

ECOLOGICAL SURVEY OF THE NOTOTHENIROID FISHES IN THE SOUTHERN OCEAN FROM BOUVET TO KERGUELEN ISLANDS

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Abstract: The oceanographical cruises of the R.S. MARION-DUFRESNE to Bouvet, Marion, Crozet, Kerguelen, Heard Islands and on the seamounts Ob', Lena, Kara Dag and Skiff, from 1974 to 1982, complemented by the observations made on board of several trawlers, have made possible to compare the different species of Nototheniidae and Channichthyidae which occur in this part of the Southern Ocean and draw some ecological conclusions: relations with the environment, abundance and geographical distribution.

First of all, it is noteworthy to point out the absence of Channichthyidae around Marion and Crozet Islands and their presence around Bouvet, Kerguelen and Heard. The species *Notothenia squamifrons* is characterized by a noticeable ubiquity and a power of adaptation to various biotopes which is not reached by other species. *Champscephalus gunnari* seems to be a tracer of lightly colder water masses and its abundance is directly related with the high productive areas of zooplankton.

1. Introduction

Since 1974, the R.S. MARION-DUFRESNE has made five oceanographical cruises aimed at the study of the benthic or benthic-pelagic fauna of the Indian and East Atlantic Sector of the Southern Ocean: MD 03 (1974, Kerguelen-Heard-Crozet Islands),

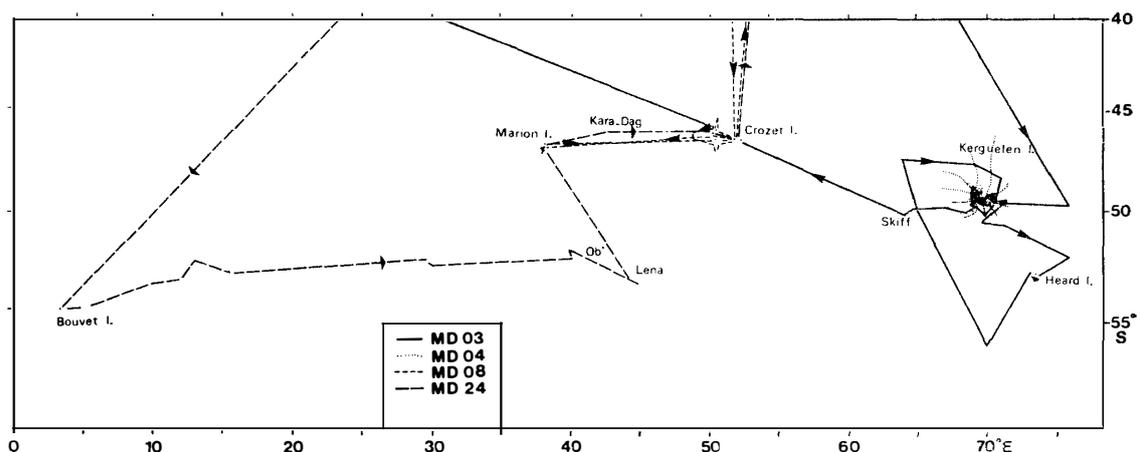


Fig. 1. Tracks of the oceanographical cruises MD 03, MD 04, MD 08 and MD 24 of the R.S. MARION-DUFRESNE. Cruise MD 30, limited to the Crozet Archipelago, has not been drawn.

MD 04 (1975, Kerguelen Archipelago), MD 08 (1976, Crozet–Marion–Prince Edward Islands), MD 24 (1980, Bouvet Island and Ob', Lena, Kara Dag seamounts), MD 30 (1982, Crozet) (Fig. 1). Moreover since 1979, the presence of observers on board the Soviet and French trawlers enabled to gather more data on Skiff and Kerguelen–Heard banks. Analysis of fish catches indicates that the distribution of the two families Nototheniidae and Channichthyidae is representative of the ecological conditions of the area.

At a specific level, the presence or absence of some species is an indication of the biogeographical zonation, particularly of the faunistical relations existing with the shelf of the Antarctic Continent or the western Antarctica (Scotia Sea, Antarctic Peninsula and Magellanic region).

