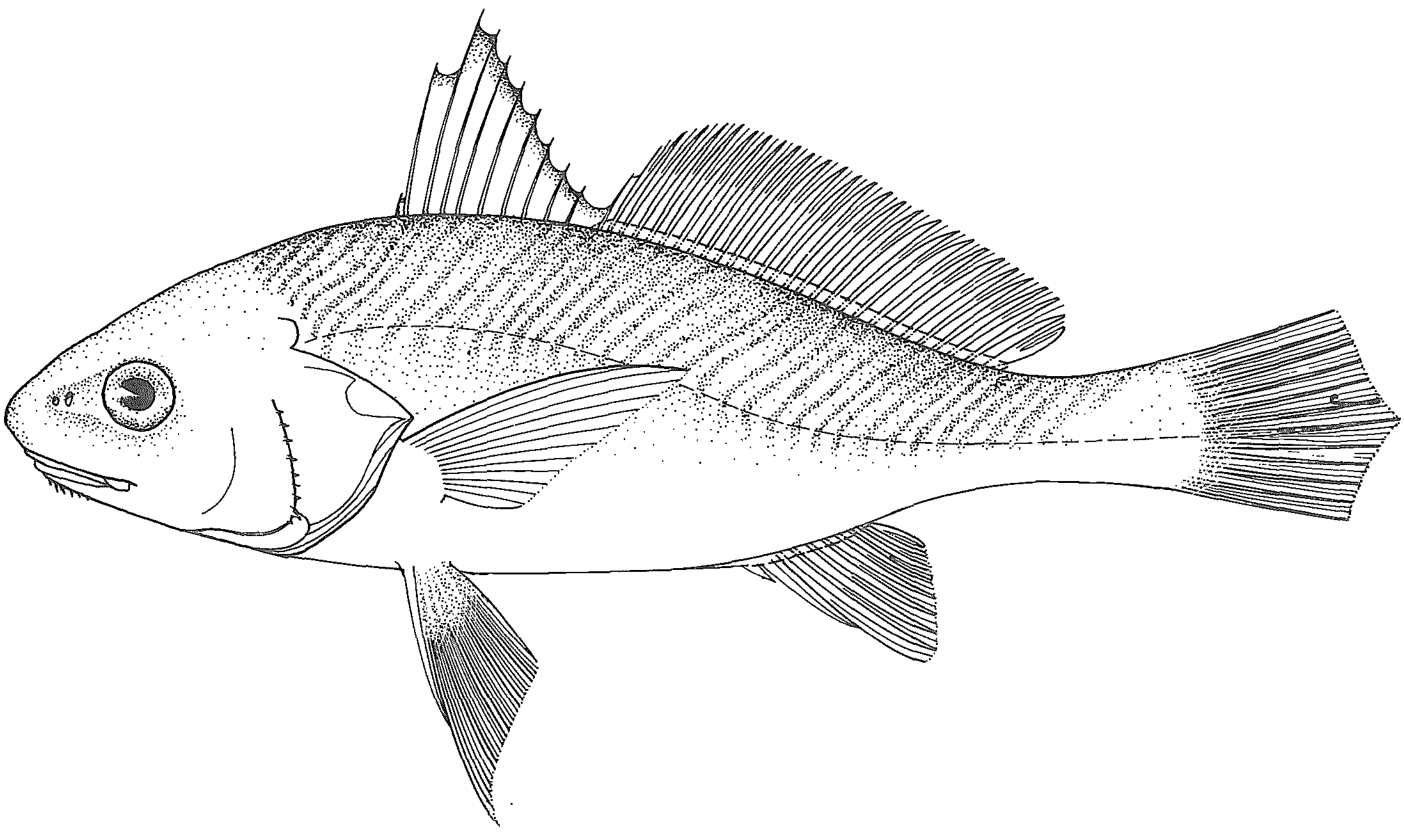
FAO Fisheries Synopsis No. 150

FIR/S150
SAST - Whitemouth Croaker - 1,70(37)038,02

SYNOPSIS OF BIOLOGICAL DATA ON THE WHITEMOUTH CROAKER
Micropogonias furnieri (Desmarest, 1823)



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

SYNOPSIS OF BIOLOGICAL DATA ON THE WHITEMOUTH CROAKER

Micropogonias furnieri (Desmarest, 1823)

Prepared by

Victoria J. Isaac
Institut für Meereskunde
Düsternbrooker Weg 20
2300 Kiel, 1 West Germany

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1988

PREPARATION OF THIS SYNOPSIS

The present synopsis was prepared during a study stage at the Institut für Meereskunde, Kiel, Federal Republic of Germany in early 1985, as part of a comprehensive review of information on the biology and population dynamics of fishes of the family Sciaenidae. Micropogonias furnieri is one of the most important commercial sciaenids in the southwestern Atlantic, and it is hoped that the present work will stimulate and facilitate future work on this species.

The synopsis is based partly on material and information collected while the author was working on her thesis at the Oceanographic Institute of São Paulo, Brazil, and partly on information received from various persons and sources, all of which are documented in the text and the bibliography.

The author wishes to express her appreciation to Mr Matthias Seaman for his helpful suggestions, manuscript review and translation. She also thanks Dr Daniel Pauly for encouraging her to undertake this study. She is greatly indebted to Dr Susan Saccardo for assisting her in the completion of the bibliography.

ABSTRACT

This synopsis compiles and reviews the presently available information on identity, distribution, bionomics, life history, population structure and dynamics, exploition, aquaculture and weed control potential of the whitemouth croaker, Micropogonias furnieri (Desmarest, 1823).

Distribution :

Author
FAO Fisheries Department
FAO Regional Fisheries Officers
Regional Fisheries Councils and Commissions
Selector SM

For bibliographic purposes this document should be cited as follows :

Isaac, V.J., 1988 Synopsis of biological data on the whitemouth croaker, Micropogonias furnieri (Desmarest, 1823). FAO Fish.Synop., (150):35 p.

CONTENTS

---

* No information available

1. IDENTITY

1.1 Nomenclature

1.1.1 Valid name

Micorpogonias furnieri (Desmarest, 1823)

1.1.2 Objective synonymy

M. patagonensis, MacDonagh, 1931, M. barretoi, MacDonagh, 1934 and Sciaena opercularis, Quoy and Gaimard, 1824 are primary synonyms of the species.

The fish genus name Micropogon Cuvier, 1830 is preoccupied by Micropogon Boie, 1826, Aves. Although the bird genus name has only been used in synonymies in recent years, and the fish genus name has gained wide and stable use since Cuvier 1830, C.G. Gruchy (NMC), Roux (1973) and Chao (1978) found that the inherent nomenclatural and systematic problems of the bird genus and its family have not been solved. To avoid further complications, they decided to readopt the valid substitute name Micropogonias (Bonaparte, 1831) for the fish genus (Chao, op.cit.).

The name Micropogon opercularis (Quoy and Gaimard, 1824) had been applied to the whitemouth croaker of the Rio de la Plata region (Argentina and Uruguay), suggesting the existence of other Micropogonias species restricted to this area. However, the original description of Sciaena opercularis (Quoy and Gaimard, 1824:347) is based on a specimen from the Bay of Rio de Janeiro.

1.2 Taxonomy

1.2.1 Affinities

- Suprageneric

Phylum - Vertebrata
Subphylum - Craniata
Superclass - Gnathostomata
Series - Pisces
Class - Teleostei
Subclass - Actinopterygii
Order - Perciformes
Family - Sciaenidae

- Generic

Micropogon Cuvier 1830:213 (type-species: Micropogon lineatus Cuvier, in part = Umbrina furnieri Desmarest, preoccupied by Micropogon Boie 1826:977, Aves).

