ZOOPLANKTONIC ASSOCIATIONS, THROPHIC RELATIONS AND STANDING STOCK OF KRILL AND OTHER GROUPS OF THE COMMUNITY NEAR ELEPHANT ISLAND (FEBRUARY — MARCH 84/85)*

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ABSTRACT

Plankton samples were taken near Elephant Island on two oceanographic cruises of "NApOc Barão de Teffé" during the 2nd and 3rd Brazilian Antarctic Expeditions in February-March 1984 and 1985. Oblique hauls were performed with 325 μm conical nets provided with calibrated flowmeters. Identification of species of zooplankton and phytoplankton of the stomach contents was made and distribution and abudance of zooplanktonic species were studied. Salps pellets were analysed too. The population structure of Euphausiacea of the two cruises was analysed and compared.

During February-March 1984 a characteristic zooplanktonic association was found named "Salpidae Water" composed by Salpidae, the dominant group, Euphausiacea, Amphipoda and species of big Copepoda. The krill standing stock was very low and only furcilias V, VI, juveniles, subadults and adults were found. The high number of Salpidae changed the common composition of the antarctic zooplanktonic community excluding small filter — feeding species and allowing the survival of ano-

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ther of big size and carnivorous. The specific composition of samples obtained in February-March 1985 was different showing a drastic diminution of Salpidae and the occurrence of Copepoda populations, species and larvae of small size. The krill standing stock was higher than 1984 and the populations were represented by all larval stages occurred in small numbers.

All these differences and variations are discussed. Based on the results of the study of the stomach contents and of the salp pellets and on the data of the other authors a trophic relations outline of the zooplankton community is given.
KEY WORDS: Antarctic Zooplankton — Food weeb — Krill

RESUMO

Associações zooplanctônicas, relações tróficas e standing stock do krill e outros grupos da comunidade próximo à Ilha Elefante (Fevereiro — Março 84/85).

Durante as 2.ª e 3.ª Expedições Brasileiras à Antártica realizadas pelo "NApOc Barão de Teffé" durante os meses de fevereiro e março de 1984 e 1985, foram efetuadas coletas de zooplâncton ao redor da Ilha Elefante. O material foi obtido mediante arrastos obliquos efetuados com redes cônicas de 325 μm de abertura de malha, providas de fluxômetros calibrados. Foi identificado o zooplâncton a nível de espécie e seu conteúdo digestivo e os "pellets" encontrados nas amostras. Foi estudada a distribuição e abundância de cada uma das espécies e foi analisada e comparada a estrutura das populações de Euphausiacea nos dois cruzeiros.

Durante a período fevereiro/março de 1984 foi encontrada uma associação característica denominada "Água de Salpas" composta por Salpidae, Euphausiacea, Amphipoda e espécies de grande porte de Copepoda. O "standing stock" de krill apresentou valores muito baixos e as populações estiveram representadas somente por furcilias V, VI, juveniles, subadultos e adultos. A dominância de Salpidae modificou, o que poderia ser chamada de composição comum da comunidade zooplanctônica, excluindo espécies filtradoras pequenas e permitindo a sobrevivência de espécies de maior porte e de carnívoros. A composição específica das amostras obtidas durante o período fevereiro/março de 1985 modificou-se apresentando uma drástica diminuição de Salpidae, o reaparecimento de populações de Copepoda e de espécies e larvas de pequeno tamanho. O 'standing stock" de krill foi maior que o registrado no período de fevereiro/março de 1984 e as populações estiveram compostas por indivíduos de todos os estadios larvais a partir de Caliptopis I e ao contrário da campanha anterior, juvenis, subadultos encontram-se em menor número.

Todas estas diferenças e variações são discutidas. Em base nos dados obtidos do conteúdo estomacal das espécies zooplanctônicas, dos "pellets" das Salpas e dados de outros autores, é dado um esboço das relações tróficas da comunidade.

PALAVRAS CHAVE: Zooplâncton Antártico — Cadeia trófica — Krill

INTRODUCTION

The initial aim of this work was to know the composition of the zooplanktonic community, compare its variations during different years and assess the standing stock of krill and of its population structure. Later, due to the results obtained a new focus was given to the work. A phenomenon of domination of Salpidae, led us to consider the feeding competition, with a detailed analysis of the diets of the main species and, thus to outline the throphic relationship of the community.

CHARACTERISTICS OF THE STUDIED AREA

The studied region (fig. 1) including the nearby areas of the Eadie, O'Brien, Aspland, Gibbs, Clarence and Elephant Islands, is under the influence of water masses whith vary according to the season of the year. These water masses were recently classified by SCAR/SCOR/SABO/ACMRR (1982) and the variations may be observed comparing the results obtained from the FIBEX * data (Summer 1981) and, those of Ikeda and al (1983), Lana and Blankesteyn (1985).

The FIBEX results showed that the area is influence by

* **FIBEX:** First International BIOMASS Experiment.

the Weddell Sea Water. According to Ikeda and others (1983) this area was under the predominant influence of the Bransfield Central Water (BRC) from 10 to 19 January 1983, and from January 31 to February 9, and under the major influence of the blended Weddell-Bellingshausen water masses.

Lana and Blankesteyn (1985), found this same area during the period of January-February 1984 under the influence of waters of the Weddell-Scotia Confluence, when the cold masses from Weddell penetrate under the warmer Drake waters. They also observed the influence of the Deep Warm Water under 150 meters, in the area between North East and South West of the South Shetland Island.

The sampled area shows particular characteristics and variations due to the local environmental conditions, besides those produced by the influences of the different masses of water. These particular characteristics may be explained by the irregular relief of the bottom, with depths varying from a few meters to over 1000 meters, between the two islands.

The two periods studied suffer during summer and in different degrees, the influences of the increase of the insolation which thaws the nearly glaciers and, consequently, raises the temperature and diminishes the salinity. The meteorological conditions of the area contribute also towards these local variations.

METHODS

The zooplankton samples were obtained using cylinder-conical nets, with 325 μm mesh and 55cm of mouth diameter, furnished with fluxometers previously calibrated; the hauls were oblique from 200m depth to the surface. The samples were preserved in 4% borax buffered formalin. Zooplankton was completely counted, excepting the Copepoda and the Appendicularia for which equivalent aliquots of 30% of the sample were analysed. The stages of development and sexual maturity of Euphausiacea species were determined based on the works of Bargman (1945), Mauchline and Fisher (1969) and following the method of classification for preserved animals proposed by Makarov and Denys (1981).

To determine the age of the krill populations, the individuals, beginning with the juvenile cathegory, were measured from the rostrum up to the tip of the telson without considering the terminal spines (Ponomareva, 1956).

