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SPECIES COMPOSITION OF COPEPODS RELATED TO SURFACE WATER MASSES IN SQUID FISHING GROUNDS OFF ARGENTINA

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Abstract: During the squid fishing ground investigation off Argentina in three successive years, 1987–1989, zooplankton were collected at 99 stations with three different plankton nets from the epipelagic zone above 200 m. Based on the surface water temperature and depth of the sea, the investigated areas were divided into three areas: the continental shelf, and offshore warm and cold water masses. A total of 74 species of copepods belonging to 36 genera and 20 families were identified. Several species occurred in only one of the three surface water masses.

1. Introduction

Fishing grounds for a kind of short-fin squid, *Illex argentinus*, are found in wide and flat continental shelf and slope waters off Argentina. The continental shelf water is influenced by fresh water from the river La Plata. In the offshore area, there are two main currents, the Falkland Current and the Brazil Current. The warm Brazil Current is a southward branch of the South Equatorial Current. The cold Falkland Current is a northward branch of the Antarctic Circumpolar Current that flows from west to east through the Drake Straits. These two currents converge around 40°S latitude. A part of the cold Falkland Current flows below the warm Brazil Current, but most of the two currents flow eastward and form the South Atlantic Current (JAMARC, 1986; MARTOS and PICCOLO, 1988; PIOLA and GORDON, 1989).

The taxonomy of planktonic copepods in the Southwest Atlantic Ocean has been studied by many planktologists (WOLFENDEN, 1908, 1911; DAHL, 1912; FARRAN, 1929; FROST and FLEMINGER, 1968; CAMPANER, 1978a, b, 1984; HÜLSEMANN, 1985; BJÖRNBERG, 1980, 1981). The distribution has been studied by MACKINTOSH (1934), HARDY and GUNTHER (1935), ALVAREZ *et al.* (1976) and CAMPANER (1985) and the biology by OMMANNEY (1936), ANDREWS (1966), FLEMINGER and HÜLSEMANN (1973). However, there is little information available on the composition of copepods and their distribution related to the water mass off Argentina.

The present study adds information on species composition of copepods in the

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waters off Argentina, and shows a relationship between their distribution and the surface water masses.

2. Materials and Methods

Oceanographic surveys were conducted in squid fishing ground off Argentina in 1987 and 1988 by the M. V. SHINKO-MARU No. 2 (JAMARC, 1989, 1990) and in 1989 by the R. V. KAIYO-MARU (FISHERIES AGENCY, 1991). Zooplankton were sampled at 99 stations, in an area covering 35°–45°S latitudes and longitudes 65°–50°W, with using either NORPAC Nets at 33 stations during July through October in 1987 and 30 stations during December in 1988 through May in 1989 or BONGO Nets at 36 stations during August through September 1989 (Fig. 1). For convenience, the second cruise is referred to as the 1988 cruise hereafter in this paper. The NORPAC Net (0.330 mm mesh openings, 45 cm in diameter and 180 cm long) was hauled vertically from 150 m to the surface, while the BONGO Net (0.335 mm mesh openings, 70 cm in diameter and 515 cm long) was hauled obliquely from 200 m to the surface. Most samples were collected at night. The specimens were preserved in 10% formalin immediately after collection.

All adult copepods in most samples were sorted out and counted by species. For samples involving a very large number of individuals, aliquots of 1/4 to 1/8 of them were used for the enumeration. Each count was converted to number of individuals per cubic meter of water.

Surface water temperature and other data were quoted from the three cruise reports (JAMARC, 1989, 1990; FISHERIES AGENCY, 1991).

3. Results and Discussion

3.1. Division of the surface water masses

An overview of distribution of surface water temperature indicates that it is usefulness to separate the fishing grounds outside the continental shelf into two parts covered by warm and cold water masses (Fig. 2). The frequency distribution of surface temperature in 1987 indicates a possible division into warm and cold regions taking 10°C as the boundary. A higher temperature of 13°C seems to apply as the boundary in 1988. In 1989, the stations were categorized into warm and cold groups, again based on the boundary of 10°C.

During the 1987 cruise, there occurred relatively warm and cold surface water masses in the area beyond the continental shelf. The temperature ranged between 10.5°C and 18.1°C at the 12 northern stations, north of 40° to 41°S latitudes, while it was between 5.2°C and 9.3°C at the 21 southern stations. The former and latter represent the warm and cold water masses, respectively. The Brazil–Falkland Confluence clearly separates these two surface water masses around 40° to 41°S latitude. Another isolated warm water mass appears in an area extending from 42° to 45°S latitude, and 52° to 55°W longitude. Similar separation between the warm and cold water masses due to the Brazil–Falkland Confluence occurred near 40°S

