Bolm Inst. oceanogr., S Paulo, 33(1):5-27, 1985

OCCURRENCE AND DISTRIBUTION OF COPEPODS (CRUSTACEA) IN THE EPIPELAGIAL OFF SOUTHERN BRAZIL*

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Synopsis

The copepods of plankton samples collected with a Bongo net of 0.333 mm mesh in 66 oceanographic stations of 4 transects off the States of Rio de Janeiro (RJ) and Santa Catarina (SC) in Nov./Dec. 75 and May 76 were qualitatively and quantitatively studied. An amount of 173 species was identified, of which Paivella naporai *Wheeler,* Xanthocalanus marlyae *Campaner, and* Corycaeus giesbrechti *F. Dahl were taxonomically reviewed. Frequency and density of each species, and absolute and mean density of total copepods were determined for every station, as well as frequency of adult females and males, and young forms. Abundance was higher in the neritic than in the oceanic zone, the mean density being twice greater of the neritic zone of RJ than in that of SC, and almost identical in the oceanic zone off both States except for SC in Nov./Dec. 75, where values were thrice greater than in RJ. These results were related to the distribution of water masses in the sampling areas. Copepod associations were determined for neritic and oceanic zones off the States of RJ and SC at both sampling seasons.*

Descriptors: Crustacea, Copepoda, Abundance, Ecological distribution, Animal morphology, Community composition, Plankton, Check list, Taxonomy, Population density, Water masses, Oceanic province, Neritic province, Associations (ecological), *Paivella naporai*, *Xanthocalanus marlyae*, *Corycaeus giesbrechti*, Rio de Janeiro, Santa Catarina, SW Atlantic.

Descritores: Crustacea, Copepoda, Abundância, Distribuição ecológica, Morfologia animal, Composição da comunidade, Plâncton, Lista de espécies, Taxonomia, Densidade da população, Massas de água, Província oceânica, Província nerítica, Associações ecológicas, *Paivella naporai*, *Xanthocalanus marlyae*, *Corycaeus giesbrechti*, Rio de Janeiro, Santa Catarina, Atlântico Sul Ocidental.

Introduction

The marine planktonic copepods from the South Atlantic off Brazil have been taxonomically and ecologically surveyed since the end of last century from material collected by foreign oceanographic expeditions. A general study of the distribution of these animals related to water masses was made by Björnberg (1963). Contemporary and latter surveys (mainly Gaudy, 1963; Björnberg, 1965, 1981) have not only enlarged our knowledge about the epipelagic species, but also contributed other data on the deepwater fauna.

From 1975 to 1979, the R/V "Prof. W. Besnard" of the University of São Paulo made seven research cruises off southern Brazil. The first results about copepod surveys based on the plankton samples collected have been recently published (Campaner, 1981). The qualitative and quantitative copepod composition in neritic and oceanic zones off the States of Rio de Janeiro and Santa Catarina during Nov./Dec. 75 and May 76 is studied here, together with the probable seasonal influence of the distribution of water masses.

Material and methods

The biological material studied was obtained from all stations of the transects I and II off the State of Rio de Janeiro, and III and IV off the State of Santa Catarina during the first cruise in Nov./Dec. 75, and third

* From part of a project supported by "Financiadora de Estudos e Projetos - FINEP".

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Publ. n. 612 do Inst. oceanogr. da Usp.

one in May 76 (Figs 1-2). Temperature and salinity data were obtained at surface, 10 m, and bottom in all stations, and temperature profiles were recorded by a bathythermograph.

Plankton samples were collected with two Bongo nets with 61 cm mouth diameter, 300 cm length and, respectively, 0.505 mm and 0.333 mm mesh, and preserved in 10% formaldehyde. Tows were taken double, obliquely from 5 m above the bottom to the surface in the neritic and from 200 m to the surface in the oceanic waters. The volume of water filtered was calculated from the flowmeter data by Dr Matsuura's staff (Instituto Oceanográfico USP), and kindly put at my disposal.

Only samples from the 0.333 mm mesh net were used here. Copepods were counted under stereoscopic microscope in Bogorov's counting chamber (Bourdillon, 1971: 168, fig. IV-22). Samples quantitatively larger were subsampled in fractions of 1/4 or 1/16 through a Folsom splitter of four divisions (Rigosha & Co. Ltd). After one subsample had been analysed, the others were also examined to separate rare species which, if found, were counted separately, and the subsampling was disregarded.

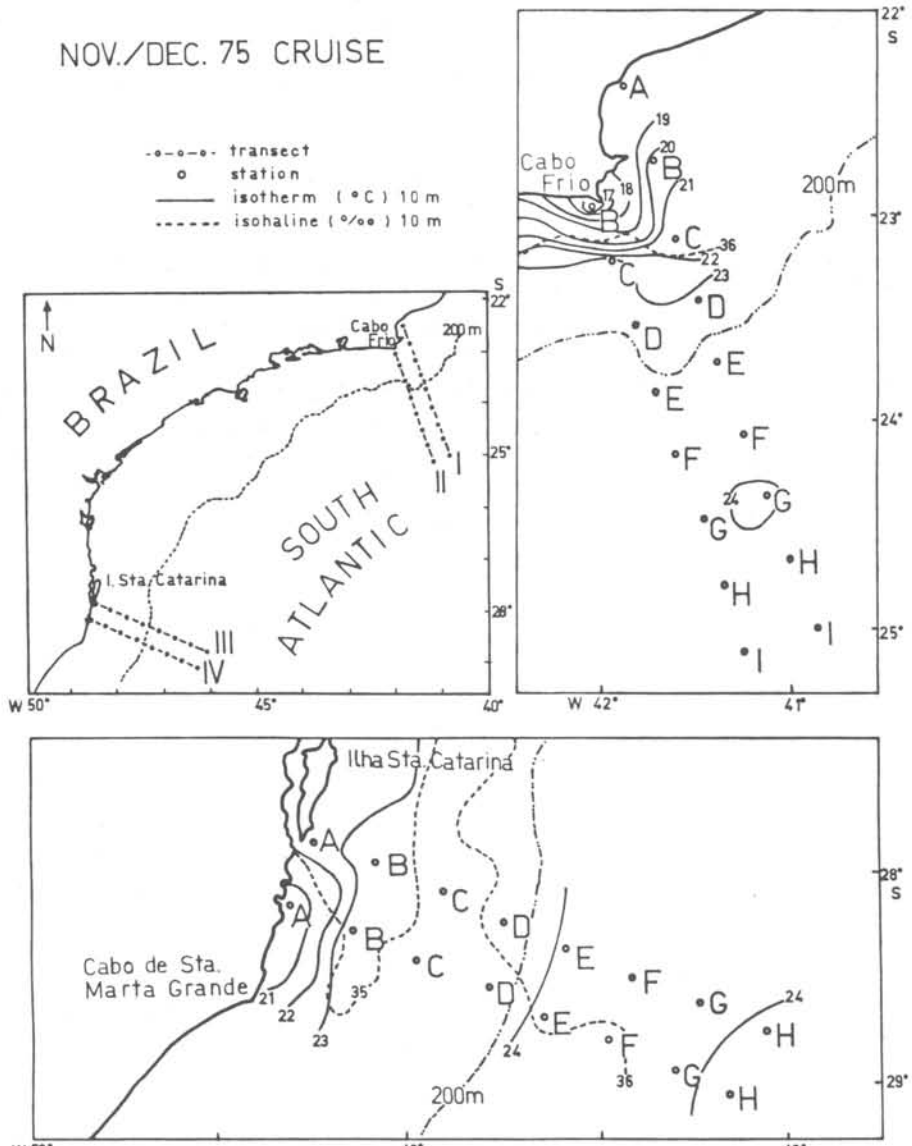

Fig. 1. Transect positions (upper left); location of stations and horizontal distribution of temperature and salinity in Nov./Dec. 75 at 10 m depth, Transects I and II (upper right) and Transects III e IV (lower). (Partially based on Matsuura, 1983: fig. 3).

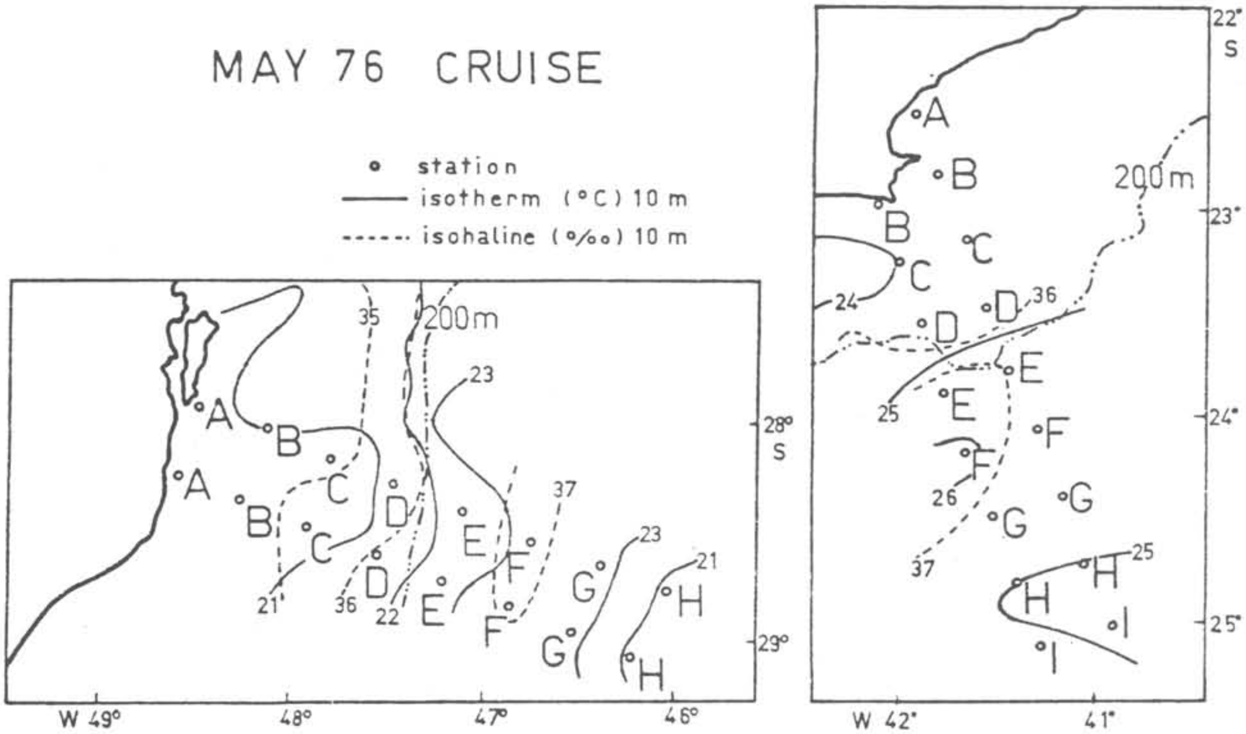

Fig. 2. Location of stations and horizontal distribution of temperature and salinity in May 76 at 10 m depth in Transects I and II (right) and in Transects III and IV (left). (Partially based on Matsuura, 1983: fig. 5).

Density of each copepod species was expressed in no.m^{-3} (number of individuals per volume of water filtered, in m^3) and frequency was represented by a proportion, in which the first number refers to the number of species occurrence, and the second refers to the number of analysed stations (*e.g.* 2:10 means that the species occurs in 2 out of 10 stations).

Results and discussion

Oceanographic features of surveyed regions

Figures 1 and 2 show the horizontal distribution of salinity and temperature at 10 m depth, and Figures 3 to 6 the vertical profile of temperature and the water mass distribution.

The water masses were characterized according to Björnberg (1963), Miranda (1982), and Matsuura (1983) and classified into four types: (1) Coastal water, with variable temperature and salinity up to 34°/oo; (2) Shelf water, with temperature from 20 to 26°C and salinity from 35 to 36°/oo; (3) Tropical water, with temperature and salinity above 20°C and 36°/oo, respectively; and (4) South Atlantic (SA) central water, with temperature and salinity from 10 to 20°C and from 35 to 36°/oo, respectively.

As stated by Miranda (*op. cit.*) and illustrated here, 50% or more of the total water volume over the continental shelf are of SA central water. This water mass is also the same which is drawn up to the surface in Nov./Dec. off the State of Rio de Janeiro (Figs 3-4) and also off Santa Catarina (Fig. 6).