Micropogonias Bonaparte 1831,52:170 (substitute name for Micropogon, therefore based on the same type-species, M. lineatus in part = U. furnieri Desmarest).

Diagnosis: Body elongate, dorsal profile elevated, ventral profile nearly straight. Head conical, preopercular margin with 10 to 14 spines, 2 to 5 strong spines at the angle. Mouth inferior, teeth in villiform bands, outer row teeth in upper jaw slightly enlarged. Gill rakers short. Vertebrae 10+15=25. The sagitta (large earstone) is very thick and shield-shaped, often with a shelf or flange on the outer surface or on the dorsal margin. The ostium of the sulcus is large and its expanded part does not reach the anterior margin of the sagitta. The cauda is oblique and ends with a round, disc-like distal base. The sagitta presents ontogenetical variations. The swimbladder has a special pattern, with a pair of tube-like diverticula that originate laterally from the posterior half of the main chamber. The diverticula extend anteriorly as far as the septum transversum, but never reach the skull; they curve posteriorly to the anterior border (Fig.1). Tropical Eastern Pacific and Western Atlantic. Inhabits estuarine rivers and coastal waters with sandy to muddy bottom (Chao, 1978; Chao, in Fischer (ed.), 1978).

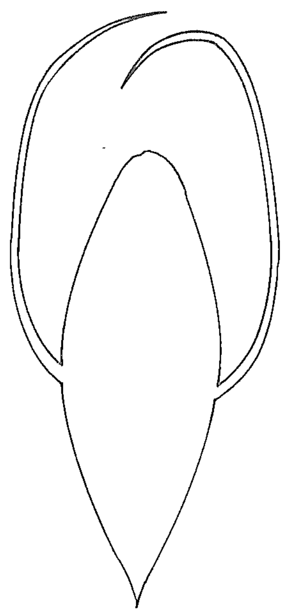


Fig. 1 Swimbladder of M. furnieri

The genus Micropogonias includes about 6 species. The two western Atlantic species M. furnieri and M. undulatus (Linnaeus, 1766) are very similar, differing mainly in their pigmentation patterns and number of scales, although these characters are valid only for adult specimens. M. furnieri has dark oblique bands on the dorsal part of the body and 6 or 7 oblique series of scales between the beginning of the dorsal fin and the lateral line. M. undulatus has small irregular dark spots on the dorsal part of the body (but they do not form continuous bands) and 8 or 9 oblique series of scales below the origin of the dorsal fin. According to Chao (in Fischer (ed.), 1978), M. undulatus occurs from Massachusetts along the Atlantic coast of the USA, in the Antilles and along the South American Atlantic coast. In the latter area it might be confused with M. furnieri. Nevertheless, Chao (1978) compared 22 morphometric and meristic characters in 22 specimens of the southern species (supposedly M. furnieri) from Colombia to Uruguay and 24 specimens of the northern species (supposedly M. undulatus) from Chesapeak Bay to Campeche Bay with a discriminant function, concluding that only one of the Campeche Bay specimens was intermediate. All northern specimens could be readily distinguished from southern ones by colour pattern and number of scales in vertical series from dorsal fin to lateral line. Many authors restrict the principal area of distribution of M. undulatus to the north and central American coast from Cape Cod (Massachusetts) to Campeche Bay (Mexico) (Johnson, 1978; Lassuy, 1983). Johnson (op.cit.) remarks that occasional ocurrences southward can be attributed to migrations due to unusually cold winter conditions.

- Specific

Micropogonias furnieri Desmarest, 1823 (Fig.2)

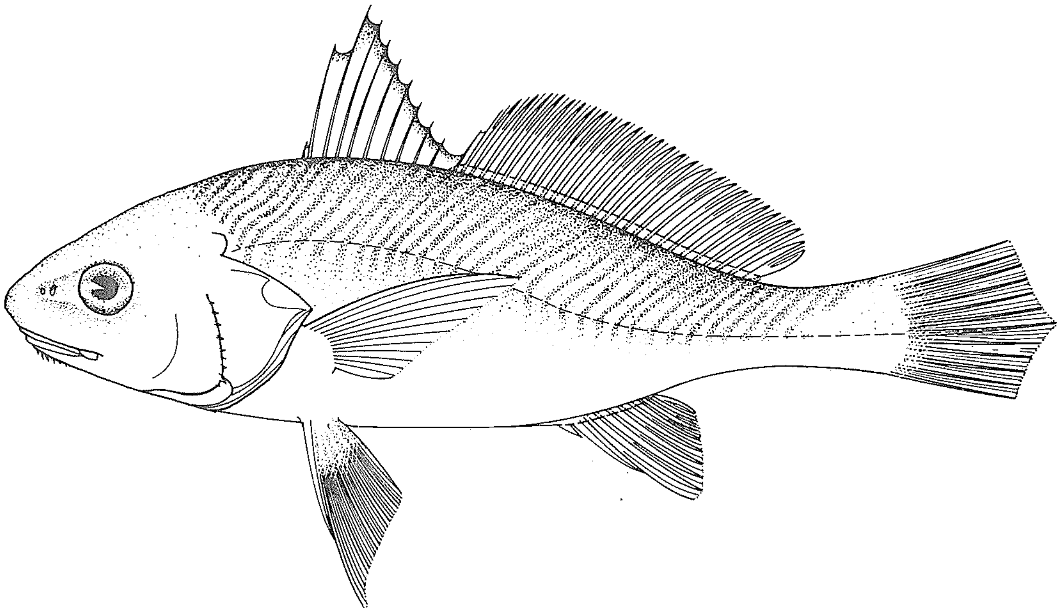


Fig.2 Micropogonias furnieri Desmarest, 1823

Umbrina furnieri Desmarest, 1823:182, pl.17, fig.3. Havana, Cuba (presumed holotype: MNHN 4968, 109 mm SL).

Micropogon lineatus Cuvier, 1830:215, pls. 119 and 138, in part, swimbladder (lectotype: MNHN 4968, 109 mm SL, Cuba: paralectotype: MNHN 7459, 159 mm SL, Montevideo).

Micropogon argentatus Cuvier, 1830:218, Surinam (holotype: RMHN 685, 300 mm SL).

Corvina crawfordii Regan, 1903:627, Montevideo (holotype: BMNH 1903.10.16.7, 210 mm SL).

Micropogon patagonensis MacDonagh, 1931:409. Rio de San Blas, Argentina (holotype: Museo de la Plata, no. 2.V.31.1 465 mm SL).

Micropogon barretoi MacDonagh, 1934:70. Punta Piedras, Argentina (holotype: Museo de la Plata, no. 12.VII.33.15. 423 mm SL).

Ophioscion woodwardi Fowler, 1937:311, fig. on p. 312, Haiti (holotype:ANSP 68257, 108 mm SL).

Diagnosis: Dorsal fins contiguous, the anterior with 10 spines and the posterior with 1 spine and 26 to 30 rays; anal fin with 2 spines and 7 or 8 rays; caudal fin with the median rays longer than the others. Gill rakers short, 21 to 25 in the first branchial arch. Ctenoid scales on body and dorsal part of the head, cycloid scales on snout, lateral part of head and operculum. Dorsal profile arched, ventral profile straight. Total length 3.5 to 4 times the length of head. Lateral line curved anteriorly, becoming straight below posterior part of second dorsal fin. Mouth inferior, almost horizontal; lower jaw with a row of barbels and with 5 pores at chin. Upper jaw becoming almost vertical near the anterior margin of orbital. Edge of preopercle bony, with strong spines.