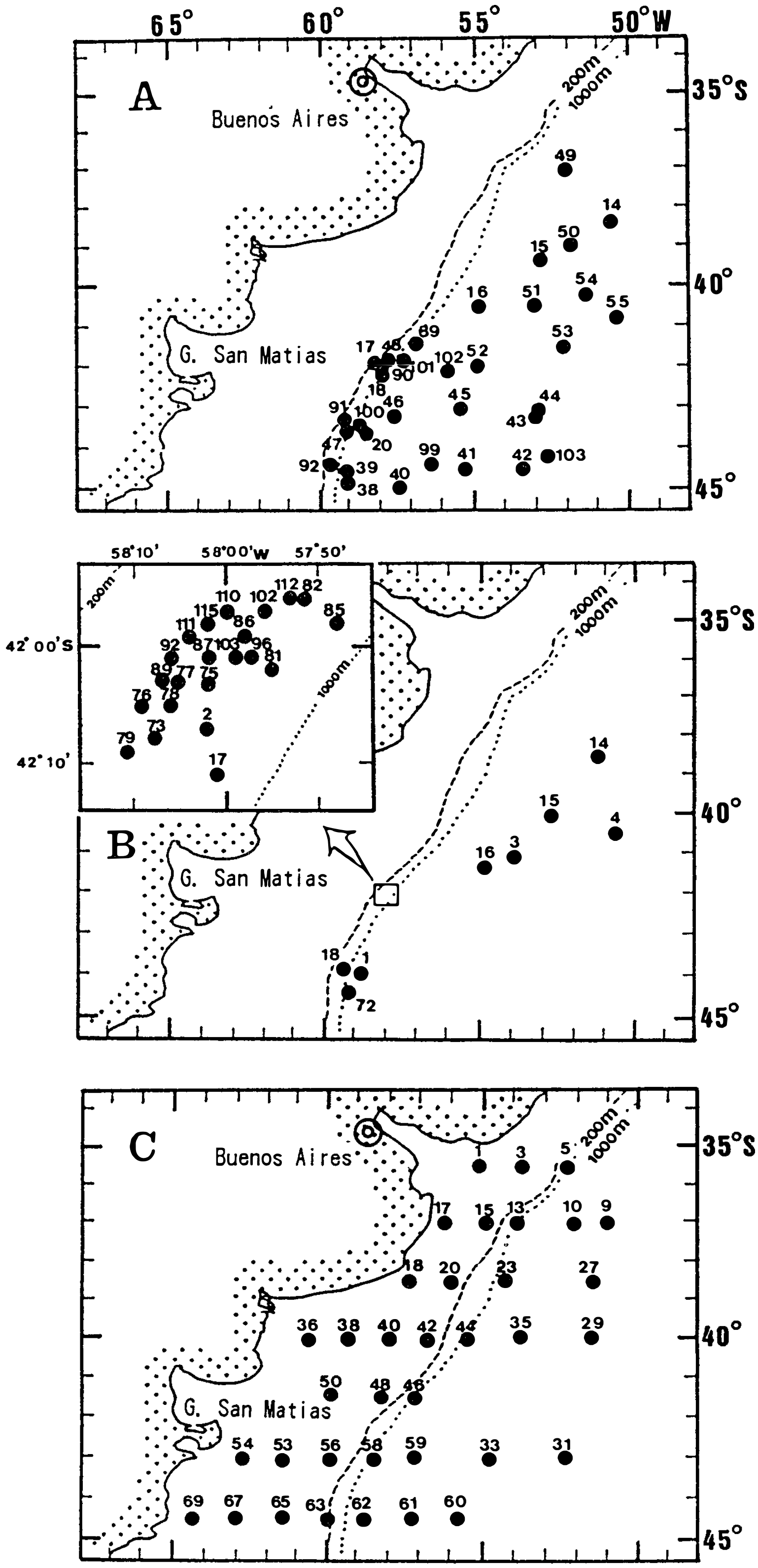

Fig. 1. *The zooplankton sampling stations off Argentina in 1987 (A), 1988 (B), and 1989 (C). Numerals indicate the station number.*

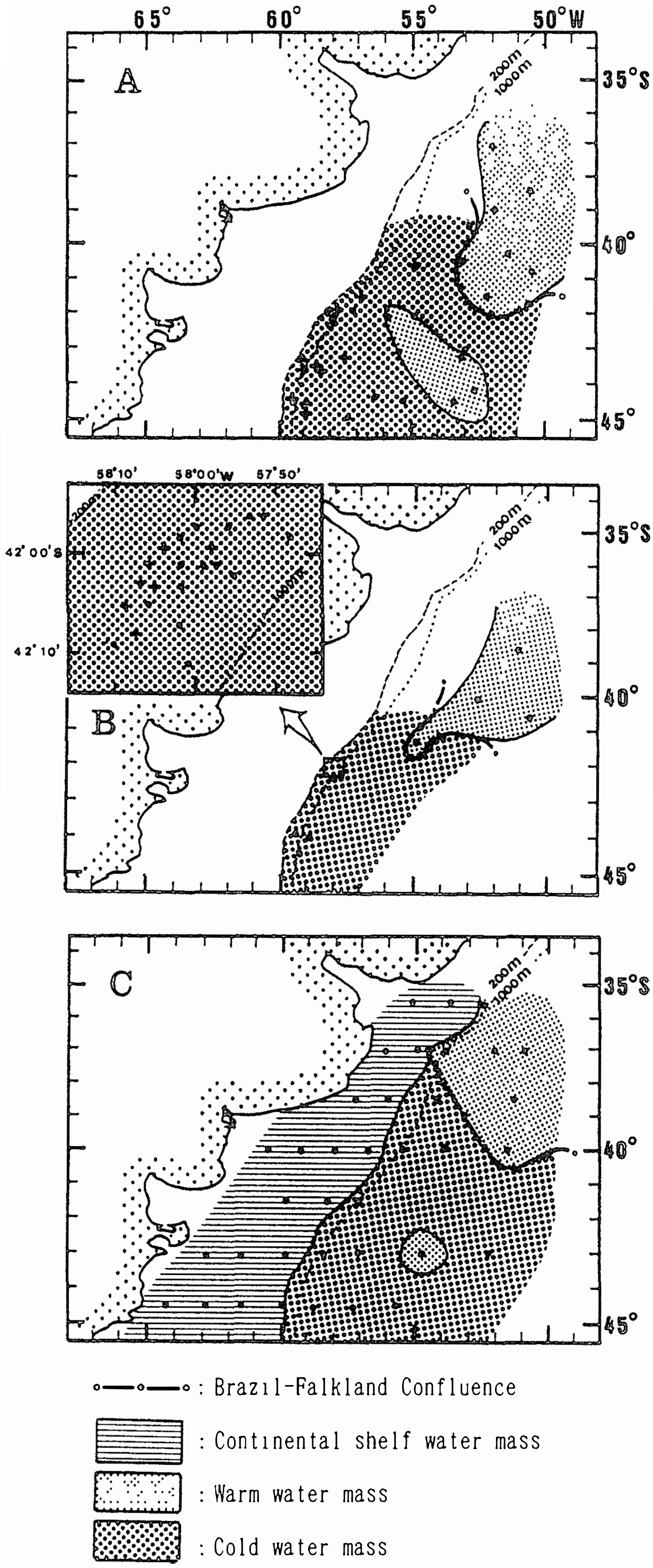

Fig. 2. Distribution of three surface water masses in 1987 (A), 1988 (B), and 1989 (C). Water masses are separated based on the surface water temperature.

latitude during the 1988 cruise. The warm water mass of 14.3 to 21.2°C appeared at 4 northern stations. The 26 southern stations of 8.9 to 12.3°C represent the cold water mass.

The warm and cold water masses covered 7 northern stations and 10 southern stations in the offshore area beyond the Continental Shelf during the 1989 cruise, taking the 10°C as the boundary. The boundary line runs north of 41°S. Thus, the position of the boundary between the warm and the cold water masses was generally stable year after year.

In general, the coastal area off Argentina has continental shelf water that differs from the offshore water (MARTOS and PICCOLO, 1988). In 1989, oceanographic casts were taken at 19 stations on the continental shelf. The surface water over the shelf was equivalent to the offshore cold water mass in temperature, whereas the shelf-break front is a permanent feature that characterizes the border of the shelf shallower than 200 m (MARTOS and PICCOLO, 1988; FISHERIES AGENCY, 1991).

