Report 16

Fishes collected in Lagoon San Rafael, with notes on some biological observations

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Abstract. Fishes were collected in Lagoon San Rafael in late November 1983, using surface gill nets as well as by hand. A total of 179 fishes belonging to the following six species in three families were collected: the zoarcid *Austrolycus depressiceps*, the four nototheniids *Eleginops maclovinus, Notothenia cornucola, N. longipes* and *N. tessellata*, and the harpagiferid *Harpagifer bispinis*. One hundred and seventy-four fishes of the three species *E. maclovinus, N. longipes* and *N. tessellata* were caught by gill net. Algae and amphipods (Gammaridae) were the most common foods for *E. maclovinus* and *N. tessellata*, and a similar composition of stomach contents was found for the two species. The small variety of stomach contents seemed to reflect the poor natural fauna of food organisms in the lagoon, under the influence of low salinity. There were more males of *E. maclovinus* than females, while in *N. tessellata* the females were dominant. The standard length of *E. maclovinus* ranged from 160 to 586 mm and the age from three to ten years. This notothenid showed a small increment of standard length, due to a probable influence of low water temperature and also poor food condition.

1. Introduction

Lagoon San Rafael is located at 46°40'S and 73°55'W between Taitao Peninsula and Mt. San Valentín (3910 m) and hidden behind Elefantes Fjord (Gulf Elefantes in Map 1). This fan-shaped lagoon is 10 km long and 12 km wide. It has a passage, Tempanos River, connecting to Elefantes Fjord (Fig. 1). Few small rivers run into the lagoon from the east and south. San Rafael Glacier from Mt. San Valentín breaks into the east side of the lagoon.

Nothing is known of the fish fauna of Lagoon San Rafael, except a brief note by VIVIANI (1980) who reported that *Eleginops maclovinus* abundantly inhabit the lagoon and is probably a principal food source for seals. I had an opportunity to sample fishes near the lagoon shore in late November 1983, as an activity of the Glaciological Research Project in Patagonia, Chile. In this paper, six fish species are recorded from Lagoon San Rafael and biological observations of some fishes are presented.

Fish collection was made in cooperation with Kobayashi and Saito. I wish to thank Saeki, Japan International Cooperation Agency, who gave me an opportunity to join in the expedition to Lagoon San Rafael.

2. Material and methods

Daily surface temperature and specific gravity were observed at station L1 (Fig. 1), which was located in Lagoon San Rafael, in the daytime during November 23 to 29, 1983. The specific gravity was converted into salinity. Besides, water temperature at the shore was taken twice when fish samplings were done.

On November 24 and 28, two collections of fishes in the lagoon were carried out, using sur-

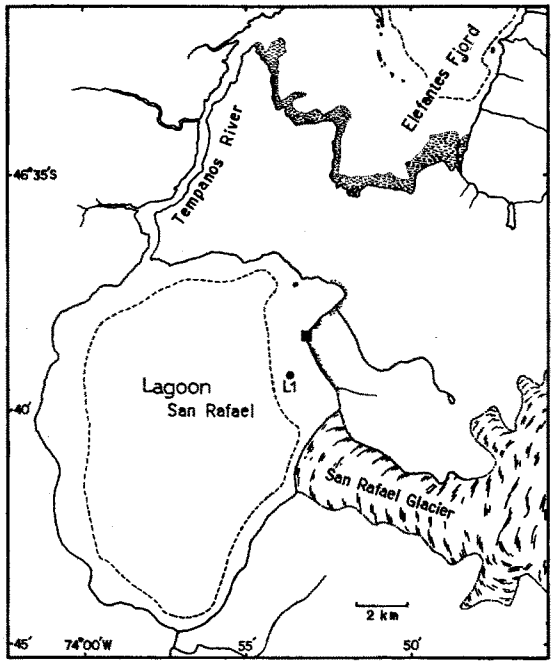

Fig. 1. Map of Lagoon San Rafael and the innermost part of Fjord Elefantes, showing the occeanographic station (L1) and the site (black square) where the gill nets were set. Broken lines indicate an isobath of approximately 50 m.

face gill nets. Three gill nets were set in two series from the shore and ends of the nets anchored at a depth of about 3 m the day before each collection (Fig. 1). The three nets used in this study were 2 m high and 15 m long each, and had different stretched meshes of 40, 50, and 135 mm. Two nets with smaller meshes were tied together.

