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REPRODUCTIVE HABITAT, BIOLOGY AND ACOUSTIC BIOMASS ESTIMATES OF THE SOUTHERN BLUE WHITING (*Micromesistius australis*) IN THE SEA OFF SOUTHERN PATAGONIA

Edited by Ramiro P. Sánchez

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República Argentina

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COMENTARIO PRELIMINAR

Si bien en forma ocasional la plataforma patagónica austral había sido explorada por campañas de investigación oceanográfico-pesqueras durante de los sesenta, no fue sino hasta fines de la década siguiente, y como resultado de sendos programas de cooperación internacional con los gobiernos de la República Federal de Alemania y Japón, que pudo alcanzarse una cobertura completa del área, estacionalmente repetida. El valor de estos estudios sobre recursos que, a la sazón, podían considerarse vírgenes, adquirió significativa importancia, ante la desmedida intensificación de la actividad extractiva en los ochenta, la cual no fue lamentablemente acompañada por programas de investigación que permitieran monitorear la evolución de las poblaciones ante el incrementento del esfuerzo pesquero sobre ellas aplicado.

En el curso de los años recientes el INIDEP ha incrementado notablemente, la asignación de recursos económicos y humanos al estudio de dos de los recursos pesqueros más importantes de la región: la polaca (*Micromesistius australis*) y la merluza de cola (*Macruronus magellanicus*). En la actualidad, tres proyectos de la institución y un proyecto de cooperación técnica con Japón, tienen como objetivo el estudio de diferentes aspectos de la dinámica poblacional, evaluación y biología de esas especies. La creciente cantidad de información obtenida como resultado de la adecuada cobertura espacio-temporal del área de estudio, mediante buques de investigación y observadores a bordo de la flota comercial, nos ha permitido profundizar en nuestro conocimiento sobre el estado de estos recursos y comparar la situación actual con la que se observaba veinte años atrás.

Ha sido nuestra intención, al preparar este documento, reunir y sintetizar los conocimientos disponibles sobre la biología reproductiva de la polaca en la región austral del Mar Argentino. Se incluyen en el mismo tres trabajos en los que se hace referencia a las características ambientales que prevalecen en las áreas de puesta de la especie, un trabajo sobre su biología reproductiva y una caracterización acústica de la estructura de los cardúmenes y evaluación de las concentraciones reproductivas que corresponden a la región malvinense. Algunos de estos estudios se han iniciado recientemente en el INIDEP, otros tienen ya una cierta tradición institucional. En consecuencia, el alcance y profundidad del análisis difiere, en cada caso, según la disponibilidad de información actual y referencias históricas.

Los estudios oceanográficos se centraron en el análisis de las condiciones termo-halinas prevalecientes en invierno en la región sud-oriental de la plataforma continental y talud argentinos. Las masas de agua en el área derivan del estrato superior del Agua Intermedia Antártica, modificada por interacción con las aguas diluídas de plataforma. Se observaron variaciones interanuales en los campos térmicos. El invierno de 1995 fue el más frío en el período analizado. Pudo definirse un intenso frente de talud en el borde oeste del canal situado entre la Isla de los Estados y el Banco Burdwood, el cual parece presentar un impacto biológicamente significativo sobre el comportamiento reproductivo de la especie.

Sabatini *et al.*describen en forma sinóptica la distribución de las biomasas zooplanctónicas durante el pico de desove invernal, a partir del análisis de dos campañas de investigación recientes, y comparan estos datos con informes previos de la abundancia zooplanctónica en la región malvinense durante el invierno y en la plataforma patagónica austral durante la primavera y el otoño. Los autores concluyen que, a pesar de ciertas diferencias, atribuíbles a los métodos de muestreo empleados en cada caso, no existen evidencias que permitan suponer la existencia de cambios de relevancia en la composición específica o en la abundancia del zooplancton durante los últimos veinte años.

Por el contrario, la distribución y composición del ictioplancton en la región, tal como se observan en la actualidad, contrastan marcadamente con las descriptas en trabajos previos. Se observa en particular una retracción del hábitat reproductivo de la polaca, y una ausencia total de formas embrionarias y larvales de *Salilota australis*, de ocurrencia frecuente en el pasado. La incorporación de nuevos sistemas de muestreo y el progreso alcanzado en el reconocimiento de los componentes del ictioplancton han permitido reseñar por primera vez, la presencia y distribución de larvas de varias especies de mictófidos, estudiar mediante análisis de clasificación jerárquica la existencia de asociaciones entre distintos niveles de la comunidad ictioplanctónica y su relación con las características del ambiente físico, y describir la estructura de tallas de las poblaciones de post-larvas y juveniles primarios de polaca y sardina fueguina.

Los estudios sobre la biología reproductiva de la especie, ponen de manifiesto que se trata de un desovante parcial, con fecundidad determinada. Se analiza asimismo la estacionalidad de la actividad de puesta y se propone una escala de madurez específica. Si bien los estimadores preliminares de la fecundidad caen dentro del rango de valores previamente calculados para la especie, la talla de primera madurez parece haber decrecido en relación con los valores calculados veinte años atrás.

Finalmente, el relevamiento acústico ha permitido describir la distribución en el plano geográfico y en la columna de agua y estimar las biomasas de las concentraciones reproductivas. El tema de la fuerza de blanco, una cuestión metodológica importante en este tipo de análisis, es tratado en detalle. Se discute también sobre la dificultad de obtener anualmente un estimador instantáneo de la población en puesta a partir de este tipo de metodología.

Confiamos que el material aquí presentado pueda servir como base para futuras investigaciones. Nuestra intención al presentar este documento ha sido poner de relieve los aportes de algunas líneas de investigación que merecen continuarse e intensificarse. Recién entonces estaremos en condiciones de encarar cuestiones fundamentales que nos lleven a comprender cuáles son los mecanismos biológicos que pueden permitir a la polaca equilibrar las pérdidas causadas por la actividad extractiva y de qué modo el ambiente es capaz de condicionar la distribución, abundancia y fluctuaciones de la especie.

EL EDITOR

FOREWORD

Although occasional oceanographic and fisheries surveys of the sea off southern Patagonia began in Argentina during the 60's, the first seasonal coverage of the complete area was attained only by the end of the 70's, as a result of joint international scientific programmes with the Federal Republic of Germany and Japan. The value of these studies on resources that were at the time unexploited was enhanced in view of the uncontrolled rise of fishing during the following decade, that was unfortunately not supported by research programmes aiming at monitoring the response of the stocks under increasing fishing effort.

In the course of recent years INIDEP remarkably increased the allocation of economic and human means to the study of the major finfish of the region: the southern blue whiting (*Micromesistius australis*) and the hoki (*Macruronus magellanicus*). Three INIDEP's projects, and one technical co-operation programme with Japan target on different aspects of the population dynamics, assessment and biology of these species. The large amount of information derived from the enhanced time-space coverage of the area has widened the scope of our understanding of these resources, and allows comparison of recent results with those of the late 70´s.

Our primary aim in preparing this document was to bring together and summarize what is known about the spawning activity of the southern blue whiting in the southern region of the Argentine Sea. It comprises three scientific contributions referring to environmental characteristics which prevail in the spawning habitat of the species, a paper on its reproductive biology, and an acoustical description and assessment of spawning concentrations of the southern blue whiting around Malvinas Islands. Some of these studies have been recently undertaken, others have a certain tradition in INIDEP. Consequently the scope and extent of each analysis differ in relation to the availability of previous and present information.

Oceanographic studies were focused on the analysis of winter thermo-haline conditions in the SE region of the Argentine continental shelf and slope. Water masses in the area are derived from the lighter upper stratum of the Antarctic Intermediate Water, after being modified by interaction with shelf diluted waters. Inter-annual variations were observed in the temperature fields. Winter 1995 was the coldest over the period analysed. A sharp shelf break front was defined at the west border of the channel between Staten Island and Burdwood Bank, which has a significant biological impact on the reproductive behaviour of the species.

Sabatini *et al.* report on the synoptic distribution of zooplankton biomass during the winter spawning peak based on the analysis of two recent surveys, and compare these data with previous reports on zooplankton abundance around the Islands in winter, and on the southern Patagonian shelf in autumn and spring. The authors conclude that in spite of some differences which may be attributed to sampling methods, there is no evidence to suspect major changes in specific composition or abundance of zooplankton in the last 20 years.

Conversely, the regional icthyoplankton distribution and composition presents some striking contrasts with those of previous reports, particularly in relation with a contraction of the spawning grounds of the southern blue whiting and the total absence of *Salilota australis*, commonly observed in the past. The incorporation of new sampling devices and the progress in the identification of the main ichthyoplankton components allowed to report for the first time on the occurrence and distribution of larvaeof several myctophiid species, describe through hierarchical classification the relationship between larval group and physical characteristics, and present length frequency distributions of post-larvae and early juveniles of sprat and blue whiting.

Results on the reproductive biology reveal that the species is a partial spawner with a determinate fecundity. Based on histological and macroscopical analysis the seasonality of spawning activity is discussed, and a maturity scale is proposed. A preliminary fecundity estimate fell in the range of values previously reported. On the other hand the size at first maturity seems to have decrease as compared to that reported for the late 70's.

Finally, the paper on acoustic focuses on the geographical occurrence, spatial distribution and biomass estimates of spawning concentrations. Target strength, an important methodological issue to this type of analysis, is addressed in detail. The difficulty of obtaining accurate point estimates of spawning biomass through a single acoustic survey is discussed.

We hope that the material discussed herein may serve as a basis for future scientific activities. Our intention in presenting this document was to point out some fields of research that deserve to be continued and intensified. We may then be in a position to address such fundamental questions as the biological mechanisms that may allow the southern blue whiting stocks to compensate for losses due to fishing and the possible linkages between the environmental forces that control the species distribution, abundance and fluctuations.

The Editor

CONTENTS

CONTENIDO

ICHTHYOPLANKTON COMPOSITION, DISTRIBUTION AND ABUNDANCE ON THE SOUTHERN PATAGONIAN SHELF AND ADJACENT WATERS*

by

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RESUMEN

Composición, distribución y abundancia del ictioplancton en la plataforma patagónica austral y aguas adyacentes. Se revisa la información existente sobre huevos y larvas de peces describiendo la distribución y estacionalidad de las diferentes especies y su agregación en conjuntos ictioplanctónicos. Se han analizado 488 muestras provenientes de 11 campañas realizadas por el INIDEP entre 1992-1995. Se han identificado huevos de peces en el 47% de las muestras que pertenecen a *Coelorhynchus fasciatus, Macrourus whitsoni* y *Micromesistius australis* y larvas en el 96% de las muestras pertenecientes a 23 especies y 17 familias. En otoño e invierno es mayor la presencia de huevos por el aporte de granadero y polaca. Las larvas de mictófidos y nototénidos están presentes durante todo el año. A través de un análisis de agrupamiento de las larvas se han reconocido cuatro conjuntos ictioplanctónicos: el primero formado por nototénidos, que ocupan la plataforma en profundidades entre 100 a 200 m, el segundo integrado por *Agonopsis chiloensis, Eleginops maclovinus, Macruronus magellanicus* y *Sprattus fuegensis* ubicados sobre la plataforma externa, el tercero formado por larvas de mictófidos, *Gymnoscopelus* spp. y *Micromesistius australis*, el cuarto grupo está integrado por *Protomyctophum* spp., *Krefftichthys anderssoni* y *Bathylagus antarcticus* que predominan en aguas de Malvinas por fuera de la plataforma. Se ha observado una contracción de las áreas de desove de polaca limitadas actualmente al sur de las Islas Malvinas, mientras que a fines de la década del setenta se encontraban abundantes concentraciones de huevos al oeste del archipiélago.

* INIDEP Contribution Nº 1056.