3.2. List of copepod species found

Table 1 gives a list of copepods collected during the three survey cruises with the classifications based on RAZOULS (1982). A total of 74 species (36 genera and 20 families) were identified, including 64 calanoids, one cyclopoid, eight poecilostomatoids and one harpacticoid. Among them, 38 species (28 genera and 18 families) were found each year.

3.3. Distributions of copepod species

Distributions of the species, in particular, those occurring with high frequency each year, are given in Figs. 3–6. There were three different forms of the distribution: one each in warm water mass, cold water mass, and continental shelf water mass throughout the survey area.

Clausocalanus spp., *Heterorhabdus spinifrons* (CLAUS), *Oithona plumifera* BAIRD, and *Oncaea conifera* GIESBRECHT were found in all waters including offshore waters in this study.

3.3.1. Distribution in the warm water mass (WWM)

Species, which were found mainly at the northern stations, included the following: *Calanus minor* (CLAUS), *Neocalanus robustior* (GIESBRECHT), *Mecynocera clausi* J. C. THOMPSON, **Pareuchaeta sarsi* (FARRAN), **Scaphocalanus curtus* (FARRAN), *Pleuromamma abdominalis* (LUBBOCK), *Pleuromamma borealis* (F. DAHL), **Pleuromamma xiphias* (GIESBRECHT), *Lucicutia flavicornis* (CLAUS), **Centropages bradyi* WHEELER, **Acartia danae* GIESBRECHT, and **Acartia negligens* DANA (*: not indicated in Fig. 3).

These species were distributed mainly north of 40°S in each year (at 7 stations in 1987, at 3 stations in 1988, at 10 stations in 1989).

Some of these species, *e.g. Calanus minor*, *Pleuromamma abdominalis*, and *Lucicutia flavicornis* (Fig. 3), have been reported from the tropical area and the subtropical area off Brazil (FARRAN, 1929; CAMPANER, 1978a, b, 1984, 1985). These species were distributed in the northern waters, and should be transported by

Table 1. A list of copepod species collected from three cruises in 1987 to 1989, and the relative abundance of each species in three different water masses.

Species	WWM	CWM	CSWM
Suborder Calanoida			
Family Calanidae			
1. *Calanus australis* Brodsky, 1959	○	○	◎
2. *C. minor* (Claus, 1863)	◎	∘	
3. *C. simillimus* Giesbrecht, 1902	○	◎	○
4. *Calanoides acutus* (Giesbrecht, 1902)	○	○	
5. *C. carinatus* (Kroyer, 1849)	○	∘	◎
6. *Neocalanus robustior* (Giesbrecht, 1888)	◎	∘	
7. *N. tonsus* Brady, 1883	○	◎	○
Family Eucalanidae			
8. *Eucalanus hyalinus* (Claus, 1866)	○	∘	
9. *E. longiceps* Matthews, 1925	∘	◎	∘
10. *E. monachus* Giesbrecht, 1888	∘	○	
11. *E. pileatus* Giesbrecht, 1888	∘		
12. *E. sewelli* Fleminger, 1973	∘		
13. *E. subtenuis* Giesbrecht, 1888	∘		∘
14. *Eucalanus* sp.	∘		
15. *Rhincalanus cornutus* (Dana, 1849)	∘		
16. *R. gigas* Brady, 1883	∘	○	∘
17. *R. nasutus* Giesbrecht, 1888	∘	∘	∘
Family Mecynoceridae			
18. *Mecynocera clausi* J. C. Thompson, 1888	◎	∘	
Family Pseudocalanidae			
19. *Clausocalanus laticeps* Farran, 1929	∘	◎	∘
20. *Clausocalanus* spp.	◎	◎	◎
21. *Drepanopus forcipatus* Giesbrecht, 1888			◎
Family Aetideidae			
22. *Aetideus armatus* (Boeck, 1872)	∘	◎	∘
23. *Gaidius tenuispinus* (Sars, 1900)	∘	∘	
24. *Gaetanus minor* Farran, 1905	∘		
25. *Euaetideus giesbrechti* (Cleve, 1904)	∘		
26. *Euchirella amoena* Giesbrecht, 1888	∘	∘	
27. *E. intermedia* With, 1915	∘		
28. *E. messinensis* (Claus, 1863)	∘		
29. *E. pulchra* (Lubbock, 1856)	∘		
30. *E. rostrata* (Claus, 1866)	∘	○	
31. *E. rostromagna* Wolfenden, 1911	∘	∘	
32. *Undeuchaeta major* Giesbrecht, 1888	○	∘	
33. *U. plumosa* (Lubbock, 1856)	○	∘	
34. *Undeuchaeta* sp.	∘	∘	
Family Euchaetidae			
35. *Pareuchaeta biloba* Farran, 1929	∘	∘	
36. *P. sarsi* Farran, 1908	○	∘	
Family Scolecithricidae			
37. *Scaphocalanus brevicornis* (Sars, 1900)	∘		
38. *S. curtus* (Farran, 1926)	○	∘	
39. *Scolecithricella bradyi* (Giesbrecht, 1888)	∘		
40. *S. minor* (Brady, 1883)	○	◎	∘
41. *Scottocalanus securifrons* (T. Scott, 1894)	∘		
42. *Scolecithrix danae* (Lubbock, 1856)	∘		

Table 1. (Continued)