Analisys of the stomach contents of the adult specimens of the following species were performed: **Conchoecia isocheira, Conchoecia hettacra, Vibilia** sp., **Cyllopus magellanicus, Hyperiella dilatata, Parathemisto gaudichaudii, Eukhronia hamata, Salpa máxima, Salpa thompsoni, Fritillaria borealis, Oikopleura gaussica, Thysanoessa macrura, Thysanoessa vicina** and **Euphausia frigida.**

These analysis were made by means of dissections after the external cleaning the specimens. The contents were dissolved in distilled water and studied under microscope, as well as the faecal pellets of the Salpae.

The phytoplankton and microzooplankton species of the stomach contents and Salp faecal pellets were determined following Frenguelli and Orlando (1958), 1962, 1975); Manguin (1960); Sournia, Grall and Jacques (1979) and Souto (1981).

The phytoplankton species were determined with the help of Dr. F.P. Brandini (Centro de Biologia Marinha da Univ. Federal do Paraná).

RESULTS

Observing the zooplankton during the period of February-March/84 (Tab. 1, Fig. 2) a large dominance of Salpidae was noticed changing the habitual species composition in the area to an association basically composed of **Salpa thompsoni** and **Salpa maxima,** species of filter feeding Copepoda such as **Rhincalanus gigas, Calanus propinquus:** carnivorous Amphipoda, **Parathemisto gaudichaudii, Cyllopus magellanicus** and **Vibilia** sp. and advanced stages of development of **Euphausia superba** (filter-feeding) and **Thysanoessa macrura** (omnivorous).

Other species of different groups and feeding habits occurred in small number.

During the period of February-March/85 (Tab. II; Fig. 2) an accentuated diminution of the Salpidae was noticed and a reestablisment of the populations of Copepoda accompanied by larvae and/or an increasing number of the small sized species.

This association was composed of the dominant **Copepoda, Oithona frigida, Calanus propinquus,** and **Rhincalanus gigas;** the Euphausiacea **Euphausia superba** and **Thyssanoessa macrura** and the Appendicularia **Fritillaria borealis.** An increase of the filter feeding species was observed. **Parathemisto gaudichaudii** and **Vibilia** sp. returned to an exclusively carnivorous diet. Others, like **Eukrohnia hamata** showed a mixed diet (Tab. III).

The values of the krill standing stock during the period February-March/84 (Tab. I, Fig. 3) reached very low densities. Also the populations structures of **Euphausia superba** and **Thysanoessa macrura** suffered changes with the total disappearance of the first larval stages. The biggest density of the **Euphausia superba** was observed at station 12, a total of 120 ind./1000m^3, 73% being adults.

The highest number of **Thysanoessa macrura,** 53 ind./ 1000m^3, all adults was found at station 9 (Fig. 3).

When the Salpidae diminished during February-March/1985, other common groups in the area increased their densities or apperead in the samples.

The standing stock of **Euphausia superba** and of **Thysanoessa macrura** increased notoriously compared to the previus year and the population structure presented all developmental stages from Caliptopis I to III (Tab. III and IV and Figs. 3 and 4).

The highest density of **Euphausia superba** was found at station C, a total of 15.458 ind./1000m^3 being the cathegories of Caliptopis I to III and Furcilia I to III the most abundant.

The maximum density of **Thysanoessa macrura** was also observed at station C (1758 ind./1000m^3) the cathegory of Furcilia IV to VI being the most abundant.

Length measurements of the body obtained from **Euphausia superba** during the first expedition to Elephant Island (Tab. IV) showed the presence of juveniles at the average of 25-27mm; subadults between 26-44mm and adults between 35-47mm. However in the material obtained during February-March/85, subadults were found at an average between 41-49mm.

A small difference is observed in the lengths of the sub adult and the adult of **Thysanoessa macrura** (Tab. IV) obtained in February-March/1984 and 1985, those from 1985 being slightly larger.

Tab. V lists the species of phytoplankton and microzooplankton found in the stomach contents and faecal pellets during the two expeditions.

Tab. VI lists the stomach contents of some planktonic species off Elephant Island.

DISCUSSION

Patchiness is a well known phenomenon in the distribution of plankton from microorganisms (Boltowskoy, 1971) to fish larvae (Hardy, 1958, Cushing, 1961).

Examples of enormous patchiness has been mentioned from three groups: the amphipod **Parathemisto gaudichaudii**, the euphausiid **Euphausia superba** and the salp **Salpa thompsoni. Parathemisto gaudichaudii** and **Euphausia superba** swarms arise as a result of many individuals congregating in opposition to salp swarm where the most part arise as a result of rapid budding (Everson, 1984).

Salps due to the assexual reproduction are able to reproduce very rapidly when feeding conditions are favourable. During the summer the greatest primary production allow the incidence of swarms (Foxton, 1966) and both aggregate and solitary forms are present in plankton (Everson, 1984).

The plankton collected during the period February-March/84 dominated by **Salpa thompsoni** and **Salpa maxima** here called "Salp water", was probably sampled from a large patch of these tunicates. They usually exclude most of the other plankton inhabitants.

This periodical phenomenon was registered by many authors. Among them Sars (1829) said that in some places in the open sea salps made it for boats to proceed. The same author

Table I. Species composition and density found during period Feb-March/84 (Ind/1000m³)

STATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Diphyes dispar								5										
Rhynchonerella bongraini		3																
Clio pyramidata fa. exisa															6			11
Pneumodermopsis paucidens													3					
Clione limacina antarctica														9				
Conchoecia isocheira		3																
Calanus propinquus					15	3			58		29		3			90	38	4
Rhincalanus gigas								11	13		68			6				11
Metridia gerlachei		14														24		
Oithona frigida																33		
Vibilia sp.	4			3			3		3	60	16	3	3		3	36	10	
Cyllopus magellanicus	4		7		4					30	3	13	3			9		
Hyperiella dilatata						3												
Parathemisto gaudichaudii	15		7	5			5				6	3	6	3	3		10	
Primno macropa			3							30								
Thysanoessa macrura	34		14	21	4		53		149		13	16	38	12	15	114		15
T. vicina		7																
Euphasia superba	41		3	3					23			120	3		3			
Euphausia superba		10												12	3	3		
Sagitta maxima																		
Salpa maxima	4	55		52	67	6	92		120	1227	110			24		51	195	
S. thompsoni	243	65	253	96	1011	3	476	134	84	6286	178	178	69	36	63	96	698	82

Table II. Species composition and density found during the period Feb-March/85 (Ind/1000m³)