SUMMARY

This paper reviews the information on pelagic and demersal fish eggs and larvae, describing the distribution and seasonality of different species and their arrangement in icthyoplankton assemblages. It also reports on 11 surveys conducted by INIDEP during 1992-1995. A total of 488 ichthyoplankton samples were analyzed. Fish eggs have been recognized in 47% of all ichthyoplankton samples. They belong to three species: *Coelorhynchus fasciatus, Macrourus whitsoni* and *Micromesistius australis.* Fish larvae of 23 species and 17 families have been identified in 96% of all samples analyzed. Spawning of most species begins in autumn, and progresses through winter, when the southern blue whiting and grenadier fish contribute to more than half of all eggs present in our samples. Nototheniid and myctophiid larvae were caught during all year long. Four larval groups were detected using cluster analysis: the first group, formed exclusively by nototheniids, which occupied a vast area on the continental shelf between 100 and 200 m depth, the second formed by *Agonopsis chiloensis, Eleginops maclovinus, Macruronus magellanicus* and *Sprattus fuegensis* in coastal waters, the third formed by myctophiids, *Gymnoscopelus* spp. and *Micromesistius australis,* inhabit the outer continental shelf and slope, and the fourth included *Protomyctophum* spp., *Krefftichthys anderssoni* and *Bathylagus antarcticus*, species typically found in Subantarctic waters of the Malvinas Current. Comparing the distribution of eggs and larvae of blue whiting from collections obtained during the 70's and 80's, with those of recent surveys, it is evident, that a significant contraction of the spawning grounds of the species has take place, particularly to the west of the archipelago.

Key words: Ichthyoplankton assemblages, Patagonian shelf, *Micromesistius australis.*
Palabras claves: Conjuntos ictioplanctónicos, plataforma patagónica, *Micromesistius australis.*

INTRODUCTION

The southern Patagonian shelf extends from 46° to 56°S with a maximum width of about 800 km, exceeding in some locations the 200-miles-from-shore limit. This extended area exhibits a variety of distinct environments such as the coastal region, the continental shelf, the slope, Burdwood Bank and the bathymetric depression between the latter and the slope around the archipelago, -that shall be termed hereinafter Malvinas Channel- which in conjunction with the oceanographic characteristics create a diversity of ecological scenarios. Several major finfish stocks supporting directed fisheries inhabit the cold, nutrient rich subantarctic waters which cover most of this region.

Our understanding of these fisheries ecosystems has increased remarkably during the last few years, as a consequence of intensified research by INIDEP's vessels, information provided by observers on the Argentine fleet operating in the area, and joint Argentine-British surveys carried out in 1994 and 1995 to assess the spawning concentrations of blue whiting around Malvinas. As shown in Table 1, the number of ichthyoplankton stations occupied in 1992-1995, largely exceeded the sampling effort applied to the area for over 25 years before that period.

Research activities on INIDEP vessels included hydrographic and plankton sampling aimed at locating spawning and nursery grounds of commercial stocks, and describing the distribution and abundance of their early life history stages and related environmental conditions. This paper reviews the information on pelagic and demersal fish eggs and larvae obtained during the period 1992-1995, describing the distribution and seasonality of diffe-rent species and their arrangement into four icthyoplankton assemblages, with comparative references to reviews presented during the 70's and 80's (Table 1). The occurrence of larval stages of several myc-

Table 1. Seasonal coverage of this and previous reviews.
Tabla 1. Cobertura estacional de esta revisión y anteriores.

Reference	No. of Cruises	No. of Stations	Spring	Summer	Autum	Winter
Ciechomski *et al*.(1975)	1	44	11	33	-	-
Ciechomski *et al*. (1981)	13	263	37	49	97	80
Cassia & Booman (1985)	2	42	-	23	-	19
Sánchez & Ciechomski (1995)	16	359	48	105	97	99
This paper	11	488	159	111	85	133

tophiid species is cited for the first time in the region.

The oceanographic setting

Waters over the Argentine shelf are predominantly of subantarctic origin. South of 45°S shelf waters are formed as a result of mixing between subantarctic waters of the Malvinas Current, flowing northwards along the slope, and less haline coastal waters mainly originated as a run-off from Magellan Strait, partly diluted by continental contributions, flowing along the Patagonian coast to the southern extreme of San Jorge Gulf (Krepper and Rivas, 1979; Bianchi *et al.*, 1982). The three water masses (coastal, Malvinas and shelf waters) are recognized by their salinity ranges: Malvinas waters are more haline (33.8-34.2 PSU), coastal waters show values below 33.2 PSU, whereas shelf waters salinity ranges between those extremes. Along the slope and eventually over the outer continental shelf a deeper flow of Intermediate Antarctic Water may be recognized.

The general pattern of circulation in the region has been estimated several times by means of theoretical models based on surface wind stress and horizontal density gradients (Zyryanov and Severov, 1979; Lusquiños and Schrott, 1983; Forbes and Garraffo, 1988). Surface velocities show in all cases a NNE orientation and magnitudes ranging between 10-30 cm/s. The Atlas of Pilot Charts (Anonymous, 1955) based on data obtained by ship drifting reports surface currents with a NNE direction, except near the coast where circulation reverses, and 25 cm/s velocities. More recently, Rivas (1994) computed geostrophic velocities from thermal wind equations, obtaining somewhat lower values (2 cm/s), but same flux direction (NNE). Glorioso and Flather (1995) applied a barotropic model of the currents off Argentina, describing the effects of the interaction between tidal propagation, the Malvinas and wind-driven currents. According to these authors, the averaged velocity field is dominated by the Malvinas Current (25 m/s), although tidal residuals around headlands are significant on the Patagonian coast. Mean wind stress generates a large anticlockwise circulation cell in southern Bahia Grande and a strong flow gradient across the shelf break. In both cases, upwelling may be induced by the associated divergence of the flow.

Mesoscale frontal zones are extremely important features of the Argentine shelf, having very strong localized effect on hydrography and fish spawning distributions (Sánchez and Ciechomski, 1995). The ecological importance of the thermohaline front produced by the arrival of a Magellan outflow to the south of Gulf San Jorge, has been accounted for by Sánchez *et al.* (1993). The presence of a circular anticyclonic current around

Malvinas, with a well defined area of shelf water sinking, has been described by Severov (1990). Glorioso and Flather (1995) mapped the location of shelf sea fronts, on the basis of contours of the stratification index (Simpson and Hunter, 1974), averaged over one month and including tidal and Malvinas currents in the computation of the speed parameter. In our study region, the model predicts frontal systems at both ends of Gulf San Jorge, along the coast of Bahia Grande, around Malvinas and Burdwood Bank.

On the southern Patagonian shelf relatively high values of nitrates and chlorophyll-a are found throughout the year. A peak of nitrate concentration (2.5-14.5 µM) is followed by a single phytoplankton maximum in spring and summer (2.3-2.7 mg/m^3). Direct observations of chlorophyll-a distribution carried out by the Coastal Zone Color Scanner, operating on NASA's Nimbus-7 research satellite, show very high pigment concentrations related to the penetration of Magellan water over the shelf and in the frontal zone between coastal and shelf waters (Sánchez and Ciechomski, 1995). High values of zooplankton biomass occur during summer with densities ranging between 101-1000 mm^3/m^3 over most of the continental shelf to the south of 48°S (Ciechomski and Sánchez, 1983).

Waters of the Malvinas Current are rich in nutrients (Mandelli and Orlando, 1966; Brandhorst and Castello, 1971) but relatively poor in phytoplankton biomass (Carreto *et al.*, 1986). However, large concentrations of chlorophyll-a are found throughout the year at the shelf-break, a frontal area which combines a steady supply of nutrients with stable conditions, thus allowing growth of dense phytoplankton concentrations. Satellite images from the Coastal Zone Color Scanner, show a lighter band along the edge of the shelf, probably associated with the presence of coccolithophores (Podestá, 1987). Primary production values around Malvinas Islands (1.3 g C/m^2/day) are among the highest reported for the Argentine Sea (Angelescu and Prenski, 1987). Maximum zooplankton densities at the southern extreme of the Argentine Sea occur over the slope north of Malvinas during summer (Ciechomski and Sánchez, 1983).

MATERIAL AND METHODS

This paper reports on 11 surveys conducted by INIDEP during 1992-1995. A total of 488 ichthyoplankton samples were analyzed (Fig. 1). A detail of space and time coverage, number of stations and sampler used in each cruise is presented in Table 2.

Ichthyoplankton samples were collected by Nackthai sampler, a German modification of the Gulf V high speed sampler (Nellen and Hempel, 1969), fitted with 400µ mesh net. This gear has proven to be robust and well adapted to the rough sea conditions prevailing in the study area. A flowmeter was mounted to the 20-cm sampler mouth for filtered water volume determination. Ship and towing speeds were 3.5-4 kn and 0.5m/s respectively. Sampling depth was determined by a SCANMAR depth sensor mounted to the sampler in most part of the cruises. The net was towed obliquely from bottom to surface in shallow waters, and from up to 500 m depth to surface in off-shore stations.

Sampling on cruise OB-09/94 was designed to identify juvenile fish concentrations. A modified Isaccs-Kidd Midwater Trawl (Corten, 1981) was towed horizontally, at different stepped intervals. Distance between steps was 10m. The duration of each horizontal tow was 5 minutes.

All fish eggs and larvae were identified to lowest taxon possible and counted. As customary, ichthyoplankton abundances are expressed as numbers per $10m^2$ sea surface.

Temperature and salinity values assigned to

Table 2. Summary of 11 icthyoplankton surveys of the southern Patagonian shelf and slope during 1992-1995.
Tabla 2. Resumen de 11 prospecciones ictioplanctónicas en la plataforma Patagónica austral y talud entre 1992-1995.

Year	Cruise	Dates	No. of stations	Sampler	Latitude Range	Longitude Range
1992	EH-03-92	05-04 17-04	24	Nackthai	47° 13' - 52° 30'	61° 37' - 68° 25'
	EH-09-92	07-11 22-11	36	Nackthai	47° 01' - 51° 58'	60° 13' - 68° 13'
	OB-01-92	28-11 12-12	10	Nackthai	52° 07' - 54°42'	57° 18' - 66° 36'
1993	EH-01-93	10-01 27-01	46	Nackthai	47° 00' - 50° 49'	59° 58' - 66° 07'
	OB-08-93	22-07 16-08	59	Nackthai	48° 09' - 55° 08'	60° 31' - 68° 22'
1994	OB-04-94	25-03 05-05	51	Nackthai	48° 03' - 54° 53'	59° 33' - 68° 33'
	OB-07-94	11-09 30-09	81	Nackthai	48° 00' - 55° 04'	55° 28' - 65° 00'
	OB-09-94	03-11 22-11	47	Nackthai	47° 59' - 55° 01'	60° 29' - 68° 40'
	OB-09-94	03-11 22-11	24	IKMT	47° 59' - 55° 01'	60° 29' - 68° 40'
1995	OB-03-95	05-02 13-02	43	Nackthai	47° 03' - 50° 43'	60° 54' - 65° 31'
	OB-04-95	07-03 24-03	32	Nackthai	48° 55' - 55° 01'	62° 51' - 68° 46'
	OB-10-95	04-09 25-09	59	Nackthai	51° 46' - 55° 04'	58° 15' - 65° 52'

each oblique tow are those of sea water at 10 m from maximum towing depth.

Numerical abundance (non-transformed values) of 11 taxa (7 species, 2 genera and 2 families) were used in hierarchical classification in order to identify ichthyopalnkton assemblages. Cluster analysis was used to describe species groupings and relate larval fish assemblages to hydrography. The cluster variables are larval groups and its densities. The single linkage method (nearest neighbour) was used. The similarity measure for the clustering Pearson product moment correlation coefficient, which was converted to a distance measure by the transformation (1-R).

RESULTS

Ichthyoplankton identification

Fish eggs have been recognized in 47% of all ichthyoplankton samples analyzed. They belong to three species: *Coelorhynchus fasciatus, Macrourus whitsoni* and *Micromesistius australis.*

Fish larvae of 23 species and 17 families have been identified in 96% of all samples analyzed (Table 3). For the first the most important myctophiid species have been identified: *Krefftichthys andersoni*, *Gymnoscopelus braueri, G. nicholsi, Protomyctophum tenisoni,* and *P. normani.* Conversely all nototheniids are presented as a group most likely including several *Patagonotothen* species which, at present, have not been recognized. Figure 2 illustrates the most frequently collected larvae in the study region.

Seasonal composition

Figure 3 shows the percent specific composition of planktonic fish eggs in each season. Remarkably, there were no evidence of fish eggs in our summer plankton samples. Spawning of most species begins in autumn, and progresses through winter, when the southern blue whiting and grenadier fish contribute to more than half of all eggs present in our samples. During spring, the contribution of the latter decrease and blue whiting eggs prevail on the overall ìchthyoplankton composition. The seasonal variation of number of positive stations and mean densities is included in Table 4.