2. Distribution of Surface Temperatures

During each cruise, the surface water temperatures were recorded with a thermosalinometer (HUREAU, 1976; GUILLE, 1977; ARNAUD and HUREAU, 1979). All the cruises took place at the end of the austral summer (February to April), except MD 24 (August–September). The cruise of MD 24 partly covered the track of the other cruises and a difference of about 1.8°C between end of summer temperatures and winter temperatures has been noted. The isotherms in Fig. 2 represent the mean values of surface

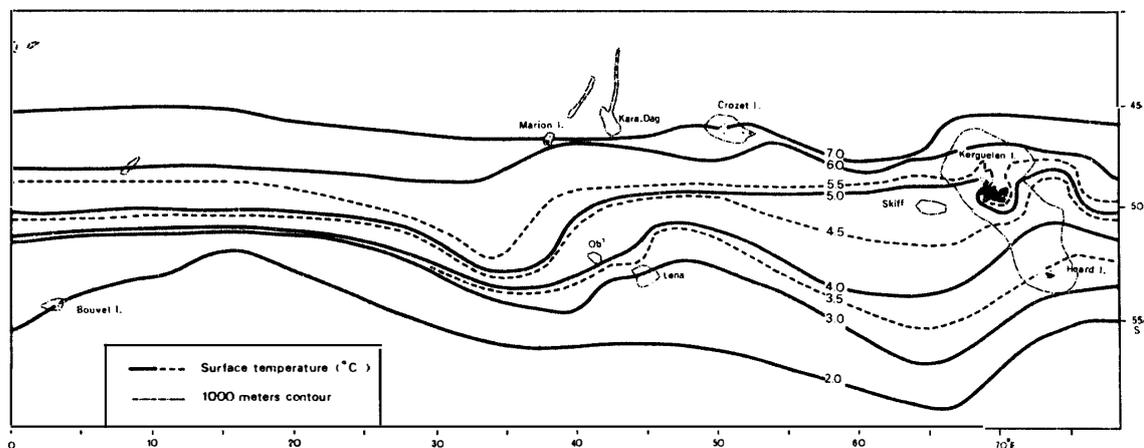


Fig. 2. Mean surface temperature in March.

temperatures at the end of March, and have taken the seasonal variations into account. Data have been completed by surface temperatures recorded during two other cruises, MD 12 (1977) (JACQUES, 1978) and MD 25 (February 1981); these two cruises studied the pelagic environment.

From the observation of the surface isotherms it is obvious that the Antarctic Convergence has a distinctive identity to the west of Crozet Islands, but at the longitude of Kerguelen Islands, this hydrological discontinuity becomes indistinct from the subtropical convergence (GAMBERONI *et al.*, 1978): therefore the Subantarctic Zone is very narrow. The great size of the Ob' and Lena seamounts and the presence of the Ker-

guelen–Heard ridge could be responsible for the modification of the direction of the West Wind Drift to the northeast.

The position of islands and seamounts in relation to the convergence is a basic feature to explain the distribution of the fish fauna: Marion and Crozet Islands and Kara Dag seamount are well positioned to the north of the Antarctic Convergence and consequently are included in the Subantarctic Zone; Bouvet Island is far to the south of the convergence and is clearly included in the Antarctic Zone; Ob' and Lena, Skiff, Kerguelen–Heard seamounts and Kerguelen and Heard Islands are just at the limit of the two zones.

They are under the influence of temperature variations which are greater than at either Marion–Crozet or Bouvet Islands. We shall see that the specific composition of the ichthyological fauna reflects these characteristics.

3. The Fish Fauna and its Geographical Distribution

The total area from Bouvet to Kerguelen–Heard Islands shelters about 23 families of benthic and pelagic fishes (more than 55 species). However, in this paper, we considered only the species of the two families Nototheniidae and Channichthyidae (15 species): these species actually take over all the benthic or benthic-pelagic niches, from

Table 1. *Nototheniids and Channichthyids occurring around the seamounts and islands of the Southeast Atlantic and Indian Sectors of the Southern Ocean.*

