and also with the coastal waters when it moves onto the shelf and constitutes another intermediate habitat — the DEEPER SHELF WATER (DST). In this many deep living "subtropical" copepods do not resist the want of depth or other factors and die off or diminish in frequency.

II — The most numerous and frequent species in the TROPICAL WATERS are *Corycella gracilis, Nannocalanus minor, Oncaea venusta, Corycaeus speciosus, Centropages violaceus, Neocalanus gracilis, Oithona plumifera, Pleuromamma abdominalis, Undinula vulgaris, Scolecithrix danae, Lucicutia flavicornis, Euchaeta marina, Macrosetella, Calocalanus pavo* and *Clausocalanus furcatus.* The dominant ones in volume may be *Clausocalanus furcatus, Scolecithrix danae, Nannocalanus minor, Undinula vulgaris* and *Pleuromamma abdominalis.* Usually nearly all the "tropical" water copepods can live also in the mixed waters of the surface shelf and in the surface subtropical water. *Clausocalanus furcatus* and *Corycella gracilis* are found in the same or almost same numbers in surface shelf waters. *Neocalanus gracilis* and *Corycella gracilis* are found in the surface subtropical and in the deep shelf waters.

III — COASTAL WATERS show the greatest frequency of the following copepods: *Oncaea media, Oithona ovalis, Sapphirella, Acartia lilljeborghi, Euterpina, Eucalanus monachus, Eucalanus subcrassus, Paracalanus crassirostris* and *Pseudodiaptomus acutus.*

The species dominant in volume belong to the genera *Oncaea, Eucalanus, Acartia* and sometimes *Oithona* or *Pseudodiaptomus.* Some species are also found in the surface shelf water like *E. subcrassus, E. monachus, Euterpina* and *Acartia lilljeborghi.* These are also found in the DEEPER SHELF WATER, thus indicating the coastal water influence in this environment. *P. crassirostris* and *O. ovalis* are found in the deeper shelf water also.

The surface subtropical waters appear to be a bad environment for nearly all coastal copepods. *Oncaea media* is the only species which is also found in the surface subtropical habitat. *Pseudodiaptomus acutus* has its optimum in the inshore waters where salinities are low.

Centropages furcatus, Calanopia americana, Temora stylifera and *Paracalanus aculeatus* have their optimum in the SURFACE SHELF WATERS but generally may be found in other environments. Only *Calanopia americana* shows a distinct preference for coastal waters and is not found in the tropical nor in the subtropical waters, but in all the mixed waters which may suffer the influence from the coastal waters.

IV — The SURFACE SUBTROPICAL WATERS show a greater frequency of *Clausocalanus arcuicornis, Corycaeus ovalis, Mecynocera clausi, Acartia danae, Candacia aethiopica, Corycella rostrata, Oithona setigera,* besides the already mentioned tropical water copepods. The above species of the surface subtropical waters excepting *Corycella rostrata* and *Candacia aethiopica* are usually found in all the other environments, but with less or no frequency at all in the coastal, which is the most different environment from that in which they have their optimum.

Corycella rostrata and *Candacia aethiopica* are also found in tropical waters. The first is frequent in deep subtropical waters also.

Calanus tenuicornis, though more frequent in surface subtropical, apparently has its maximum number in the DEEPER SHELF WATERS. These are also preferred by the following copepods: *Calanoides carinatus, Ctenocalanus vanus, Clytemnestra* sp., *Corycaeus amazonicus, Paracalanus parvus, Oithona nana.* All these copepods usually appear also in the coastal and surface shelf waters, specially in lower temperatures. *Clytemnestra* sp., *Corycaeus giesbrechti* are also frequent in the tropical waters and less frequent in the cooler waters (surface subtropical).

Calanoides carinatus, Calanus tenuicornis, Ctenocalanus vanus are copepods found in cooler waters and therefore usually less frequent or absent in tropical waters and warm shelf and coastal waters. They may be the dominant copepods in volume in cooler waters off Brazil.

V — Besides these frequent copepods there are several species which appear only in one environment and are therefore characteristic of it. Many copepods were only registered in tropical waters, others only in deep waters, but in too small numbers to be useful as ecological indicator species.