Figure 4 shows the percent specific composition

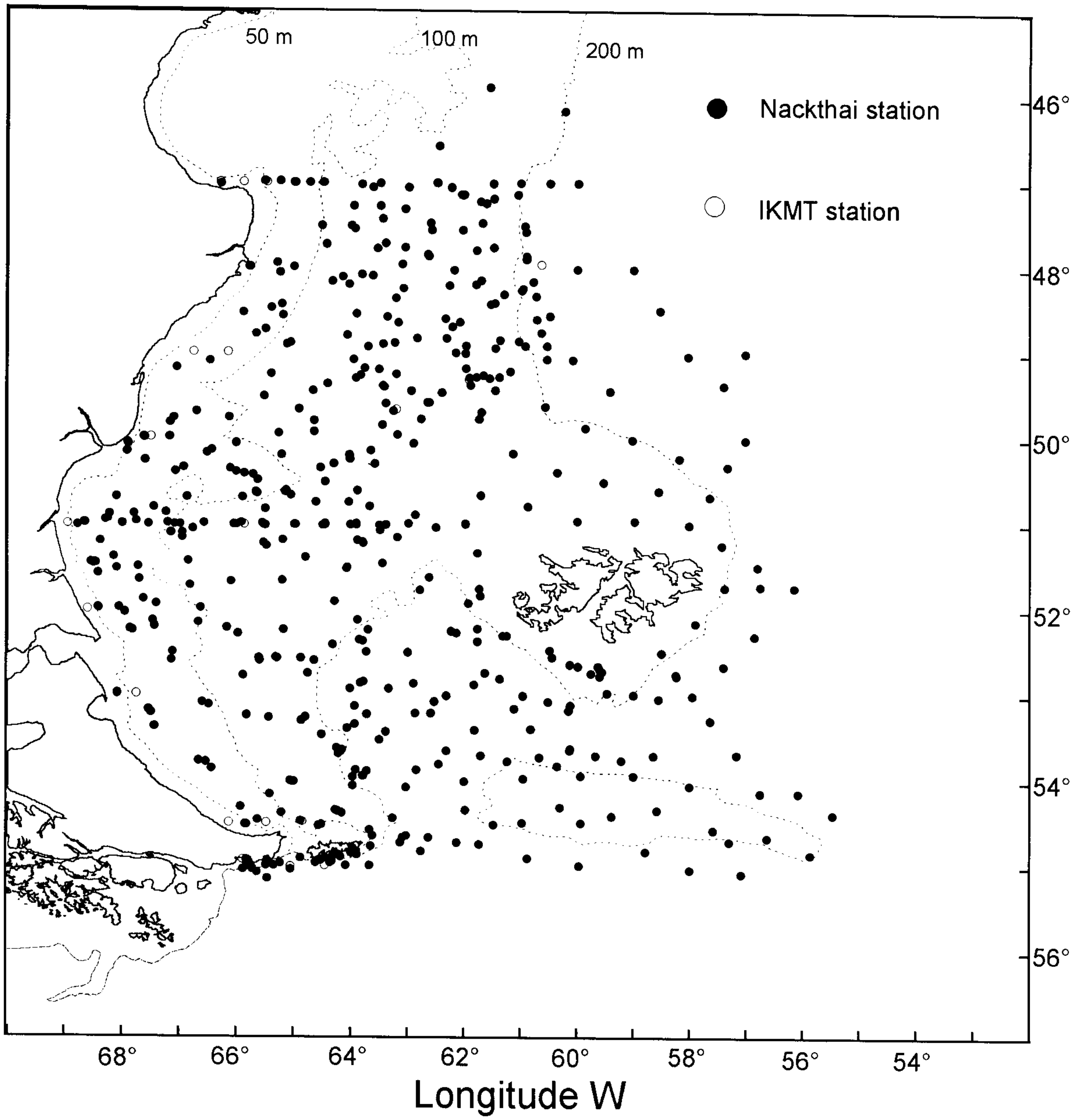

Figure 1. Investigated area with total Nackthai and IKMT stations.
Figura 1. Area de investigación con el total de estaciones de Nackthai e IKMT.

Table 3. Identified larval taxa in the study area, in different ichthyoplankton reviews.
Tabla 3. Taxiones larvales identificados en el área de estudio en diferentes revisiones ictioplanctónicas.

	Ciechomski *et al.* (1975)	Ciechomski *et al.* (1981)	Cassia & Booman (1985)	Sánchez & Ciechomski (1995)	This paper
Agonidae					
Agonopsis chiloensis	present	present			present
Argentinidae					present
Atherinidae	present				
Austroatherina nigricans					present
Bathylagidae					
Bathylagus antarcticus					present
Clupeidae					
Sprattus fuegensis	present	present	present	present	present
Ramnogaster arcuata					present
Centrolophidae	present				
Gadidae					
Micromesistius australis		present	present	present	present
Gonostomatidae					present
Maurolicus muelleri		present			
Idiacanthidae					
Idiacanthus atlanticus	present	present			
Macrouridae					
Coelorhynchus fasciatus		present			present
Macrourus whitsoni		present			present
Merluccidae					
Macruronus magellanicus	present				present
Moridae					
Salilota australis	present	present	present	present	present
Myctophidae	present	present	present	present	present
Krefftichthys anderssoni					present
Gymnoscopelus braueri					present
Gymnoscopelus nicholsi					present
Protomyctophum tenisoni					present
Protomyctophum normani					present
Nototheniidae	present	present	present	present	present
Dissostichus eleginoides	present	present			present
Eleginops maclovinus	present				present
Paralepididae					
Notolepis coatsi					present
Lestidiops sp.					present
Scorpaenidae	present	present			
Sebastes oculatus					present
Cyclopteridae					
Careproctus pallidus					present
Trichiuridae					
Lepidopus caudatus	present				present
Tripterygiidae					
Tripterygion cunninghami	present				present
Zoarcidae	present	present	present	present	present
Total number of taxa	15	13	6	6	28

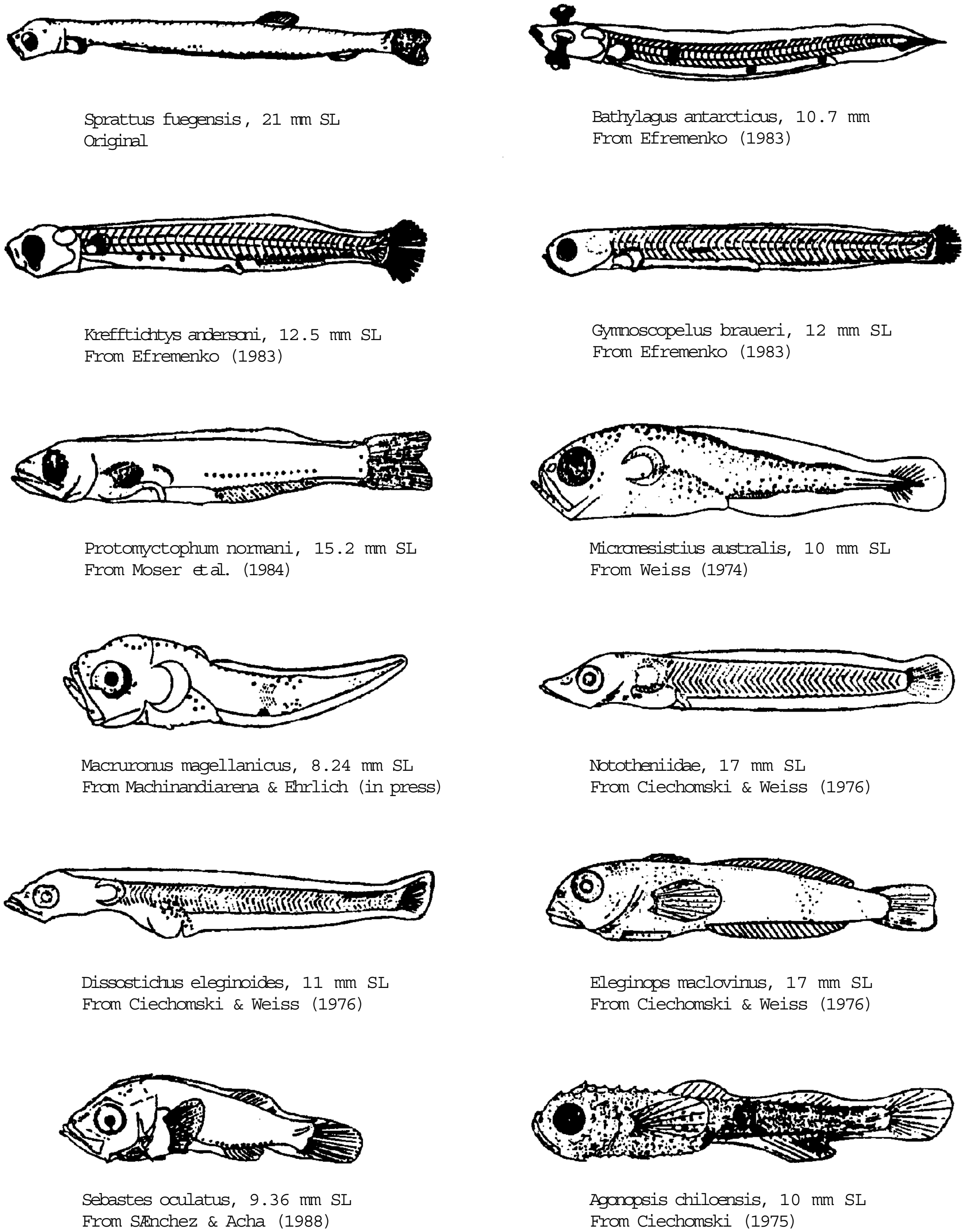

Figure 2. Representative larvae of the south Patagonian shelf and adjacent waters.
Figura 2. Larvas representativas de la plataforma patagónica austral y aguas adyacentes.

of planktonic fish larvae in each season. Myctophiid species comprise the most frequent group all year round. Nototheniids rank second in importance. During the period analyzed in this paper, the Fuegan sprat was recorded only during spring and autumn. This should be attributed to sampling limitations, since it is well known that larvae of the species comprise a large proportion (57%) of all larvae collected off Southern Patagonia during summer (see Sánchez *et al*., (1993) for a review).

Seasonal densities, incidence and number of positive stations, of every identified taxon, is listed in Table 5.

Unidentified larvae are more abundant in winter (54.95%) and markedly less abundant in summer (8.03%). This is due to the fact that as larvae grow the chances to recognize specimens increase.

Under "other fish larvae" we have grouped se-veral demersal fish species that were present at low densities. Their contribution to the overall ichthyoplankton composition ranged from 8 to 14 %, according to the season.

Composition variation with depth

Tables 6 and 7 summarize the information on abundance of fish eggs and larvae at different depth intervals.

Southern blue whiting eggs were largely found over the continental shelf, whereas those of the two species of grenadier fish prevailed over the slope at depths ranging from 400 to 700 m. Unidentified eggs, to a large extent, were obtained in stations at depths over 900 m. Quite likely they belong to such Families as Myctophidae or Macrouridae.

Larvae of Fuegan sprat, southern blue whiting, Patagonian tooth fish (*D. eleginoides*), and Patagonian blennie (*E. maclovinus*) prevail in coastal and shelf waters. Nototheniid larvae occupy a wide bathymetric range, from less than 100 m to over 1000 m. At a depth range between 800-1000 m there is a predominance of myctophiid larvae (*Krefftichthys anderssoni*) and other subantarctic species such as *Notolepis coatsi* and *Bathylagus antarcticus.* Over 50 % of all larvae were collected at the 800-1000 m depth range. Unidentified larvae were mostly obtained from shelf waters at the 100-200 m depth range.