STATIONS	A	B	C	D	E	F	G	H
Diphyes antarctica								11
Calycopsis borchgrevinki			7					
Rhynchonerella bongraini	3							
Tomopteris septentrionalis							7	
T. carpenteri			7					
Pelagobia longicirrata							13	
Conchoecia hettacra								3
Calanus propinquus	3400	148	358			14	249	8
Calanoides carinatus			16170	755		3	290	3
Rhincalanus gigas	2506		232		5	8	7	14
Paraeuchaeta antarctica			176					
Metridia gerlachei			50094	586			155	3
Oithona frigida	79760	44099		1213	612	3		
Copepoditos					174	215		
Vibilia sp.							7	
Parathemisto gaudichaudii	16	13				5		
Thysanoessa macrura	67	72	1758	398	5	316	1300	76
T. vicina			112					
Euphausia superba	38	9	15468	398		3		11
E. frigida	3		56	10				
Eukrohnia bathyantarctica	5					5		
E. hamatta				20		14		11
Salpa maxima							61	
S. thompsoni			120					
Fritillaria borealis		13198	135342	2833	231			
Oikopleura gaussica			351					

Table III. Lenght values of the diferent population cathegories from juvenil to adults registered during each of the two periods studied.

	E. superba		**T. macrura**	
	Feb-Mar/84	FebMar/85	Fev-Mar/84	Fev-Mar/85
Juvenil	25 — 27	— — —	13 — 14	13 — 15
Subadults	26 — 44	44 — 46	14 — 16	16 — 17
Adults	35 — 47	41 — 49	15 — 20	16 — 23

Table IV. Food of some zooplanktonic species according to different authors. The information of authors not cited in the references were taken from "Atlas del Zooplancton del Atlántico Sudoccidental", 1981. INIDEP. Publ., D. Boltovskoy, Edit. Mar del Plata, Argentina, p. 1-936.

Species	Food	Authors
Diphyes dispar	Fish larvae and Copepoda.	Alvariño, 1981
Calycopsis borchgrevinki	Eggs and fish larvae.	Alvariño, 1975
Rhynchonerella bongraini	Copepoda, Euphausiid and Taliacea.	Fauchald e Jumars, 1979
Tomopteris sp.	Fish larvae, Chaetognata, Tunicata, Bacillariophyta and Dinoflagellata.	Lebour, 1923; Rakusa-Suszcewski, 1968; Evans 1971; Hatmann—Schroeder, 1971.
Clio pyramidata f. excisa	Bacillariophyta (Diatoms, Dinoflagellata. Silicoflagellata, Cocolitoforida, Radiolaria, Foraminifera, Tintinida, Infusoria, organic and inorganic particles	Boas, 1886; Pelseneer, 1888; Morton, 1954; Paranjape, 1968.
Clione limacina antarctica and **Pneumodermopsis** sp.	Other Pteropoda	Van der Spoel and Boltovskoy, 1981.
Calanus propinquus and **Rhincalanus gigas**	Phytoplankton and nannoplankton	Bjornberg, 1981; Almeida Prado Por, 1984.
Metridia gerlachei and **Oithona** sp.	Phytoplankton, nannoplankton and detritus	Bjornberg, 1981; Almeida Prado Por, 1984.
Parathemisto gaudichaudii	Copepoda, Dinoflagellata and vegetal matter	Bigelow, 1926.
Euphausia superba	Detritus, Bacillariophyta, Tintinida, Radiolaria, Foraminifera and Crustacea.	Barkley, 1940; Marr, 1962; Mauchline and Fisher, 1969; Pavlov, 1971 and 1974.
Eukrohnia hamata	Bacillariophyta, Ciliata, Copepoda and Fish Larvae	Burfield, 1927; Tokioka, 1939; Varadarajan and Chacko, 1943; Tompson, 1947; Lea, 1955; Vinogradov, 1962.
Sagitta maxima	Copepoda and Tomopteridae	Bigelow, 1926; Vinogradov, 1962.
Appendicularia	Coccolitophorida, small Bacillariophyta, Dinoflagellata and naked Flagellata	Esnal, 1981.

Table V. Dinoflagellata and tintinida found in the stomach and faecal pellets during Feb-March/1984 and 1985.

BACILLARIOPHYTA
Melosira sol (Ehr.) Kutz.
Thalassiosira tumida (Janisch Hasle
Coscinodiscus furcatus Karsten
C. oculus-iridis Ehrenberg
Coscinodiscus spp.
Charcotia australis (Karst.) M. Peragallo
Arachnoidiscus ehrenbbergii Bailey
Asteromphalus sp.
Corethron criophilum Castracane
* **Rhizosolenia simplex** Karsten
R. antarctica Karsten
R. hebetata f. semispina (Hensen) Gran
R. alata Brightwell
R. bidens Karsten
Chaetoceros criophilum Castracane
* **C. cf. deflandrei** Manguin
Triceratium arcticum Brightwell
Eucampia antarctica (Castr.) Manguin
Biddulphia striata Karsten
Fragilariopsis kerguelensis (O. Meara) Hustedt
Synedra sp.
Thalassiothrix antarctica (Schimper) Karsten
Navicula spp.
Pseudonitzschia sp.

DINOFLAGELLATA
Prorocentrum antarcticum (Hada) Balech
Protoperidinium antarcticum Balech
Ceratium sp.
Gyrodinium lachryma (Meunier) Kofoid e Swezi

TINTINIDA
* **Cymatocylis drygalskii** (Laackmann) Laackmann
C. convallaria Laackmann
C. antarctica (Cleve) Kofoid e Campbell
Codonellopsis sp.
Laackmanniella naviculaefera (Laackmann) Kofoid e Campbell

* The species marked were absents in the samples during the period Feb-March/1984.

Table VI: Stomach contents of some zooplanktonic species near Elephant Island.