VI — Although some species occur off the Brazilian coast in very saline or in deeper waters, they seem to prefer other environments in other regions, thus strongly suggesting the existence of different races within the same species or at least a great adaptational capacity. *Ctenocalanus vanus* is an example of this.

VII — Many copepods are usually very conservative as to certain parameters of their surroundings like *Eucalanus subcrassus* and *Paracalanus crassirostris.* The first prefers medium salinities all over the world and the second prefers coastal waters also all over the world.

VIII — Usually copepods from high salinities and high temperatures may occur in low salinities and low temperatures, but rarely (as *Corycaeus*) in high salinities and low temperatures.

IX — When only Brazilian waters are studied wrong conclusions may be taken, for instance, that certain copepods are more stenohaline than stenothermic. When our lists of species are compared to those of the Pacific, the conclusion is that copepods tend to be stenothermic and usually strongly euryhaline.

Tables VI, X and XVII contain very few data from the Pacific Ocean. There are differences between the lists of species of the Pacific, especially of the North East Pacific and those of the Atlantic of waters of approximately the same temperatures, because the salinities of the Pacific waters are generally lower than those of the Atlantic (Sverdrup *et al.*, 1942, p. 721). Thus the species lists published by Wilson (1950, p. 352-432) and by Scott (1909, p. 278-313) for a number of stations in the oceanic waters of the North Pacific and in the Indo-Pacific usually show: 1 — a greater richness in the number of species per genus found in

each station when compared to our lists, 2 — the presence of species which here are characteristic of shelf waters (waters of lower salinities, around 35.00 °/₀₀) like *Eucalanus subcrassus*, 3 — the presence of copepods which only occur here in waters of high salinities, and 4 — the presence of copepods of very saline warm waters that survive in lower salinities and lower temperatures.

Thus, *Haloptilus* and *Heterorhabdus, Pontellina plumata, Rhincalanus* are listed in waters of salinities known to be between 33.00 and 35.00 °/₀₀ (for instance, off Ecuador) in temperatures around 27°C (therefore comparable in temperature to our tropical waters). These species which are never found in low salinities in pure coastal waters off the Brazilian coast probably are stenoecious, rather than stenohaline. They are usually found in waters overlaying big depths. *Calanopia* is found in the Pacific stations inside gulfs or near islands (Wilson 1950, p. 352-432; Scott 1909, p. 278-373) where there is influence probably of shallower water. It is therefore a good indicator of shelf and coastal water.

X — Some copepods are good geographical indicators, thus some coastal and inshore species endemic in the Brazilian waters have not yet been recorded in any of the other waters of the world. *Oithona ovalis* Herbst, *Acartia giesbrechti* Dahl, *Pseudodiaptomus acutus* and *P. richardi* Dahl seem to be good examples of this.

XI — Zoogeographically the waters off the southern coast of Brazil (State of Rio Grande do Sul) may be termed as a "Mischgebiet" (Steuer 1928, p. 217-218) a zone where the cold southern water current (Falkland Current) meets the warm originally tropical water and where several intermediate habitats with their characteristic faunae are found together.

XII — There is usually a dominance of copepods in the open sea plankton (Hentschel 1933, p. 96). Thus the dominant species determined for the copepods present in a sample is possibly dominant for the whole community to which it belongs in that environment.

XIII — The three schematic profiles (Figs. 49, 50, 51 and map 1) along parallels 23°, 25° and 35° S represent the usual associations of frequencies of species found in the different environments off the southern Brazilian coast and summarizes the results.