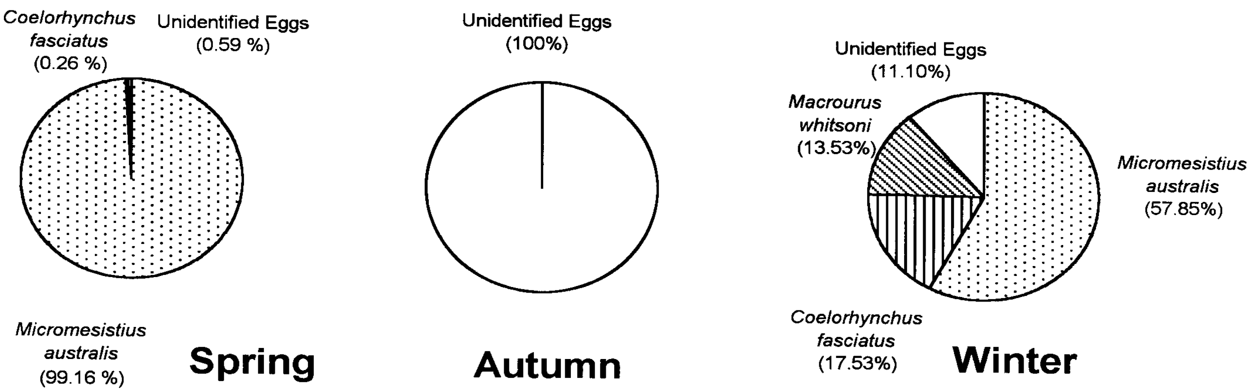

Figure 3. Percentual incidence of different groups in total eggs in each year season.
Figura 3. Incidencia porcentual de diferentes grupos en el total de huevos en cada estación del año.

Table 4. Relative seasonal incidence of fish eggs in our ichthyoplankton collections.
Tabla 4. Incidencia relativa estacional de huevos de peces en las colecciones de ictioplancton.

	Spring			Summer			Autumn			Winter		
Total stations with eggs	19			-			1			23		
Identified taxa	2			-			-			3		
Mean density (eggs.10m^{-2})	3864.32			-			64.63			142.85		
Eggs	N° st.	Density	%	N° st.	Density	%	N° st.	Density	%	N° st.	Density	%
Micromesistius australis	5	15198	99.16	-	-	-	-	-	-	2	512.2	57.85
Coelorhynchus fasciatus	1	39.7	0.26	-	-	-	-	-	-	9	155.2	17.53
Macrourus whitsoni	-	-	-	-	-	-	-	-	-	2	119.8	13.53
Unidentified eggs	14	89.7	0.59	-	-	-	1	64.63	100	18	98.18	11.09

Table 5. Relative seasonal incidence of fish larvae in the ichthyoplankton collections.
Tabla 5. Incidencia relativa estacional de larvas de peces en las colecciones de ictioplancton.

	Spring			Summer			Autumn			Winter		
Total stations with larvae	85			16			34			48		
Identified taxa	16			4			6			9		
Mean density (larvae. 10m^{-2})	134.87			68.13			28.59			110.51		
Larvae	N° st.	Density	%	N° st.	Density	%	N° st.	Density	%	N° st.	Density	%
Sprattus fuegensis	5	371.89	25.5	-	-	-	11	37.25	22.9	-	-	-
Argentinidae	1	11.45	0.7	-	-	-	-	-	-	-	-	-
Bathylagus antarcticus	3	43.82	3.0	-	-	-	-	-	-	2	31.83	3.0
Gonostomatidae	-	-	-	-	-	-	-	-	-	8	13.20	1.2
Notolepis coatsi	1	43.93	3.0	-	-	-	-	-	-	-	-	-
Myctophidae	5	31.15	2.1	-	-	-	2	15.46	9.5	8	38.06	3.6
Krefftichthys anderssoni	52	223.87	15.3	-	-	-	-	-	-	27	70.69	6.7
Gymnoscopelus spp.	4	27.56	1.8	7	130.11	53.0	15	20.94	12.9	5	24.39	2.3
Protomyctophum spp.	27	54.90	3.7	7	27.83	11.3	12	31.42	19.3	29	78.54	7.5
Salilota australis	1	9.52	0.6	-	-	-	-	-	-	-	-	-
Micromesistius australis	9	66.90	4.6	-	-	-	-	-	-	1	140.99	13.5
Macruronus magellanicus	6	33.26	2.2	-	-	-	-	-	-	-	-	-
Austroatherina nigricans	-	-	-	1	34.38	14.0	-	-	-	-	-	-
Sebastes capensis	-	-	-	-	-	-	-	-	-	1	35.02	3.3
Agonopsis chiloensis	2	10.60	0.7	-	-	-	-	-	-	-	-	-
Nototheniidae	24	70.74	4.8	2	33.31	13.5	2	40.27	24.8	1	37.98	3.6
Dissostichus eleginoides	1	22.91	1.5	-	-	-	-	-	-	-	-	-
Eleginops maclovinus	4	19.58	1.3	-	-	-	-	-	-	-	-	-
Tripterygion cunninghami	-	-	-	-	-	-	1	17.00	10.4	-	-	-
Lepidopus caudatus	1	9.52	0.6	-	-	-	-	-	-	-	-	-
Unidentified larvae	6	403.93	27.7	1	19.71	8.0	-	-	-	5	573.02	54.9

Ichthyoplankton assemblages in the study area

The resulting dendrogram in the cluster analysis is presented in Figure 5. The vertical line at 0.93 is indicative of cluster recognition. At this level four characteristic groups may be identified. Nototheniid larvae formed the first group. The second includes larvae of *Agonopsis chiloensis*, *Eleginops maclovi-*

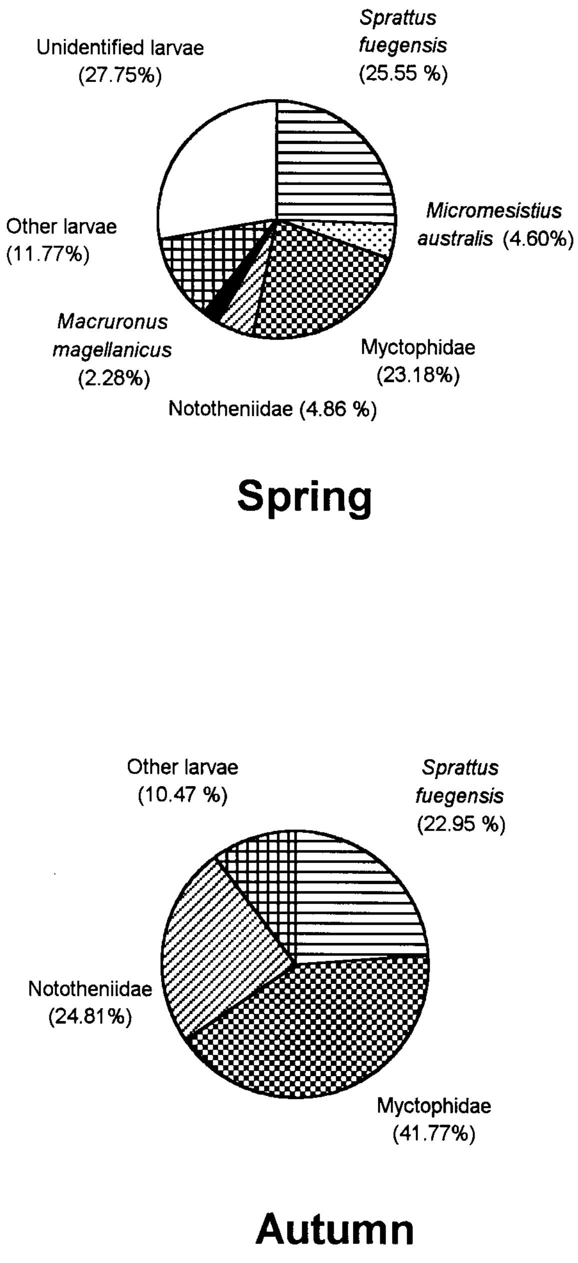

Figure 4. Percentual incidence of different groups in total larvae in each year season.
Figura 4. Incidencia porcentual de diferentes grupos en el total de larvas en cada estación del año.

Table 6. Egg composition in relation to bottom depth.
Tabla 6. Distribución de huevos en relación a la profundidad del fondo.

Depth (m)	*C. fasciatus*			*M. whitsoni*			*M. australis*			Unidentified eggs			Total eggs		
	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%
<100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100-200	1	24.9	4.0	-	-	-	6	12740.6	95.7	2	48.7	4.2	9	8512.8	87.4
200-300	-	-	-	-	-	-	-	-	-	1	24.5	2.1	1	24.5	0.2
300-400	1	19.4	3.1	-	-	-	1	571.4	4.2	4	98.9	8.5	6	136.8	1.4
400-500	3	315.6	51.6	-	-	-	-	-	-	7	93.0	8.0	8	178.9	1.8
500-600	3	97.0	15.8	1	209.6	87.5	-	-	-	5	97.0	8.4	5	121.2	1.2
600-700	1	119.8	19.6	1	29.9	12.5	-	-	-	2	97.0	8.4	2	72.0	0.7
700-800	-	-	-	-	-	-	-	-	-	1	76.8	6.6	1	76.8	0.7
800-900	-	-	-	-	-	-	-	-	-	1	408.4	35.3	1	408.4	4.1
900-1000	-	-	-	-	-	-	-	-	-	1	156.7	13.5	1	156.7	1.6
> 1000	1	34.4	5.6	-	-	-	-	-	-	9	52.5	4.5	9	50.7	0.5

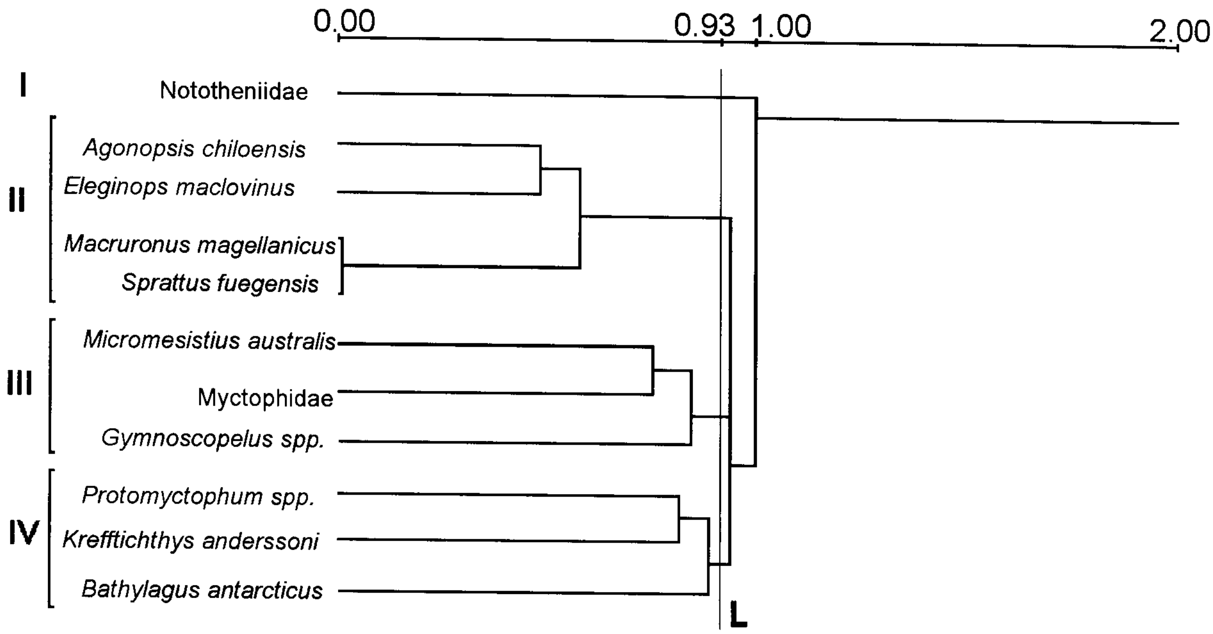

Figure 5. Dendrogram showing the four recognized ichthyoplankton assemblages. Vertical line **L** indicates level of cluster recognition.
Figura 5. Dendrograma que indica los cuatro conjuntos ictioplanctónicos reconocidos. La línea vertical L indica el nivel de corte.

Table 7. Larval composition in relation to bottom depth.
Tabla 7. Distribución de larvas en relación a la profundidad del fondo.