Total length (TL), standard length (SL), and body weight (BW) of all fishes captured by gill net were measured immediately after capture, and the gonads were inspected to determine sex. Stomach contents were examined by naked eye in the field for all specimens of *Notothenia longipes* and *N. tessellata* and 40 of *E. maclovinus* selected in various sizes.

In *E. maclovinus*, 26 scale samples were obtained selectively from the smallest to the largest fish. The scales of each fish were taken from the side of the body behind the tip of the pectoral fin below the lateral line. The radii of scale annulii were measured from the focus along the axis on a scale selected for each fish under a microprojector at 10 to 50 magnification. From both standard length at capture and scale radii, the proportionate calculation of standard length at previous ages was done using Fraser's formula (KUBO and YOSHIHARA, 1979). The size at squamation of *E. maclovinus* was regarded as 30 mm SL, on the basis of 24 specimens (25 to 35 mm SL) obtained from Puerto Perez (45°15'S), Aysén Fjord, apart from this study.

At ebb tide, on November 26, five fishes of three species, which occurred under exposed stones, were caught by hand near the site where the gill nets were set. The size of these fishes was measured, but examination for stomach contents and sex was not carried out.

3. Results and discussion

3.1. Water temperature and salinity

Surface water temperature at station L1 ranged from 3.8 to 6.8°C and surface salinity from 13.7 to 17.1‰. During the first three days, both the temperature and salinity were lower, about 4°C and 14‰, respectively, because blocks of drift-ice approached the station. The water temperature at the shore was estimated to be about 1°C higher than at station L1.

3.2. Number and size of fishes collected

A total of 179 fishes belonging to the following six species in three families were collected in Lagoon San Rafael during this study (Table 1): *Austrolycus depressiceps* Regan (Zoarcidae), *Eleginops maclovinus* (Valenciennes), *Notothenia cornucola* Richardson, *N. longipes* Steindachner and *N. tessellata* Richardson (Nototheniidae for the preceding four), and *Harpagifer bispinis* (Schneider) (Harpagiferidae). These species all are inshore inhabitants of subantarctic waters of South America or circumantarctic islands. They are known from Elefantes Fjord (NAVARRO and PEQUEÑO, 1979; ZAMA and CÁRDENAS, 1984), and may have become established in Lagoon San Rafael through the Tempanos River, which connects the lagoon to Elefantes Fjord. More intensive collecting from the entire lake would probably increase the number of species. Of the 179 fishes collected, five belonging to *A. depressiceps, N. cornucola* and *H. bispinis* were caught by hand by turning over exposed stones at ebb tide, and the remaining 174 consisted of the three nototheniids caught by gill net. In *A. depressiceps* and *H. bispinis*, a considerable number of individuals were encountered under exposed stones (20 to 50 cm across) and two to four of each or both species sometimes occupied the same stone. *H. bispinis* had two types in coloration: one with greenish-brown body and the other with the reddish.

The catch by gill net was composed of 133 fish of *E. maclovinus*, 40 of *N. tessellata*, and one of *N. longipes*. The standard length of *E. maclovinus* ranged from 160 to 586 mm, *N. tessellata* from 98 to 210 mm, and *N. longipes* was 160 mm (Table 1 and Fig. 2). There were more males of *E. maclovinus* than females. All the largest five of this species were females and had spent gonads. In *N. tessellata*, the females were dominant in number. On the basis of the specimens of *E. maclovinus* from Mehín (39°25'S), PEQUEÑO (1979) reported that females were relatively larger than males and exceed males in number in summer months. According to ZAMA and CÁRDENAS (1984), the approximate spawning season of the species in Aysén Fjord and Moraleda Channel (45° 20'S) is from August to January.

Table 1. Number and size of fishes collected in Lagoon San Rafael in November 1983. Sex was not determined for fishes caught by hand.

Species	No. collected				TL (mm)	SL (mm)	BW (g)	Method of collection
	♂	♀	?	Total				
Austrolycus depressiceps			1	1	131	130	10	Hand
Eleginops maclovinus	117	16		133	190–664	160–586	60–3000	Gill net
Notothenia cornucola			1	1	95	81	10	Hand
Notothenia longipes		1		1	186	160	58	Gill net
Notothenia tessellata	5	28	7	40	116–246	98–210	15–150	Gill net
Harpagifer bispinis			3	3	77–78	64–65	7–9	Hand
Total	122	45	12	179				

