

Zooplankton investigations in Lagoon San Rafael and Elefantes Fjord

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Abstract. Zooplankton distribution was observed on the samples collected by vertical tows with a Norpac net in Elefantes Fjord and Lagoon San Rafael in November 1983.

Zooplankton mainly consisted of Copepoda which was the most abundant group, accounting for more than 83% of the total zooplankton at each station. Sixteen species of planktonic copepods were identified, of which *Calanus simillimus*, *Calanoides patagoniensis*, *Paracalanus parvus*, *Drepanopus forcipatus* and *Acartia tonsa* were major constituents. All except *D. forcipatus*, found as the dominant from the fjord and lagoon waters, were more abundantly distributed in the fjord. Of these copepods, the large-sized species *C. simillimus* reached maximum abundance in the southern end of the fjord, and was the most important copepod in increasing the zooplankton biomass of the San Rafael region. From the relationship between the regional distribution of zooplankton and hydrographic structure, it is noted that the zooplankton community in the glacier lagoon may be less influenced by immigration of copepods from the fjord through a narrow channel.

1. Introduction

Several papers on zooplankton ecology in fjord waters of the southern Chile have been published (cf. ANTEZANA, 1976, 1981; ANTEZANA et al., 1976; ARCOS, 1974, 1976) since a series of expeditions ("HERO 72-4, 73-2" cruises etc.) to the Magellan region were carried out. None of them, however, refer to the influence of the glacial runoff and circulation of the fjord water on the abundance and species composition of zooplankton.

Of the present authors, A. Zama, and S. Kobayashi and T. Saito had an opportunity of participating at "Glaciological Research Project in Patagonia, Chile, 1983-1984", and collected zooplankton and fish from Elefantes Fjord and Lagoon San Rafael (a glacier lagoon of water connected to the fjord by a narrow channel) in November 1983. K. Hirakawa analyzed these samples at the laboratory of Marine Biological Research Institute of Japan, Co., Ltd., Tokyo.

This report deals with the distribution of zooplankton, especially planktonic copepods, in the San Rafael region during the southern summer.

2. Material and methods

Samples were collected at four stations (C-1, C-3, C-5 and C-7) in Elefantes Fjord between 1100-1945 LT on November 25 and 26, and at St. L-1 in Lagoon San Rafael between 0810-1710 LT at daily intervals during November 23 to 29 (Fig. 1). Vertical tows were made with a

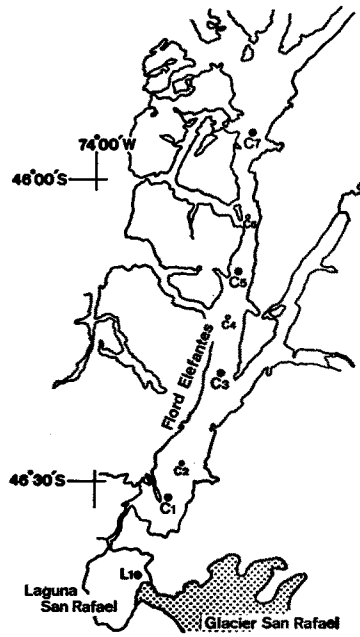


Fig. 1. Map showing stations occupied in Elefantes Fjord and Lagoon San Rafael, southern Chile. Solid circle: the stations for both zooplankton sampling and hydrographic observations; open circle: the stations for hydrographic observations.

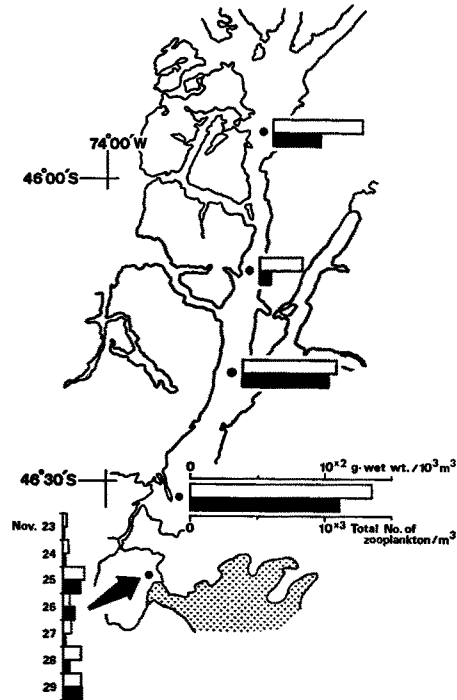


Fig. 2. Wet weight and total number of zooplankton in Elefantes Fjord and Lagoon San Rafael in November 1983.