Species	WWM	CWM	CSWM
Family Metridinidae			
43. *Metridia lucens* BOECK, 1864	○	◎	•
44. *Pleuromamma abdominalis* (LUBBOCK, 1856)	◎	○	•
45. *P. borealis* (F. DAHL, 1893)	◎	○	
46. *P. xiphias* (GIESBRECHT, 1889)	○	•	
47. *Pleuromamma* sp.	○	○	
Family Centropagidae			
48. *Centropages brachiatus* (DANA, 1849)	○	○	◎
49. *C. bradyi* WHEELER, 1900	○	•	
50. *C. velificatus* DE OLIVEIRA, 1947			•
Family Lucicutiidae			
51. *Lucicutia flavicornis* (CLAUS, 1863)	◎	•	
52. *L. gaussae* GRICE, 1963	○	•	
Family Heterorhabdidae			
53. *Heterorhabdus austrinus* GIESBRECHT, 1902	◎		
54. *H. spinifrons* (CLAUS, 1863)	◎	○	
Family Augaptilidae			
55. *Haloptilus acutifrons* (GIESBRECHT, 1892)	•	○	
56. *H. ornatus* (GIESBRECHT, 1892)	•		
57. *Euaugaptilus humilis* FARRAN, 1926	○	•	
Family Candaciidae			
58. *Candacia longimana* (CLAUS, 1863)	○	•	
59. *C. maxima* VERVOORT, 1957	○	○	
60. *Candacia* sp.	○	•	
Family Pontellidae			
61. *Labidocera fluviatilis* F. DAHL, 1894	•		○
Family Acartiidae			
62. *Acartia danae* GIESBRECHT, 1889	○	•	
63. *A. negligens* DANA, 1849	○	•	
64. *A. tonsa* DANA, 1849	•		•
Suborder Cyclopoida			
Family Oithonidae			
65. *Oithona plumifera* BAIRD, 1843	◎	◎	◎
Suborder Poecilostomatoida			
Family Oncaeidae			
66. *Oncaea conifera* GIESBRECHT, 1891	◎	◎	•
67. *O. venusta* PHILIPPI, 1843	○	○	
68. *Lubbockia aculeata* GIESBRECHT, 1891	•	•	
Family Corycaeidae			
69. *Corycaeus latus* DANA, 1848	•		
70. *C. limbatus* BRADY, 1883	•	•	
71. *C. typicus* (KROYER, 1849)		•	
Family Sapphirinidae			
72. *Sapphirina angusta* DANA, 1849	•		
73. *Copilia vitrea* (HAECKEL, 1864)	•		
Suborder Harpacticoida			
Family Clytemnestridae			
74. *Clytemnestra scutellata* DANA, 1847	○	○	
Total ◎ (Very abundant)	11	10	6
○ (Abundant)	25	14	3
• (Common)	35	27	12

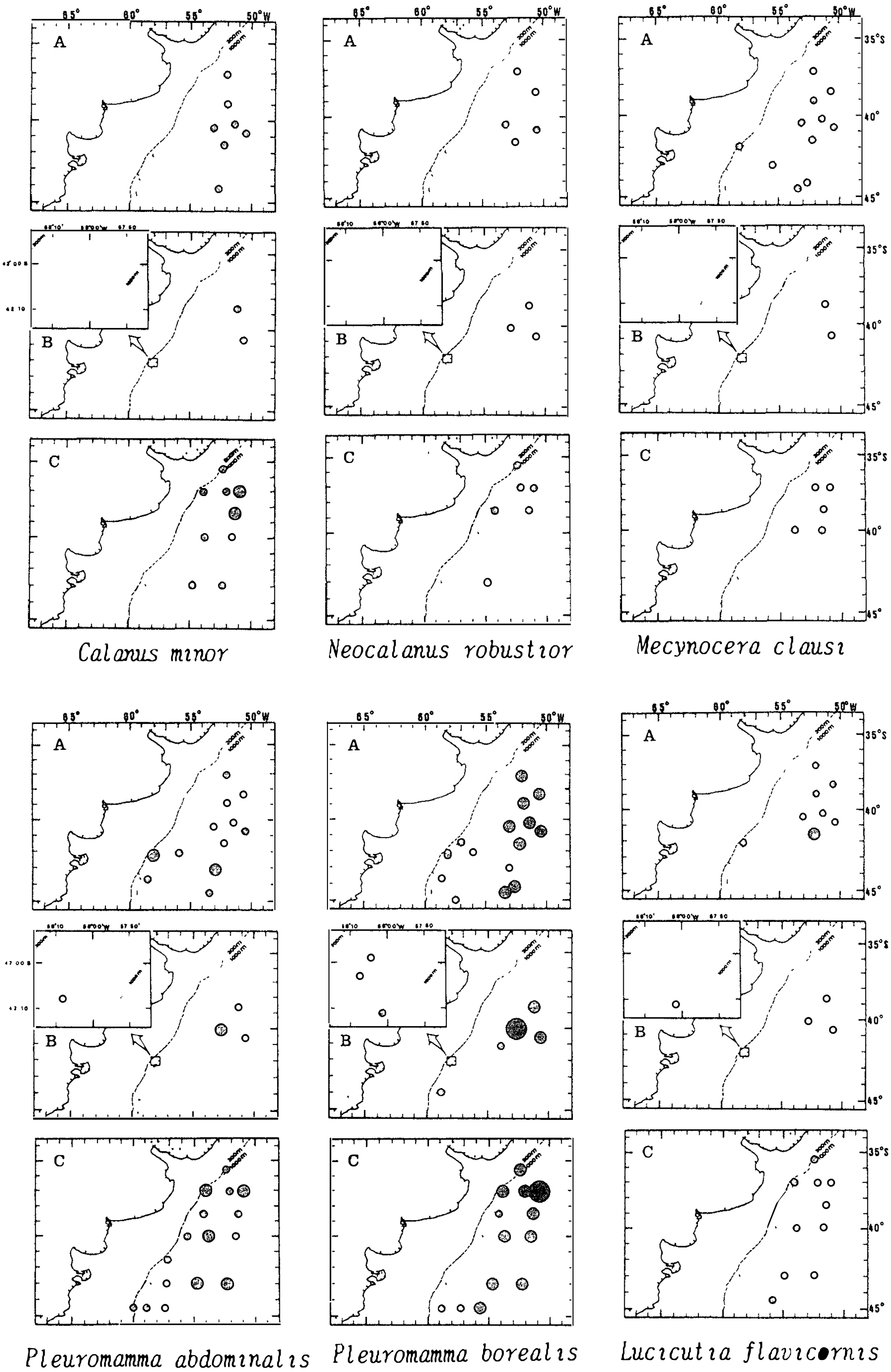

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Fig. 3. Distribution of six species in the warm water mass in 1987 (A), 1988 (B), and 1989 (C).

the Brazil Current to the northern part of the study area. The waters transported from the north were hindered by the Brazil–Falkland Confluence; thus, the area of distribution of these species was considered in the Brazil Current.

3.3.2. Distribution in the cold water mass (CWM)

Species found mainly in the southern stations in the cold water mass included *Calanus simillimus* GIESBRECHT, *Neocalanus tonsus* BRADY, *Eucalanus longiceps* MATTHEWS, **Eucalanus monachus* GIESBRECHT, *Clausocalanus laticeps* FARRAN, **Aetideus armatus* (BOECK), *Scolecithricella minor* (BRADY), *Metridia lucens* BOECK, and **Clytemnestra scutellata* DANA (*: not indicated in Fig. 4).