Species	FEB-MARCH/1984	FEB—MARCH/1985
Conchoecia isocheira	— animal tissue fragments (2 — 7μm) — phytoplankton cells (3 — 8μm) — non identified particles (1.5 — 7μm)	
Conchoecia hettacra		— animal tissue fragments (2.5 — 8 μm) — phytoplankton cells (1.5 — 9 μm) — non identified particles (4 — 16 μm)
Copepodites		— non identified particles (1 — 3 μm)
Vibilia sp.	— **Charcotia** sp. — Fragilariacea chains — animal tissue fragments (5 — 11μm)	— animal tissue fragments (8 — 12 μm) — eggs (109 μm)
Cyllopus magellanicus	— phytoplankton cells remains (17.2 — 19:5μm) — Flagellates — Dinoflagellates fragments (9 — 14μm) — Ciliates — animal tissue fragments non identified (7.2 — 39.5μm)	
Hyperiella dilatata	— animal tissue fragments (11 — 21μm)	
Parathemisto gaudichaudii	— Fragilariacea chains — Flagellates (2 — 3μm) — chitin remains (9 — 21μm) — eggs (43μm)	— Copepoda fragments (25 — 39 μm) — Crustacea antenna parts (16 — 19 μm)
Thysanoessa macrura	— non identified particles (1 — 6μm) — Diatoms valves fragments (4 — 9μm)	— non identified fragments (1 — 4 μm) — Diatoms valves fragments Tintinidae and Dinoflagellates (5 — 18 μm)
Thysanoessa vicina	— non identified particles (2 — 8μm) — phytoplankton cells (6 — 10μm)	— non identified particles (1 — 5 μm) — phytoplantkton cells (7 — 12 μm)
Euphausia frigida		— non identified particles (1 — 7 μm) — oil globules with diatoms fragments — Chlorophyll pigments
Eukrohnia hamata	— oil globules with diatoms frag ments — Chlorophyll pigments.	— oil globules with diatoms fragments — Copepoda fragments
Salpa maxima	— non identified particles (1 — 20 μm) — Corethron criophilum — Thalassiothrix antarctica — Rhizosolenia spp. — R. alata — R. antarctica — Fragilariopsis spp. — Charcotia sp. — Synedra sp. — Pseudonitzschia sp. — Chaetoceros sp. — non identified centric diatoms — Gyrodinium lachryma — Prorocentrum sp. — Flagellates — Ciliates	
Salpa thompsoni	— non identified particles (1 — 57 μm) — **Corethron criophilum** — Fragilariaceae chains — **Coscinodiscus** spp. — **Charcotia sp.** — **Asteromphalus sp.** — **Eucampia** sp. — **Pseudonitzschia** sp. — **Synedra sp.** — Flagellates — Ciliates	— non identified centric diatoms (30 — 36 μm) — **Corethron criophilum** — **Rhizosolenia** spp. — **R. bidens** — Fragilariaceae chains — **Biddulphia striata** — **Chaetoceros** sp. — **Asteromphalus** sp. — **Cymatocylis antarctica** — **C. drygalskii** — Tintinnidae (220 μm) — Ciliates — parts of Crustacea filter feeding legs (165 μm)
Fritillaria borealis		— non identified particles (3 — 7 μm) — Flagellates (4 — 10 μm) — Ciliates
Oikopleura gaussica		— non identified particles (1.5 — 6 μm) — Flagellates (1 — 3.5 μm) — Ciliates

in 1846 mentioned that fishermen said that the salps affect a good herring fishery and that the fish avoided areas with salps. Hardy (1923) like other authors considered that the diminution of fish was caused by the active consumption of smaller plankton organism by the salps. Brattström (1972) registered in norwegian waters during 1955, big quantities of **Salpa fusiformis** that caused a serious drawback to the fisheries, partly because the salps made the use of fishing gear impossible and partly because the fish kept away from salps masses.

Esnal (1981) considers the Salpidae as one of the most important groups of consumers of nannoplankton. And according to the study performed in this work, we could add microzooplankton with particle size up to 735μm, without taking into account the chains of diatoms that exceed 1mm (Tab. VI). In this way they would act as true exhausters of the medium, competing with the species filtering inside this rank of particle size, for example: larvae of Copepoda (1-3μm) and Euphausiacea 1-6μm) and subadults of Euphausiacea (1-20μm). The diminishing in the plankton of the small filter feeding organisms, common preys to the carnivores, oblige them, partially, to change their feeding habits. For example: **Eukrohnia hamata, Sagitta maxima, Parathemisto gaudichaudii, Cyllopus magellanicus, Vibilia** sp., considered as mainly carnivores, showed remains of diatoms in their digestive contents.

Strickland (1972) said that "**the terms herbivore and carnivore are an oversimplification for use with zooplankton. Certain animals may well be obligate carnivores, but most herbivores can and will eat animal matter if it is of the correct size and texture, and if they can capture it. Probably filter-feeders and predators are better terms but even they fall short of perfection because the so-called filter-feeders seem capable of being highly selective in what they eat and may be capable of some predation.**"

According to Margalef (1977) when the species start tending towards macrophagy, they do not return to microphagy since the decision between the microphagy and macrophagy is fatal in evolution, leading to morphologic modifications and divergences which tend to increase. But in this case the surrounding pressure caused by the disapperance or diminution of prey oblige these species to face two alternatives: either they must alter their diets, adapting them to the feeding availability of the medium or they more elsewere until the return of the favorable conditions. This phenomenon has been observed also in some Antarctic organisms (fishes, f.^{e} which change their feeding habits drastically during the long polar winter, when fod becomes very scarce (Andriashev, 1965).

The possible mechanisms for the ingestion of phytoplankton by the curstaceans would be through the capture of faecal pellets, mainly of the Salpidae, which contain a great amount of non digested diatoms, also of organic matter in decomposition, and of bacteria. Copepods studied experimentally, are known to change from a carnivorous to a herbivorous diet and vice-versa (Anraku, 1963).

With the data on Tab. IV and V and information obtained from the literature (Table V) a tentative throphic relation chart, during the periods of February-March/84 (Fig. 5) and February-March/85 was proposed (Fig. 6).

The values of the standing stock of krill during February-March/84 were probably affected by the demographic explosion of the Salpidae. During February-March/85, the small number of the Salpidae allowed for the normal development of the populations of other species.

The influence of the feeding factor justifies only partially the specific composition and the variations of structure of the populations found during the two expeditions. The collection of plankton inside a large **Salpa** patch shows once again the necessity of many **"repetitive hauls at short intervals to see if the nets do repeatedly give a sufficiently reliable result to be used at any one place."** (Hardy, 1958).

The analyses of other surrounding factors, not considered here, would contribute to a better understanding of the population regulating mechanisms.

Concerning the age and origin of the populations, Mauchline (1980) worked out an hypothetical life cycle for **Euphausia su-**

perba, based on the calculation of its growing factor by measurements of fixed material (Makarov, 1974; Mackintosh, 1972; among others) and on data by Mc Whinnie et al. (1976) obtained from rearing experiments, size increment and growth factors in adolescent and adults.

There is a difference in the duration of the stages, from the spawning up to the stage of Caliptopis I (5 to 11 days) and for the different stages of Caliptopis (only a few hours) when these results are compared to those obtained by Quetin and Ross (1982).

Based on this hypothetical cycle it seems that the community observed during the period February-March/84, contains two populations of **Euphausia superba**: one with sub-adults about 1 year old and adults 1 year and 3 months old, and another with sub-adults almost 2 years old and adults, more than 2 years old.