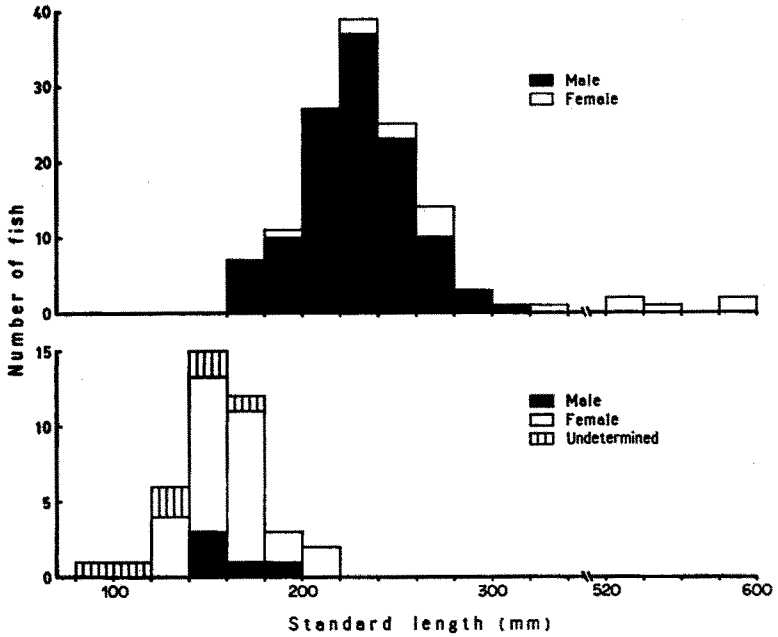

Fig. 2. Standard length composition of the two nototheniids, *Eleginops maclovinus* and *Notothenia tessellata*, collected in Lagoon San Rafael on November 24 and 28, 1983.

3.3. Standard length-body weight relationship

The relationship between standard length and body weight for *E. maclovinus* and *N. tessellata* is shown in Figure 3. Growth in relative body weight (y) to standard length (X), respectively, is given by equations: $y = 1.15 \times 10^{-5} \times X^{3.05}$ ($r = 0.993$) and $y = 3.49 \times 10^{-5} \times X^{2.83}$ ($r = 0.968$). The *E. maclovinus* specimens from Lagoon San Rafael showed a growth curve similar to that of the Deseado (about 48°S) specimens, Argentina (GOSZTONYI, 1974), but relatively higher body weight than those from Puerto Edén (49°08'S) (GUZMÁN and CAMPODÓNICO, 1973).

3.4. Stomach contents

The stomach contents of the three nototheniids captured by gill net are shown in Table 2. The percentage of empty stomachs to the total number collected was 4.5% in *E. maclovinus* and 7.5% in *N. tessellata*. The stomach contents were classified into only five higher taxonomic categories, Algae, Bivalvia, Amphipoda (Gammaridae), Insectsa (Chironomidae larvae) and Pisces (Nototheniidae). The algae were found at the highest frequency (about 90%) in the stomachs of *E. maclovinus* and *N. tessellata*, followed by amphipods (65%). There was a similar composition of foods between the two species.

GUZMÁN and CAMPODÓNICO (1973) mentioned that *E. maclovinus* feeds preferentially on algae from the standard length of 160 mm, but PEQUEÑO (1979) pointed out that the utilization frequency of algae as food is lower for fish larger than 481 mm SL. There were communities of algae and mussels (*Mytilus*) in poor condition along the shore of Lagoon San Rafael, as noted by VIVIANI (1980). The small variety of stomach contents of fishes from the lake was considered to reflect the poor natural fauna of food organisms in the lake, under the influence of low salinity. ZAMA and CÁRDENAS (1982) reported on the rare occurrence of crustaceans