Norpac net (mouth diameter 45 cm, mesh openings 0.33 mm, length in filtering portion 180 cm) from near the bottom (15 or 20 m depth) at St. L-1 and from 25 or 50 m depth to the surface at the other stations. As a flow-meter was not used for estimating the water filtered and plankton densities were calculated assuming 100% filtration efficiency, the densities were probably underestimated. The materials were immediately preserved with about 10% formalin sea water on board. The whole or aliquot of 1/4 of each sample was examined in accordance with abundance, and the individuals were counted.

In addition, water temperature and salinity were measured at the all stations (L-1 and C-1 to C-7) shown in Figure 1.

3. Results

Zooplankton showed daily change at St. L-1, increasing twice a week (on November 25 and 28–29) in wet weight and number of individuals (Fig. 2). The means for the week were 8.4 (2.9–16.3) g/1000 m³ and 62 (6–135) indiv./m³. Zooplankton biomass (wet weight) and abundance (number of individuals) were higher in the fjord than in the lagoon. The highest

Table 1. Individual numbers (per m³) of zooplankton found at four stations in Elefantas Fjord on November 25–26, 1983.

Species	C-1	C-3	C-5	C-7
Hydroida	1			+
Siphonophorae			+	1
<i>Sigitta</i> juvenile				1
<i>Podon leuckarti</i>		2		
Ostracoda	+			
<i>Calanus simillimus</i>	715	194	2	4
<i>Calanoides patagoniensis</i>	37	49	11	59
<i>Rhincalanus nasutus</i>	1	+		+
<i>Paracalanus parvus</i>	51	68	15	19
<i>Calausocalanus arcuicornis</i>	1	2	+	1
<i>Clausocalanus brevipes</i>		1		+
<i>Drepanopus forcipatus</i>	138	57	12	145
<i>Aetideus armatus</i>				1
<i>Centropages brachiatus</i>			+	1
<i>Metridia lucens</i>				1
<i>Candacia cheirura</i>		2	+	+
<i>Acartia tonsa</i>	63	167	32	106
unidentified calanoids				+
unidentified Calanidae nauplius	1			
<i>Oithona similis</i>	1	2		1
<i>Oncaea conifera</i>				1
unidentified cyclopoids			+	
<i>Oikopleura</i> sp.	1	1		4
Balanidae nauplius	85	88	3	4
Balanidae cypris	2	2		1
Cyphonautes larvae	+	1		3
Polychaeta larvae		+	+	+
Euphausiacea calyptopis	1	1	1	+
Euphausiacea furcilia	+	+	1	1
<i>Macrura mysis</i>	1	1	1	+
Callianassidae zoea			1	1
Galatheididae zoea	1			
Brachyura zoea	8	3	+	
<i>Parathemisto</i> larva	+			

+: less than 1 individ./m³.

Table 2. Individual numbers (per m³) of zooplankton found at St. L-1 in Lagoon San Rafael during November 23–29, 1983.

Species	Nov. 23	24	25	26	27	28	29
<i>Calanus simillimus</i>	2	1	11	4	3	7	2
<i>Calanoides patagoniensis</i>	+	+	+	1			1
<i>Paracalanus parvus</i>							+
<i>Clausocalanus brevipes</i>				+			
<i>Drepanopus forcipatus</i>	1	8	102	75	9	27	126
<i>Acartia tonsa</i>	2	2	7	2	3	11	5
<i>Harpacticus</i> sp.		4	2		+	+	
<i>Phyllothalestris</i> sp.		1				+	+
Thalestridae		+	+		1		+
unidentified harpacticoids						+	
Balanidae nauplius	1	1	8	1	1	+	
Cyphonautes larvae				+			

+ : less than 1 individ./m³.

values (135 g/1000 m³ and 1110 individs./m³) were recorded at St. C-1 located in the southern end of the fjord.

Zooplankton were composed of Copepoda, non-pelagic invertebrate larvae (mostly Balanidae nauplii), Euphausiacea, Decapoda, Amphipoda and Appendicularia (*Oikopleura* sp.), of which the first two groups were distributed in both areas but the others were restricted to the fjord. Copepoda was the most abundant group, accounting for more than 83% of the total number of zooplankton at each station.