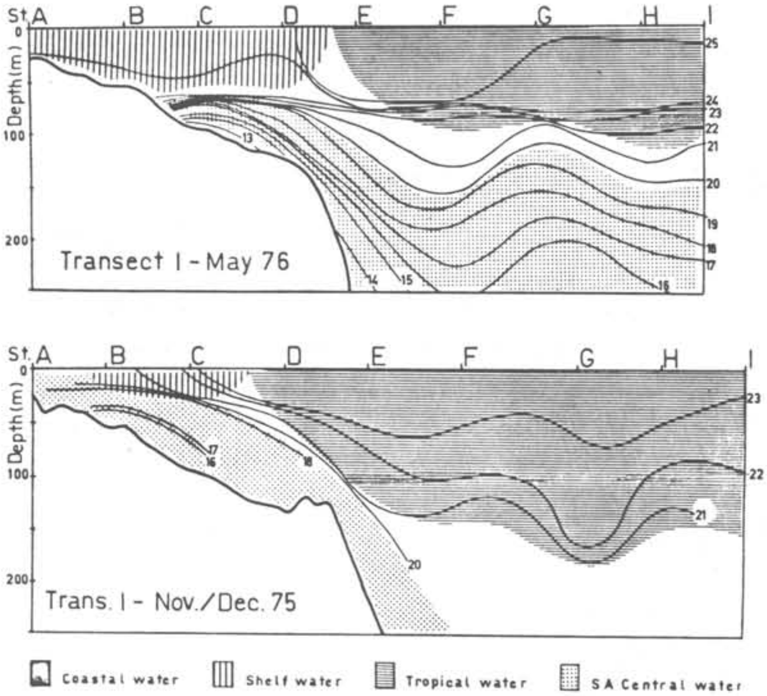

Fig. 3: Vertical distribution of temperature and water masses, Transect I - Nov./Dec. 75 and May 76. (Partially based on Matsuura, 1978: figs 52 and 54).

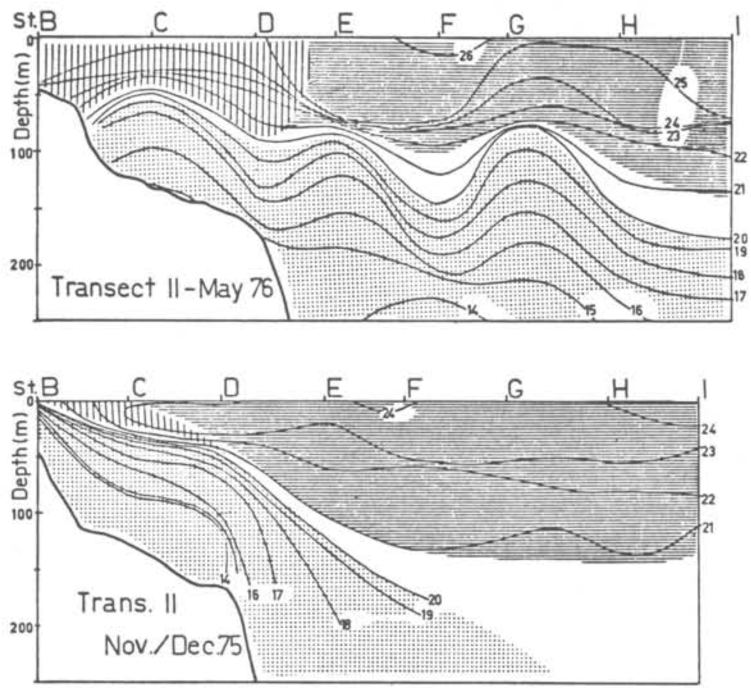

Fig. 4. Vertical distribution of temperature and water masses (see caption in Fig. 3), Transect II - Nov./Dec. 75 and May 76. (Partially based on Matsuura, 1978: figs 52 and 54).

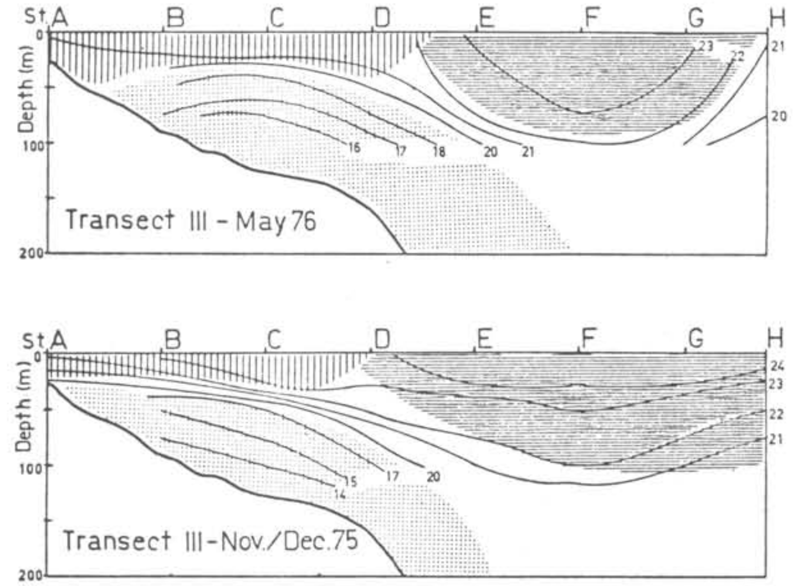

Fig. 5. Vertical distribution of temperature and water masses (see caption in Fig. 3), Transect III - Nov./Dec. 75 and May 76.

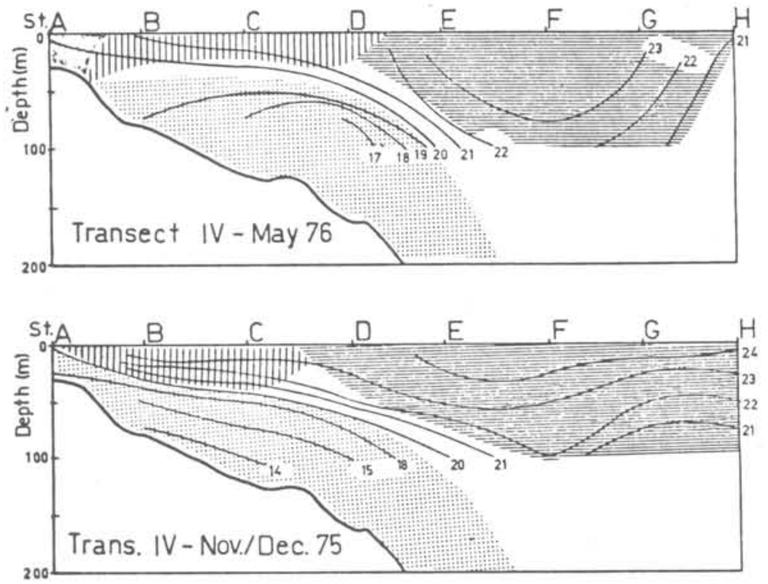

Fig. 6. Vertical distribution of temperature and water masses (see caption in Fig. 3), Transect IV - Nov./Dec. 75 and May 76.

Epipelagic copepod fauna: qualitative analysis

(a) List of species identified

Sub-Order Calanoida G.O. Sars, 1902

Fam. Calanidae Dana, 1849
1. *Calanoides carinatus* (Krøyer, 1849)
2. *Calanus minor* (Claus, 1863)
3. *C. tenuicornis* Dana, 1849
4. *Neocalanus gracilis* (Dana, 1849)
5. *N. robustior* (Giesbrecht, 1888)
6. *Undinula vulgaris* (Dana, 1849)

Fam. Eucalanidae Giesbrecht, 1892
7. *Eucalanus crassus* Giesbrecht, 1888
8. *E. monachus* Giesbrecht, 1888
9. *E. pileatus* Giesbrecht, 1888
10. *E. sewelli* Fleminger, 1973
11. *Rhincalanus cornutus* (Dana, 1849)
12. *R. nasutus* Giesbrecht, 1888

Fam. Paracalanidae Giesbrecht, 1892
13. *Acrocalanus gracilis* Giesbrecht, 1888
14. *A. longicornis* Giesbrecht, 1888
15. *Paracalanus aculeatus* Giesbrecht, 1888
16. *P. campaneri* Björnberg, 1980
17. *P. indicus* Wolfenden, 1905
18. *P. parvus* (Claus, 1863)
19. *P. quasimodo* Bowman, 1971

Fam. Calocalanidae M. Bernard, 1958
20. *Calocalanus contractus* Farran, 1926
21. *C. pavo* (Dana, 1849)
22. *Ischnocalanus equalicauda* (Bernard, 1958)
23. *I. plumulosus* (Claus, 1863)
24. *Mecynocera clausi* J.C. Thompson, 1888

Fam. Pseudocalanidae G.O. Sars, 1900
25. *Clausocalanus arcuicornis* (Dana, 1849)
26. *C. brevipes* Frost & Fleminger, 1968
27. *C. furcatus* (Brady, 1883)
28. *C. ingens* Frost & Fleminger, 1968
29. *C. mastigophorus* (Claus, 1863)
30. *C. parapergens* Frost & Fleminger, 1968
31. *C. paululus* Farran, 1926
32. *C. pergens* Farran, 1926
33. *Ctenocalanus vanus s.l.* Giesbrecht, 1888

Fam. Aetideidae Giesbrecht, 1892
34. *Chiridius poppei* Giesbrecht, 1892
35. *Chirundina streetsi* Giesbrecht, 1895
36. *Euaetideus acutus* (Farran, 1929)
37. *E. bradyi* (A. Scott, 1909)
38. *E. giesbrechti* (Cleve, 1904)
39. *Euchirella amoena* Giesbrecht, 1888
40. *E. bitumida* With, 1915
41. *E. curticauda* Giesbrecht, 1888
42. *E. formosa* Vervoort, 1949
43. *E. messinensis* (Claus, 1863)
44. *E. pulchra* (Lubbock, 1856)
45. *Gaetanus minor* Farran, 1905
46. *Paivella naporai* Wheeler, 1970
47. *Undeuchaeta major* Giesbrecht, 1888
48. *U. plumosa* (Lubbock, 1856)

Fam. Euchaetidae Giesbrecht, 1892
49. *Euchaeta acuta* Giesbrecht, 1892
50. *E. marina* (Prestandrea, 1833)
51. *E. media* Giesbrecht, 1888
52. *E. spinosa* Giesbrecht, 1892

Fam. Phaennidae G.O. Sars, 1902
53. *Phaenna spinifera* Claus, 1863
54. *Xanthocalanus agilis* Giesbrecht, 1892
55. *Xanthocalanus marlyae* Campaner, 1978

Fam. Scolecithricidae Giesbrecht, 1892
56. *Lophothrix latipes* (T. Scott, 1894)
57. *Scaphocalanus curtus* (Farran, 1926)
58. *S. echinatus* (Farran, 1905)
59. *Scolecithricella dentata* (Giesbrecht, 1892)
60. *S. profunda* (Giesbrecht, 1892)
61. *S. ovata* (Farran, 1905)
62. *S. tenuiserrata* (Giesbrecht, 1892)
63. *S. vittata* (Giesbrecht, 1892)
64. *Scolecithrix bradyi* Giesbrecht, 1888
65. *S. danae* (Lubbock, 1856)
66. *Scottocalanus securifrons* (T. Scott, 1894)

Fam. Temoridae Giesbrecht, 1892
67. *Temora stylifera* (Dana, 1849)

Fam. Metridinidae G.O. Sars 1902
68. *Pleuromamma abdominalis* (Lubbock, 1856)
69. *P. gracilis* (Claus, 1863)
70. *P. piseki* Farran, 1929
71. *P. xiphias* (Giesbrecht, 1889)

Fam. Centropagidae Giesbrecht, 1892
72. *Centropages (?) gracilis* (Dana, 1849)
73. *C. velificatus* (de Oliveira, 1946)
74. *C. violaceus* (Claus, 1863)

Fam. Lucicutiidae G.O. Sars, 1902
75. *Lucicutia clausi* (Giesbrecht, 1889)
76. *L. flavicornis* (Claus, 1863)
77. *L. gaussae* Grice, 1963
78. *L. gemina* Farran, 1926

Fam. Heterorhabdidae G.O. Sars, 1902
79. *Heterorhabdus papilliger* (Claus,1863)
80. *H. spinifrons* (Claus, 1863)
81. *Heterostylites longicornis* (Giesbrecht,1889)

Fam. Augaptilidae G.O. Sars, 1905
82. *Augaptilus cf. anceps* Farran, 1908
83. *A. (?) longicaudatus* (Claus, 1863)
84. *A. megalurus* Giesbrecht, 1889
85. *A. spinifrons* Sars, 1907
86. *Euaugaptilus hecticus* (Giesbrecht, 1889)
87. *Haloptilus acutifrons* (Giesbrecht, 1892)
88. *H. cf. angusticeps* Sars, 1907
89. *H. austini* Grice, 1959
90. *H. fertilis* (Giesbrecht, 1892)
91. *H. fons* Farran, 1908
92. *H. longicornis* (Claus, 1863)
93. *H. mucronatus* (Claus, 1863)
94. *H. ornatus* (Giesbrecnt, 1892)
95. *H. oxycephalus* (Giesbrecht, 1889)
96. *H. spiniceps* (Giesbrecht, 1892)