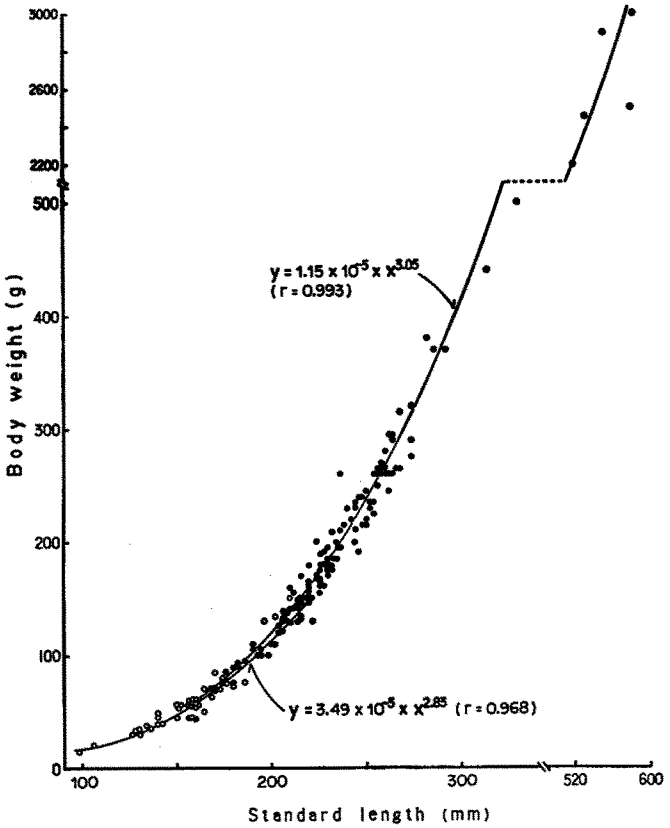

Fig. 3. Relationship between standard length and body weight for *Eleginops maclovinus* (black circle) and *Notothenia tessellata* (white circle) from Lagoon San Rafael.

Table 2. Stomach contents of fishes captured by gill net in Lagoon San Rafeal, showing frequency of occurrence and percentage of the number examined in parentheses.

Species	*E. maclovinus*	*N. tessellata*	*N. longipes*	Total
No. of fish collected	133	40	1	174
No. of empty stomachs (% of total)	6 (4.5)	3 (7.5)	0	9 (5.2)
No. of samples for stomach content examination (empty stomachs included)	40 (1)	40 (3)	1 (0)	81 (4)
Algae	35 (87.5)	37 (92.5)		72 (88.9)
Bivalvia	3 (7.5)	1 (2.5)	1 (100)	5 (6.2)
Amphipoda (Gammaridae)	26 (65.0)	27 (67.5)		53 (65.4)
Insecta (Chironomidae larvae)	5 (12.5)	4 (10.0)		9 (11.1)
Pisces (Nototheniidae)	1 (2.5)	1 (2.5)		2 (2.5)

(such as mysids, isopods and decapods) and algae in the stomachs of fishes obtained from Ensenada Baja, Aysén Fjord, where salinity is lower than in Lagoon San Rafael. The faunal study of tidal and benthic communities in Lagoon San Rafael is desirable.

3.5. Scale examination for *Eleginops maclovinus*

Twenty-six specimens (160 to 586 mm SL) of *E. maclovinus*, for which the age determination was made, consisted of age groups ranging from three to ten years (Table 3). The last

Table 3. Estimated mean standard length (mm) and scale radii (mm) in parentheses at previous ages for each age group of *E. maclovinus* from Lagoon San Rafael. The last figures show the mean values at capture.

Age group	No. of samples	Previous age									
		I	II	III	IV	V	VI	VII	VIII	IX	X
III	5	77	121	173							
		(1.3)	(2.1)	(3.0)							
IV	4	81	122	170	215						
		(1.4)	(2.1)	(2.9)	(3.7)						
V	8	73	120	149	193	242					
		(1.2)	(2.1)	(2.6)	(3.4)	(4.2)					
VI	3	78	116	144	176	226	284				
		(1.3)	(2.0)	(2.5)	(3.1)	(4.0)	(5.0)				
VII	1	74	123	167	199	237	275	330			
		(1.3)	(2.2)	(3.0)	(3.6)	(4.3)	(5.0)	(6.0)			
IX	2	86	133	181	225	282	334	388	453	527	
		(1.4)	(2.2)	(3.0)	(3.8)	(4.7)	(5.6)	(6.5)	(7.6)	(8.9)	
X	3	73	130	183	235	284	334	390	452	520	573
		(1.2)	(2.2)	(3.1)	(4.0)	(4.8)	(5.7)	(6.6)	(7.7)	(8.9)	(9.8)
Total or mean	26	76	122	163	204	251	311	379	452	520	573
		(1.3)	(2.1)	(2.8)	(3.5)	(4.3)	(5.4)	(6.5)	(7.7)	(8.9)	(9.8)