These species were distributed mainly south of 41°S in each year (at around 22 stations in 1987, at 24 stations in 1988, at 13 stations in 1989).

Some of these species, *e.g. Calanus simillimus*, *Eucalanus longiceps*, and *Clausocalanus laticeps* (Fig. 4), have been reported from the Subantarctic area off South Georgia and the Antarctic area (WOLFENDEN, 1911; HARDY and GUNTHER, 1935). These species were distributed in southern waters, and these species were transported northward by the Falkland Current.

Calanus simillimus and *Neocalanus tonsus*, which occurred abundantly in the present study, are known as subantarctic species (MACKINTOSH, 1934; VERVOORT; 1957). Moreover, *Calanoides acutus* GIESBRECHT and *Rhincalanus gigas* BRADY, found in the present study (Fig. 5), are well known antarctic species. These results indicate that some of the species distributed in the southern region were transported by the Falkland Current.

3.3.3. Distribution in the continental shelf water mass (CSWM)

The coastal type species were *Calanus australis* BRODSKY, *Calanoides carinatus* (KROYER), *Drepanopus forcipatus* GIESBRECHT, *Centropages brachiatus* (DANA), and *Labidocera fluviatilis* F. DAHL (Fig. 6).

These species were hardly observed in the offshore waters in 1987 and 1988, whereas they were mainly distributed in 15 shelf side stations in the continental shelf water mass in 1989.

The continental shelf water mass covers a wide and flat continental shelf. This water has been found to be separated from deep ocean water not only hydrographically (MARTOS and PICCOLO, 1988) but also from biogeographical studies of benthic decapods (BOSCHI, 1965). Distribution of *Drepanopus forcipatus* was showed the division biogeographically; this species is known to be distributed to coastal and shelf waters of the Atlantic and Pacific, and the limit of distribution of the species coincides with the extent of the shelf (HÜLSEMANN, 1985).

In the continental shelf water mass, fresh water flows in large quantities from the river La Plata. The surface water at the river mouth is influenced by the inland water (MARTOS and PICCOLO, 1988). The present investigation confirmed this environment as salinity at the river mouth was lower than about 33.0‰ (*c.f.* FISHERIES AGENCY, 1991). The species, *Labidocera fluviatilis*, occurred merely in areas of inland water at the surface water. In fact, the distribution of several species revealed the influence of inflow of the inland water at the surface (*c.f.* FISHERIES AGENCY, 1991).

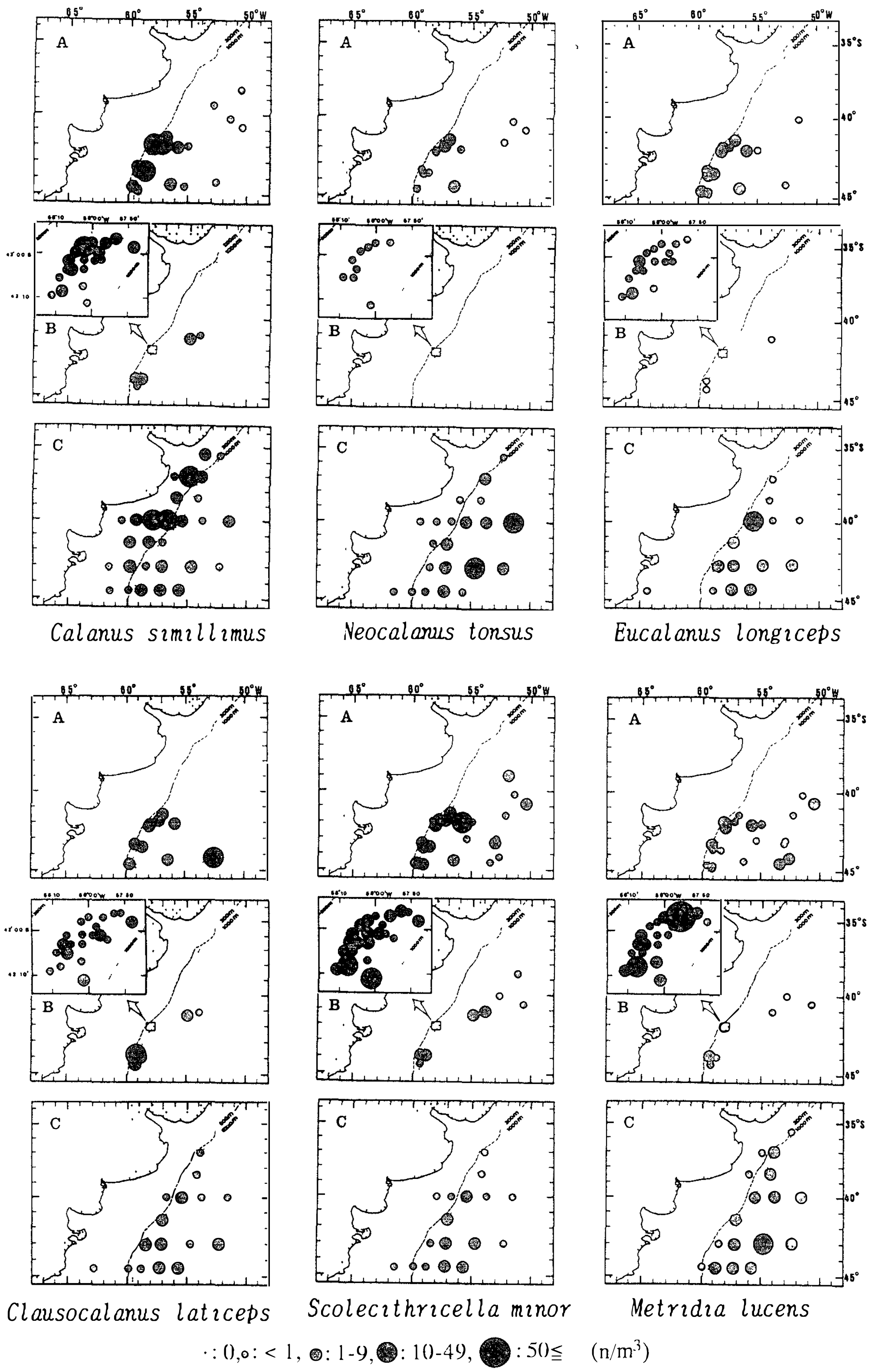

Fig. 4. Distribution of six species in the cold water mass in 1987 (A), 1988 (B), and 1989 (C).