In Febraury-March/85 samples there also seem to be two populations, about 2 years old, one with sub-adults averaging 44-46mm and another of adults between 41-49mm, suggesting a different geographical origin. Rakusa — Suszcezwski (1984) showed the relation between the distribution of larvae of **Euphausia superba** and the relative geostrophic superficial current of 500 dbar, with the larvae following the flux SW and SE excepting at some places, for example, in the region of 50.° where they may drift from N to SE. In the area between 48.°-56.° — W (which includes the region here studied) the larvae did not seem to drift, though there was evidence of the flux of the N-SE current. Thus our populations would originate in the regions near the Peninsula and Weddell Sea.

Fevolden (1979) sugest that the populations that develop in the Weddell Sea reach the maturity in 3 years and that the populations farther north reach it in only 2 years. He found, in Atka Bay, juveniles with a length of about 14-30mm, sub-adults 30-49mm long, and adults between 41.5 and 56mm length, in the Bransfield Strait the juveniles measured 22-40mm, the sub-adults oscilating between 28 and 40mm and the adults, 40-60mm.

Siegel (1982) studying material of the Second German Expedition (January-February/1981) compared the populations of the Bransfield Strait and those originating from the Weddell Sea (East Wind Drift) and found that the latter grow more slowly and grow less than the former.

Retamal (1983) studying samples of Drake Passage and of NE and SW of Bransfield Strait found that the females can reach maturity before the first year of life, due to changes in the conditions of the different water masses.

Brinton and Antezana (1984) studying samples from Elephant Island, during January-March 1981, found two kinds of size distributions, separate in space, one 50-55mm (year-3) mode wherein adult males predominated and the other 30-50mm range wherein females were more abundant. In the Bransfield Strait and near Elephant Island were observed mixtures of age groups of different origins. A swarm found in Bransfield Strait had specimens of 30-45mm range (year 2) and others of 50-53mm adults.

Based on the cultivation experiment by Quetin and Ross (1982) and on the works of Rakusa-Suszczewski (1984), the larvae found at stations 1 and 9 during February-March/1984 originated from spawnings which occurred approximately in the middle December 1983; those found during the period February-March/1985 at stations A, B, C, F, and H, originated from spawning in the middle of January, and the ones from station D, originated from the beginning of January 1985.

Concerning the populations of **Thysanoessa macrura** the absence of data on laboratory cultivation and on the growth time of the species makes it difficult to determine their approximate age and their origin.

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REFERENCES

ALVARINO, A. 1981. Siphonophorae. In "Atlas del Zooplancton del Atlántico Sudoccidental y metodos de trabajo con el zooplancton marino, p. 487. Ed. by. D. Boltovskoy. INIDEP — Mar del Plata, Argentina.

ALMEIDA PRADO — POR. 1984. Relationship of mouthpart structure and food in Copepods from the collection of the Firts Brazilian Antarctic Expedition (1983). Resumos do "Simposio Nacional do Programa Antartico-PROANTAR — São Paulo — Brasil, outubro de 1984.

ANDRIASHEV, A.P. 1965. A general review of the Antartic fish fauna. In "Biogeography and ecology in Antarctica". Eds. J.v. Mieghem, P.v. Oye and J. Schell; Dr. W. Junk Publs., The Hague, pp. 491-550.

ANRAKU, M. 1963. Feeding habits of planktonic copepods (review). Inf. Bull. Planktol. Japan **9**:10-35.

BALECH, E. 1975. Clave ilustrada de Dinoflagelados antarticos. Publ. Inst. Ant. Argentino, **11**:1-99 pgs.

BARGMAN, H.E. 1945. The development and life-history of adolescent and adult krill, **Euphausia superba.** Discovery Rep. **23**:107-176.

BIGELOW, H.B. 1926. Plankton of the offshore waters of the Gulf of Maine. Bull. Bur. Fish. Washington, Doc. 968,40 (1924) **pt2:**1-509.

BOAS, J.E.V. 1886. Spolia Atlantica Bidragti e pterodermes. Morfologi og sistematik samt til kundskabn om deres geografiske udbredelse. Vidensk. Selsk. Skr., **6,4**(1):1-231.

BOLTOVSKOY, E. 1971. Patchiness in the distribution of planktonic Foraminifera. In Proc. II Planktonic Confer., Roma 1970 Ediz. Tecnoscienza, Roma. pp. 107-115.

BRATTSTRÖM, H. 1972. On **Salpa fusiformis** Cuvier (Thaliacea) in Norwegian coastal and offshore waters. Sarsia **48**:(I)71-90.

BRINTON, E. and T. Antezana. 1984. Structures of swarming and dispersed populations of krill **(Euphausia superba)** in Scotia Sea and South Shetland waters during January-March 1981, determined by Bongo nets. Journal of Crustacean Biology, **4** (Spec n.° **1**): 45-66.

BURFIELD, S.T. 1927. Cambridge Expedition to the Suez Canal, 1924. Report on the Chaetognatha. Trans. Zool. Soc, **3**:355-357.

CUSHING, D.H. 1961. Patchiness. Symposium on "Zooplankton Production" Paper n.° 14. Intern. Counc. Explor. Sea, 16 pp.

EVANS, F. 1961. The Planktonic Crustacea of the "Petula" transatlantic expedition. Proc. Linneau Soc. London, **72(2)**:181-207.

EVERSON, I. 1984. 9. Zooplankton. In Antarctic Ecology **2**:463-490.

FAUCHALD, K & JUMARS, P. 1979. The diet of worms: a study of polychaets feeding guilds. Oceanogr. Mar. Biol. Ann. Rev., **17**:193-284.

FEVOLDEN, S.E. 1979. Investigation on krill (Euphausiacea) sampled during the Norwegian Antarctic Research Expedition 1976 — 77 Sarsia **64**:189-198.

FOXTON, P. 1966. The distribution and life history of **Salpa thompsoni** Foxton with observations on a related species **Salpas gerlachei** Foxton. "Discovery Reports" **34**:1-116.

FRASER, F.C. 1936. On the development and distribution of the young stages of krill **(Euphausia superba).** Discovery Rep. **14**:3-192. Academic Press, London — New York.

FRENGUELLI, J. & H.A. ORLANDO. 1958. Diatomaceas y silicoflagelados del sector Antartico e Sudamericano. Publ. Inst. Antart. Argentino. Bs. As. **5:1-191** incl. pl. 1-17.

HARDY, A. 1958. The open sea. Ist. natural history. Part 1, The world of plankton, Collins Cleartype Press, London, pp. XV + 335.