Swimbladder with a pair of long, tube-like and forward-directed lateral appendages. Sagitta thick and short (Fig.3); lapilus (small earstone) rudimentary. Colour silvery, darker and with bands on the dorsum. First dorsal fin with a black margin; other fins clear, with small dark spots. Inhabits inshore and estuarine waters. Size up to about 70 cm standard length (Vazzoler, 1969; Chao, in Fischer (ed.), 1978; Menezes and Figueiredo, 1980).

1.2.2 Taxonomic status

Variations in meristic characters, body proportions, reproductive and growth features suggest the existence of a population in the region between 23°S and 29°S (population I) and another between 29°S and 33°S (population II) of the south-central Brasilian coast (Vazzoler, 1971).

Similar studies suggest that the fishes inhabiting the Rio de la Plata region probably form a population (population III) with a spawning area located west of Montevideo, and that those further south form another one with a spawning area in Bahia Blanca (39°S) (population IV) (Figueroa, 1985; Cotrina, 1986) (Fig.4).

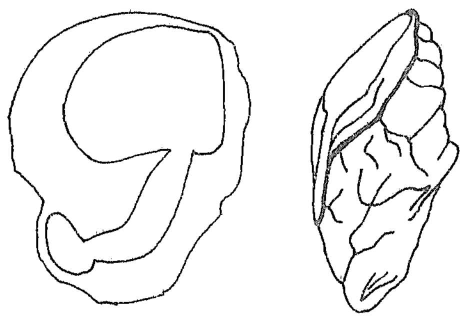


Fig.3 Sagitta (large earstone) of M. furnieri (from Fischer (ed.), 1978)

The existence of further population inside the Lagoa dos Patos (32°S) which grows slower than the fishes living offshore has also been postulated (Castelo, 1986).

The status of the populations north of 23°S latitude has not yet been investigated.

1.2.3 Subspecies

Subspecies are not established at present. Nevertheless, the systematic status of M. furnieri and M. undulatus is not very clear. Therefore, the hypothesis that both represent subspecies of one species requires deeper study (Chao, 1978) (see 1.2.1).

1.2.4 Common names

Venezuela - roncador
Guyana - croaker, two-belly bashaw
Uruguay - corvina blanca
Argentina - corvina rubia
Brazil (south) - corvina
Brazil (Rio de Janeiro) - corvina marisqueira
Brazil (Bahia) - murucaia
FAO - En: whitemouth croaker; Fr: tambour rayé; Sp: corvinón rayado.

1.3 Morphology

1.3.1 External morphology

See 1.2.1 and Fig.2.

1.3.2 Cytomorphology

The chromosomes (2n=48; n=24) are acrocentric, 1.49 to 3.38 µm in length. The diploid DNA content of blood cell nuclei is 1.24 ± 0.01 picograms. Staining with C and G banding techniques did not lead to visible patterns. No differences between males and females have been observed (Gomez, Vazzoler and Phan, 1983).

1.3.3 Protein specificity

Individual diferences in the plasma proteins in population I (sec. 1.2.1) have been found; these differences appear unrelated to size, sex or maturity stage (Phan and Vazzoler, 1976). Pattern variations in eye-lens proteins of the same population were related to ontogenetic development by Vazzoler et al. (1985), since they observed a stabilization in the adult forms. In comparative studies on skeletal muscle proteins Suzuki, Vazzoler and Phan (1983; 1983a) found no differences between populations I and II, but individual differences related to the fishes' ontogenetic development; these differences were independent of sex, gonadal maturity or sampling site.

Fig.4 Distribution of M. furnieri and of its assumed populations

2. DISTRIBUTION

2.1 Total area

Micropogonias furnieri is a euryhaline sublittoral species of the Western Central and Southwestern Atlantic. It is distributed from the Yucatan Peninsula along the Antilles, the southern Caribbean and the South American coast to the Gulf of San Matias, Argentina, at 41°S (Fig.4). It is particularly abundant on the southeastern coast of Brazil (south of 23°S) and on the coast of Uruguay (Cervigón, 1966; Chao, in Fischer (ed.), 1978; López, 1963, 1964).

2.2 Differential distribution

2.2.1 Spawn, larvae and juveniles

Spawning areas and seasons (see Table I).

The eggs are pelagic, as is the case for all known sciaenids (Johnson, 1978). Concentrations of spawning adults have been observed in the Rio de la Plata estuary, west of Montevideo, in 5 m of water, in a region with low salinity, on sandy or muddy bottoms and also in other river mouths (Arena and Hertl, 1983; Arena, 1984). population II spawns offshore Rio Grande do Sul (29°S-33°S) and population I in the region of Bom Abrigo (25°S-26°S) (Vazzoler, 1971). Spawning of the Guyana stock occurs in coastal areas (Lowe-McConnell, 1966).

Table I

Spawning areas and seasons of Micropogonias furnieri

Area	Principal Spawning Areas	Spawning Season	Peak	Author
Argentina and Rio de la Plata (41° to 33°S)	Shallow waters around Montevideo, Uruguay	Summer	December	Daneri, 1957; Haimovici, 1977; Arena & Hertl, 1983; Arena, 1984
Rio Grande do Sul (Brazil) (33° to 29°S)	Rio Grande, Brazil	Spring and Summer	September to December	Vazzoler, 1971
Santa Catarina, São Paulo, Rio de Janeiro (Brazil) (29° to 23°S)	Bom Abrigo, Brazil	Throughout the year	April, September, November	Vazzoler, 1971; Isaac-Nahum & Vazzoler, 1983
Guyana (6° to 9°N)	Coastal areas	Throughout the year	April ?	Lowe-McConnell, 1966

- Larvae and juveniles

Croaker juveniles may be found all year round in the Rio de la Plata (up to 200 km upstream) and in the Bay of San Boronbón (Lopez and Castelo, 1968). Nion (1985) observed juveniles on the coast of Uruguay being especially abundant in river mouths.

Larvae and juveniles of M. furnieri are usually found in the estuarine lagoon region of Cananéia, (25°S) (Sinque, 1980), in the Lagoa dos Patos (32°S) (Weiss, 1981; Castelo, 1986) and other brackish water regions off the Brazilian coast, preferring shallow waters (Barbieri, 1986). Lowe-McConnell (1966) reported larvae and juveniles in tidal pools along the open coast of Guyana, and in river mouths. Juveniles were also found in tidal mudflats; fry 2 to 5 cm long were caught in large numbers in a canal leading from the sea into brackish water ponds and swamps, particularly during spring tides.

2.2.2 Adults

M. furnieri is a demersal fish that lives on muddy and sandy bottoms of the littoral zone with high propension towards estuarine regions.

Seasonal migrations are undertaken by the southern Brazilian stock (population II), which shows highest densities between 31°S and 35°S in summer and 27° to 31°S in winter (Vazzoler, 1963). population I does not migrate.

On the southern coast of Brazil and off Uruguay, the whitemouth croaker is usually not found below 50 m depth, preferring depths of 15 to 30 m (Vazzoler, G. and Iwai, 1971). However, an unexploited stock has been suggested to occur at 50 to 99 m depth off Rio Grande do Sul, Brazil (Yesaki, Rahn and Siva, 1976). Paiva Filho (1977) describes the microdistribution of the stock between 29° and 33°S; during summer, the highest concentrations are found further south, with large schools at 30 to 50 m depth; a northern migration begins in autumn, with the formation of smaller schools that may be found up to 100 m deep; during winter, the highest concentrations occur in the northern part of the distributional area, with the same schooling behaviour and depth distribution; the fish form large schools again in spring, while migrating southward along the coast.