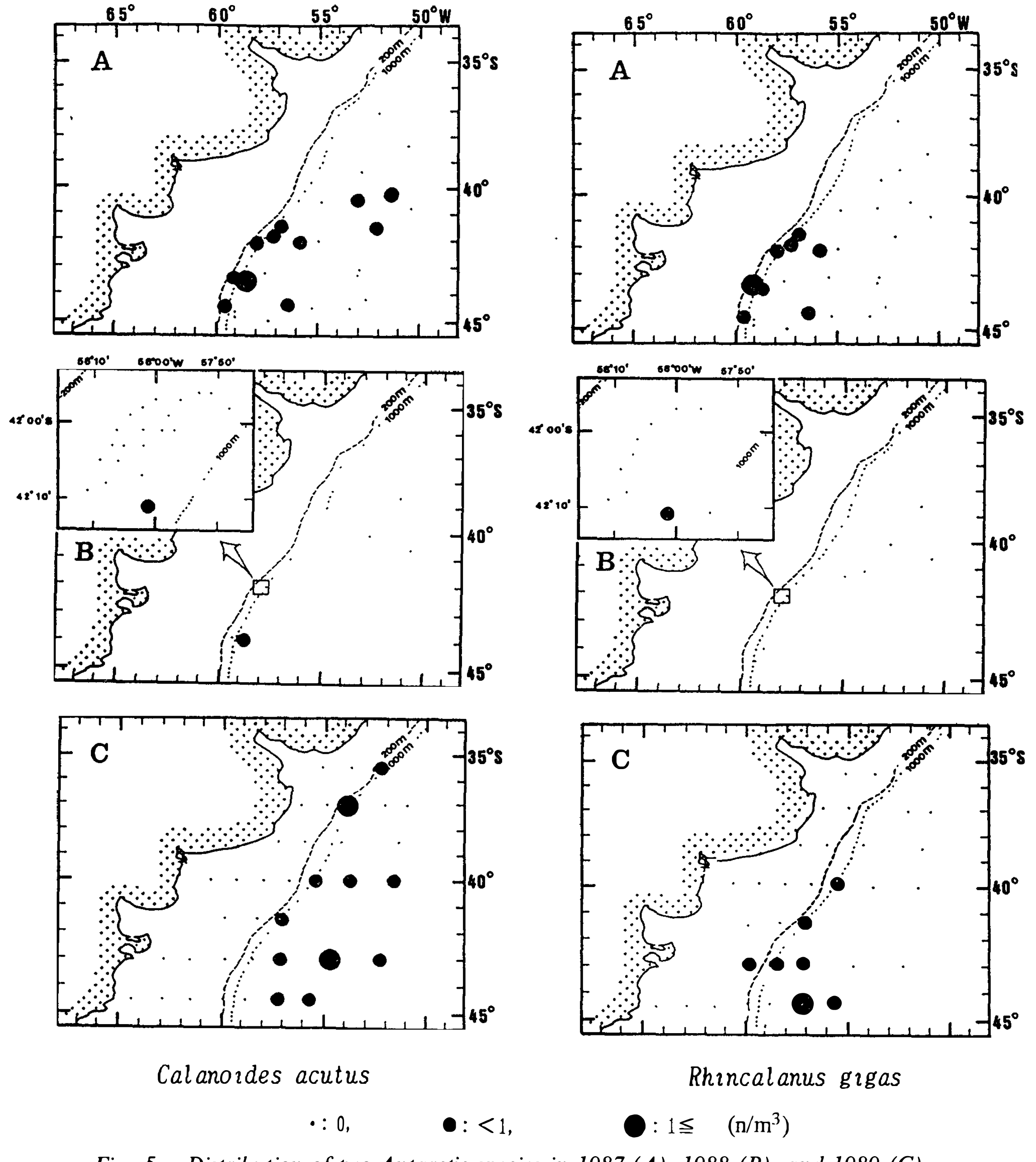

Fig. 5. Distribution of two Antarctic species in 1987 (A), 1988 (B), and 1989 (C).

3.4. Conclusions

The Brazil and Falkland Currents, together with inflow of the inland water, form a very complicated structure of surface water masses in the Southwest Atlantic Ocean (*c.f.* JAMARC, 1986). In the present study, there were extremely large differences in species composition of copepods between the warm water mass, about 10–20°C of the surface water temperature at northern stations, and the cold water mass, about 5–10°C of the surface water temperature at southern stations (Figs. 3–4). These surface water masses were influenced by physical features of the Brazil and the Falkland Currents. The species composition of copepods in the continental shelf water mass, shallower than 200 m depth, was different from that in the two offshore waters (Figs. 3–6).