— 1923. Notes of the Atlantic plankton taken off the east of England in 1921 and 1922. Publs. Circonst. Cons. perm. int. Explor. Mer **(78)**:5-10.

HARTMAN —SCHRODER, G 1971. Annelida, Borstenwürmer, Polychaeta. Tierwelt Deutschl, Jena, **58**:1-594.

IKEDA, Y; MIRANDA, L.B. & CACCIANI, P.L. 1983. Parámetros ambientais do Estreito de Bransfield. Estudos preliminares. Co. Nac. para Assuntos Antarticos CIRM. Brasilia: 110-119.

LANA, P. DA CUNHA & BLANKESTEYN, A. 1985. Distributional patterns of Pelagic Polychaets in the Southern Drake Passage and in the Bransfield Strait (January-February 1984). Resumos do Simpósio Internacional de Biol. Aquat. Antartica. Rio de Janeiro, Brazil.

LEBOUR, M.V. 1923. The food of plankton organism. II. J. Mar. Biol. Ass. Uk, **13**:70-92.

MACKINTOSH, N.A. 1972. Life cicle of Antarctic krill in relation to ice and water conditions. Discovery Rep. **36**:1-94.

MAKAROV, R.R. & c.J. DENYS 1981. Stages of sexual maturity of **Euphausia superba.** Biomass Handbook n.° **11**:1-250.

MANGUIN, E. 1960. Les diatomées de la Terre Adélie Campagne du "Comandant Charcot" 1949-1950. Ann. Des. Sc. Nat. Bot. 12.° ser. 224-363.

Mc WHINNIE, M.A.; DENYS, C. & SCHENBORN, D. 1976. Biology of krill **(Euphausia superba)** and other Antarctic invertebrates. Antarctic Jour. U. States **11**:55-58.

MORTON, J.E. 1954. The biology of **Limacina retroversa.** J. Mar. Biol. Ass. Uk.. **33**:297-312.

PARANJAPE, M.A. 1962. The egg mass and veliger of **Limacina helicina** Phipps. Veliger, **10**(4):322-326.

PELSENEER, P. 1888. Report on the Pteropoda collected by H.M.S. "Challenger". Rep. Sci. Res. Voy. HMS "Challenger". Zool. **23**(1):1-32.

QUETIN, L.B. & R.M. ROSS, 1984. Depth distribution of developing **E. superba** embryos, predicted from sinking rates. Mar. Biol. **79**:47-53.

RAKUSA — SUSCZCWSKI, S. 1983. The relationship between the distribution of plankton biomass and plankton communities in the Drake Passage and the Bransfield Strait (Biomass-Fibex, FebruaryMarch, 1931). Proceed. Biomass Coll. **27**:77-83.

RETAMAL. M.A. 1983. Dinámica poblacional del krill. Abstracts of "Symposium and Workshop on Recent Advances in Aquatic Antarctic Biology with special reference to the Antarctic Península Region". San Carlos de Bariloche, Rio Negro, Argentina.

SARS, M. 1829. Bidrag til Sodyrenes Naturhistorie. Bergen. 1846. Beobachtungen uber die Organisation der Entwickelung der Salpen. Fauna littoralis Norwegie **(11)**:63-85.

SCAR/SCOR/IABO/ACMRR. 1982. Group of Specialist on Southern Ocean Ecosystem and their lliving resources. First Post-FIBEX hydrographic data interpretation workshop. Hamburg. FRG; 20-26 Setember BIOMASS Report Ser. **30**:1-11.

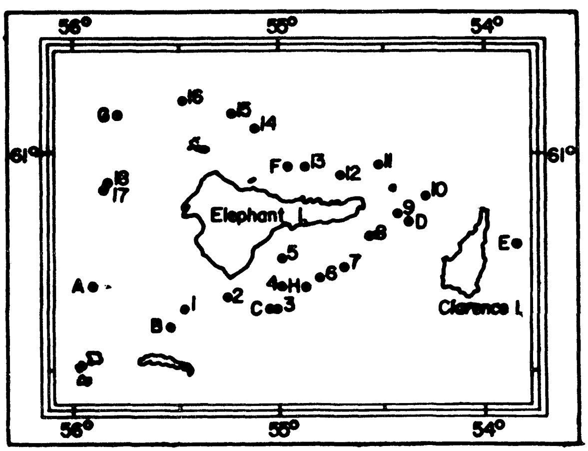
SIEGEL, V. 1983. Investigations on krill **(E. superba)** in the Southern Weddell Sea. Rep. Mar. Research **29**:244-252.

SOURNIA, A; J.R. GRALL & G. JACQUES. 1979. Diatomées et Dinoflagelles planctoniques d'une coupe méridienne dans le sud de l'océan Indian (Campagne "Antipod I" du Marion — Dufresne mars 1977). Botanica Marina XXII **(3)**:183-198.

SOUTO, SARA. 1981. Tintinnina. in "Atlas del zooplancton del Atlantico Sudoccidental y métodos de trabajo con el zooplancton marino. pp. 355-356. Ed. by D. Boltovskoy. INIDEP Mar Del Plata, Argentina.

STRICKLAND, J.D. 1972. Research on the marine planktonic food web at the Institute of Marine Resources: a review of the past seven years of work. Oceanogr. Mar. Biol. Ann. Rev. **10**:349-414.

TOKIOKA, T. 1939. Three new Chaetognatha from japanese water. Mem. Imp. Mar. Oss. Koke (Japan). **7(1)**:129-139.



• FIRST ELEPHANT ISLAND EXPEDITION
(february-march/1984)

• SECOND ELEPHANT ISLAND EXPEDITION
(february-march/1985)

Fig. 1. Map showing the stations locations for each of the two cruises. (Feb.-March/1984 in numbers; Feb-March/1985 in letters).