No diel differential distribution is observed in the population at the entry of the Lagoa dos Patos (Pereira, 1986).

The population of the Rio de la Plata region forms large concentrations near the coast of Montevideo during spring and summer, dispersing in autumn and winter (Nion, 1985). According to Cousseau et al., (1986) larger specimens were found in deeper waters at the northernmost region of the marine front of the Rio de la Plata, while the average size decreased southward.

There are no regular seasonal fluctuations in the distribution of the Guyana stock, but the whitemouth croaker may virtually disappear in some areas. It is more abundant inshore during the rainy season (June-July), and gathers offshore in 30 to 60 m depth off the northwestern coast during the windy season, from January to March (Lowe-McConnell, 1966).

2.3 Determinants of distributional changes

Paiva Filho (1977) has found that the microdistribution of the stock between 29° and 33°S depends on environmental factors. The migration of the whitemouth croaker off southern Brazil follows the seasonal displacements of the convergence of subtropical and subantarctic waters (Vazzoler, 1963). This convergence represents a marked transition of temperature and salinity, and is situated off the coast of Uruguay (35°S) during summer and north of Santa Catarina Island (27°S to 28°S) in winter (Emilsson, 1961). The prime environmental factors influencing the distribution and abundance of sciaenids off southern Brazil are considered to be bottom sediment types, thermohaline gradients, dissolved oxygen and composition of the benthic fauna (Vazzoler, 1975).

The movements of the Guyana stock appear to be linked to the volume of freshwater runoff in June-July and to the strong onshore winds prevailing from January to March; instances of local disappearance of the stock were associated with congregations of sharks in the fishing areas (Lowe-McConnell, 1966).

In the Rio de la Plata, differences of distribution patterns seem to be related to spawning behaviour (Nion, 1985).

3. BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality

The sexes are separate: there are no external sexual characters.

3.1.2 Maturity

Table II shows the various estimates of average size (L_{50}) and age at first maturity, which differs in the various populations.

Table II

Size and age at first maturity of Micropogonias furnieri

Area	Sex	Age	Size (cm)	Author
Rio de la Plata (40° to 34°S)	- -	2.5 years	31.0	Arena and Hertl, 1983
Argentina and Rio de la Plata (41° to 33°S)	- -	? ?	30.0-40.0	Haimovici, 1977
Rio Grande do Sul (Brazil) (33° to 29°S)	F M	1 year and 11 months 1 year and 5 months	35.0 33.0	Vazzoler, 1971
Lagoa dos Patos (Brazil) (32°S)	F M	? ?	18.1 20.5	Castelo, 1986
Sta. Catarina, São Paulo, Rio de Janeiro (Brazil, 29° to 23°S)	F M	7 months 4 months	27.5 25.0	Vazzoler, 1971
Guyana (6° to 9°N)	F M	? ?	26.0 21.0	Lowe-McConnell, 1966

3.1.3 Mating

Probably polygamous and promiscuous.

3.1.4 Fertilization

External.

3.1.5 Gonads

- Maturity phases

Males have paired testes extending along the dorsal surface of the coelomic cavity. Vazzoler (1971) proposed the following scale of four maturity stages:

Immature: testes very small, thin and transparent, located next to the spine.

Maturing: testes swollen, white, occupying 1/3 to 2/3 of the abdominal cavity, liberating viscous seminal fluid upon application of pressure.

Mature: testes turgid, very white, occupying all or almost all of the abdominal cavity, liberating seminal fluid upon application of very slight pressure.

Spent: flaccid with visible hemorrage.

The location of the ovary in the female is the same as that of the testes in the male. Vazzoler (1971). Arena and Hertl (1983) proposed a strictly macroscopic maturity scale, while Haimovici (1977) and Isaac-Nahum (1981) take into account the changes in histological structure of the ovary. The histological characters described by Isaac-Nahum (op.cit.) and a comparison with other studies are summarized in Table III.

- Gonado-somatic ratio (GSR)

Isaac-Nahum (1981) reported GSR averages between 0.34 and 3.06 for females of M. furnieri in different maturity phases. The GSR does not vary with increasing fish size, depending solely on the maturity phase.

- Fecundity

Vazzoler (1970) found the following relationships for 54 females in the size range from 32.5 to 59.5 cm:

$$F = -276.4 + 190.3 \log L_t \qquad r^2 = 0.523$$

$$F = -132.2 + 57.1 \log W_t \qquad r^2 = 0.488$$

$$F = 2\,187.7 + 50.2\, W_g \qquad r^2 = 0.363$$

where F = fecundity; L_t = total length (mm); W_t = total weight (g); W_g = weight of ovary (g). In addition, she found no correlation between individual fecundity and condition factor.

In a sample of 15 females between 35.4 and 49.0 cm total length, the absolute fecundity values varied from $0.21 \cdot 10^6$ to $1.39 \cdot 10^6$ mature oocytes and the relative fecundity was between 187 and 1 037 mature oocytes per gram of total weight, with averages of $0.49 \cdot 10^6$ and 521, respectively (Isaac-Nahum, 1981).

3.1.6 Spawning

- Type of spawning

M. furnieri has partial or asynchronic spawning, as is shown by histological sections of ovaries and frequency histograms of oocyte development stages (Vazzoler, 1971; Haimovici, 1977). Histological analysis of maturing ovaries shows the presence of post-ovulatory follicles and residual oocytes, thus indicating that some spawning has already occurred (Isaac-Nahum, op.cit.).

- Number of spawnings per year

Investigations on the Guyana stock suggest that spawning does not necessarily follow a strict seasonal pattern, ripe individuals, fry and young of M. furnieri being found throughout the year (Lowe-McConnell, 1966).

Isaac-Nahum (1981) and Isaac-Nahum & Vazzoler (1983) found three major spawning periods (in autumn, winter and spring-summer) for population I from the Brazilian coast.

Table III

Classification of maturity stages for females of Micropogonias furnieri

Initial classification (Vazzoler, 1971)		A	B		C		D	B
Classification of Haimovici (1977)		I	III	IV	IV-V		VI	II
Present classification (Isaac-Nahum, 1981)		A	B1	B2	C1	C2	D	R
Maturity stages		virgin	maturing		mature		spent	resting
MACRO-SCOPIC APPEA-RANCE	Size with respect to the abdominal cavity	1/3	1/2 to 3/4	1/3 to 1/2	3/4 to total	1/2 to 3/4	1/2	1/3
	Oocytes visible	No	Yes	Yes	Yes	Yes	Occasionally	No
	Appearance of the oocytes	-	Small & medium joined	Small & medium separated	Medium & large joined	Medium & large separated	Isolated	-
	Vascularization	-	+	+	++	++	Hemorrhage	-
GENERAL HISTOLOGICAL APPEARANCE		Regular deposition lamellae. Small oocytes adhering to the lamellae. Nests of young cells.	Beginning of vitellogenensis. Lamellae almost orderly. Predominantly (?) bassofily.	Vitellogenesis with signs of spawning activity. Hemorrhages and follicular bodies.	Mature oocytes predominating appearing pressed against each other. No signs of spawning activity.	Mature oocytes predominating but somewhat separate, and with signs of spawning activity.	Disorganized. Processes of resorption and degeneration. Follicules empty. Macrophageous cells.	Similar to A, but with expanded lamellae.
TYPES OF OOCYTES		Phases I & II	II, III, IV & (V)	II, III, IV & (V)	II, (III), (IV) & V	II, (III), (IV) & V	I & II. Others under resorption	I & II
CHARACTERISTICS OF THE CELLS DEVELOPED FURTHEST	Cytoplasma							
	Lipids	-	++	++	+	+	-	-
	Vitelline granules	-	+	+	++	++	-	-
	Follicles	-	+	+	++	++	-	-
	M. pellucida	-	+	+	++	++	-	-
	Cell dimensions	13.80 μm	220-320 μm	320-450 μm	320-450 μm	15-120 μm	15-120 μm	15-120 μm

(-) not visible; (+) visible; (++) very developed

According to the observed recruitment pattern in the Lagoa dos Patos (Barbieri, 1986), the species should have at least two spawning peaks in the population of southern Brazil.