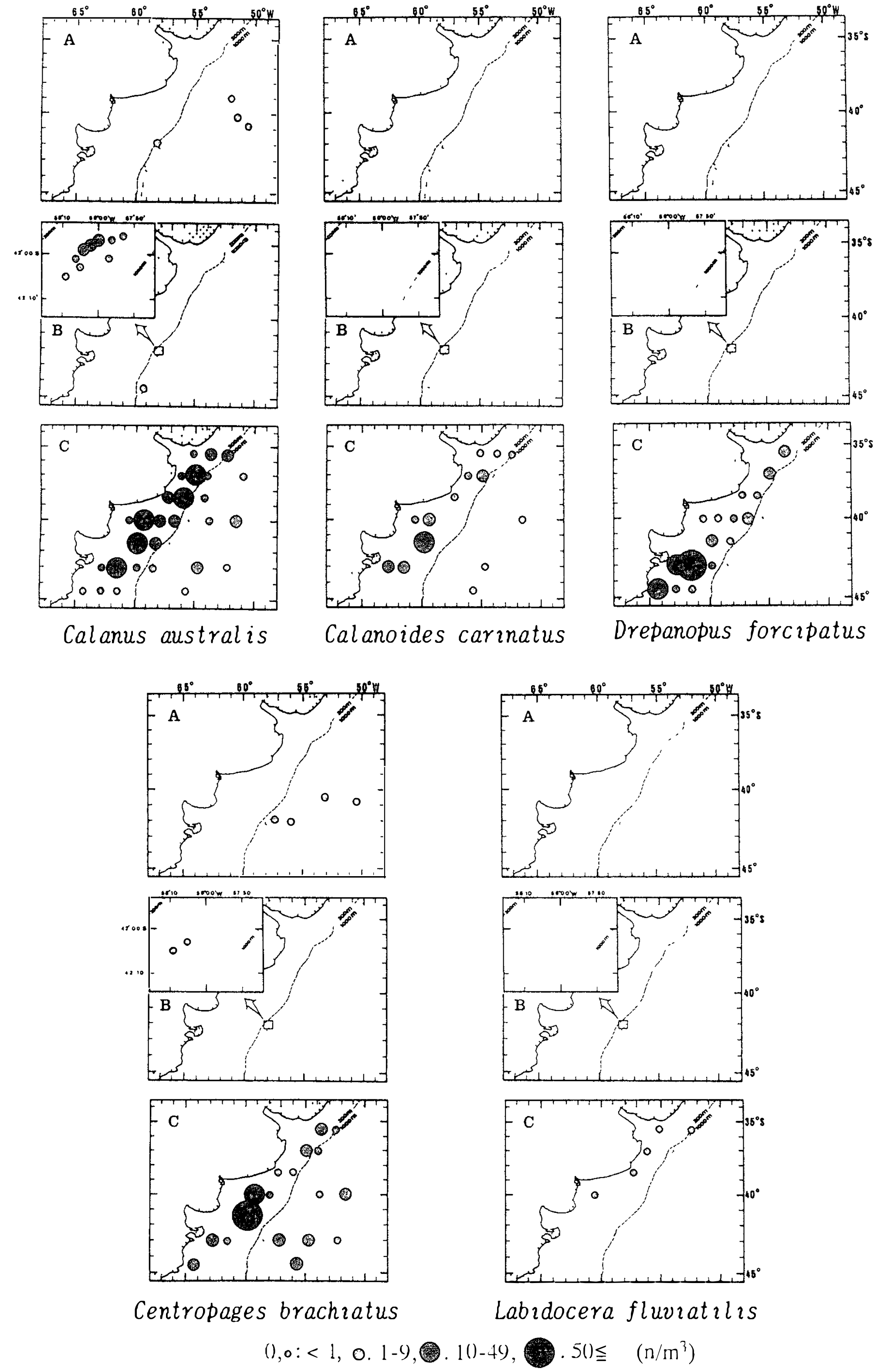

Fig. 6. Distribution of five species in the continental shelf water mass in 1987 (A), 1988 (B), and 1989 (C).

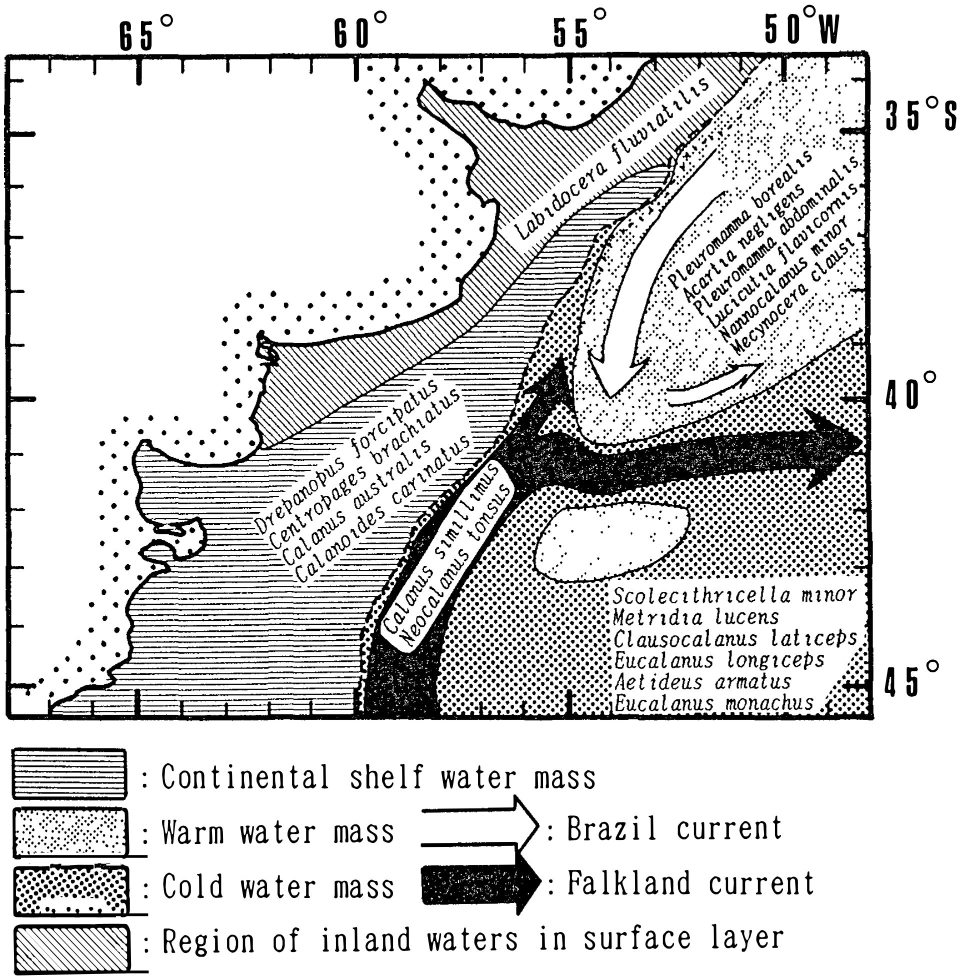

Fig. 7. Schematic chart of currents and surface water masses and the occurrence of some characteristic and representative species.

Figure 7 shows the distributions of the three surface water masses, the two water currents, and the distribution of some major species in each surface water mass.

Pleuromamma borealis, *Acartia negligens*, *Pleuromamma abdominalis*, *Lucicutia flavicornis*, *Calanus minor*, and *Mecynocera clausi* occurred more frequently in the warm water mass than in the other water masses. *Pleuromamma borealis* in particular was abundant in the warm water mass (Fig. 3).

Scolecithricella minor, *Metridia lucens*, *Clausocalanus laticeps*, *Eucalanus longiceps*, *Aetideus armatus*, and *Eucalanus monachus* were distributed mainly and prospered in the cold water mass. The last two species are not indicated in Fig. 4. *Calanus simillimus* and *Neocalanus tonsus* were distributed mainly in the cold water mass, abundantly in the main Falkland Current (Fig. 4).

Drepanopus forcipatus, *Centropages brachiatus*, *Calanus australis*, *Calanoides carinatus*, and *Labidocera fluviatilis* appear more frequently in the continental shelf water mass than the other water masses. The limit of distribution of *Drepanopus forcipatus* coincides with the 200 m depth isobath. These species, particularly

Labidocera fluviatilis, occur solely in water receiving inflow of inland water (Fig 5).