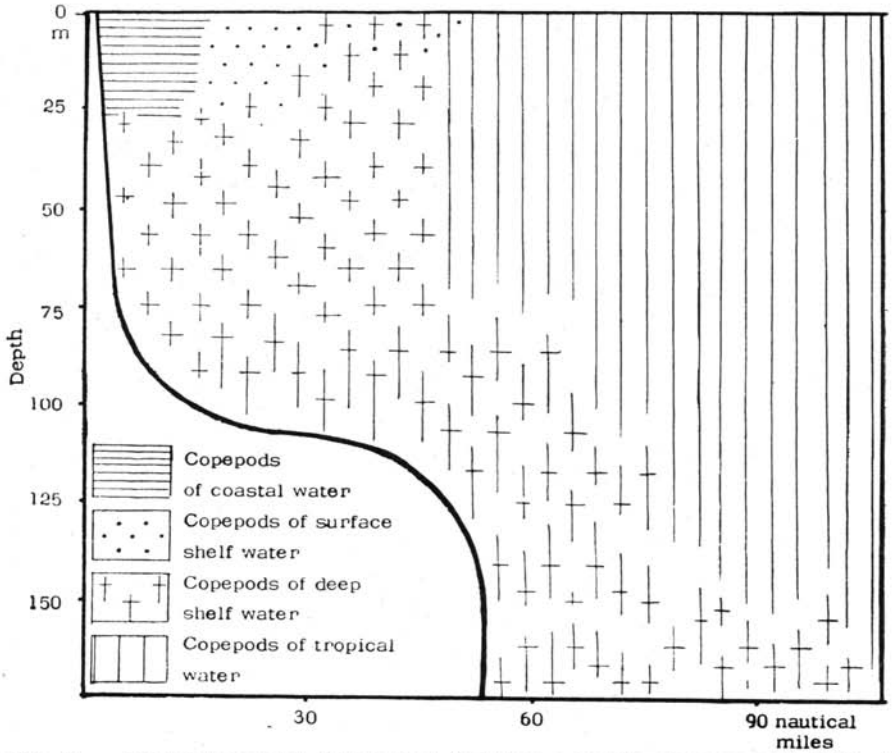

Fig. 49 — Different copepod associations found in a profile along parallel 23° S off Brazil (schematic representation). Notice the deep water reaching the surface.

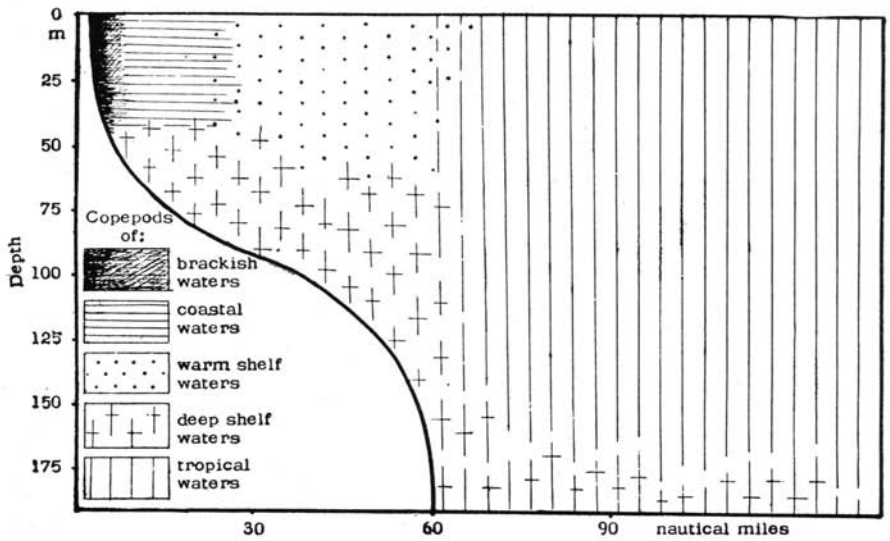

Fig. 50 — Different copepod associations found in a profile along 25° S off Brazil (schematic representation).