Arena and Hertl (1983) mention a single extended spawning period for the species in the Rio de la Plata.

Spawning seasons and locations

See Table I (section 2.2.1).

3.1.7 Spawn

Eggs buoyant, transparent, with oil globules. Sinque (1980) was unable to distinguish the eggs of whitemouth croaker from the eggs of other sciaenids. Weiss (1981) identified them in the Lagoa dos Patos (32^{o}S), where eggs were present in spring, summer and autumn. The average diameter decreased with the advancing of the spawning season.

3.2 Pre-adult phase

3.2.1 Embryonic phase

Spawning and fertilization of the eggs were accomplished by treatment with human chorionic gonadotropin in a laboratory in Cuba (Garcia, 1979). The embryonic development and the larval stages up to the 4th day were described. The average egg diameter was 0.7 mm (Fig.5). The duration of each phase after fertilization at a temperature of 27^{o}C was as follows: 15 minutes, two blastomeres (Fig.5a); 20 minutes, four blatomeres (Fig.5b); 45 minutes, early blastula (Fig.5c); 2 hours 45 minutes, blastula completely formed; 7 hours 15 minutes, first embryo; 13 hours, optic vesicles and myotomes are developed (Fig.5d, e); 14 hours, convulsive contractions; 16 hours, hatching.

3.2.2 Larval phase

Garcia (1979) described the development of larvae in the laboratory (Fig.5). Recently hatched larvae measured 1.3 mm and had a large oil drop in the yolk sac. Growth after hatching was as follows: 3 hours 30 minutes, total length between 1.75 and 1.80 mm: anus placed in the anterior half of the body (Fig.5f); 11 hours 30 minutes, total length between 1.95 and 2.05 mm: the first support structures appear (Fig.5g); 21 hours, total length 2.2 mm: anus moves forward (Fig.5h); 33 hours: development of the pectoral fins (Fig.5i); 47 hours: mouth is completely formed; eyes pigmented; yolk sac fully resorbed (Fig.5j); 4 days: small decrease in length; chromatophores on head, abdomen, ventral part of trunk; oil globule disappears (Fig.5k).

Sinque (1980) described the development of whitemouth croaker larvae from 2.48 to 31.4 mm standard length collected in the estuarine region of Cananéia at 25^{o}S (Fig.6).

The larvae of M. furnieri differ from those of M. undulatus (described by Lippson and Moran, 1947) by their straight dorsal margin (convex in young specimens of M. undulatus). The youngest larvae of M. furnieri also lack pigmented spots on the dorsal flanks. In addition, the relation between depth of head and distance from the tip of snout to the posterior edge of operculum is 1:1 for M. furnieri, but different in M. undulatus. The latter species has no spines on the dorso-lateral parts of the head, and its pigmentation forms a sparse pattern of spots, which is in contrast with the pigmented dorsal bands of M. furnieri.

3.2.3 Adolescent phase

Whitemouth croaker reach first sexual maturity at different sizes depending on the population in question (Table II). The adolescent phase extends from 4 months to almost 2 years.

3.3 Adult phase

3.3.1 Longevity

According to the interpretations of different authors, the oldest specimens of M. furnieri caught are approximately 7 years old for the stock of Ceará (4^{o}S) (Rodrigues, 1968) and for population II (Vazzoler, 1971). For population I, the oldest fish were 5 years old (Vazzoler, op.cit.) (see also 3.4.3 and Table VIII).

3.3.2 Hardiness

In view of their widespread distribution (between 10^{o}N and 41^{o}S latitude), whitemouth croakers inhabit water masses with different temperature-salinity combinations. M. furnieri is also often found in brackish waters (Ihering, 1897), and in the Rio de la Plata estuary, and is present all year round in waters where winter temperatures and salinities average 9^{o}C and 20^{o}/oo, respectively (Argentina, Servicio de Hidrografia Naval, 1966). In southern Brazil, it is also found all year round (but more abundant during summer) in the Lagoa dos Patos (32^{o}S) (Chao et al., 1982; Barbieri, 1986), in waters that vary from 0.1 to 32.8^{o}/oo and from 11^{o}C to 28^{o}C (Castelo, 1986). Off the coast it is most common in waters of 30^{o}/oo, 13^{o}C to 25^{o}C temperature and dissolved oxygen contents of 4.0 to 55 ml/l (Vazzoler, G., 1975).