However, several species which are distributed both in the warm and the cold water masses occurred at some stations within the Brazil–Falkland Confluence (Figs. 3 and 4). It seems reasonable to assume that both warm and cold water masses existed at these stations, separated vertically with warm water in the upper layer and cold water in the lower layer.

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References

ALVAREZ, M. P. J., BJÖRNBERG, T. K. S., NOGUCHI, H., DAROCHA, C. E. F. and SINQUE, C. (1976): Migracão vertical do plancton ao Largo de Santos. An. Acad. Bras. Ciênc., **48**(2), 360–361.

ANDREWS, K. J. H. (1966): The distribution and life-history of *Calanoides acutus* (GIESBRECHT). Discovery Rep., **34**, 117–162.

BJÖRNBERG, T. K. S. (1980): Revisão da distribuicão dos gêneros *Paracalanus*, *Clausocalanus* e *Ctenocalanus* (Copepoda, Crustacea) ao largo do Brazil. Bolm. Inst. Oceanogr., S. Paulo, **29**(2), 65–68.

BJÖRNBERG, T. K. S. (1981): Copepoda. Atlas del Zooplancton del Atlántico Sudoccidental, y Methods de Trabajo con el Zooplancton Marino, ed. by D. BOLTOVSKOY. Mal del Plata, INIDEP, 587–679.

BOSCHI, E. E. (1965): Preliminary note on the geographic distribution of the decapod crustaceans of the marine waters of Argentina (South-west Atlantic Ocean). Proceedings of the Symposium on Crustacea hold at Frnkulam, part **1**, 449–456.

BRADFORD, J. M. and JILLETT, J. B. (1974): A revision of generic definitions in the Calanidae (Copepoda, Calanoida) Crustaceana, **27**(1), 5–17.

CAMPANER, A. F. (1978a): On some new planktobenthic Aetideidae and Phaennidae (Copepoda, Calanoida) from the Brazilian continental shelf. I. Aetideidae. Cienc. Cult., **30**, 863–876.

CAMPANER, A. F. (1978b): On some new planktobenthic Aetideidae and Phaennidae (Copepoda, Calanoida) from the Brazilian continental shelf. II. Phaennidae. Cienc. Cult., **30**, 966–982.

CAMPANER, A. F. (1984): *Scaphocalanus* and *Scolecithricella* (Copepoda, Scolecithricidae) from the epipelagical off southern Brazil: a taxonomic and distributional survey. Bolm. Zool., Univ. S. Paulo, **8**, 165–187.

CAMPANER, A. F. (1985): Occurrence and distribution of copepods (Crustacea) in the epipelagical off southern Brazil. Bolm. Inst. Oceanogr., S. Paulo, **33**(1), 5–27.

DAHL, M. (1912): Die Corycaeinen. Die Copepoden der Plankton Expedition., 135 p.

FARRAN, G. P. (1929): Copepoda. British Antarctic "Terra Nova" Expedition, 1910. Nat. Hist. Rep., Zool., **8**(4), 203–306.

FISHERIES AGENCY (1991): Heisei gan-nendo Kaiyo-Maru Chôsa-Kôkai Hôkokusho, Nippon, Argentina, Uruguay Kyôdô Nansei-Taiseiyô Matsuika Chôsa. 90 p.

FLEMINGER, A. and HÜLSEMANN, K. (1973): Relationship of Indian Ocean epiplanktonic calanoid to the world oceans. Ecological Studies; Analysis and Synthesis, Vol. 3, ed. by J. JACOBS. Berlin, Springer, 339–347 (The Biology of the Indian Ocean, ed. by B. ZEITZSCHEL).

FROST, B. and FLEMINGER, A. (1968): A revision of the genus *Clausocalanus* (Copepoda: Calanoida) with remarks on distributional patterns in diagnostic characters. Bull. Scripps Inst. Oceanogr., Univ. California, **12**, 1–235.

HARDY, A. C. and GUNTHER, E. R. (1935): The plankton of the South Georgia whaling grounds and adjacent waters, 1926–1927. Discovery Rep., **11**, 1–456.

HÜLSEMANN, K. (1985): Two species of *Drepanopus* BRADY (Copepoda Calanoida) with discrete ranges in the Southern Hemisphere. J. Plankton Res., **7**, 909–925.

JAMARC (1986): Patagonia Kaiiki no Jûyô Suizoku (Important Fishes Trawled off Patagonia). Tokyo, JAMARC, 369 p.

JAMARC (1989): Showa 62-nendo Ikatsuri Shin-gyojô Kaihatsu Chôsa Hôkokusho, Minami-Taiseiyô Seibu Kaiiki, Chuô-Taiheiyô Tôbu Kaiiki. Showa 62-nendo Hôkokusho, **7**, 27 p.

JAMARC (1990): Showa 63-nendo Ikatsuri Shin-gyojô Kaihatsu Chôsa Hôkokusho, Nettai-Taiheiyô Tôbu Kaiiki, Minami-Taiseiyô Seibu Kaiiki. Showa 63-nendo Hôkokusho, **7**, 155 p.

MACKINTOSH, N. A. (1934): Distribution of the macroplankton in the Atlantic sector of the Antarctic. Discovery Rep., **9**, 65–160.

MARTOS, P. and PICCOLO, M. C. (1988): Hydrography of the Argentine continental shelf between 38° and 42°S. Cont. Shelf Res., **8**, 1043–1056.

OMMANNEY, F. D. (1936): *Rhincalanus gigas* (BRADY) a copepod of the southern macroplankton. Discovery Rep., **13**, 277–384.

PIOLA, A. R. and GORDON, A. L. (1989): Intermediate waters in the southwest South Atlantic. Deep-Sea Res., **36**, 1–16.

RAZOULS. C. (1982): Repertoire mondial Taxinomoique et Bibliographique Provisoire des Copepodes Planktoniques Marins et des eaux Saumatres. Divers Systemes de Classification. Lab. Arago, Univ. Pierre et Marine Curie, Paris, 875 p.

VERVOORT, W. (1957): Copepods from Atlantic and Sub-Atlantic plankton samples. B.A.N.Z. Antarct. Res. Exped., 1929–1931. Rep. Ser. B, **3**, 1–160.

WOLFENDEN, R. N. (1908): Crustacea VIII. Copepoda. I. Nat. Antarct. Exped., 1901–1904, **4**, Zool., 1–46.

WOLFENDEN, R. N. (1911): Die marinen Copepoden, II. Die pelagischen Copepoden der Westwind Drift und des sudlichen Eismeers. Dtsch. Sudpolar Exped., 1901–1903, **7**(4), 181–380.

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