Copepoda has the maximum number of species (more than 16 species) in the six zooplankton groups as mentioned above, and its diversity was higher in the fjord than in the lagoon. Five species, *Calanus simillimus*, *Calanoides patagoniensis*, *Paracalanus parvus*, *Drepanopus forcipatus* and *Acartia tonsa* were major constituents of the copepods (Tables 1 and 2). All except *Drepanopus forcipatus* found as the dominant species from the fjord and lagoon, were more abundantly distributed in the fjord and remarkably declined in the lagoon. The large-sized species *C. simillimus* reached maximum abundance (about 64% of the total number of zooplankton) at St. C-1 and was the most important copepod in increasing the zooplankton biomass in these waters. However, the small-sized species *D. forcipatus* was exclusively responsible for sustaining the biomass in the lagoon, accounting for 77.8% and 93.3% of the total number of zooplankton on November 25 and 29 respectively.

4. Discussion

C. simillimus was regionally distributed in the San Rafael region and replaced with *Calanus chilensis* in Canal Moraleda connected to the northern Elefantes Fjord, from where *C. patagoniensis*, *P. parvus*, *D. forcipatus* and *A. tonsa* were also found as the major summer copepods (HIRAKAWA et al., in preparation). *C. simillimus* can be taken as representing characteristic sub-Antarctic surface species and undoubtedly plays an important role which can to some extent be compared with that of the northern Pacific species, *Calanus helgolandicus* and *C. finmarchicus* (VERVOORT, 1965). This species was recorded at the head of Fjord Almirantazgo in the Magellan region (ARCOS, 1976), where there were glaciers evidently yielding fresh water to reduce the upper layer salinity somewhat (PICKARD, 1973). From the regional distribution of this species in the Patagonian fjords, its occurrence is likely to be associated with the hydrographic conditions of the glacier lagoon waters.

According to HARDY and GUNTHER (1935), and MINODA and HOSHIAI (1982), *D. forcipatus* (Hardy and Gunther incorrectly reported it as *D. pectinatus*, cf. BAYLY, 1982) was the most abundant copepod in South Georgia waters during summer. The zooplankton community, which was overwhelmingly dominated by *D. forcipatus*, in Lagoon San Rafael is more monotonous than in Elefantes Fjord and Canal Moraleda. It has been presumably less subject to the immigrants accompanying the fjord water from the outside which enters with the tide. We are deeply interested in the succession of the pelagic ecosystem in the waters of the glacier lagoon with the retreat of the glacier.

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Resumen. Investigaciones del zooplancton en la Laguna San Rafael y el Fiordo Elefantes

Se examinó las características ecológicas del zooplancton en las aguas de bahías glaciares. El muestreo se realizó en una estación en la Laguna San Rafael, y en 4 estaciones en Fiordo Elefantes en Noviembre de 1983 (Fig. 1). El zooplancton fue recogido mediante extracciones verticales con una red NORPAC.

La biomasa del zooplancton (peso húmedo) y la diversidad eran mayores en Fiordo Elefantes que en la Laguna San Rafael. La biomasa más alta (135 g/1000 m³) se registró en la estación C-1 en la parte más austral del Fiordo Elefantes (Fig. 2).

El zooplancton consistió principalmente de Copépoda, el grupo más abundante en cada estación, abarcando entre 83-100% del número total de zooplancton. En las tablas 1 y 2 se muestra que los mayores constituyentes de los Copépoda son *Calanus simillimus*, *Calanoides patagoniensis*, *Paracalanus parvus*, *Drepanopus forcipatus* y *Acartia tonsa*. Excepto por

Drepanopus forcipatus, que era la especie dominante en ambas regiones, estos copépoda estaban más abundantemente distribuidos en el fiordo.

La especie de gran tamaño *Calanus simillimus*, alcanzó una abundancia máxima en la parte más austral (Est. C-1) del fiordo y era responsable por incrementar la biomasa del zooplancton.

A partir de la relación de la distribución de zooplancton (Tablas 1 y 2) y la estructura hidrográfica se asume que la comunidad de zooplancton en la laguna ha sido menos afectada por migrantes que visitan las aguas del fiordo desde el exterior.