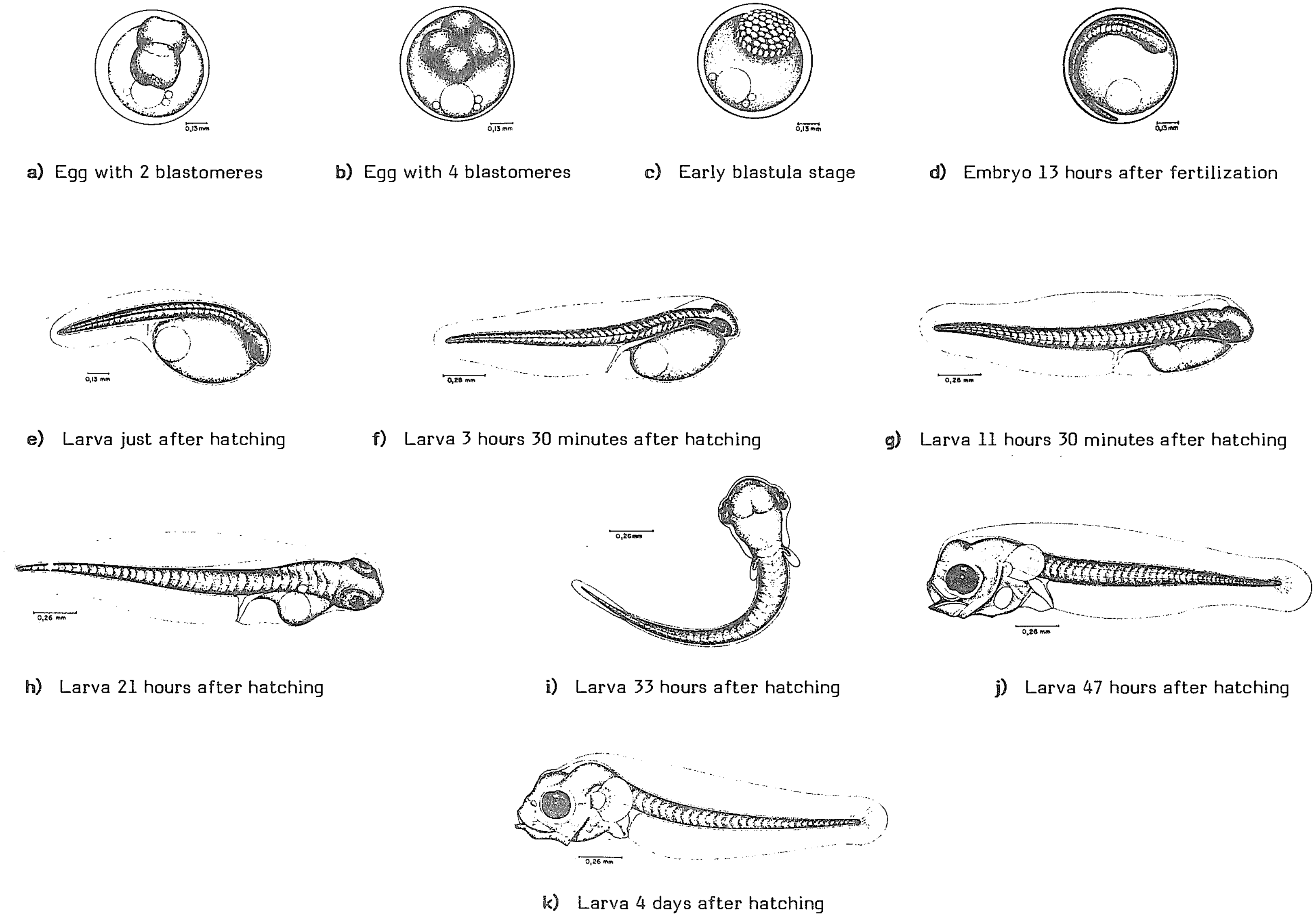


Fig.5. Development of eggs and larvae of M. furnieri up to 4 days after hatching obtained in laboratory (from Garcia, 1979)

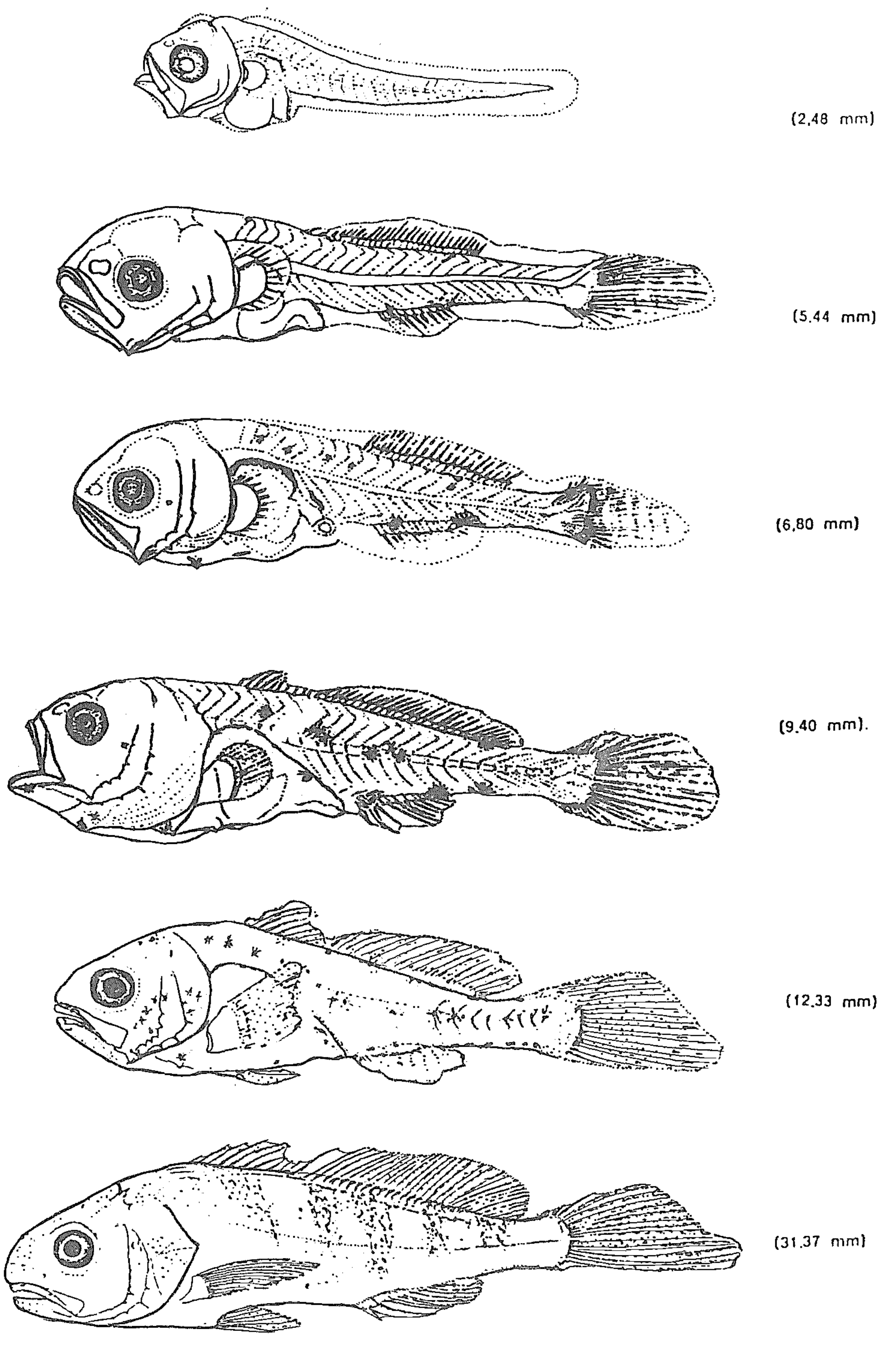


Fig.6 Larval development of M. furnieri from 2.48 to 31.4 mm standard length (from Sinque, 1980)

3.3.3 Competitors

Although M. furnieri and Umbrina canosai (another sciaenid species) have similar diets off Brazil (29°S to 33°S), the major concentrations of these species do not overlap, thus diminishing competitive effects (Vazzoler, G., 1975).

Nion (1985) suggests that Cynoscion striatus is in spatial competition with the whitemouth croaker in the Rio de la Plata.

3.3.4 Predators

M. furnieri has been found in stomachs of another croaker, Cynoscion virescens, off the coast of Guyana (Lowe-McConnell, 1966). Mermoz (1977) reported a bottle-nosed dolphin (Tursiops truncatus) with 475 whitemouth croakers in its stomach, in the mouth of the Rio de la Plata. Pinedo (1982) and Pinedo and Barros (1983) found specimens of M. undulatus in stomachs of Pontoporia blainvillei, Tursiops gephyreus, Otaria flavescens and Arctocephalus australis (Mammalia) collected off the southern coast of Rio Grande do Sul (29°S-33°S).

3.3.5 Parasites, diseases, injuries and abnormalities

- Parasites and diseases

The body cavity of whitemouth croakers caught in Guyanan waters was found infested by numerous cestode larvae (Pterobothrium heterocanthum, Diesing, 1850). The fish sometimes also carried a long, thin red nematode in their intestine and ovaries (Lowe-McConell, 1966).