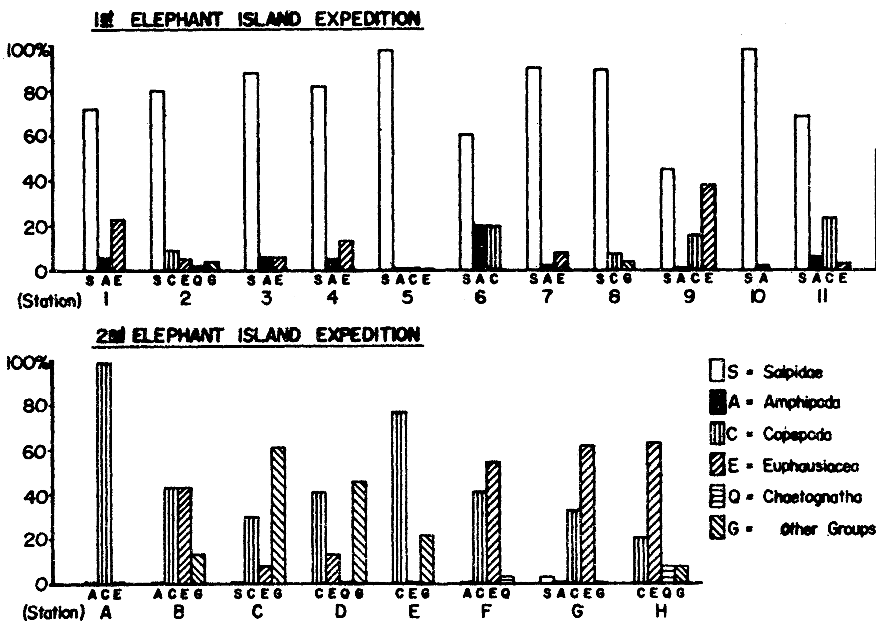


Fig. 2. Density of the zooplanktonic groups during Feb.-March/1984 and Feb.-March/85, expressed in numbers of individual for 1000 m³.

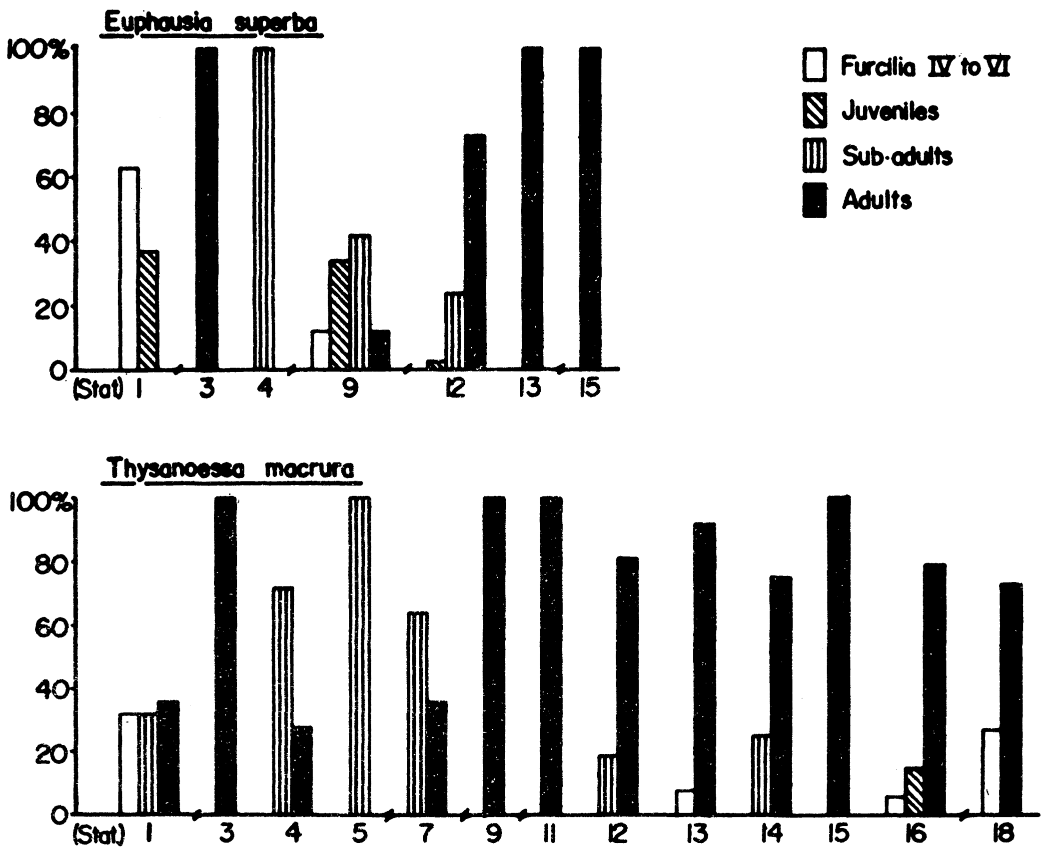


Fig. 3. Populational structure of **Euphausia superba** and **Thysanoesa macrura** during Feb.-March/1984.

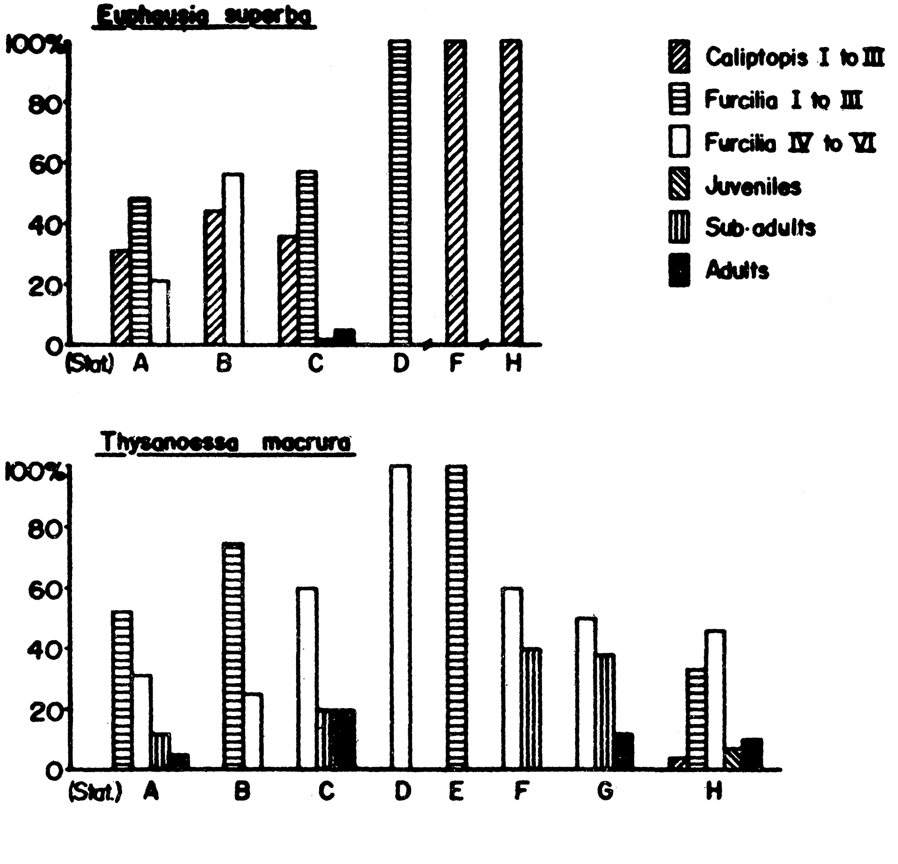


Fig. 4. Populational structure of **Euphausia superba** and **Thysanoessa macrura** during Feb.-March/1985.