Depth (m)	*Sprattus fuegensis*			Argentinidae			*Bathylagus antarcticus*			Gonostomatidae			*Notolepis coatsi*		
	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%
<100	10	150.8	33.5	-	-	-	-	-	-	-	-	-	-	-	-
100-200	4	154.1	34.3	1	11.4	100	-	-	-	2	16.5	30.6	-	-	-
200-300	1	14.9	3.3	-	-	-	-	-	-	2	13.5	25.2	-	-	-
300-400	1	129.3	28.7	-	-	-	1	29.2	26.0	3	10.8	20.0	-	-	-
400-500	-	-	-	-	-	-	-	-	-	1	12.9	24.0	-	-	-
500-600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
600-700	-	-	-	-	-	-	2	46.3	41.3	-	-	-	-	-	-
700-800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
800-900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
900-1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
>1000	-	-	-	-	-	-	2	36.6	32.6	-	-	-	1	43.9	100.0

Depth (m)	Myctophidae			*Krefftichthys anderssoni*			*Gymnoscopelus* spp.			*Protomyctophum* spp.			*Salilota australis*		
	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%
<100	-	-	-	2	24.8	1.0	1	37.06	11.0	-	-	-	-	-	-
100-200	8	37.0	25.5	32	39.3	1.6	23	29.27	8.7	38	36.0	5.9	1	9.5	100.0
200-300	1	14.7	10.1	7	70.4	2.8	3	174.27	51.8	8	63.5	10.5	-	-	-
300-400	4	28.7	19.7	8	78.0	3.2	3	57.30	17.0	10	70.8	11.7	-	-	-
400-500	1	39.7	27.3	6	215.8	8.8	2	38.37	11.4	7	136.7	22.7	-	-	-
500-600	-	-	-	3	103.3	4.2	-	-	-	1	78.9	13.1	-	-	-
600-700	-	-	-	3	40.8	1.6	-	-	-	1	54.1	9.0	-	-	-
700-800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
800-900	-	-	-	1	816.9	33.4	-	-	-	1	51.0	8.4	-	-	-
900-1000	-	-	-	1	431.1	17.6	-	-	-	1	39.2	6.5	-	-	-
>1000	1	25.0	17.2	16	618.8	25.3	-	-	-	9	71.2	11.8	-	-	-

Table 7. Continued.
Tabla 7. Continuación.

Depth (m)	*Micromesistius australis*			*Macruronus magellanicus*			*Austroatherina nigricans*			*Sebastes oculatus*			*Agonopsis chiloensis*		
	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%
<100	2	24.8	17.0	2	62.6	77.1	1	34.3	100	-	-	-	-	-	-
100-200	7	95.5	65.8	4	18.5	22.8	-	-	-	1	35.0	100.0	2	10.6	100.0
200-300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300-400	1	24.8	17.1	-	-	-	-	-	-	-	-	-	-	-	-
400-500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500-600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
600-700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
700-800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
800-900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
900-1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
>1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Depth (m)	Nototheniidae			*Dissostichus eleginoides*			*Eleginops maclovinus*			*Tripterygion cunninghami*			*Lepidopus caudatus*		
	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%	No.St.	Density	%
<100	6	46.9	31.0	-	-	-	3	9.3	15.6	1	17.0	100.0	-	-	-
100-200	22	71.2	47.1	1	22.9	100	1	50.2	84.3	-	-	-	1	9.5	100.0
200-300	-	-	-	-	-	-	-	59.6	-	-	-	-	-	-	-
300-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
400-500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500-600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
600-700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
700-800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
800-900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
900-1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
>1000	1	32.8	21.7	-	-	-	-	-	-	-	-	-	-	-	-

Depth (m)	Unidentified larvae			Total larvae		
	No.St.	Density	%	No.St.	Density	%
<100	1	14.6	1.5	21	73.9	4.7
100-200	6	861.	89.6	89	77.1	4.9
200-300	-	-	-	13	71.8	4.6
300-400	2	12.6	1.3	18	56.3	3.6
400-500	1	38.9	4.0	10	134.4	8.6
500-600	-	-	-	4	97.2	6.2
600-700	-	-	-	3	44.9	2.8
700-800	-	-	-	-	-	-
800-900	-	-	-	1	433.9	27.7
900-1000	-	-	-	1	235.1	15.0
>1000	2	32.8	3.4	16	336.8	21.5

nus, Macruronus magellanicus and *Sprattus fuegensis*. The third cluster contains larvae of *Micromesistius australis, Gymnoscopelus* spp. and unidentified mycthophiid larvae. The fourth comprises larvae of *Krefftichthys anderssoni, Protomyctophum* spp. and *Bathylagus antarcticus.*

Figure 6 shows the distribution of larvae of the first group, formed exclusively by nototheniid larvae, which occupy a vast area on the continental shelf between latitudes 46° and 52°S. They are also found to the south of Tierra del Fuego, Isla de los Estados and Burdwood Bank in coastal waters between 50-200 m bottom depth.

The four species included in the second group are relatively rare, appearing in few stations in small numbers, always in coastal waters off southern Patagonia, Tierra del Fuego, Isla de los Estados and the Strait of Le Maire (Fig. 7), whereas species grouped in the third cluster inhabit the outer continental shelf and slope (Fig. 8). The fourth cluster includes species typically found in Subantarctic waters of the Malvinas Current along the outer con-

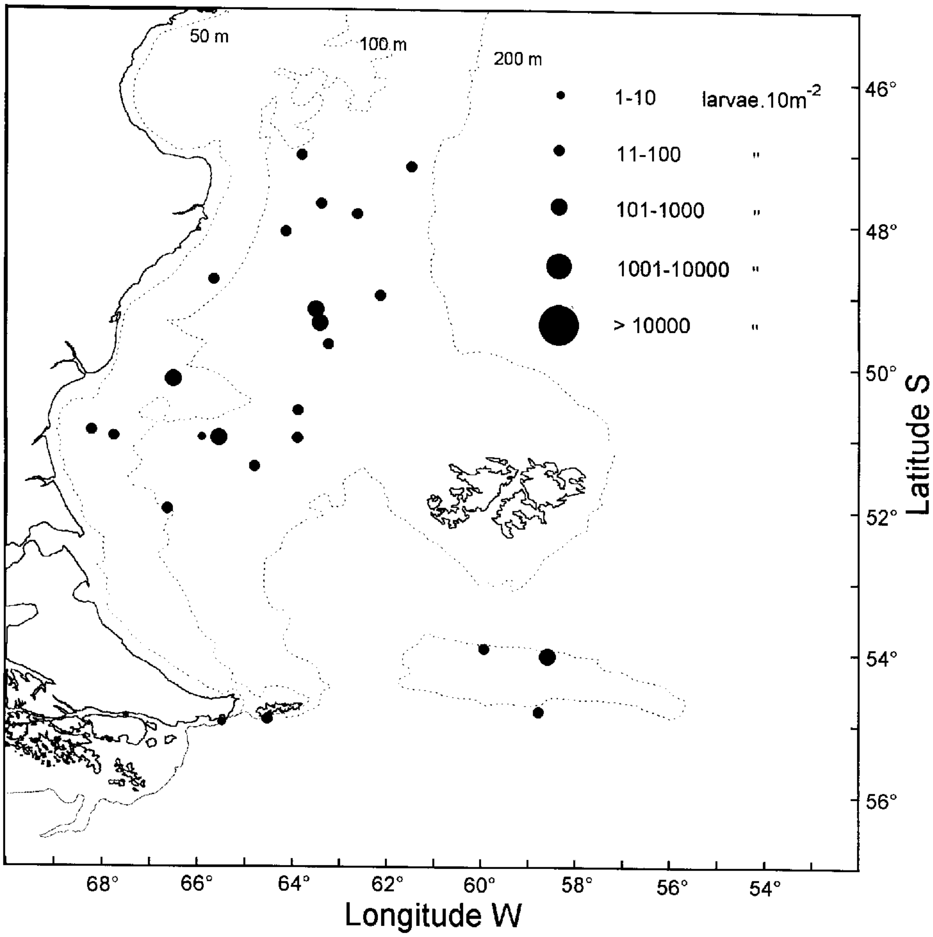

Figure 6. Spring distribution of nototheniid larvae corresponding to the first cluster group.
Figura 6. Distribución primaveral de larvas de Nototheniidae correspondientes al primer grupo.

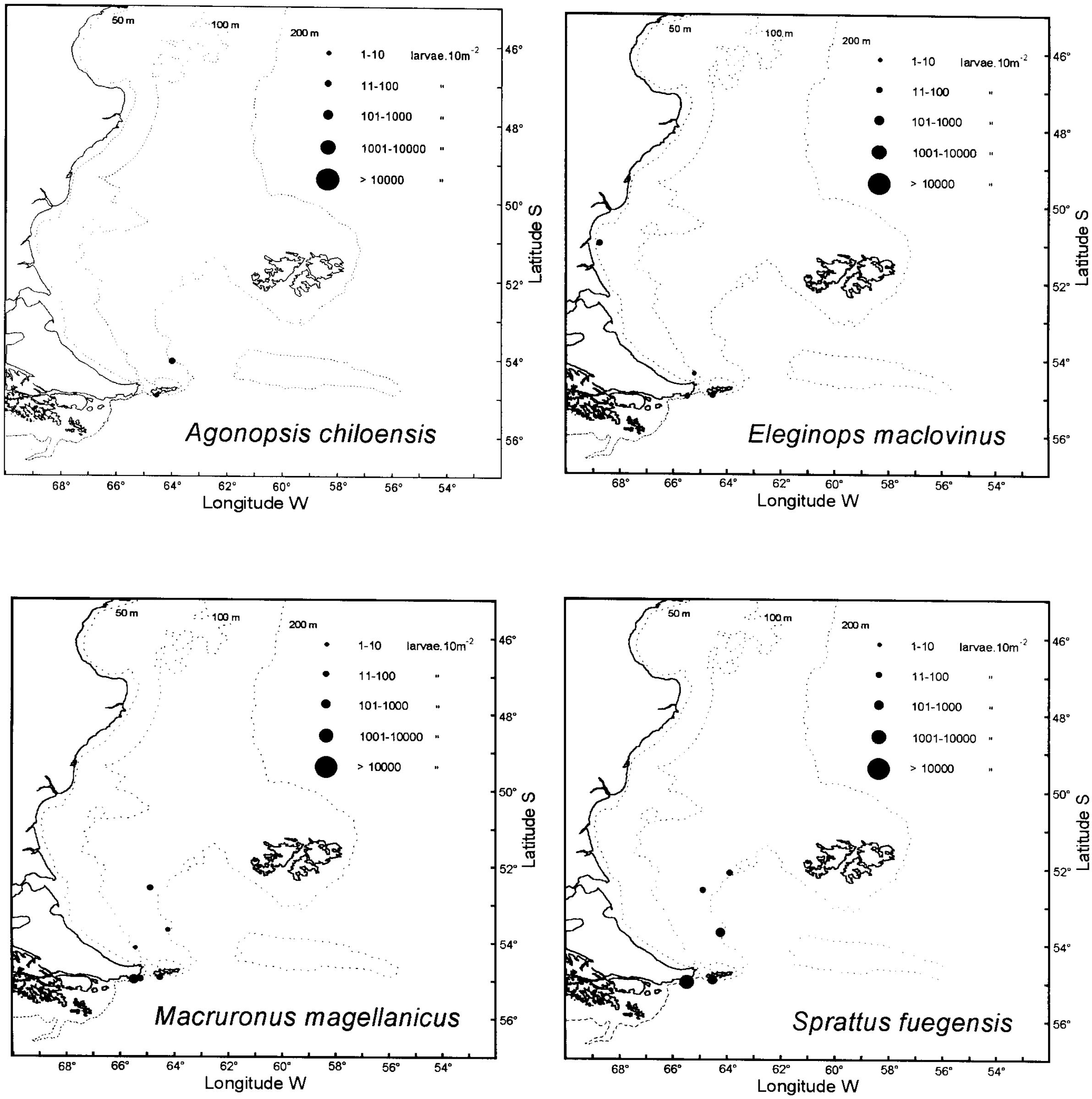

Figure 7. Spring distribution of larvae corresponding to the second cluster group.
Figura 7. Distribución primaveral de larvas correspondientes al segundo grupo.