Fam. Arietellidae G.O. Sars, 1902
97. *Arietellus cf giesbrechti* Sars,1905
98. *A. setosus* Giesbrecht, 1892

Fam. Phyllopodidae Brodsky, 1950
99. *Phyllopus helgae* Farran, 1908

Fam. Candaciidae Giesbrecht, 1892
100. *Candacia bipinnata* (Giesbrecht, 1889)
101. *C. curta* (Dana, 1849)
102. *C. ethiopica* (Dana, 1849)
103. *C. longimana* (Claus, 1863)
104. *C. pachydactyla* (Dana, 1849)
105. *C. varicans* (Giesbrecht, 1892)
106. *Paracandacia bispinosa* (Claus, 1863)
107. *P. simplex* (Giesbrecht, 1889)

Fam. Pontellidae Dana, 1852
108. *Calanopia americana* F. Dahl, 1894
109. *Labidocera acutifrons* (Dana, 1849)
110. *L. fluviatilis* F. Dahl, 1894
111. *Pontella atlantica* (Milne-Edwards,1840)
112. *P. marplatensis* Ramirez, 1966
113. *P. securifer* Brady, 1883
114. *Pontellina platychaela* Fleminger & Hulsemann, 1974
115. *P. plumata* (Dana, 1849)
116. *Pontellopsis brevis* (Giesbrecht, 1889)
117. *P. perspicax* (Dana, 1849)
118. *P. regalis* (Dana, 1849)
119. *P. villosa* Brady, 1883

Fam. Acartiidae G. O. Sars, 1900
120. *Acartia danae* Giesbrecht, 1889
121. *A. lilljeborgi* Giesbrecht, 1889
122. *A. longicornis* (Lilljeborg, 1853)
123. *A. negligens* (Dana, 1849)

Sub-Order Cyclopoida Bürmeister, 1843

Fam. Oithonidae Dana, 1853
124. *Oithona nana* Giesbrecht, 1892
125. *O. plumifera* Baird, 1843

126. *O. robusta* Giesbrecht, 1891
127. *O. setigera* (Dana, 1849)
128. *O. similis* Claus, 1866
129. *O. tenuis* Rosendorn , 1917

Sub-Order Poecilostomatoida Thorell, 1859

Fam. Oncaeidae Giesbrecht, 1891
130. *Lubbockia aculeata* Giesbrecht, 1891
131. *L. squillimana* Claus, 1863
132. *Oncaea conifera* Giesbrecht, 1891
133. *O. media* Giesbrecht, 1891
134. *O. mediterranea* (Claus, 1863)
135. *O. minuta* Giesbrecht, 1892
136. *O. venusta* Philippi, 1843
137. *Pachos punctatum* (Claus, 1863)

Fam. Sapphirinidae Thorell, 1859
138. *Copilia lata* Giesbrecht, 1891
139. *C. mediterranea* (Claus, 1863)
140. *C. mirabilis* Dana, 1849
141. *C. quadrata* Dana, 1849
142. *C. vitrea* Haeckel, 1864
143. *Sapphirina angusta* Dana, 1849
144. *S. auronites* Claus, 1863 - *sinuicauda* Brady, 1883
145. *S. bicuspidata* Giesbrecht, 1891
146. *S. gemma* Dana, 1849
147. *S. intestinata* Giesbrecht, 1891
148. *S. metallina* Dana, 1849
149. *S. nigromaculata* Claus, 1863
150. *S. opalina* Dana, 1849 - *darwini* Haeckel, 1864
151. *S. ovatolanceolata* Dana, 1849 - *gemma* Dana, 1849
152. *S. scarlata* Giesbrecht, 1891
153. *S. stellata* Giesbrecht, 1891

Fam. Corycaeidae Dana, 1849
154. *Corycaeus amazonicus* F. Dahl, 1894
155. *C. clausi* F. Dahl, 1894
156. *C. cf crassiusculus* Dana, 1849
157. *C. flaccus* Giesbrecht, 1891
158. *C. furcifer* Claus, 1863
159. *C. giesbrechti* F. Dahl, 1894
160. *C. latus* (Dana, 1849)
161. *C. lautus* Dana, 1849
162. *C. limbatus* Brady, 1883
163. *C. speciosus* Dana, 1849
164. *C. typicus* (Krøyer, 1849)
165. *Farranula gracilis* (Dana, 1849)
166. *F. rostrata* (Claus, 1863)

Sub-Order Harpacticoida G.O. Sars, 1911

Fam. Ectinosomatidae Oloffson, 1917
167. *Microsetella norvegica* (Boeck, 1864)

Fam. Miracidae Dana, 1846
168. *Macrosetella gracilis* (Dana, 1847)
169. *Miracia efferata* (Dana, 1847)

Fam. Tachydiidae G.O. Sars, 1909
170. *Euterpina acutifrons* (Dana, 1847)

Fam. Pseudopeltiidae Poppe, 1891
171. *Clytemnestra rostrata* (Brady, 1883)
172. *C. scutellata* Dana, 1847

Fam. Aegisthidae Giesbrecht, 1891
173. *Aegisthus mucronatus* Giesbrecht, 1891

(b) Taxonomic remarks on some species

FAMILY AETIDEIDAE

Paivella naporai Wheeler, 1970
(Fig. 7)

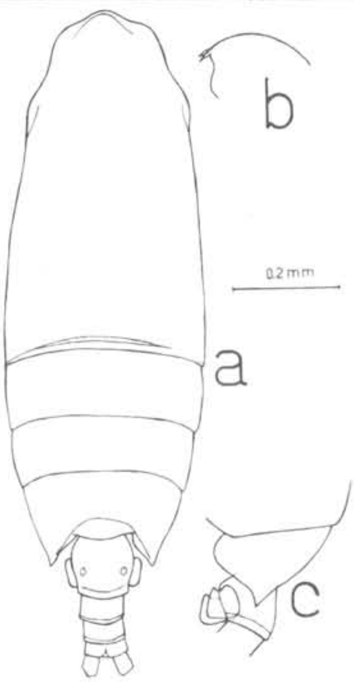

Fig. 7. *Paivella naporai* female. a, Habitus, dorsal; b, Prosome anterior, lateral; c, Last prosomal and first urosomal somites, lateral.

Paivella naporai Wheeler, 1970: 10-1, figs 33-48.

Material examined - Proj. FINEP/IOUSP collection: 3 females, oblique tows from 200 m to surface in oceanic waters off the States of Rio de Janeiro (Trans. II - Nov./Dec. 75, local depth 2360 m) and Santa Catarina (Trans. III - Nov./Dec. 75, local depths 360 and 1234 m) at night, SW Atlantic, Brazil.

Type locality - Equatorial Atlantic, Lat. 10°00'N, Long. 30°00'W, collecting depth 4100 to 2200 m.

Remarks - Length (3 specimens) 1.27-1.31 mm. Morphological features identical to holotype, except for the rostrum more curved ventrad (Fig. 7b) and prosomal posterolateral corners slightly more pointed (Fig. 7c).

Habitat and distribution - Originally described as deepwater species, it however occurred here in the epipelagial. Therefore, it may be considered a migratory mesoplanktonic species. This is the first record outside its type locality.

FAMILY PHAENNIDAE

Xanthocalanus marlyae Campaner, 1978
(Fig. 8)

Xanthocalanus marlyae Campaner, 1978: 969-976, figs 2-37.

Material examined - Proj. FINEP/IOUSP collection: 1 adult female and 2 male V copepodites, oblique tow from 189 m to surface off the State of Rio de Janeiro; 1 female V copepodite, oblique tow from 174 m to surface, Trans. IV off the State of Santa Catarina, Nov./Dec. 75, at night.

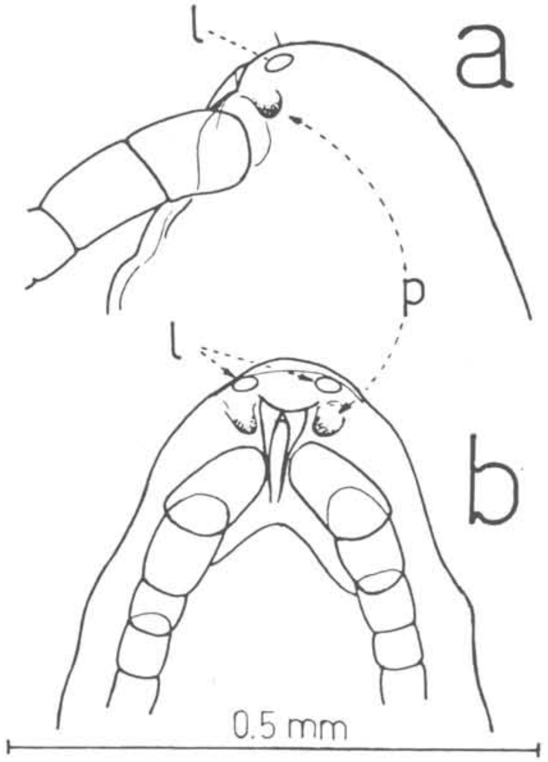

Fig. 8. *Xanthocalanus marlyae* female. a, Prosome anterior, lateral; b, Ditto, ventral. (l, lens; p, pigment cup).

Remarks - This species was originally described as devoid of eyes (Campaner, 1978: 976), but examining the well-preserved specimens of these newly collected samples, it is now possible to state the contrary. Two frontal eyes were observed, each one composed of a lens and an internal wine red pigment cup (Fig. 8*a*-*b*). The lenses were also found by re-examining the specimens of the MBT collection (Campaner, *op. cit.*), which I had formerly interpreted as points of muscle attachment. Thus, the resemblance between *Xanthocalanus minor* Giesbrecht, 1982 and *X. marlyae* increased, although other differences exist. A comparative morphological study of specimens of both species should be conclusive concerning their real taxonomic status.

These new records confirm that this species lives in near-bottom waters over the shelf, as it only occurred in samples from night towings at 5 m from the bottom to the surface.

FAMILY CORYCAEIDAE

Corycaeus giesbrechti F. Dahl, 1894 (Figs 9-10)

Corycaeus giesbrechti F. Dahl, 1894: 68, 72, fig. 1. -M. Dahl, 1912: 88, pl. 12, figs 1-9. - Rose, 1933: 330-1, fig. 427. - Björnberg, 1963: 82-3, fig. 43. - Cervigón, 1964: 184-7, figs 15-6. - Björnberg, 1965: 223. - Razouls, 1974: 89-90, 106, fig. 8. - Björnberg, 1981: 674-6, fig. 227.

Corycaeus venustus Dana. - Giesbrecht, 1892: 659, pl. 51, figs 32-4, 47.

Material examined - Project FINEP/IOUSP collection: 40 females and 10 males, oblique tows in neritic and oceanic waters off the States of Rio de Janeiro (Trans. I and II) and Santa Catarina (Trans. III and IV).

Length of specimens - Ten females were randomly sellected from each of the following four regions: neritic (N) and oceanic (O) waters off the States of Rio de Janeiro (RJ) and Santa Catarina (SC), respectively. The measurements (mm) were: N-RJ, 0.98-1.04 (average 1.01); O-RJ, 0.97-1.03 (average 1.01); N-SC, 0.93-1.03 (average 0.97); and O-SC, 0.99-1.02 (average 1.00). The males (10 specimens) measured 0.82-0.88 (average 0.85).

Remarks - The prosomal pedigerous somites of the females (Fig. 9*a*-*b*) are differently shaped, this apparent dimorphism being mainly due to fixation, with each somite retracting in different degrees into the previous one. The differences in length are not significative, especially when mean values are taken into account. As a result of the relative scarcity of morphological descriptions of this species, the main structural features are illustrated here. The P6 armature and structure, not considered until now, are included, as they may contribute to a future specific or generic revision.