Vazzoler and Phan (1981) reported the presence of eye cataracts in individuals of M. furnieri from the estuarine lagoon of Cananéia (25°S). The disease was neither caused by parasites, nor by bacteria, and affected primarily immature individuals between 20 and 25 cm total length. Differences in the electrophoretic patterns of soluble eye-lens proteins of fishes suffering from cataracts were related to the progression of this disease. The authors concluded that the cataracts represented an important mortality factor for croakers in that region, and that they were caused by physiological or metabolic stress resulting from environmental conditions.

- Injuries and abnormalities

Abnormalities of the vertebral column (exostoses) have been found in specimens from southern Brazil, Uruguay and Argentina (Barcellos, 1962). The abnormalities may occur on the body of one or more vertebrae (which may appear fused together), on the pterygiophores of the dorsal fin, and on bony formations which protrude from the vertebrae towards the epipleural ribs (Fig.7). The frequency of individuals with exostoses was related to the species' diversification and to differences in the environmental conditions prevailing in the habitats of the various stocks (Vazzoler, 1971).

Abnormal asymmetric ovaries in whitemouth croakers from Brazilian waters have also been reported (Paiva, 1958).

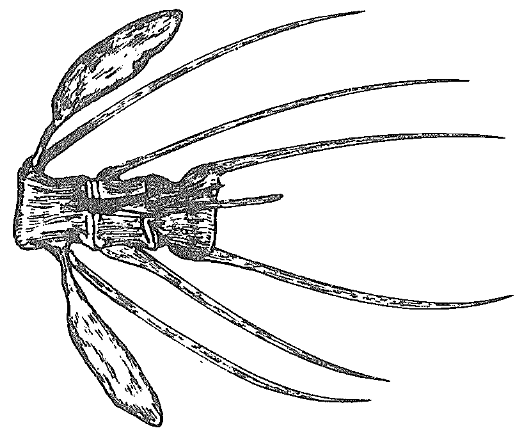


Fig.7 Dorsal view of 8th, 9th and 10th vertebrae of M. Furnieri with anomaly formations (exostoses) (from Vazzoler, 1971)

3.4 Nutrition and growth

3.4.1 Feeding

Whitemouth croakers are essentially bottom feeders with an inferior mouth which is surrounded by well-developed pores of the acustico-lateralis system, and with barbels on the lower jaw.

- Localities

The type of bottom appears to be the controlling factor of distribution. Whitemouth croakers seem to prefer sandy-mud and sandy (fine sand and muddy sand) bottoms (Lowe-McConnell, 1966; Vazzoler, G., 1975).

- Time of day

Puig (1986), having analysed the frequency of empty stomachs, affirms that M. furnieri feeds intensively in the morning (4 to 6 a.m.), at noon (12 to 2 p.m.) and in the afternoon (6 to 8 p.m.).

- Frequency

All information available refers only to populations III and IV. In the course of one year, Oliver, Bastida and Torti (1968) found 57% of the stomachs empty, mainly in juvenile individuals (under 30 cm). Faedo and Sierra (1973) determined an average of 17% empty stomachs between August and March. Haimovici (1977) presents a qualitative analysis of the stomach contents for 64 specimens. He reports more than 90% empty stomachs between July and September (Table IV).

Table IV

Precentage of stomachs of M. furnieri in different repletion stages:
"O = empty; I = semi-empty; II = semi-full; III = full" (from Haimovici, 1977)

MONTH	STOMACH REPLETION			
	O	I	II	III
January 1974	58.5	24.5	11.3	5.7
March 1974	42.4	13.8	8.9	34.9
May 1974	91.1	0.9	-	-
June 1974	75.0	25.0	-	-
July 1974	93.4	4.4	2.2	-
August 1974	97.4	2.6	-	-
September 1974	99.3	0.7	-	-
November 1974	54.5	31.3	6.8	3.4
December 1974	57.4	11.0	18.1	5.5
January 1975	64.3	31.8	3.7	1.2
March 1975	27.7	34.1	25.5	12.7

- Variation of feeding habits with ontogenic development, season, etc.

While the larvae are plankton phagons, juveniles and adults are benthic feeders.

In the Rio de la Plata, individuals of 21 to 25 cm preferred molluscs, crustaceans and vegetal debris; individuals of 26 to 35 cm fed predominantly on crustaceans; individuals of 36 to 45 cm fed on fishes and crustaceans, and those larger than 46 cm included Holothuroidea in their diet. Fishes were preferentially ingested at noon (Piug, 1986).

In the Mar del Plata region, M. furnieri undergoes an intensive feeding period during summer, from November to March (Haimovici, 1977).

3.4.2 Food

Sinque (1980) reported that larvae from the southern Brazilian coast (25°S) feed on copepods of the species Acartia lillieborgii and Pseudodiaptomus acutus.

Juveniles feed on benthic migratory crustaceans, such as Peissos petrunkievittchi and Artemesia longinaris, and also on sedentary and sessile benthic boring molluscs (Oliver, Bastida and Torti, 1968). Mysidaceans and polychaetes were also reported in the stomach contents (Lopez and Castelo, 1968).

Adults are mainly benthos-feeders and occasionally capture fishes. Polychaetes, crustaceans, molluscs and ophiuroids are the principal items found in various other investigations (Carvalho, 1941; Santos, 1952; Franco, 1959; Vannucci, 1963; Lowe-McConnell, 1966; Faedo and Sierra, 1973; Vazzoler, G., 1975) (Table V).

Table V

Summary of information on feeding habits of M. furnieri

	FOOD	AREA	AUTHOR
ADULTS	Small fishes and crustaceans.	Brazil	Carvalho, 1941; Santos, 1952
	Polychaetes, ophiuroids, fishes.	Brazil	Franco, 1959
	Benthic feeding, occasional capture of swimming prey.	Brazil	Vannucci, 1963
	Bottom mud with small invertebrates, mainly polychaete worms, and occasionally small molluscs and tiny crustacea (shrimps and small spider crabs). Only one record of a fish being found in the diet.	Guyana	Lowe-McConnell, 1966
	Polychaetes, ophiuroids; Decapoda, Macrura, Natantia and Brachiura; micro-crustaceans and molluscs; small fishes.	Brazil	Vazzoler, G., 1975
	Mostly decapod crustaceans and molluscs, (pelecypods, scaphopods and gastropods); smaller proportion of holothurians, ophiuroids, polychaetes and fishes.	Uruguay	Faedo and Sierra, 1973
JUVENILES	Benthic migratory crustaceans (Peissos petrunskievittchi and Artemesia longinaris), sessile and sedentary benthic boring molluscs.	Argentina	Oliver, Bastida and Torti, 1968
	Mysidaceans of the genus Neomysis and polychaetes.	Argentina	Lopez and Castello, 1968
LARVAE	Copepods: Acartia lilljeborgi and Pseudodiaptomus acutus.	Brazil	Sinque, 1980

3.4.3 Growth

Relative and absolute growth patterns and rates

Age determination by reading periodic marks is difficult in M. furnieri. The otoliths are large and thick structures (Fig.3) and the scales of older individuals are often too opaque for recognizing growth rings (Fig.8). In spite of this, there are numerous publications on the growth of this species (Table VI and Fig.9), mostly based on the reading of scales (Rodrigues, 1968; Vazzoler, 1971; Ehrhardt, Arena and Menendez, 1976; Haimovici, 1977; Castelo, 1986).