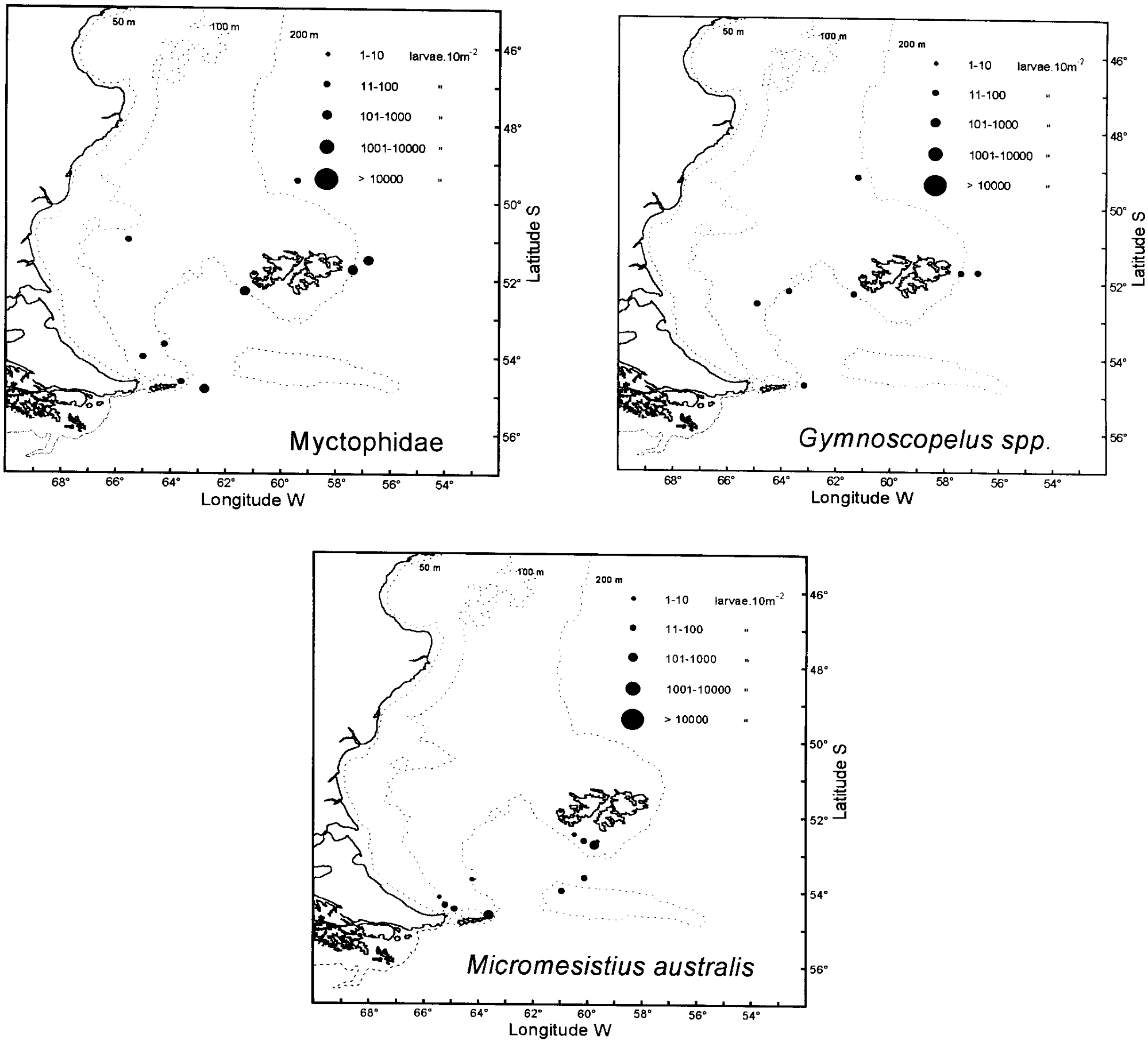

Figure 8. Spring distribution of larvae corresponding to the third cluster group.
Figura 8. Distribución primaveral de larvas correspondientes al tercer grupo.

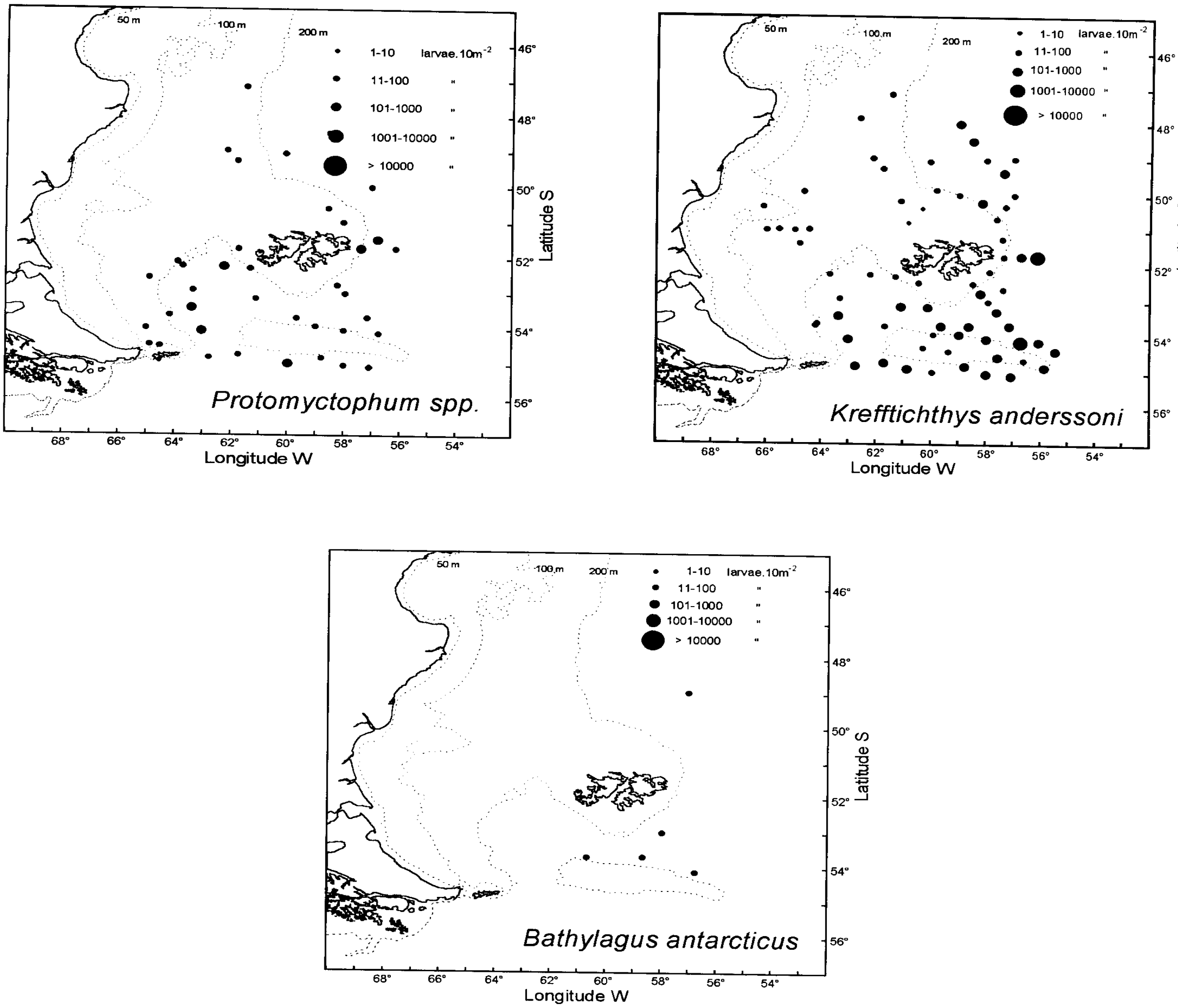

Figure 9. Spring distribution of larvae corresponding to the fourth cluster group.
Figura 9. Distribución primaveral de larvas correspondientes al cuarto grupo.

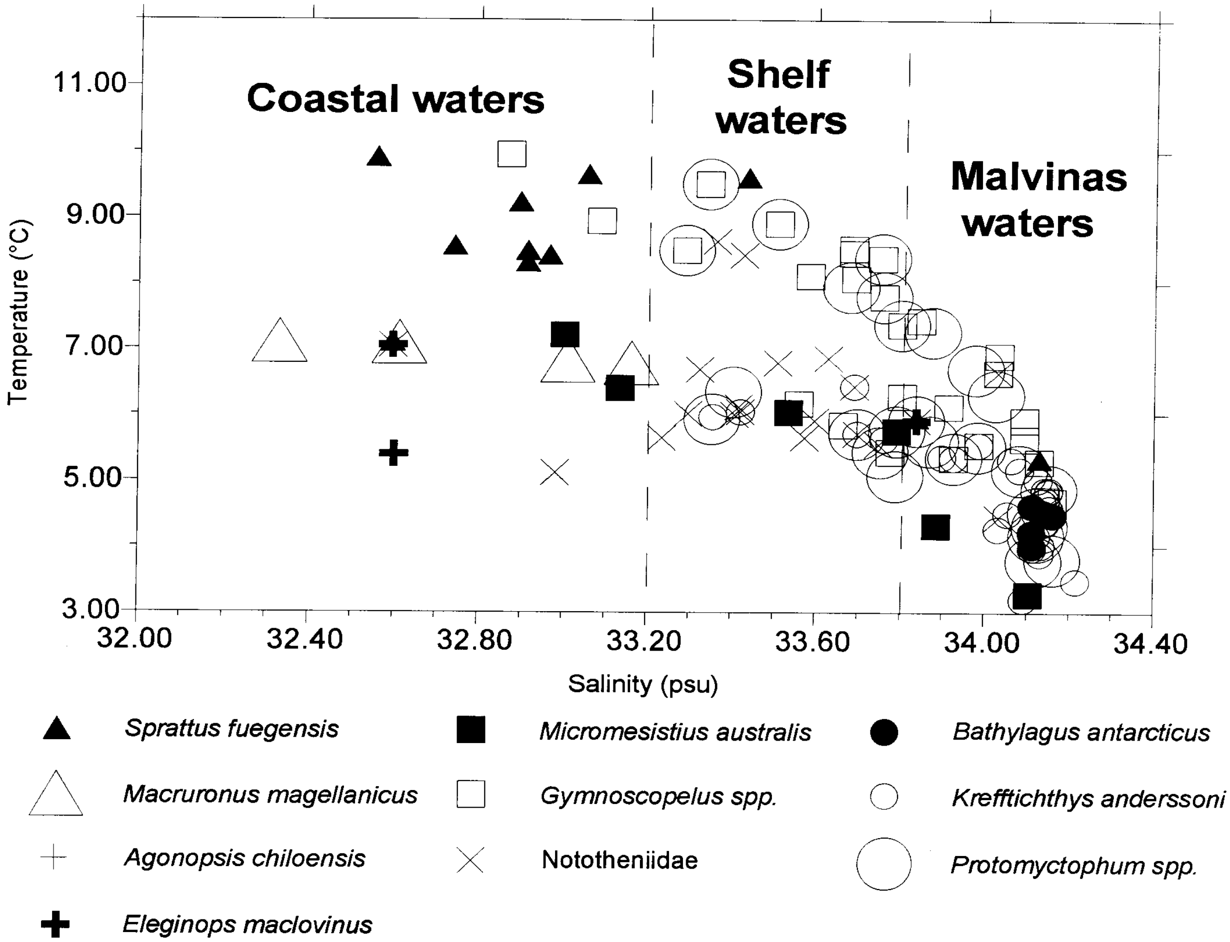

Figure 10. TS diagram showing the occurrence of fish larvae in different water masses.
Figura 10. Diagrama TS donde se muestra la presencia de larvas de peces en diferentes masas de agua.