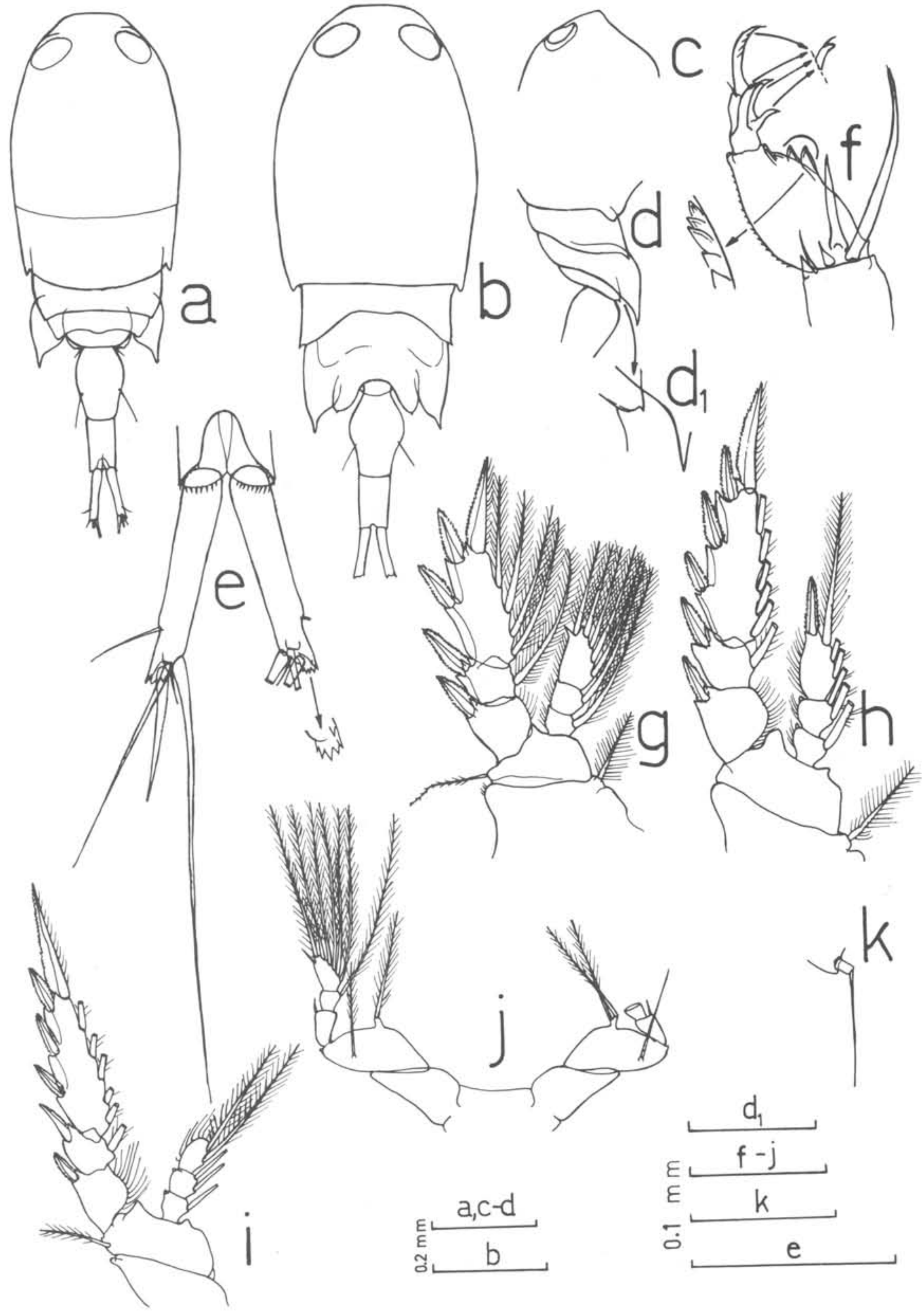

Fig. 9. *Corycaeus giesbrechti* female. a-b, Habitus, dorsal, of two specimens in different aspects of the retraction of pedigerous somites; c, Prosome anterior, lateral; d, Last three prosomal and first urosomal somites, lateral; d1, Last prosomal somite enlarged, lateral; e, Last urosomal somite (terminal portion) and furca, dorsal; f, Antenna (A2); g, Leg 1; h, Leg 2; i, Leg 3; j, Leg 4; k, Leg 6, lateral.

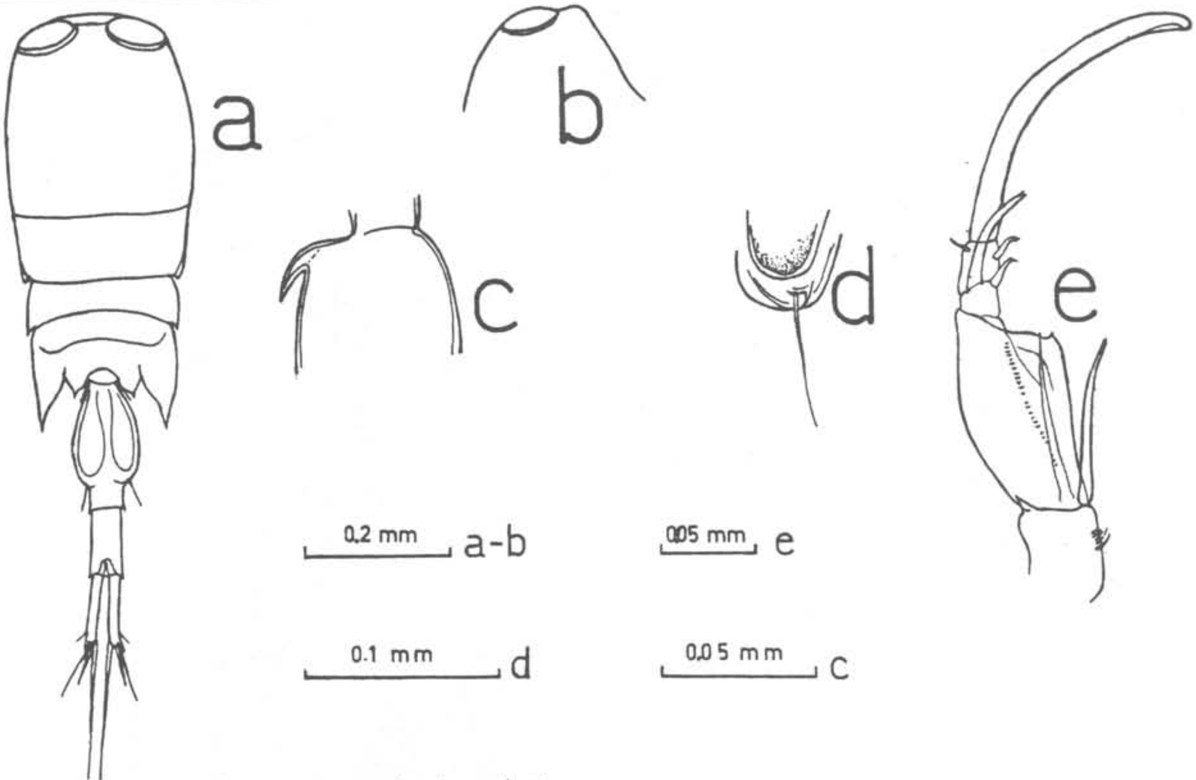

Fig. 10. *Corycaeus giesbrechti* male. a, Habitus, dorsal; b, Prosome anterior, lateral; c, Urosomal somite 1 anterior, lateral; d, Leg 6, lateral; e, Antenna (A2).

Epipelagic copepod fauna: quantitative analysis

Copepod countings are summarized in Tables 1 and 2 (see Appendix), presenting frequency and density of each species in the two surveyed regions during the two seasons.

Density and relative percentage of adults and copepodites plus nauplii are given for every station of the transects performed in each cruise in Figures 11 to 14, and for the neritic and oceanic zones of the States of Rio de Janeiro (RJ) and Santa Catarina (SC) in Figure 15.

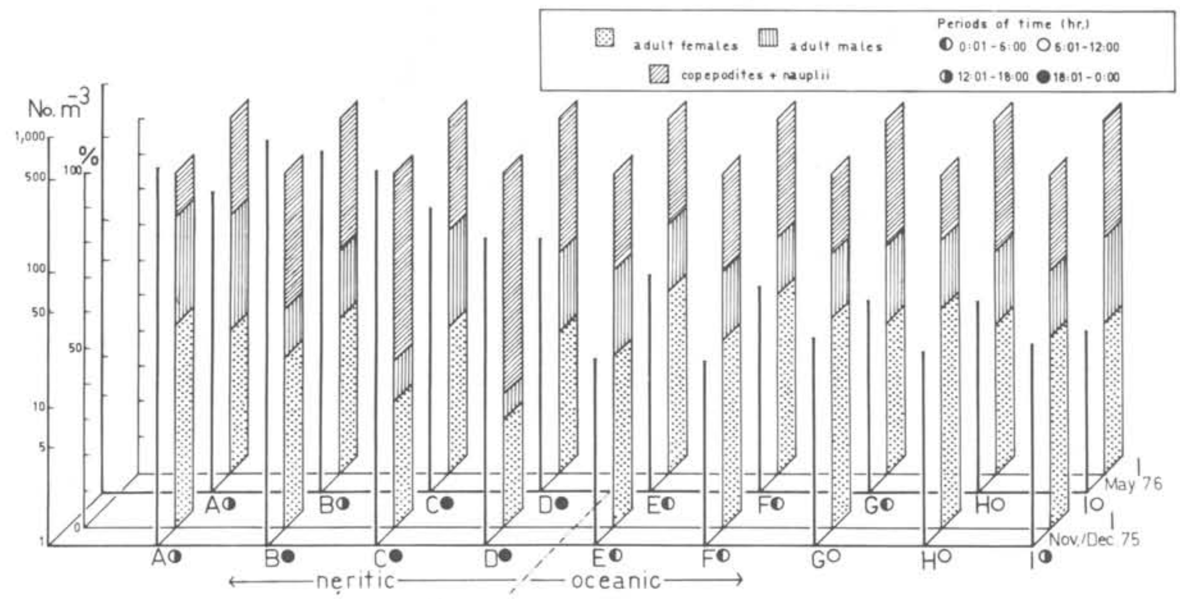

Fig. 11. Density (no. m^{-3}) and relative percentage (%) of copepods at each station of Transect I (State of Rio de Janeiro) in Nov./Dec. 75 and May 76.

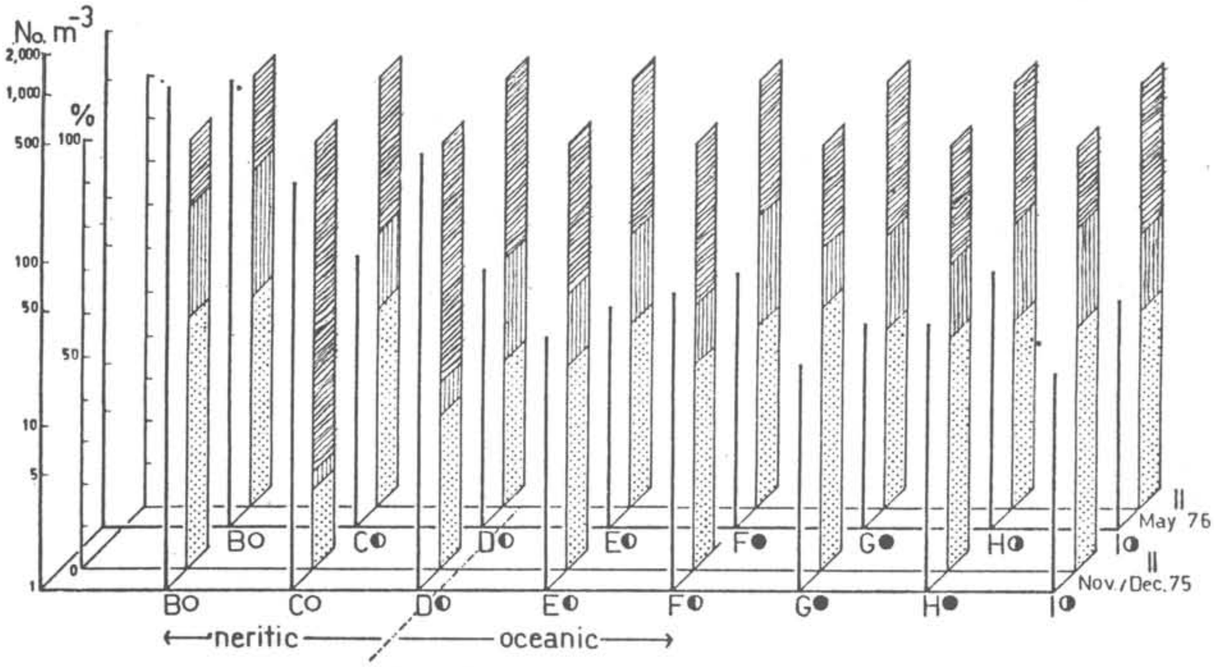

Fig. 12. Density (no. m^{-3}) and relative percentage (%) of copepods at each station of Transect II (State of Rio de Janeiro) in Nov./Dec. 75 and May 76. (see also upper caption in Fig. 11).