	Marion Prince Edward	Crozet	Kara Dag	Ker- guelen	Skiff	Ker.- Heard	Heard	Ob'	Lena	Bouvet
Nototheniidae										
<i>Notothenia rossii rossii</i>	+	+		+	+	(+)	(+)*	+*	+*	
<i>N. coriiceps coriiceps</i>	+	+		+			+			
<i>N. coriiceps neglecta</i>										+
<i>N. magellanica</i>	+	+		+						
<i>N. acuta</i>	+	+		+			+			
<i>N. marionensis</i>	+									
<i>N. mizops</i>				+	+	+	+			
<i>N. squamifrons squamifrons</i>	+	+	+	+	+	+	+	+	+	
<i>N. squamifrons atlantica</i>										+
<i>N. cyanobrancha</i>				+						
<i>N. larseni</i>	+	+					+	+	+	+
<i>Dissostichus eleginoides</i>	+	+	+	+	+	+	+	+	+	
Channichthyidae										
<i>Channichthys rhinoceratus</i>				+	+	+	+			
<i>Champscephalus gunnari</i>				+	+	+	+			+
<i>Chaenocephalus aceratus</i>										+

(+) Species whose presence is occasional.

* Data from MEISNER and KRATKII (1979).

the coast to the slope of the shelf, and consequently are representative of the ecological conditions of this part of the Southern Ocean.

Table 1 lists the species occurring around the seamounts and islands studied during the various cruises.

First of all let us see that Channichthyidae are found only around Bouvet (*Chamsocephalus gunnari* and *Chaenocephalus aceratus*), Kerguelen and Heard (*Ch. gunnari* and *Channichthys rhinoceratus*), Skiff and Kerguelen-Heard banks being considered as a part of the last group. *Ch. aceratus* indicates the geographical link between Bouvet and the western Antarctica (Scotia Arch and Antarctic Peninsula). *Ch. rhinoceratus* is an endemic species of the Kerguelen-Heard group. *Ch. gunnari* is common also in the Scotia Sea region. Then the family Channichthyidae can be considered as characteristic of cold waters nearby or south to the Antarctic Convergence. The absence of *Ch. gunnari* on the seamounts Ob' and Lena can be explained by the absence of spawning grounds on these banks which could provide enough food (Euphausiids) for this semi-pelagic species, but the closest known spawning grounds (Kerguelen and Bouvet Islands) appear too far to maintain a sufficient stock recruitment.

Concerning the geographical distribution of the Nototheniidae, this family is found all over the area (HUREAU, 1979). However, several remarks can be made:

1) *Notothenia coriiceps neglecta* is a link between Bouvet Island and the Antarctic Zone: this subspecies, actually very common on the shelf of the Antarctic Continent, is replaced by the subspecies *N. coriiceps coriiceps* in the other parts of the studied area. These two subspecies have a very close behaviour: they are only found near the coast in shallow waters, at least for juveniles and adults, larval and post-larval stages being pelagic. This coastal life particularity may explain their absence on the seamounts.

2) *Notothenia squamifrons atlantica* confirms the biogeographical relation between Bouvet Island and the Scotia Sea region, already obvious with the presence of *Chaenocephalus aceratus*. *N. squamifrons atlantica* is replaced by *N. squamifrons squamifrons* around the other islands and on the seamounts. The latter subspecies has a very large horizontal and vertical (10 to 600 m) distribution and its ubiquity is noteworthy.

3) *Dissostichus eleginoides* and *Notothenia rossii rossii* have the same type of geographical distribution as *N. squamifrons squamifrons* and are not found at Bouvet Island. *D. eleginoides* has a large distribution within the Subantarctic Zone and the northern part of the Antarctic Zone, in waters of which temperature is over 3°C, including the Scotia Sea region where *N. rossii rossii* is replaced by *N. rossii marmorata*. At Bouvet Island, the presence of the latter subspecies (PERMITIN, 1978) is doubtful, and the genus *Dissostichus* has not been yet recorded; however, because of the hydrological conditions which made this island included in the Antarctic Zone, this genus could be represented by the purely antarctic species, *D. mawsoni*.

4) *Notothenia larseni* has never been recorded on the shelf of Kerguelen Islands, despite of the numerous scientific and commercial trawlings already made. This species is elsewhere omnipresent, so its absence near Kerguelen cannot be easily explained: nevertheless, this archipelago shelters so large populations of other nototheniids that all the ecological niches are occupied by them and it is possible that there is a competition

between the abundant species *N. squamifrons* and *N. larseni*.