Table 8. Abundance of eggs in relation to water masses (densities in eggs/10 m^2)
Tabla 8. Abundancia de huevos en relación a las masas de agua (densidades en huevos/10 m^2)

	Coastal Waters			Shelf Waters			Malvinas Waters		
Total stations with eggs	-			1			9		
No. of identified taxa	-			1			3		
Egg mean density	-			210.08			5782.75		
Eggs	No. St.	Density	%	No. St.	Density	%	No. St.	Density	%
Micromesistius australis	-	-	-	1	210.08	0.74	2	28223.63	99.26
Coelorhynchus fasciatus	-	-	-	-	-	-	7	192.90	100.00
Macrourus whitsoni	-	-	-	-	-	-	1	29.96	100.00

Table 9. Abundance of larvae in relation to water masses (densities in larvae/10 m^2)
Tabla 9. Abundancia de larvas en relación a las masas de agua (densidades en larvas/10 m^2)

	Coastal Waters			Shelf Waters			Malvinas Waters		
Total stations with larvae	16			46			80		
No. of identified taxa	8			8			13		
Larval mean density	85.65			44.53			154.67		
Larvae	No. St.	Density	%	No. St.	Density	%	No. St.	Density	%
Sprattus fuegensis	8	181.56	45.35	1	28.50	7.12	2	190.32	47.53
Argentinidae	-	-	-	-	-	-	1	11.45	100.00
Bathylagus antarcticus	-	-	-	-	-	-	5	39.02	100.00
Notolepis coatsi	-	-	-	-	-	-	1	43.93	100.00
Krefftichthys anderssoni	-	-		14	28.02	9.17	52	277.42	90.83
Gymnoscopelus spp.	2	26.15	20.20	12	37.00	28.58	13	66.31	51.22
Protomyctophum spp.	-	-	-	16	31.00	31.16	39	68.50	68.84
Micromesistius australis	2	24.80	10.77	2	81.47	35.37	4	124.04	53.86
Macruronus magellanicus	2	62.67	55.42	1	16.89	14.94	1	33.52	29.64
Austroatherina nigricans	1	34.38	100.00	-	-	-	-	-	
Sebastes oculatus	-	-	-	1	35.02	100.00	-	-	-
Agonopsis chiloensis	-	-	-	-	-		1	8.38	100.00
Nototheniidae	2	19.70	15.19	16	76.88	59.28	4	33.10	25.52
Dissostichus eleginoides	-	-	-	-	-	-	1	22.91	100.00
Eleginops maclovinus	3	9.35	15.68	-	-	-	1	50.28	84.32
Tripterygion cunninghami	1	17.00	100.00	-	-	-	-	-	-

tinental shelf and Burdwood Bank (Fig. 9).

Temperature and salinity values which characterized the maximum sampling depths at the stations where the different components of each cluster were collected, are plotted in Figure 10. The detail of abundance of eggs and larvae in each of the water masses identified in the area is presented in Tables 8 and 9. Coastal and shelf waters correspond to the "shelf regime" and Malvinas waters to the "open ocean regime" according to Guerrero *et al.* (1998).

Distribution and abundance of eggs and larvae of the southern blue whiting

The southern blue whiting, an unexploited resource prior to the late 70's, has suported during the 80's a directed fishery operating on its spawning concentrations to the west and southwest of Malvinas. First quantitative data on eggs and larvae of the species around the archipelago were obtained by INIDEP in 1978 and later in 1981, 1994 and 1995. In order to compare their abundance and distribution during the 70's, 80's and 90's, we have subdivided the area surrounding Malvinas Islands in three sectors: west, north and south.

Figures 11 and 12 show the distribution of eggs and larvae of blue whiting, collected in each sector, in late winter-early spring, from 1978 to 1995. In the late 70's eggs of the species were found in the three sectors. In the early eighties no eggs were collected to the north of the islands, whereas in 1994 and 1995 eggs were obtained to the south of Malvinas. The distribution of larvae is somewhat similar, with the exception of 1994, where larvae of blue whiting were collected in the SW extreme of the west sector, and to the north of the Strait of Le Maire.

Some of these differences may be accounted for by variations in the sampling design applied each year. However, the decline of the proportion of positive stations in the area (i.e. stations with at least 1 egg/larva of the species) may also be taken as an indicative of a contraction of the spawning grounds around Malvinas (Fig. 13).

Distribution of post-larvae and juveniles

As a first step towards a description of migratory patterns during the early life history stages of fish in the study region, we include the first references on the quantitative distribution of post-larvae and juveniles in late spring in the area. The samples were obtained with an IKMT at the locations indicated in Figure 1. Predominant species were two small pelagic clupeoids (*Sprattus fuegensis* and *Ramnogaster arcuata)* along the coast, the southern blue whiting on shelf waters (100-200 m depth) from 52° to 55°S, and nototheniid specimens widely distributed over the shelf (Fig. 14). The occurrence of post-larvae and juveniles of less frequent species (i.e. *Lepidopus caudatus*, *Lestidiops* sp., *Careproctus pallidus, Agonopsis chiloensis* and several zoarcids) is represented in Figure 15.

Figure 16 shows the length frequency distribution of post-larvae and juveniles of sprat and blue whiting. Size ranges encountered indicate that the sprat material comes from spring-early summer spawnings during the previous season (Sánchez *et al.*, 1993) whereas the blue whiting specimens must have been born during the previous winter [2].

DISCUSSION AND CONCLUSIONS

In spite of methodological limitations, particularly as regards consistency of the sampling design, the large number of samples analyzed and the vast spatial coverage considered allow to reach some interesting conclusions as regards the distribution

[2] The exact birth date of these juveniles will be determined by back calculation of daily ring countings.

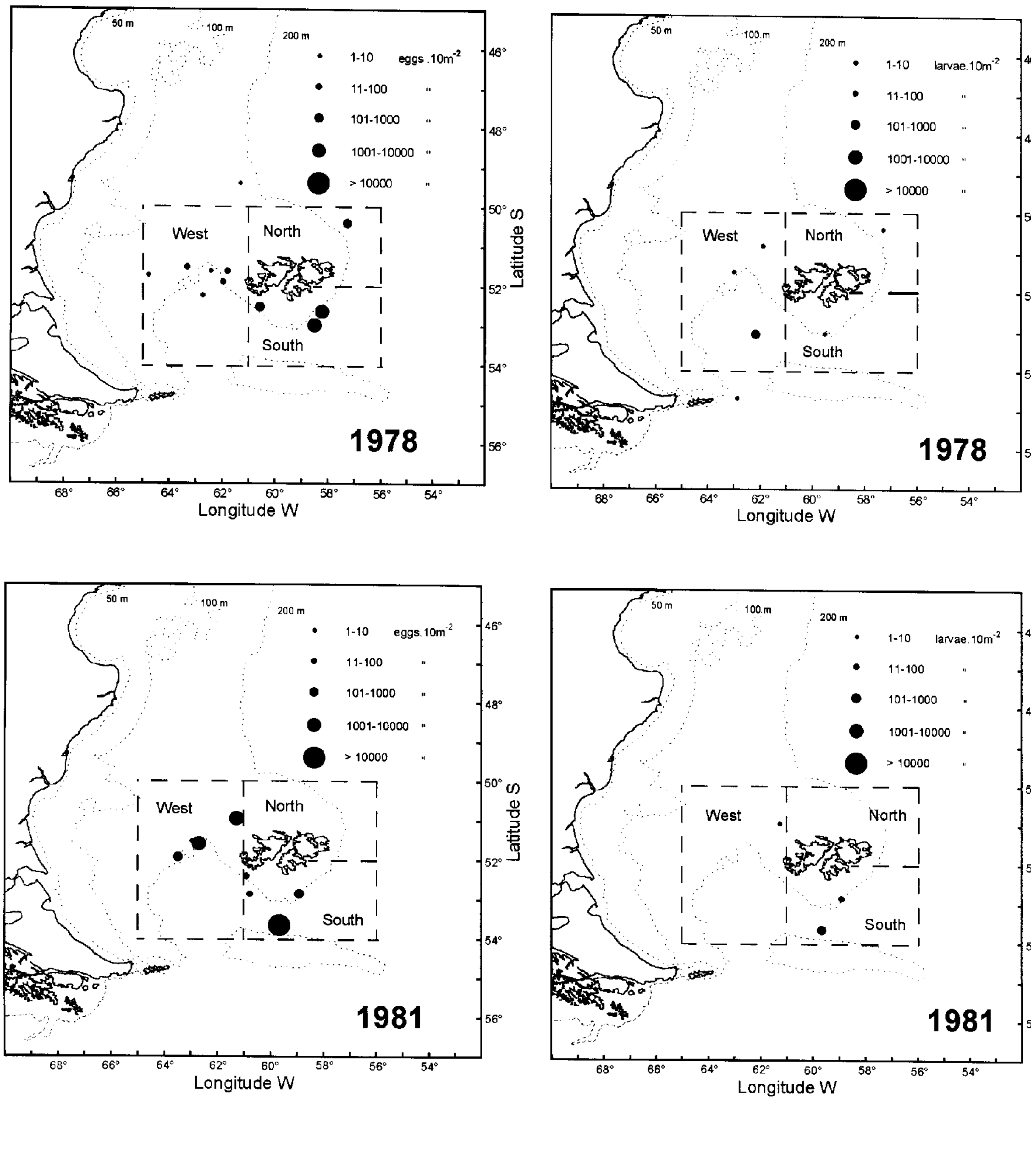

Figure 11. Distribution and abundance of *Micromesistius australis* eggs and larvae during late winter and early spring in 1978 and 1981.

Figura 11. Distribución y abundancia de huevos y larvas de Micromesistius australis a fines del invierno y comienzos de la primavera en 1978 y 1981.

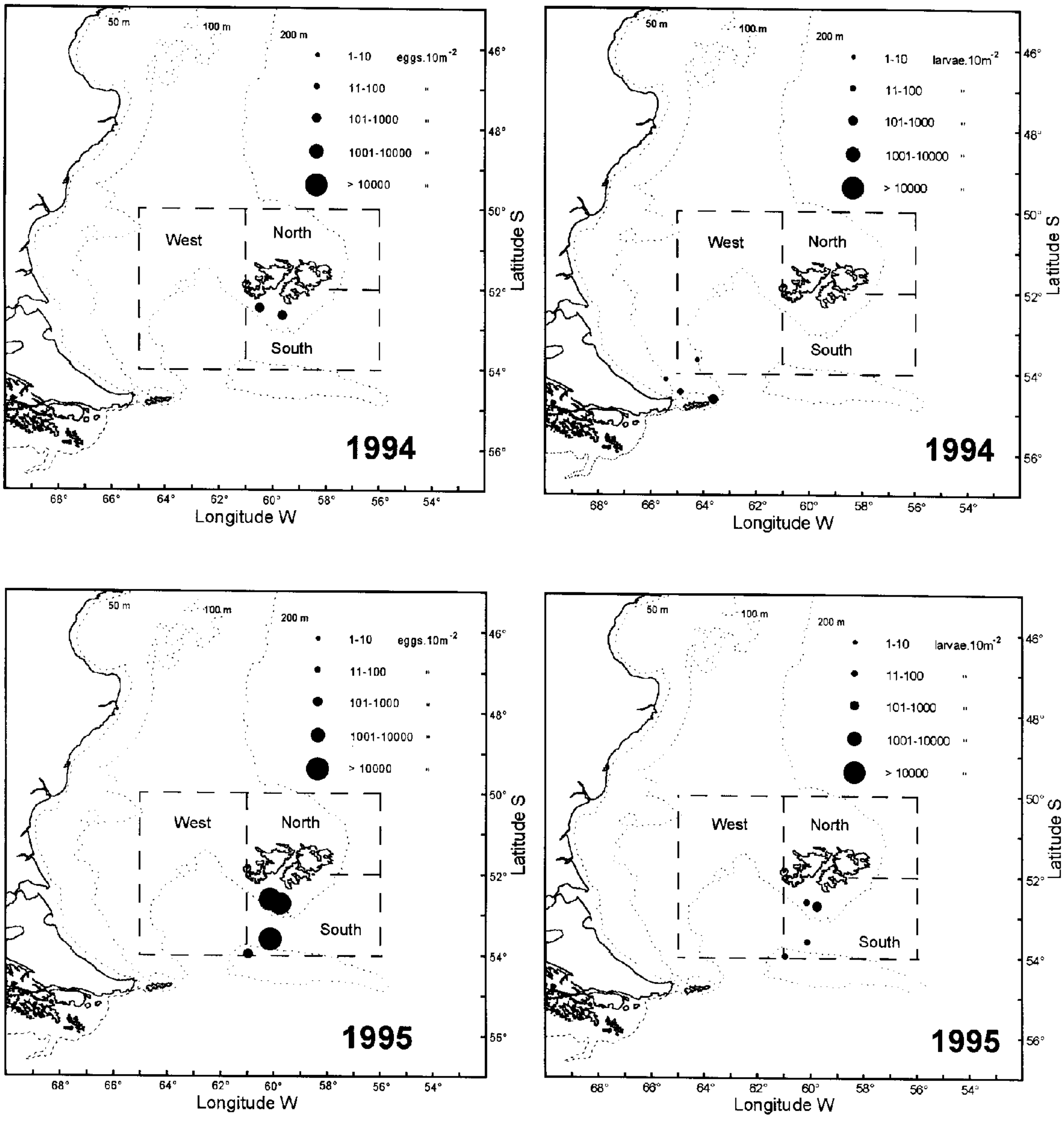

Figure 12. Distribution and abundance of *Micromesistius australis* eggs and larvae during late winter and early spring in 1994 and 1995.