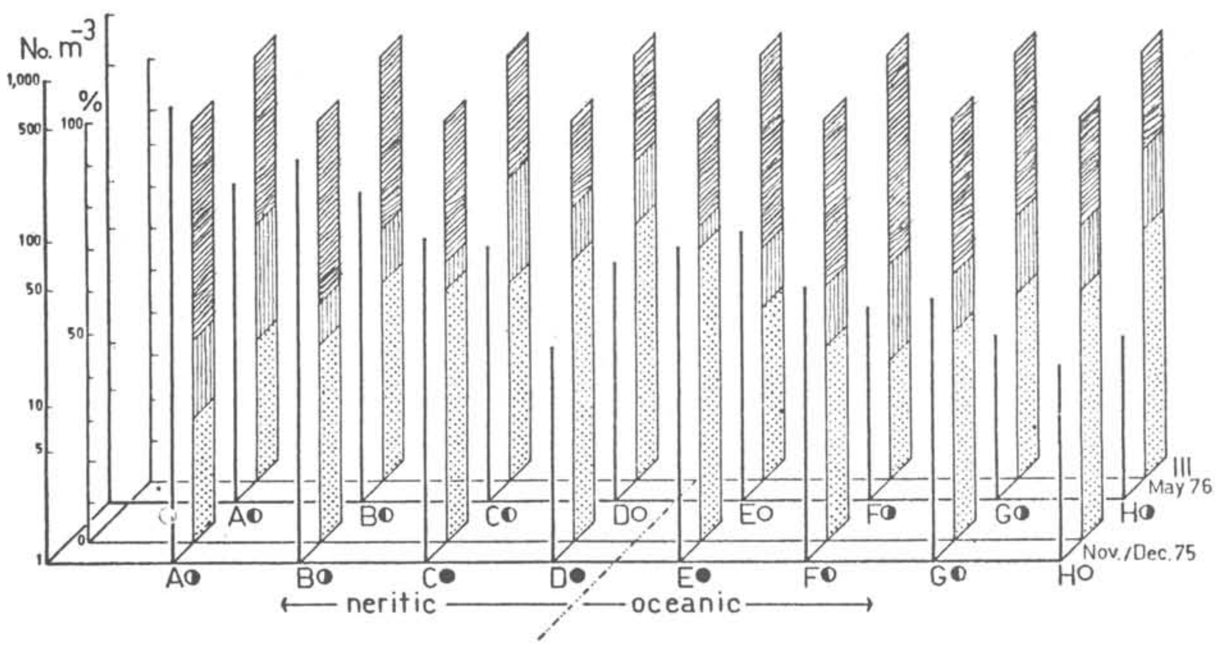

Fig. 13. Density (no. m^{-3}) and relative percentage (%) of copepods at each station of Transect III (State of Santa Catarina) in Nov./Dec. 75 and May 76. (see also upper caption in Fig. 11).

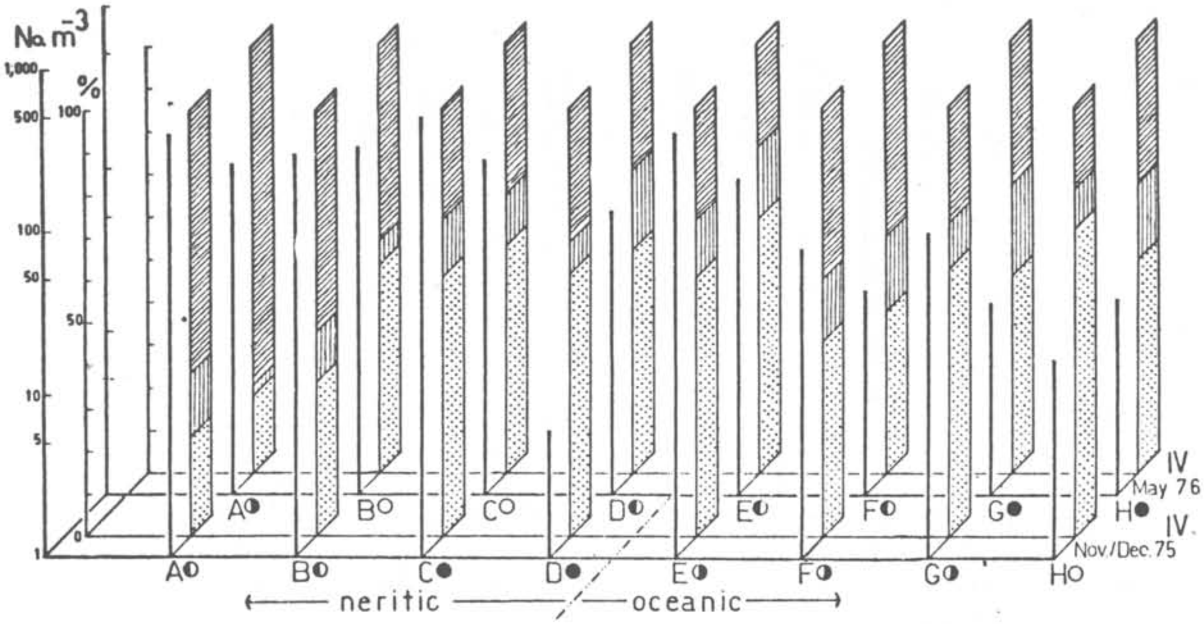

Fig. 14. Density (no. m^{-3}) and relative percentage (%) of copepods at each station of Transect IV (State of Santa Catarina) in Nov./Dec. 75 and May 76. (see also upper caption in Fig. 11).

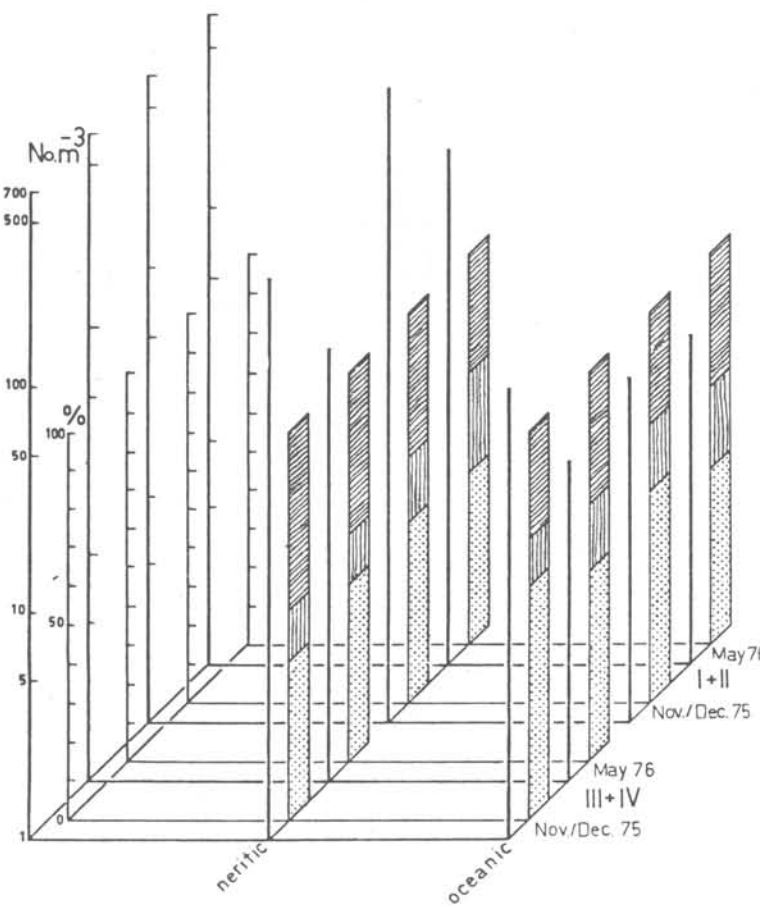

Fig. 15. Mean density (no. m^{-3}) and relative percentage (%) of copepods in neritic and oceanic zones off the States of Rio de Janeiro and Santa Catarina in Nov./Dec. 75 and May 76. (see also upper caption in Fig. 11).

Density values were evidently higher in the neritic than in the oceanic zone in all analysed areas and seasons sampled (Fig. 15). However, differences between the neritic regions off RJ (Trans. I + II) and SC (Trans. III + IV) in Nov./Dec. and in May were recorded. The mean density in RJ is approximately twice greater than that in SC in both seasons, but few species had high frequency and density.

This fact is probably due to the unequal water mass distribution (Figs 3-6), since there was a greater volume of SA central water over the shelf of RJ than over that of SC, at least in Nov./Dec. In this period, typical species inhabiting this productive water, like *Calanoides carinatus* and *Ctenocalanus vanus*, increased the copepod biomass off RJ, but they were scarcely present off SC. It should be also noted that a greater influence of the oceanic species over the neritic copepod fauna was verified off SC in May.

There was an evident inverse correlation in the abundance of *Calanoides carinatus* and *Eucalanus pileatus*. Thus, the former was more numerous than the latter off RJ in Nov./Dec., the contrary occurring in May (see Tables 1 and 2). On the other hand, *C. carinatus* was always less abundant off SC. According to Paffenhöffer (1983), the abundance of *E. pileatus* is positively related to the abundance of particulate matter, probably rich in cool and cold waters over the shelf. The alternating seasonal development of these species populations, as shown off RJ, leads to the conclusion that both species might be in some way competitors.

In addition, Aidar-Aragão *et al.* (1980) and Vieira & Teixeira (1981) recorded relatively high values of chlorophyll-*a* concentration and primary productivity in near-coastal stations off RJ and SC which corresponded in location, and generally in season to those where these two species occurred abundantly.

Unlike in neritic waters, the mean density was very similar in the oceanic zone off RJ and SC, except for the relatively higher value recorded in SC in Nov./Dec. Once more, the unequal distribution of water masses should explain this last fact, as in Nov./Dec. the sampled area of RJ was occupied more extensively by tropical water (Figs 3-4) than that of SC (Figs 5-6).

Concerning sex and developmental stage distribution, a predominance of adult females over copepodites and nauplii, and of these over adult males was observed in both pelagic zones. This could be due to the selective power of the large meshed net which was not appropriate for sampling small copepodites and nauplii. There was some predominance of young forms in few stations, chiefly in the neritic ones nearest the coast (Fig. 14), or the continental edge (Figs 11-12).

The period of collecting (day or night) seemed not to have influenced the total and mean copepod densities. In the neritic zone, almost the entire water column was sampled; consequently, most of the copepods really present in it were caught during both periods. In the oceanic pelagial, some samples taken at dawn generally showed greater density. It is known that the vertical migration plays an important role in changing the qualitative and quantitative composition of the epiplankton during the night, but here only the qualitative aspect was clearly demonstrated. Most of the rare and less abundant species (Tables 1-2) are migratory, and therefore sampled only in the epipelagial at night.

Epipelagic copepod fauna: concluding characterization

Based on the most representative species previously analysed qualitatively and quantitatively, the neritic and oceanic zones off the States of Rio de Janeiro and Santa Catarina could be characterized by the following copepod associations in Nov./Dec. 75, and their respective changes in May 76:

1. *Neritic zone*

   (a) Rio de Janeiro - *Calanoides carinatus*, *Ctenocalanus vanus*, *Paracalanus aculeatus*, *P. indicus*, *P. quasimodo*, *Temora stylifera*, *Centropages velificatus*, *Candacia bipinnata*, *Corycaeus giesbrechti*, and *Oithona setigera*. *Eucalanus pileatus* and *Calanopia americana* also occurred, but in lower densities.

Changes in May 76 - *P. indicus* and *P. quasimodo* did not occur; *C. carinatus*, *C. vanus*, *C. bipinnata*, *C. giesbrechti*, and *O. setigera* diminished in density; *E. pileatus* and *C. americana* increased in density; *Calanus minor* and copepodites of Candaciidae occurred in significant densities. The other species maintained their frequency and density.

(b) Santa Catarina - *Calanus minor*, *C. tenuicornis*, *Eucalanus pileatus*, *Paracalanus aculeatus*, *P. indicus*, *Clausocalanus furcatus*, *C. arcuicornis*, *Ctenocalanus vanus*, *Calocalanus pavo*, *Temora stylifera*, *Centropages velificatus*, *Candacia curta*, *Acartia danae*, *Oithona setigera*, *Oncaea venusta*, *Copilia mirabilis*, *Corycaeus amazonicus*, and *C. giesbrechti*. *Calanoides carinatus* also occurred, but in lower densities.