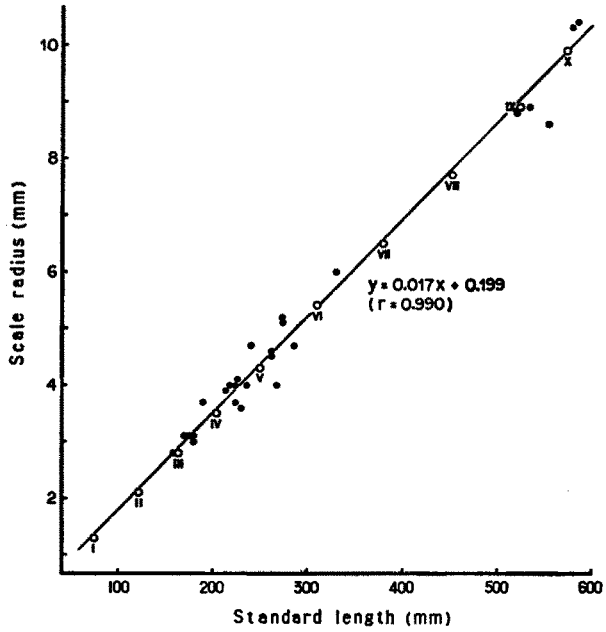

Fig. 4. Relationship between standard length and scale radius for *Eleginops maclovinus* from Lagoon San Rafael. White circles (I to X) show the estimated mean standard length at each previous age.

annulus was being or had formed on the margin of each scale and was counted as one. The relationship between standard length and scale radius is graphed in Figure 4. Relative scale radius (y) to the standard length (X) is expressed as $y = 0.017X + 0.199$ ($r = 0.990$). Table 3 and Figure 4 also show estimated mean scale radius to annulus at each previous age. The mean

radii at the ends of the first, second, fifth, and tenth years were estimated to be 1.3, 2.1, 4.3, and 9.8 mm, respectively. The estimated mean standard lenghts at previous ages for each age group are shown in Table 3 and Figure 4. At age I, the mean stadard length was 76 mm, 122 mm at II, 251 mm at V, and 573 mm at X. The annual increment of standard length during the second to fifth years was approximately 40 to 50 mm, smaller than during the sixth to tenth years (50 to 60 mm).

In comparison with studies made by GUZMÁN and CAMPODÓNICO (1973) and GOSZTONYI (1974), the specimens in the present collection had larger scales at the same standard length, but showed smaller radius at the same age. By extrapolation of the fish length-scale radius relationship, the above authors estimated the size at squamation to be 17.3 mm SL and 46.57 mm TL, respectively. As mentioned above, I observed the appearance of scales at about 30 mm SL in the Aysén Fjord specimens collected in a separate study. GUZMÁN and CAMPODÓNICO (1973) estimated that this nototheniid attain 125 mm SL in the first year and 170 mm in the second year. According to the estimation by GOSZTONYI (1974), the total length is 113.8 mm at age I, 227.2 mm at II, 575.9 mm at V, and increases to 784.0 mm at VIII, at an annual increment of about 110 mm. The present nototheniid from Lagoon San Rafael showed a much smaller growth rate in standard length than those reported by GUZMÁN and CAMPODÓNICO (1973) and GOSZTONYI (1974). It seemed that the low temperature of the lagoon, as well as poor natural food fauna, has a great influence on the growth of the nototheniid.

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Resumen. Peces recolectados en la Laguna San Rafael, con notas sobre algunas observaciones biológicas

La recolección de peces fue realizada en la Laguna San Rafael (Fig. 1), en Noviembre de 1983, utilizando redes agalleras superficiales como también a mano. Un total de 179 peces

fueron capturados, perteneciendo a las siguientes seis especies, agrupados en tres familias: El zoarcido *Austrolycus depressiceps*, los cuatro nototénidos *Eleginops maclovinus*, *Notothenia cornucola*, *N. longipes* y *N. tessellata* y el harpagiférido *Harpagifer bispinis* (Tabla 1). Ciento setenta y cuatro peces pertenecientes a tres especies (*E. maclovinus*, *N. longipes* y *N. tessellata*) fueron capturados mediante redes agalleras. El contenido estomacal en las especies *E. maclovinus* y *N. tessellata* fue de una composición similar, siendo el alimento más común algas y amfípodos (Gammaridae) (Tabla 2). La poca variedad en el contenido estomacal pareció reflejar una fauna natural pobre de alimentos en la laguna, influenciada por la baja salinidad. Se encontró más machos que hembras de *E. maclovinus*, mientras que en *N. tessellata* las hembras fueron dominantes (Fig. 2). La longitud estándar de *E. maclovinus* fluctuó desde 160 a 586 mm y la edad desde 3 a 10 anos (Figs. 3 y 4 y Tabla 3). Esta especie mostró un pequeño incremento anual en la longitud estándar probablemente debido a la influencia de la baja temperatura del agua y también de la escasez de alimento.