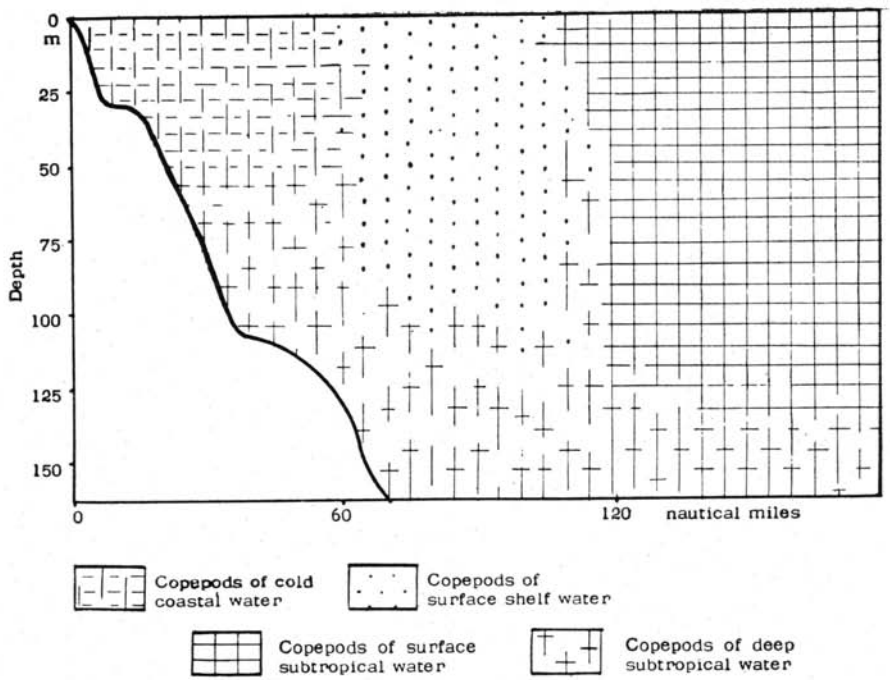

Fig. 51 — Diagram showing the associations present off Rio Grande do Sul. Notice absence of the typical tropical associations of species and the presence of cold coastal water fauna.

SUMÁRIO

Poucos autores dedicaram-se ao estudo de copépodos da região tropical e subtropical do Atlântico Sul ocidental. Alguns autores estudaram águas costeiras e salobras. As águas do alto mar e da plataforma continental foram estudadas pouco ou nada, sob o ponto de vista dos copépodos, pelas grandes expedições.

O presente trabalho é um estudo comparativo da fauna de copépodos nestas diferentes águas, tendo distinguido os seguintes *habitats*: água tropical, água subtropical de superfície, água de plataforma quente superficial, água de plataforma fria de profundidade e águas costeiras.

Estudou-se ainda alguns parâmetros característicos do ambiente em que vive cada uma das espécies de copépodos assinalada em nossas águas e procurou-se analisar as aparentes discrepâncias na ocorrência destas espécies em outros ambientes, assim como a homogeneidade das associações características das regiões tropical, subtropical, costeira e de plataforma em todos os oceanos do mundo. Algumas características morfológicas de certas espécies foram assinaladas e a variedade nova *"cryophyla"* de *Acartia tonsa* descrita.

ADDENDUM — List of samples taken off Brazil and not used in the distribution tables but mentioned in the text

SAMPLE NUMBER	Position	Date	Time (h)	Salinity (‰)	Temperature (°C)	Local depth (m)	Depth of haul (m)	Net	Haul	Plankton vol. (cc/m³)
E 3	25°8.4' S 47°44.2' W	10/1/58	12:00-12:35	34.11 34.70 35.48	27.10- 0 m 25.07- 7 m 19.08-18 m	20	17	H	V	3.2
E 4	25°8.4' S 47°44.2' W	10/1/58	12:12	34.11 34.70 35.48	27.10- 8 m 25.07- 7 m 19.08-18 m	20	18	C.B.	H	1.2
E 5	25°9.5' S 47°35.7' W	10/1/58	10:00	34.79 35.08 35.55	26.49- 0 m 24.20-10 m 16.87-25 m	28	20-25	C.B.	H	9.5
E 10	25°7.9' S 47°48.4' W	12/2/58	10:28-10:43	33.73 35.40 35.49	28.80- 0 m 27.8 - 7 m 27.4 -18 m	20	17	C.B.	H	0.87
E 11	25°8.4' S 47°44.2' W	12/2/58	14:52	33.35 36.78 34.96	28.4 - 0 m 27.2 - 7 m 26.0 -18 m	20	17-0	H	V	1.3
E 12	25°8.4' S 47°44.2' W	12/2/58	14:59-15:14	33.35 36.78 34.96	28.4 - 0 m 27.2 - 7 m 26.0 -18 m	20	17	C.B.	H	1.9
E 13	25°9.5' S 47°35.7' W	12/2/58	13:53	34.14 35.31 35.56	27.7 - 0 m 25.8 -15 m 25.7 -25 m	28	25-0	H	V	5.7
E 20	25°9.5' S 47°35.7' W	25/2/58	10:50-11:05	34.90 35.22 35.29	27.5 - 0 m 26.1 -15 m 25.8 -25 m	29	25	C.B.	H	3.9

ADDENDUM — List of samples taken off Brazil and not used in the distribution tables but mentioned in the text (contd.)