Changes in May 76 - *C. carinatus* practically did not occur; *P. aculeatus*, *P. indicus*, *C. furcatus*, *C. arcuicornis*, *C. vanus*, *C. pavo*, *A. danae*, *C. mirabilis*, *C. amazonicus*, and *C. giesbrechti* diminished in density; *Undinula vulgaris*, *Clausocalanus parapergens*, *Eucalanus sewelli*, *Euchaeta marina*, *Candacia pachydactyla*, and copepodites of Candaciidae occurred in significant densities. The other species maintained their frequency and density.

2. *Oceanic zone*

(a) Rio de Janeiro - *Calanus minor*, *C. tenuicornis*, *Clausocalanus furcatus*, *C. parapergens*, *Euchaeta marina*, *Scolecithricella tenuiserrata*, *Temora stylifera*, *Pleuromamma* spp, *Lucicutia flavicornis*, *Heterorhabdus papilliger*, *Haloptilus longicornis*, *Paracandacia bispinosa*, *P. simplex*, *Acartia negligens*, *Oithona robusta*, *O. setigera*, *Oncaea venusta*, *Corycaeus giesbrechti*, *C. speciosus*, *C. typicus*, and *Farranula gracilis*. *Copilia mirabilis* also occurred, but in lower densities.

Changes in May 76 - *C. furcatus*, *C. parapergens*, *O. robusta*, and *C. giesbrechti* diminished in frequency and/or density; *C. mirabilis* increased in density; *Neocalanus* spp, *Undinula vulgaris*, *Undeuchaeta plumosa*, *Scolecithrix danae*, and *Candacia pachydactyla* occurred in significant densities. The other species maintained their frequency and density.

(b) Santa Catarina - *Calanus minor*, *C. tenuicornis*, *Neocalanus* spp, *Undinula vulgaris*, *Clausocalanus furcatus*, *C. parapergens*, *Euchaeta marina*, *Scolecithricella tenuiserrata*, *Scolecithrix danae*, *Temora stylifera*, *Lucicutia flavicornis*, *Heterorhabdus papilliger*, *Acartia danae*, *Oithona robusta*, *O. setigera*, *Oncaea venusta*, *Copilia mirabilis*, *Corycaeus speciosus*, *C. typicus*, and *Farranula gracilis*. *Eucalanus pileatus* and *Ctenocalanus vanus* occurred not frequently, but in higher densities.

Changes in May 76 - *C. tenuicornis*, *C. furcatus*, *C. vanus*, *E. pileatus*, *S. tenuiserrata*, *T. stylifera*, *A. danae*, *C. mirabilis*, and *F. gracilis* diminished in frequency and/or density; *Haloptilus longicornis* and copepodites of Candaciidae occurred in significant densities. The other species maintained their frequency and density.

Resumo

Foram estudados qualitativa e quantitativamente os copépodos de amostras de plâncton coletadas com uma rede Bongo de 0,333 mm de abertura de malha, em 66 estações oceanográficas constantes de quatro transecções ao largo dos Estados do Rio de Janeiro (RJ) e Santa Catarina (SC) em Nov./Dez. 75 e Maio 76. Foram identificadas 173 espécies, das quais *Paivella naporai* Wheeler, *Xanthocalanus marlyae* Campaner e *Corycaeus giesbrechti* F. Dahl foram revistas taxonomicamente. Foram determinadas as freqüências e densidades de cada espécie e as densidades absoluta e média do total de copépodos, assim como a freqüência dos machos e fêmeas adultos e formas jovens. A abundância foi maior na zona nerítica do que na oceânica, sendo a densidade média duas vezes maior na nerítica ao largo do RJ do que naquela ao largo de SC e quase idêntica na oceânica ao largo dos dois Estados, exceto em SC em Nov./Dez. 75, quando os valores atingiram o triplo daqueles ao largo do RJ. Esses resultados foram relacionados com a distribuição das massas de água presentes nas áreas de coleta. Determinou-se, finalmente, as associações de copépodos das zonas

nerítica e oceânica ao largo dos dois Estados para as duas épocas de realização das coletas.

Acknowledgements

I am indebted to Dr Y. Matsuura and Miss K. Suzuki (Instituto Oceanográfico, USP) for the oceanographic and sampling data and allowing the partial reproduction of some of their original figures, and to Dr Tagea K. S. Björnberg for her critical reading of the manuscript and valuable suggestions.

References

AIDAR-ARAGÃO, E.; TEIXEIRA, C. & VIEIRA, A. A. H. 1980. Produção primária e concentração de clorofila-*a* na costa brasileira (Lat. 22°31'S - Long. 41°52'W a Lat. 28°43'S - Long. 47°57'W). Bolm Inst. oceanogr., S Paulo, *29*(2):9-14.

BJÖRNBERG, T. K. S. 1963. On the marine free-living copepods off Brazil. Bolm Inst. oceanogr., S Paulo, *13*(1):3-142.

——————— 1965. The study of planktonic copepods in the South West Atlantic. Anais Acad. bras. Ciênc., *37*(2), supl.:219-230.

——————— 1981. Copepoda. *In:* Boltovskoy, D., ed. - Atlas del zooplancton del Atlantico Sudoccidental y métodos de trabajo con zooplancton marino. Mar del Plata, Inst. Nacional Invest. Desarrollo Pesquero, p.587-679.

BOURDILLON, A. 1971. L'échantillonnage du zooplancton marin. *In:* Lamotte, M. & Boulière, F., eds - Problèmes d'écologie: l'échantillonnage des peuplements animaux des milieux aquatiques. Paris, Masson, p.109-184.

CAMPANER, A. F. 1978. On some new planktobenthic Aetideidae and Phaennidae (Copepoda, Calanoida) from the Brazilian continental shelf II. Phaennidae. Ciênc. Cult., S Paulo, *30*(8):966-982.

——————— 1981. Resultados preliminares sobre a ocorrência e distribuição de copépodos ao largo de Cabo Frio, Brasil. Seminários de Biologia Marinha. Rio de Janeiro, Academia Brasileira de Ciências, p. 281-282.

CERVIGÓN, F. M. 1964. Los Corycaeidae del Caribe sur-Ocidental (Copepoda, Cyclopoida). Mems Soc. Cienc. nat. 'La Salle', (68)*24*:163-201.

DAHL, F. 1894. Über die horizontale und verticale Verbreitung der Copepoden im Ocean. Verh. dt. zool. Ges., *4*:61-80.

DAHL, M. 1912. Die Copepoden der Plankton-Expedition I. Die Corycaeinen. Ergebn. Atlant. Ozean Plankton-exped. Humboldt-Stift., *26*(1):1-132, 16 pls.

GAUDY, R. 1963. Campagne du navire océanographique "Calypso" dans les eaux cotières du Brésil (Janvier-Frevier 1962), Copépodes pélagiques. Recl Trav. Stn mar. Endôume, *30*(45): 15-42.

GIESBRECHT, W. 1892. Systematik und Faunistik der Pelagischen Copepoden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Fauna Flora Golf. Neapel, *19*:1-831, 54 pls.

MATSUURA, Y., coord. 1978. Exploração e avaliação de estoque de peixes pelágicos no sul do Brasil (de novembro de 1975 a novembro de 1977). Relatório SubProj. Biologia da Pesca, Proj. Integrado para Uso e Expl. Racional do Ambiente Marinho. Universidade de São Paulo, Instituto Oceanográfico, 46 p., 24 tabs, 91 figs.

——————— 1983. Estudo comparativo das fases iniciais do ciclo de vida da sardinha verdadeira, *Sardinella brasiliensis*, e da sardinha-cascuda, *Harengula jaguana*, (Pisces: Clupeidae) e nota sobre a dinâmica da população da sardinha-verdadeira na região sudeste do Brasil. Tese de Livre-Docência. Universidade de São Paulo, Instituto Oceanográfico, 150 p.

MIRANDA, L. B. de 1982. Análise de massas de água da plataforma continental e da região oceânica adjacente: Cabo de São Tomé (RJ) e a Ilha de São Sebastião (SP). Tese de Livre-Docência. Universidade de São Paulo, Instituto Oceanográfico, 200 p.

PAFFENHÖFER, G.-A. 1983. Vertical zooplankton distribution on the northeastern Florida shelf and its relation to temperature and food abundance. J. Plankton Res., *5*(1): 15-33.

RAZOULS, C. 1974. Les Corycaeidae (Copepoda, Cyclopoidea) de la région de Banyuls (Golfe du Lion). Vie Milieu, *24*(1):83-113.

ROSE, M. 1933. Copépodes pélagiques. Faune Fr., (26):1-374.

VIEIRA, A. A. H. & TEIXEIRA, C. 1981. Excreção de matéria orgânica dissolvida por populações fitoplanctônicas da costa Leste e Sudeste do Brasil. Bolm Inst. oceanogr., S Paulo, *30*(1):9-25.

WHEELER Jr., E. H. 1970. Atlantic deep-sea calanoid Copepoda. Smithson. Contr. Zool., (55):1-31.

(Received 16-Jan-84;
accepted 12-Sept-84)

APPENDIX

Table 1. Frequency (Freq.) and density ranges (no. m^{-3}) of copepod species in neritic and oceanic zones off the State of Rio de Janeiro in Nov./Dec. 75 and May 76. Obs: (1) Number of the species (sp no.) corresponds to the number and name in the List of Species, and (2) * means up to 0.01

	TRANSECTS I + II							
	NERITIC				OCEANIC			
	Nov./Dec. 75		May 76		Nov./Dec. 75		May 76	
Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
1	6:7	55.50-370.78	7:7	0.13-6.78	3:10	0.01-0.22	1:10	*
2	4:7	0.97-5:61	7:7	0.36-10.65	10:10	0.14-3.93	10:10	2.37-10.20
3	5:7	0.26-3.12	2:7	0.13-2.53	10:10	1.23-5.98	10:10	0.18-2.09
4	-	-	1:7	*	8:10	0.01-0.16	10:10	0.01-0.16
5	-	-	-	-	9:10	0.03-0.49	10:10	* -1.03
6	2:7	0.08-0.61	7:7	0.13-5.14	9:10	0.03-0.82	10:10	0.66-3.00
7	4:7	0.23-7.00	2:7	0.02-0.05	-	-	1:10	0.01
8	-	-	1:7	0.09	1:10	0.01	-	-
9	5:7	0.75-22.74	7:7	1.38-80.57	-	-	5:10	* -0.14
10	2:7	0.08-0.26	2:7	0.06-0.23	10:10	0.13-1.09	10:10	0.01-0.19
11	-	-	1:7	0.01	9:10	0.01-0.15	3:10	0.01-0.04
12	-	-	-	-	1:10	0.01	-	-
13	-	-	-	-	1:10	0.01	-	-
14	-	-	-	-	3:10	0.03-0.21	10:10	0.05-0.41
15	6:7	1.03-41.98	7:7	0.23-25.14	1:10	0.03	1:10	0.01
16	3:7	0.62-4.45	-	-	1:10	0.03	-	-
17	4:7	0.18-8.91	-	-	-	-	-	-
18	1:7	3.67	-	-	-	-	-	-
19	5:7	0.14-5.25	-	-	1:10	0.08	-	-
20	-	-	-	-	-	-	-	-
21	1:7	0.31	-	-	10:10	0.03-0.32	4:10	0.02-0.10
22	-	-	-	-	-	-	-	-
23	-	-	-	-	1:10	0.05	-	-
24	-	-	-	-	7:10	0.03-0.36	1:10	*
25	5:7	0.17-2.45	1:7	0.26	8:10	0.03-0.56	1:10	0.05
26	-	-	-	-	3:10	0.04-0.39	-	-
27	5:7	9.45-73.49	2:7	0.18-0.23	10:10	0.03-4,73	2:10	0.01-0.06
28	-	-	-	-	1:10	0.15	-	-
29	-	-	1:7	0.04	3:10	0.14-0.36	3:10	0.01-0.17
30	-	-	3:7	0.13-0.23	7:10	0.06-2.03	9:10	0.06-0.48
31	-	-	-	-	1:10	0.06	1:10	*
32	-	-	-	-	3:10	0.06-0.39	-	-
33	5:7	1.13-712.40	2:7	0.18-2.05	1:10	0.05	-	-
34	-	-	1:7	*	4:10	0.01-0.06	6:10	* -0.12
35	-	-	-	-	2:10	0.01	3:10	* -0.01
36	-	-	-	-	3:10	0.21-0.77	-	-
37	-	-	-	-	1:10	0.29	-	-
38	-	-	2:7	0.09-0.69	7:10	0.03-0.44	10:10	0.01-0.80
39	-	-	-	-	2:10	* -0.01	5:10	* -0.01
40	-	-	-	-	-	-	1:10	*
41	-	-	-	-	4:10	* -0.02	3:10	0.01-0.03
42	-	-	-	-	1:10	0.01	-	-
43	-	-	-	-	4:10	* 0.01	2:10	*

Table 1. (Cont.)

Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
44	-	-	-	-	4:10	0.01-0.05	5:10	* -0.08
45	-	-	-	-	4:10	0.03-0.09	3:10	0.01-0.14
46	-	-	-	-	1:10	*	-	-
47	-	-	-	-	4:10	*	1:10	0.01
48	-	-	-	-	5:10	0.17-0.99	6:10	0.02-2.46
49	-	-	-	-	1:10	0.01	2:10	0.01
50	1:7	0.20	7:7	0.13-1.38	10:10	0.04-4.17	10:10	0.28-3.75
51	1:7	0.19	3:7	0.01	6:10	0.01-0.20	5:10	0.01-0.12
52	-	-	-	-	1:10	*	2:10	* -0.01
53	-	-	-	-	9:10	0.01-0.13	7:10	* -0.01
54	-	-	-	-	1:10	0.01	-	-
55	-	-	-	-	-	-	-	-
56	-	-	-	-	4:10	* -0.05	4:10	* -0.01
57	1:7	0.74	-	-	3:10	0.01-0.20	1:10	0.01
58	-	-	-	-	4:10	* -0.16	5:10	0.01-0.24
59	-	-	2:7	0.09-0.11	6:10	0.03-0.47	6:10	0.05-0.47
60	-	-	-	-	1:10	*	-	-
61	-	-	-	-	1:10	*	1:10	0.01
62	4:7	0.17-3.71	2:7	0.02-1.15	10:10	0.21-1.77	9:10	0.07-0.79
63	-	-	-	-	2:10	0.11-0.23	4:10	* -0.01
64	4:7	0.04-1.75	-	-	9:10	0.02-0.26	10:10	0.02-0.35
65	1:7	4.05	6:7	0.02-1.43	10:10	0.01-0.66	10:10	0.32-2.91
66	-	-	-	-	4:10	* -0.02	5:10	* -0.04
67	7:7	3.01-101.67	7:7	6.65-212.58	10:10	0.29-5.87	10:10	0.62-5.08
68	2:7	0.04-1.11	3:7	0.02-0.04	6:10	0.03-0.78	8:10	* -1.50
69	2:7	1.75-3.06	2:7	0.27-1.15	6:10	0.03-2.23	7:10	0.01-0.87
70	2:7	0.37-0.93	4:7	0.32-1.15	6:10	0.13-1.61	7:10	0.63-1.89
71	-	-	-	-	6:10	* -0.20	5:10	0.04-4.74
72	-	-	-	-	2:10	0.03-0.04	-	-
73	6:7	0.42-27.98	7:7	5.04-121.14	2:10	0.01-0.03	3:10	0.01-0.16
74	-	-	1:7	0.02	9:10	0.03-0.37	10:10	0.01-0.55
75	-	-	2:7	0.05-0.12	4:10	0.04-0.19	6:10	0.05-0.28
76	4:7	0.61-5.87	3:7	0.18-1.38	10:10	0.13-4.37	10:10	0.13-1.19
77	1:7	0.26	-	-	7:10	* -0.26	5:10	* -0.12
78	-	-	-	-	1:10	*	-	-
79	1:7	0.62	2:7	0.18-0.26	10:10	0.22-1.18	10:10	0.10-0.88
80	-	-	-	-	-	-	2:10	* -0.01
81	-	-	-	-	-	-	-	-
82	-	-	-	-	-	-	1:10	*
83	-	-	-	-	1:10	*	-	-
84	-	-	-	-	-	-	1:10	*
85	-	-	-	-	1:10	*	1:10	*
86	-	-	-	-	7:10	* -0.12	5:10	* -0.01
87	-	-	1:7	0.01	1:10	*	4:10	0.01
88	-	-	-	-	-	-	1:10	0.01
89	1:7	0.04	-	-	6:10	* -0.06	3:10	* -0.01
90	-	-	1:7	0.01	6:10	0.01-0.05	8:10	* -0.05
91	-	-	-	-	1:10	*	-	-
92	2:7	0.19-3.12	3:7	0.27-1.08	10:10	0.21-2.00	10:10	0.38-2.05
93	2:7	0.04-0.19	-	-	9:10	0.01-0.34	7:10	* -0.15
94	-	-	-	-	-	-	1:10	0.01
95	-	-	-	-	7:10	* -0.14	4:10	* -0.03
96	-	-	-	-	9:10	0.01-0.78	8:10	* -0.13
97	-	-	-	-	-	-	2:10	*
98	-	-	-	-	1:10	*	-	-
99	-	-	-	-	-	-	1:10	0.01
100	6:7	0.12-17.15	6:7	0.04-0.57	4:10	0.03-0.12	4:10	0.01-0.29
101	-	-	6:7	0.02-1.12	-	-	-	-

Table 1. (Cont.)

Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
102	-	-	-	-	7:10	0.02-0.15	1:10	*
103	-	-	1:7	*	5:10	* -0.10	4:10	0.01-0.12
104	1:7	0.02	2:7	* -0.04	7:10	* -0.20	10:10	0.06-0.41
105	-	-	-	-	-	-	1:10	*
106	1:7	0.40	-	-	10:10	0.09-0.89	10:10	0.01-0.61
107	3:7	0.32-3.50	1:7	0.46	10:10	0.03-0.46	10:10	0.01-0.46
108	5:7	0.74-18.37	7:7	0.36-36.69	1:10	0.03	1:10	0.07
109	2:7	0.16-1.11	6:7	* -0.03	5:10	* -0.06	5:10	* -0.03
110	3:7	0.61-2.63	2:7	0.01-2.69	-	-	1:10	*
111	-	-	-	-	-	-	-	-
112	-	-	1:7	1.00	-	-	-	-
113	-	-	-	-	-	-	1:10	0.01
114	-	-	-	-	-	-	1:10	*
115	-	-	1:7	0.01	2:10	0.01-0.09	7:10	* -0.05
116	2:7	0.06-0.37	4:7	0.14-2.28	-	-	1:10	0.01
117	-	-	3:7	1.11-2.71	1:10	*	9:10	* -0.02
118	-	-	-	-	1:10	0.01	-	-
119	-	-	-	-	-	-	3:10	*
120	4:7	0.77-4.05	2:7	0.04-0.09	8:10	0.05-1.06	6:10	0.07-0.20
121	5:7	0.32-596.25	2:7	0.09-0.25	1:10	0.03	-	-
122	-	-	-	-	1:10	0.01	-	-
123	-	-	-	-	8:10	0.07-1.71	3:10	0.01-0.08
124	-	-	-	-	-	-	-	-
125	-	-	1:7	0.09	9:10	0.06-0.42	1:10	0.12
126	3:7	0.65-1.87	1:7	0.46	10:10	0.03-1.14	9:10	0.05-1.68
127	6:7	1.84-18.08	7:7	0.32-0.89	10:10	0.23-3.91	9:10	0.04-1.33
128	-	-	-	-	-	-	-	-
129	2:7	0.02-2.23	1:7	0.04	3:10	0.07-0.62	2:10	0.12-0.46
130	-	-	-	-	-	-	-	-
131	1:7	0.31	-	-	4:10	0.01-0.09	1:10	*
132	6:7	0.19-4.60	2:7	0.16-0.23	4:10	0.10-0.37	-	-
133	1:7	0.31	-	-	3:10	0.06-0.34	-	-
134	4:7	0.08-0.74	-	-	6:10	0.06-0.55	-	-
135	-	-	-	-	1:10	0.03	-	-
136	5:7	0.08-4.60	6:7	0.09-1.43	10:10	0.22-3.99	10:10	0.17-2.48
137	-	-	-	-	1:10	*	6:10	* -0.01
138	-	-	-	-	9:10	0.01-0.26	8:10	0.01-0.41
139	-	-	-	-	3:10	0.06-0.11	-	-
140	2:7	0.26-0.84	7:7	0.18-3.82	9:10	0.07-0.29	10:10	0.21-1.20
141	-	-	-	-	-	-	2:10	* -0.01
142	-	-	-	-	2:10	* -0.01	4:10	0.01-0.06
143	-	-	-	-	-	-	4:10	0.01-0.13
144	1:7	0.52	1:7	0.06	4:10	0.04-0.41	9:10	* -0.38
145	-	-	-	-	-	-	1:10	0.01
146	-	-	-	-	2:10	0.01	-	-
147	1:7	0.31	-	-	3:10	0.04-0.36	9:10	0.07-0.51
148	2:7	0.02-0.31	2:7	* -0.02	10:10	0.01-3.38	8:10	0.01-0.06
149	2:7	0.04-0.12	6:7	0.05-0.65	6:10	0.04-0.78	6:10	* -0.18
150	1:7	0.31	3:7	0.02-0.12	2:10	0.01-0.12	7:10	* -0.25
151	1:7	0.13	1:7	0.04	6:10	* -0.10	4:10	0.01-0.11
152	3:7	0.69-1.88	-	-	1:10	0.01	-	-
153	-	-	-	-	1:10	0.24	-	-
154	5:7	0.79-1.79	-	-	1:10	0.03	1:10	0.01
155	-	-	1:7	0.02	5:10	0.13-0.92	8:10	* -0.30
156	-	-	-	-	-	-	-	-
157	2:7	0.26-0.31	2:7	0.22-0.46	9:10	0.06-0.55	9:10	0.07-0.78
158	-	-	1:7	0.27	5:10	0.05-0.15	6:10	* -0.18
159	7:7	0.08-54.25	6:7	0.22-1.14	9:10	0.32-1.58	1:10	0.07

Table 1. (Cont.)

Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
160	3:7	0.05-0.61	-	-	9:10	0.01-0.31	6:10	0.02-0.12
161	1:7	0.26	-	-	6:10	0.03-0.55	3:10	0.02-0.04
162	4:7	1.03-10.91	-	-	10:10	0.10-1.35	-	-
163	5:7	0.05-6.55	7:7	0.14-2.21	9:10	0.26-1.89	10:10	0.48-2.52
164	3:7	1.48-17.15	2:7	0.09-0.46	10:10	0.58-6.05	10:10	0.49-2.30
165	3:7	2.04-10.91	-	-	10:10	0.26-2.05	2:10	0.02-0.04
166	-	-	-	-	2:10	0.03-0.07	-	-
167	-	-	-	-	1:10	0.01	-	-
168	-	-	1:7	0.57	3:10	0.01-0.04	1:10	*
169	-	-	-	-	4:10	* -0.04	1:10	*
170	-	-	-	-	-	-	-	-
171	-	-	-	-	-	-	-	-
172	-	-	-	-	4:10	* -0.03	-	-
173	-	-	-	-	-	-	-	-

Table 2. Frequency (Freq.) and density ranges (no. m^{-3}) of copepod species in neritic and oceanic zones off the State of Santa Catarina in Nov./Dec. 75 and May 76. (see the same Obs. in Tab. 1)

	TRANSECTS III + IV							
	NERITIC				OCEANIC			
	Nov./Dec. 75		May 76		Nov./Dec. 75		May 76	
Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
1	8:8	0.03-13.65	1:8	0.07	4:8	* -10.79	-	-
2	8:8	0.01-8.19	8:8	0.35-8.06	8:8	1.22-6.47	8:8	0.89-7.77
3	1:8	0.35	6:8	0.14-1.53	7:8	0.08-2.65	6:8	0.17-1.00
4	1:8	0.01	1:8	0.01	5:8	0.01-0.11	7:8	0.01-0.20
5	1:8	0.01	5:8	* -0.04	6:8	0.02-0.21	7:8	0.01-0.07
6	1:8	0.08	7:8	0.02-3.91	7:8	0.07-1.57	8:8	0.09-0.91
7	4:8	0.01-0.48	-	-	-	-	-	-
8	-	-	-	-	4:8	0.05-0.11	-	-
9	8:8	0.03-197.24	8:8	0.10-17.04	2:8	0.54-63.86	4:8	* -2.08
10	-	-	7:8	0.02-2.62	6:8	0.06-0.64	7:8	0.01-0.50
11	1:8	0.01	3:8	* -0.02	4:8	0.03-0.16	4:8	* -0.03
12	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-
14	-	-	7:8	0.03-1.15	5:8	0.12-0.34	3:8	0.01-0.26
15	5:8	0.15-2.72	4:8	0.07-1.01	4:8	0.08-1.16	1:8	0.26
16	2:8	0.05-1.09	1:8	0.24	-	-	-	-
17	5:8	0.19-2.17	2:8	0.07-0.43	1:8	0.86	1:8	0.01
18	-	-	-	-	-	-	-	-
19	1:8	1.45	2:8	0.09-1.10	-	-	-	-
20	-	-	-	-	-	-	1:8	*
21	6:8	0.04-2.73	7:8	0.03-0.72	8:8	0.01-2.16	2:8	0.04-0.65
22	1:8	0.38	1:8	0.02	-	-	-	-
23	-	-	-	-	1:8	0.17	-	-
24	7:8	0.02-1.45	4:8	0.01-0.47	7:8	0.08-1.98	4:8	* -0.26
25	5:8	0.18-13.66	-	-	3:8	0.17-10.79	2:8	* -0.03
26	-	-	-	-	-	-	-	-
27	7:8	0.13-52.99	7:8	0.04-4.11	8:8	0.10-41.85	2:8	* -3.62
28	-	-	-	-	1:8	*	-	-
29	-	-	4:8	0.14-0.47	6:8	0.08-1.24	4:8	* -0.26

Table 2. (Cont.)

Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
30	1:8	0.08	8:8	0.09-3.44	6:8	0.16-2.65	8:8	0.01-1.16
31	-	-	-	-	1:8	0.21	-	-
32	-	-	2:8	0.03-0.07	-	-	-	-
33	8:8	0.35-67.19	6:8	0.07-8.77	3:8	0.17-53.07	1:8	5.04
34	-	-	2:8	0.01-0.63	-	-	4:8	* -0.03
35	-	-	-	-	-	-	3:8	0.02-0.20
36	-	-	1:8	0.17	-	-	-	-
37	-	-	3:8	0.05-0.13	-	-	1:8	0.26
38	1:8	0.24	4:8	0.06-0.22	2:8	0.15-0.21	6:8	0.06-1.36
39	-	-	-	-	4:8	* -0.01	5:8	* -0.01
40	-	-	-	-	-	-	1:8	*
41	-	-	-	-	1:8	*	2:8	0.02-0.04
42	-	-	-	-	1:8	*	2:8	*
43	-	-	-	-	-	-	3:8	* -0.01
44	-	-	-	-	2:8	*	4:8	* -0.06
45	-	-	-	-	-	-	3:8	0.02
46	-	-	-	-	2:8	*	-	-
47	-	-	-	-	1:8	0.01	-	-
48	-	-	-	-	1:8	0.08	5:8	* -0.94
49	-	-	-	-	1:8	*	2:8	0.03-0.20
50	3:8	0.23-1.09	7:8	0.11-5.00	7:8	0.20-2.27	8:8	0.39-2.77
51	-	-	1:8	0.01	2:8	0.02-0.20	3:8	0.07-0.21
52	-	-	-	-	-	-	3:8	* -0.11
53	2:8	0.01-0.03	4:8	* -0.06	4:8	0.01-0.05	6:8	* -0.06
54	-	-	1:8	*	-	-	1:8	*
55	1:8	*	-	-	-	-	-	-
56	-	-	-	-	-	-	2:8	* -0.01
57	-	-	2:8	* -0.01	2:8	0.16-0.17	-	-
58	-	-	-	-	1:8	0.10	3:8	0.08-0.18
59	2:8	0.04-0.27	1:8	0.03	4:8	0.21-0.30	6:8	0.01-0.18
60	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-
62	2:8	0.03-0.22	6:8	0.12-1.07	6:8	0.05-1.41	7:8	0.02-0.36
63	-	-	-	-	-	-	3:8	0.01-0.04
64	-	-	1:8	0.23	4:8	0.06-0.40	7:8	0.01-1.00
65	5:8	0.24-9.32	7:8	0.02-3.08	8:8	0.08-1.83	8:8	0.31-1.94
66	-	-	-	-	-	-	3:8	0.01-0.02
67	8:8	0.22-224.53	8:8	7.54-67.83	8:8	1.26-74.64	4:8	0.08-4.36
68	1:8	0.02	3:8	* -0.68	2:8	0.25-0.54	5:8	0.16-0.75
69	-	-	2:8	0.70-2.05	1:8	0.21	5:8	0.23-1.68
70	1:8	0.41	5:8	* -4.32	4:8	0.04-1.97	5:8	0.11-7.38
71	-	-	1:8	*	2:8	0.04-0.05	3:8	0.12-0.30
72	-	-	-	-	-	-	-	-
73	8:8	0.04-204.87	8:8	0.01-21.60	4:8	* -2.59	2:8	0.03-0.07
74	3:8	0.05-0.55	4:8	0.07-0.53	8:8	0.02-0.62	8:8	0.08-0.78
75	-	-	-	-	-	-	4:8	0.01-0.10
76	3:8	0.25-2.74	4:8	0.07-0.72	6:8	0.87-2.57	8:8	0.02-2.45
77	-	-	3:8	0.06-0.12	3:8	0.09-0.25	3:8	* -0.07
78	-	-	-	-	-	-	-	-
79	1:8	0.04	4:8	0.14-0.24	5:8	0.16-1.56	8:8	0.02-1.14
80	-	-	-	-	-	-	2:8	*
81	-	-	-	-	-	-	1:8	*
82	-	-	-	-	-	-	-	-
83	-	-	-	-	-	-	-	-
84	-	-	-	-	-	-	-	-
85	-	-	1:8	*	-	-	-	-
86	-	-	-	-	-	-	1:8	*
87	-	-	1:8	0.01	3:8	* -0.10	3:8	* -0.03

Table 2. (Cont.)

Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
88	-	-	-	-	-	-	-	-
89	-	-	-	-	-	-	3:8	*
90	1:8	0.01	-	-	4:8	0.03-0.17	2:8	*
91	-	-	-	-	-	-	-	-
92	1:8	0.08	6:8	0.01-0.68	2:8	0.31-0.58	7:8	0.01-3.00
93	-	-	2:8	* -0.06	5:8	0.01-0.17	4:8	* -0.02
94	-	-	-	-	-	-	1:8	*
95	-	-	-	-	1:8	0.04	2:8	*
96	-	-	1:8	0.05	3:8	0.08-0.17	3:8	* -0.07
97	-	-	-	-	-	-	-	-
98	-	-	-	-	-	-	-	-
99	-	-	-	-	-	-	-	-
100	2:8	0.06-0.27	5:8	0.02-0.24	3:8	* -0.16	3:8	* -0.11
101	5:8	0.03-2.72	8:8	0.13-3.43	1:8	1.08	2:8	0.04-0.07
102	-	-	-	-	6:8	* -0.17	3:8	* -0.01
103	-	-	-	-	1:8	0.10	2:8	0.01-0.05
104	-	-	6:8	0.16-1.42	6:8	0.07-0.60	8:8	* -0.39
105	-	-	-	-	-	-	-	-
106	2:8	0.01-0.29	2:8	0.12-0.16	4:8	0.20-0.87	6:8	0.09-0.34
107	-	-	6:8	0.03-0.48	4:8	0.31-0.91	7:8	0.07-0.91
108	1:8	0.20	5:8	0.04-0.96	-	-	-	-
109	2:8	0.03-0.68	4:8	* -0.45	4:8	* -0.54	7:8	* -0.14
110	1:8	0.39	2:8	0.07-0.17	-	-	-	-
111	-	-	-	-	2:8	*	1:8	*
112	-	-	-	-	-	-	-	-
113	-	-	-	-	-	-	-	-
114	-	-	2:8	* -0.02	1:8	*	-	-
115	3:8	0.03-0.10	3:8	* -0.48	1:8	0.10	6:8	* -0.14
116	5:8	0.19-1.21	8:8	0.01-1.73	1:8	0.86	1:8	0.01
117	-	-	1:8	0.01	2:8	*	3:8	* -0.01
118	-	-	1:8	*	-	-	2:8	*
119	1:8	0.01	-	-	1:8	*	4:8	* -0.04
120	8:8	0.29-19.12	8:8	0.04-0.59	7:8	0.16-15.10	6:8	0.03-1.16
121	1:8	0.29	-	-	-	-	-	-
122	-	-	-	-	-	-	-	-
123	-	-	5:8	0.13-0.72	5:8	0.17-5.29	4:8	0.02-1.66
124	-	-	-	-	1:8	0.33	-	-
125	3:8	0.06-0.38	1:8	0.72	4:8	0.15-0.31	1:8	0.13
126	1:8	0.05	3:8	0.01-0.42	4:8	0.03-3.31	5:8	0.03-1.57
127	8:8	1.21-27.86	8:8	0.61-6.99	8:8	0.15-22.00	8:8	0.01-8.15
128	-	-	-	-	-	-	1:8	0.03
129	-	-	-	-	4:8	0.07-0.99	2:8	0.0.-0.03
130	-	-	-	-	2:8	0.09-0.10	3:8	*
131	-	-	2:8	0.12-0.16	5:8	0.10-0.91	1:8	*
132	4:8	0.01-0.84	6:8	0.04-1.01	3:8	0.16-0.73	5:8	* -0.26
133	2:8	0.10-0.58	1:8	0.07	5:8	0.16-0.46	-	-
134	1:8	0.05	-	-	-	-	1:8	0.39
135	1:8	0.54	-	-	-	-	-	-
136	8:8	0.19-47.13	8:8	0.09-39.71	8:8	0.35-9.49	8:8	0.20-10.61
137	-	-	3:8	* -0.01	2:8	*	2:8	*
138	1:8	0.15	1:8	0.06	4:8	0.21-0.31	5:8	* -0.01
139	-	-	-	-	-	-	-	-
140	7:8	0.27-50.80	8:8	0.09-0.88	8:8	0.07-40.12	6:8	* -0.86
141	-	-	-	-	2:8	0.04-0.34	-	-
142	-	-	1:8	*	2:8	0.01-0.04	1:8	0.02
143	3:8	0.07-0.41	6:8	* -0.36	3:8	0.06-0.32	3:8	* .-0.07
144	1:8	0.03	6:8	* -0.72	7:8	0.03-0.57	4:8	* -0.18
145	-	-	-	-	-	-	-	-

Table 2. (Cont.)

Sp. nº	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}	Freq.	No. m^{-3}
146	-	-	-	-	-	-	-	-
147	1:8	0.05	2:8	0.51-0.66	2:8	0.03-0.26	7:8	* -0.71
148	-	-	2:8	0.01-0.03	4:8	0.02-0.06	4:8	* -0.02
149	3:8	0.03-1.24	7:8	0.03	5:8	0.01-0.97	2:8	* -0.07
150	1:8	0.05	3:8	0.04-0.22	1:8	0.18	1:8	*
151	5:8	0.01-1.23	7:8	0.02-0.68	7:8	0.06-0.97	3:8	* -0.02
152	4:8	0.10-1.09	-	-	1:8	0.01	-	-
153	-	-	-	-	-	-	-	-
154	8:8	0.01-32.69	7:8	0.03-2.24	3:8	0.08-0.86	-	-
155	-	-	5:8	0.01-0.46	4:8	0.16-0.52	5:8	* -0.78
156	-	-	-	-	1:8	0.03	-	-
157	3:8	0.10-0.97	7:8	0.03-1.16	6:8	0.02-0.70	7:8	0.20-0.43
158	1:8	0.01	4:8	0.07-0.75	1:8	0.03	4:8	0.03-1.04
159	8:8	0.13-43.04	8:8	0.07-9.23	8:8	0.55-19.42	3:8	0.03-1.03
160	1:8	0.25	-	-	3:8	0.05-0.10	3:8	0.01-0.14
161	2:8	0.15-0.19	-	-	2:8	0.05-0.10	2:8	* -0.05
162	2:8	0.10-0.19	1:8	0.03	2:8	0.17-0.21	2:8	0.01-0.02
163	3:8	0.06-2.19	8:8	0.18-1.82	8:8	0.28-2.79	8:8	0.08-1.49
164	2:8	0.19-0.81	7:8	0.27-1.97	7:8	0.21-4.19	8:8	0.19-2.79
165	5:8	0.24-2.87	4:8	0.09-1.66	8:8	1.15-23.12	2:8	0.01-0.91
166	-	-	-	-	-	-	-	-
167	1:8	0.08	-	-	-	-	-	-
168	5:8	0.03-0.41	4:8	* -0.48	5:8	0.02-0.32	2:8	0.01
169	-	-	2:8	*	1:8	0.05	2:8	* -0.02
170	3:8	0.29-0.54	1:8	0.17	-	-	-	-
171	6:8	0.04-0.55	-	-	1:8	0.43	-	-
172	-	-	-	-	1:8	0.08	-	-
173	-	-	-	-	-	-	1:8	*