5) *Notothenia magellanica*, a circum-antarctic species, is always characteristic of waters whose temperature is over 5°C. This coastal species requires very shallow waters which explains its absence on the seamounts.

6) *Notothenia acuta* and *N. mizops* are not found outside the Indian Sector of the Southern Ocean (DEWITT, 1971) where they have a geographical distribution comparable to that of *N. magellanica* but they accept colder waters (they are found at Heard Island).

7) Lastly three other species are endemic, one at Marion Island (*N. marionensis*), the second at Kerguelen Islands (*N. cyanobrancha*), the third one (*N. mizops*) on the Kerguelen–Heard ridge.

In brief, we can say that the fish distribution in the studied area is under the influence of two parameters: first, the position of the Antarctic Convergence which separates clearly Marion and Crozet Islands from Bouvet Island; secondly, the fact that this area is a biogeographical zone of transition between western and eastern Antarctic Waters of the Southern Ocean.

4. Abundance of the Species in Function of Their Behaviour and of the Environment

Among the 55 fish species recorded in the studied area, only a few exist in great abundance, and only 4 are exploited: *Notothenia rossii*, *N. squamifrons*, *Dissostichus eleginoides* and *Champsocephalus gunnari*. From 1970 to 1981, the total catches in the area of Kerguelen and Heard Islands reached 722000 t (DUHAMEL and HUREAU, 1981).

<i>N. rossii</i>	: 263000 t,
<i>N. squamifrons</i>	: 218000 t,
<i>Ch. gunnari</i>	: 223000 t,
Others	: 18000 t.

However, it is necessary to point out the fact that most of these catches have been realized during the first 3 or 4 years: for example, the *Notothenia rossii* catches from 1970 to 1972 reach 207000 t.

At the present time, on Kerguelen shelf, the level of catches is purposely limited: in 1981, 9850 t of *N. rossii*, 7400 t of *N. squamifrons* and 8000 t of *Ch. gunnari* were fished.

Beside Kerguelen Islands, Ob' and Lena Banks are exploited for *N. squamifrons*. Since 1978, Crozet Islands have not been exploited in order to restore the fish populations existing there in the beginning.

The abundance of these species can be explained by three factors:

1) Abundance of the food sources: according to their situation in relation to the Antarctic Convergence, Kerguelen Islands and Ob' and Lena Banks are high planktonic productive zones, as cold and warmer waters are merging there. The most abundant fish species have a mainly zooplanktonic diet (DUHAMEL, 1981) and draw a profit on these waters rich in plankton. Furthermore, in Kerguelen Islands, local hydrological phenomena cause upwellings (specially along the eastern coast) which facilitate primary and secondary productivity.

2) Presence of spawning areas adapted to species: shelves surrounding Kerguelen, Crozet, Heard Islands and seamounts are large enough to offer to each species the ecological conditions which suit the best to spawning and post-larvae development.

3) Abundance of algae in some coastal zones: it particularly facilitates the extension of *Notothenia rossii* populations, for their juveniles need to stay in a coastal biotope providing them a protection (algae) and abundant food (amphipods, isopods, young fishes). The same kind of biotope can also be found in South Georgia, where the stock of *N. rossii* is also very important. The presence of *N. rossii* on seamounts can be explained by their ability to migrate over rather extensive distances when they are adult; till now only adults have been caught there.

5. Conclusion

The data obtained during the different cruises enable us to define the biogeographical position of Bouvet Island: it can be obviously distinguished from the other islands and banks by its fauna, which is close to that of the Western Antarctica. The important part played by the position of the Antarctic Convergence in relation with islands and banks, where Notothenioidei are abundant, must be pointed out.

It was possible to show that distribution and abundance of fishes are sharply related to hydrological factors: particularly Channichthyidae and especially *Champocephalus gunnari* can be considered as a tracer for the cold water masses situated south or nearby the convergence; the latter corresponds to high productive zones and directly affects the abundance of species.

Notothenia squamifrons is a ubiquitous species and can adapt itself to various biotopes; however, abundant populations are bound to the areas of high productivity. It is the same for *N. rossii* that needs an additional factor: the presence of large coastal zones, rich in algae, necessary for the growth of the juveniles, which explains the abundance of this species in Kerguelen Islands.

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(Received November 7, 1982)