SAMPLE NUMBER	Position	Date	Time (h)	Salinity (°/₀₀)	Temperature (°C)	Local depth (m)	Depth of haul (m)	Net	Haul	Plankton vol. (cc/m³)
E 30	25°8.4' S 47°44.2' W	27/3/58	15:40 15:19	32.58 32.63 34.06	25.8 - 0 m 25.5 - 7 m 25.2 -18 m	20	15	C.B.	H	0.14
M 76	25°15' S 46°18' W	25/9/55	20:50	35.86 35.14	18.72- 50 m 13.30-110 m	113	95-50	S	V	1.5
M 112	26°40' S 43°59' W	15/6/56	06:10	36.45 36.42	21.90- 0 m 21.20-10 m	2000	0-10	C.B.	H	—
M 173	32°30' S 51°23' W	9/11/56	08:58	33.15 35.23	19.21- 0 m 16.96-52 m	58	50-0	S	O	—
M 389	33°11' S 50°59' W	15/4/58	—	32.18 35.62	19.92- 0 m 19.41-75 m	100	75-0	20	H	0.25
P 2	23°52.7' S 45°58' W	17/7/59	13:00	33.62	21.9 -20 m	22	20	C.B.	H	0.42
P 3	23°53.6' S 45°46.9' W	17/7/59	15:20	33.91	22.1 -25 m	29	25	C.B.	H	0.04
P 4	23°53.5' S 45°43.9' W	17/7/59	16:25	34.02	22.2 -25 m	27	25	C.B.	H	0.38
P 5	23°47.5' S 45°40.5' W	18/7/59	08:30	33.85	22.2 -15 m	17	15	C.B.	H	—

P 6	23°51.5' S 45°28.8' W	18/7/59	10:40	34.76	22.3 -10 m	16	10	C.B.	H	0.21
P 7	23°39.1' S 45°17.3' W	18/7/59	13:20	34.20	22.5 -10 m	14	10	C.B.	H	0.35
P 8	23°35.5' S 45°12.6' W	18/7/59	15:15	34.64	23.0 -10 m	14	10	C.B.	H	—
P 11	23°35.4' S 45°09.4' W	20/7/59	10:30	34.04 34.25	22.6 - 0 m 22.8 -15 m	18	10	C.B.	H	0.18
P 12	23°37.5' S 45°16.8' W	20/7/59	12:40	34.12 34.25	23.4 - 0 m 23.0 - 9 m	10	surface	C.B.	H	0.51
P 13	23°38.7' S 45°23.8' W	20/7/59	14:42	34.23	23.3 - 3 m	5	surface	C.B.	H	0.13
V 2	24°16.8' S 46°00.4' W	8/4/60	00:24 00:21 00:17	36.00 35.49 35.00	19.8 -15 m 16.6 -25 m 16.4 -35 m	49	20	S	H	—
V 3	24°16.8' S 46°00.4' W	8/4/60	00:30 00:27 00:24	35.23 35.49 36.00	25.7 - 0 m 24.7 - 7 m 19.8 -15 m	49	0	S	S	—
V 13	24°16.8' S 44°00.4' W	8/4/60	16:07 16:03	35.63 35.27	16.4 -35 m 16.4 -45 m	49	45	S	H	—

Nets: H = Hensen; C.B. = Clarke-Bumpus; 20 = American nº 20; S = Standard closing (Nansen type).

Haul: V = vertical; H = horizontal; O = oblique; S = surface.

ACKNOWLEDGEMENTS

Dr. Vannucci, Dr. Forneris, Miss Almeida Prado and Mr. Teixeira made helpful suggestions. Dr. Emilsson gave good advice concerning the hydrographic part of the work. Miss Alves Costa, Mr. Silva Telles, Mr. del Rio Garcia helped in the calculations, the preparation of the sample lists, the revision of the text, and drawing of the graphs. Mr. Lucki helped in the translation of the Russian texts consulted.

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Note — The literature marked with an * was used to complete the hydrographical data of Tables IV, VI, X, XVI, XVII.