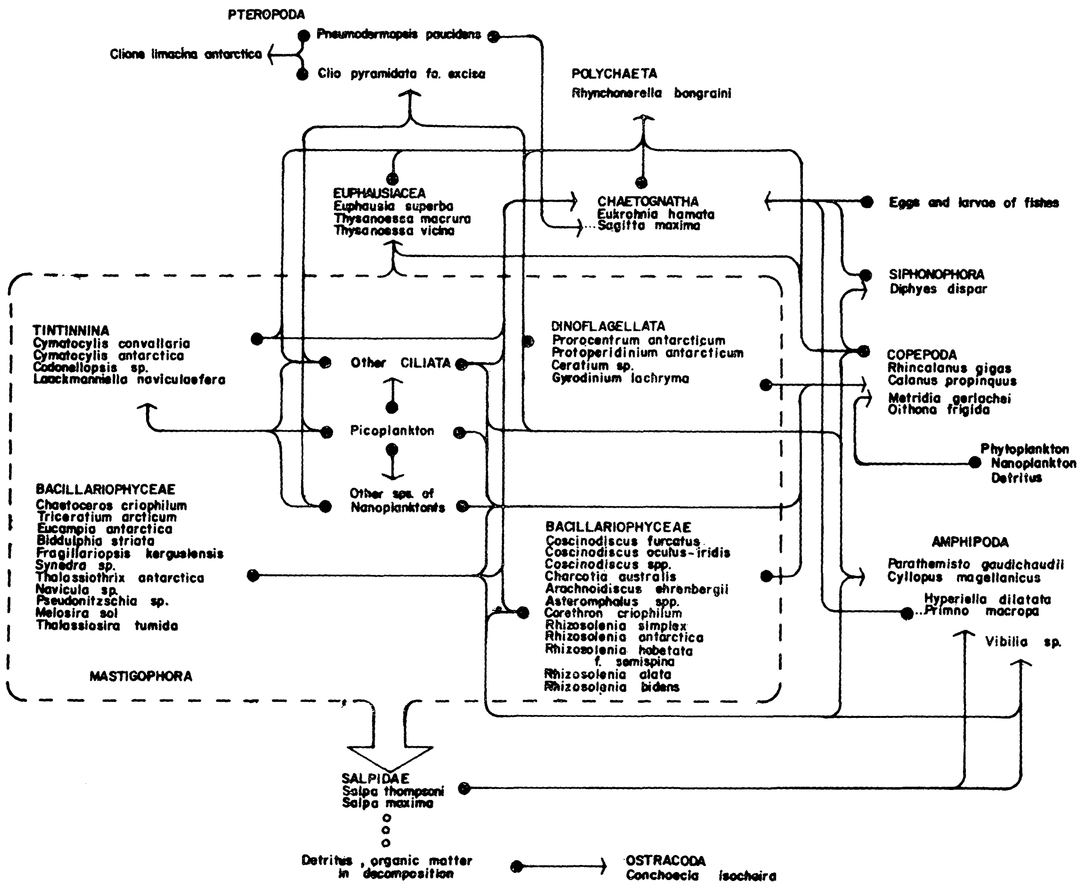


Fig. 5. Outline of the throphic relations of the zooplankton species found during Feb-March/1984.

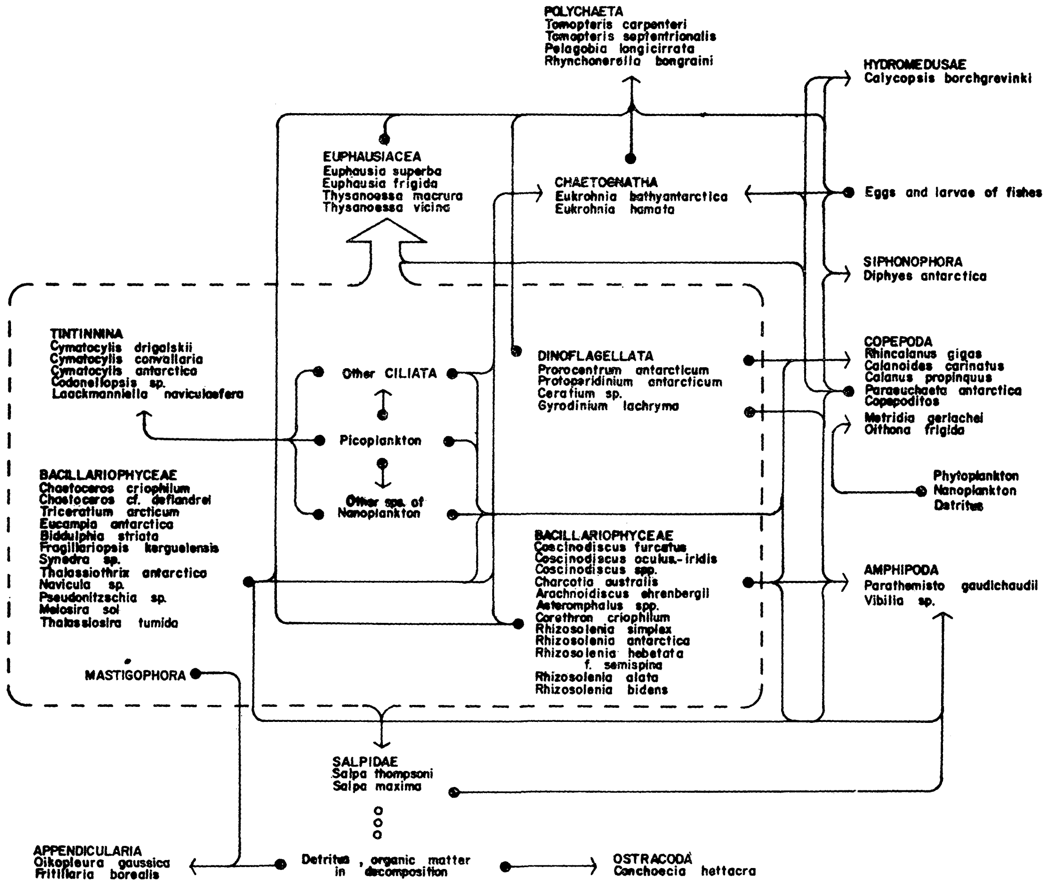


Fig. 6. Outline of the throphic relations of the zooplankton species found during Feb-March/1985.