Figura 12. Distribución y abundancia de huevos y larvas de Micromesistius australis a fines del invierno y comienzos de la primavera en 1994 y 1995.

and abundance of the early life history of commercial fish in the area.

As reported in previous reviews (Ciechomski *et al.,* 1981) the main spawning period, in the study area, takes place in late winter/early spring. At this time of the year the southern blue whiting still contributes to a large percentage of the overall ichthyoplankton composition. Surprisingly, eggs of *Salilota australis*, an important component of the ichthyoplankton of the region in spring (15 % according to Ciechomski *et al.,* 1981) were totally absent in our samples. The absence of eggs of *Sprattus fuegensis*, on the other hand, may be attributed to the characteristics of sampling design, as the spawning areas were outside the geographical coverage of the surveys analyzed (Sánchez *et al*., 1983) .

Also in agreement with previous reports, larvae are more commonly found in spring and summer, as a natural consequence of timing of spawning in the region. Myctophid larvae prevailed in the region throughout the year, with a contribution of over 20% to the overall ichtyoplankton composition.

Although four larval fish assemblages could be recognized in the area, and their relationships with the hydrographical characteristics could be established, their validity needs further examination, particularly for lack of more detailed information on the taxonomy of such Families as Nototheniidae and Myctophidae. In relation with the latter, this report includes the first analysis of occurrence of 5 species and 3 genera.

The most important blue whiting eggs concentrations detected in this decade on the Malvinas shelf, south from San Carlos Strait in late winter and early spring (Figure 12), are coincident with the adult spawning schools reported by Madirolas (1998) by acoustic surveys.

Comparing the distribution of eggs and larvae of blue whiting from collections obtained during the 70's and 80's, with those of recent surveys (1994-1995), it is evident that a significant contraction of the spawning grounds of the species has take place, particularly to the west of the archipelago.

Reduction of spawning seasons and grounds

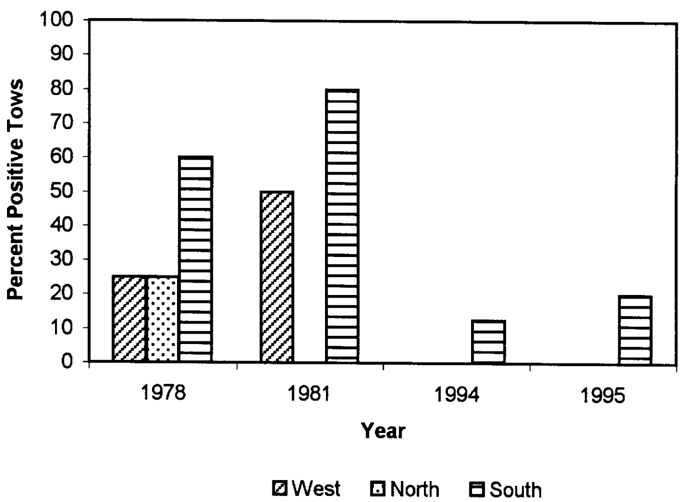

Figure 13. Incidence of *Micromesistius australis* eggs and larvae in ichthyoplankton samples.
Figura 13. Incidencia de huevos y larvas de Micromesistius australis en las muestras de ictioplancton.

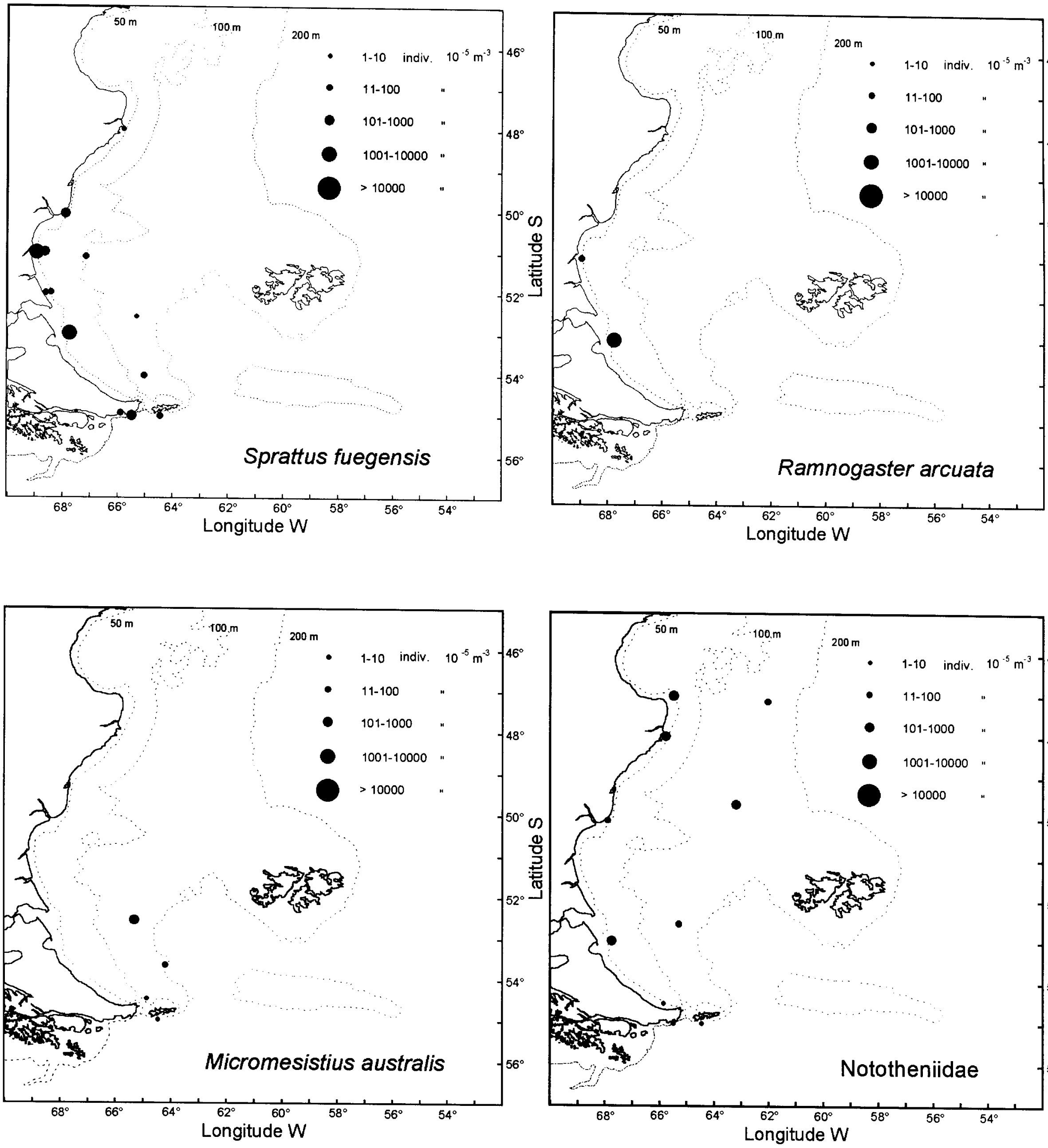

Figure 14. Distribution and abundance of post-larvae and juveniles of *Sprattus fuegensis*, *Ramnogaster arcuata*, *Micromesistius australis* and Nototheniidae collected with IKMT during late spring 1994.

Figura 14.Distribución y abundancia de postlarvas y juveniles de Sprattus fuegensis, Ramnogaster arcuata, Micromesistius australis y Nototheniidae colectados con IKMT en la primavera tardía de 1994.

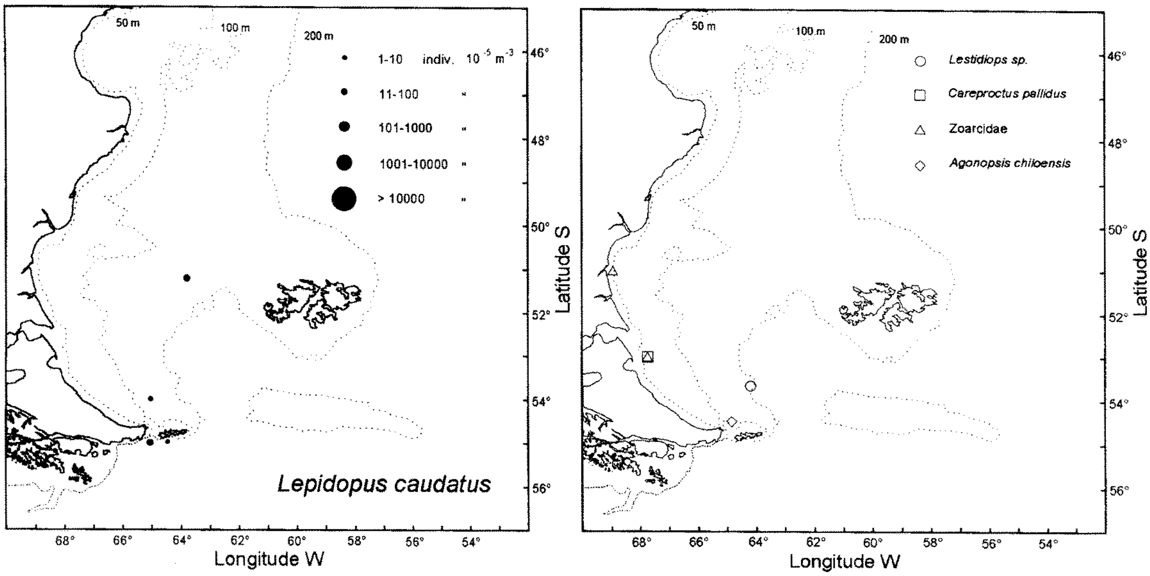

Figure 15. Distribution and abundance of different post-larvae and juveniles collected with IKMT during late spring 1994.
Figura 15. Distribución y abundancia de diferentes postlarvas y juveniles colectados con IKMT en la primavera tardía de 1994.

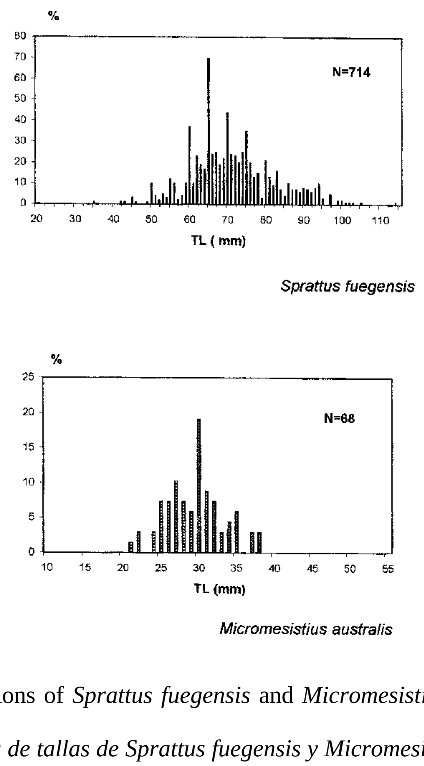

Figure 16. Length frequency distributions of *Sprattus fuegensis* and *Micromesistius australis* collected with IKMT during late spring 1994.
Figura 16. Distribución de frecuencias de tallas de Sprattus fuegensis y Micromesistius australis colectadas con IKMT en la primavera tardía de 1994.

along with changes in other reproductive parameters, have been cited elsewhere as indicative of high levels of fishery exploitation.

The nursery grounds of the two most important pelagic species were detected in a survey carried out in the spring of 1994 in which IKMT was used. Post-larvae of the blue whiting were obtained over the shelf from 52°30'S to 55°S, most probably resulting from winter spawning, based on the sizes encountered. Although at present conjectural, the characteristic of the circulation regime in the area, may be indicative that the material collected to the NE and S of Isla de los Estados could have originated in a spawning ground to the south of Tierra del Fuego, still undetected.[1]

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