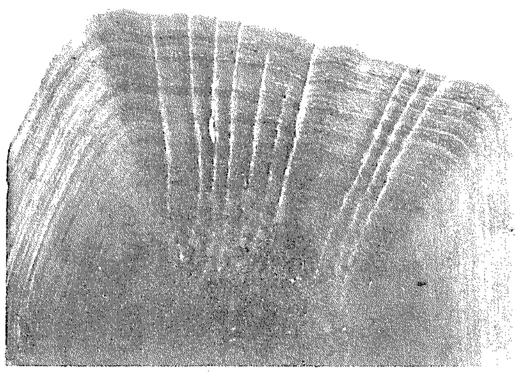


Fig.8 Scale of M. furnieri
(52 cm total length) with 6 growth rings

Table VI

Parameters of the von Bertalanffy equation for M. furnieri (see also Fig.9)

STOCK	SEX	L_{oo}	W_{oo}	T	T_o	AUTHOR
40^oS-34^oS	F	53.69	1 759	0.279	-0.499	Ehrhardt, Arena
	M	49.98	1 354	0.335	-0.367	and Menendez, 1976
41^oS-33^oS	F + M	48.84	1 225	0.194	-1.47	Haimovici, 1977
33^oS-29^oS	F	69.33	3 409	0.149	-2.79	Vazzoler, 1971
	M	89.57	7 459	0.076	-4.64	
29^oS-23^oS	F	60.10	2 466	0.219	-2.08	Vazzoler, 1971
	M	82.90	6 652	0.106	-2.97	
4^oS	F	67.60	-	0.18	-0.42	Rodriguez, 1968
	M	68.60	-	0.18	-0.52	direct method
4^oS	F	78.23	-	0.13	-0.67	Rodriguez, 1968
	M	73.15	-	0.14	-0.90	back calculation

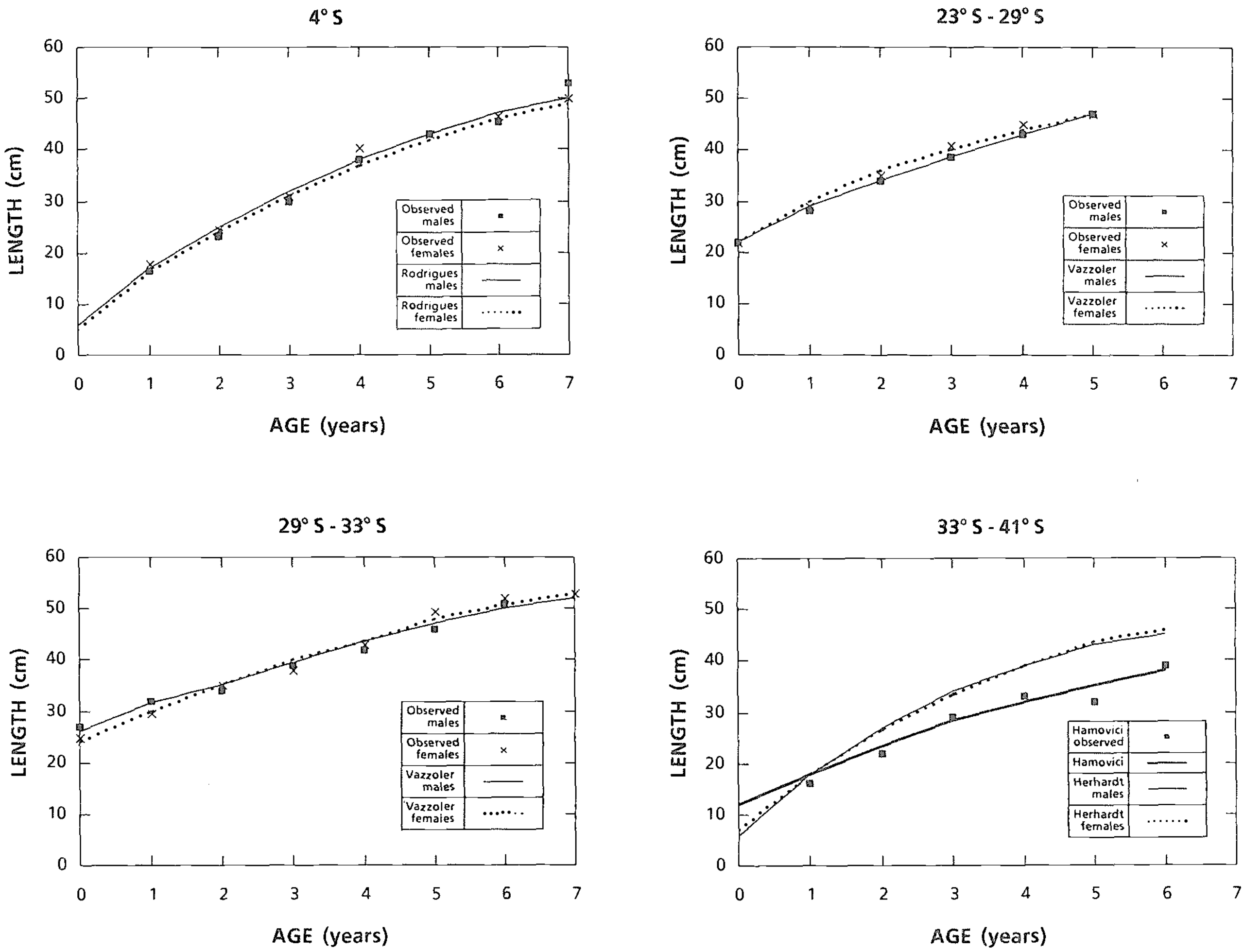


Fig.9 Calculated growth curves for M. furnieri from various authors

The growth rate varies between areas. The first investigation on this subject was conducted by Vazzoler, G. (1962), but his results are misleading, because the calculations were based on a mix of various stocks. Vazzoler (1971) investigated individuals between 13 and 75 cm total length and 0 to 7 years of age of both central-south Brazilian stocks. Erhardt, Arena and Menendez (1976) studied the Rio de la Plata stock. Rodriguez (1968) studied individuals ranging in size from 18 to 60 cm off the coast of Ceará, Brazil (4^{o}S) and Castelo those of the Lagoa dos Patos (32^{o}S) from 8 to 21 cm.

Haimovici (1977), reading both scales and otoliths of individuals under 40 cm in size and up to 5 years old off Mar del Plata, determined growth parameters by back-calculations, but they should be viewed with caution because of the difficulty in reading the scales of older animals. He also found between 0 and 40 rings on the otoliths, but refrained from using them for age determination, because the periodicity was unclear. Cotrina and Lasta (1986) determined the age of specimens caught between 35^{o} and 38^{o}S by wearing down one of the faces of the otoliths and then burning them. The number of marks varied between 0 and 30. ± Rings appear clearly defined but their interpretation was not resolved. Mean sizes of fish were 10.37 ± 0.05 cm, 18.20 ± 0.15 cm, 28.23 ± 0.15 cm, 32.80 ± 0.19 cm, 35.10 ± 0.18 cm, 36.09 ± 0.17 cm and 38.30 ± 0.14 cm for individuals with 0 to 6 rings in the otoliths.

- Growth ring formation

Fishes of population I formed age rings in their scales in summer; those of population II formed rings at the end of autumn and in winter (Vazzoler, 1971). Rings on the scales were formed in spring by individuals from the Lagoa dos Patos (32S) (Castelo, 1986) and from Ceará (4^{o}S) (Rodrigues, 1968).

- Condition factor

The condition factor is highest in March and lowest in August for croakers from Argentinian waters (Mar del Plata). The values decrease with increasing size (Haimovici, 1977), and they are the same for both sexes, with an overall mean of 0.01248 (weight in g; length in cm).

In the Lagoa dos Patos, the condition factor is highest in April-May, probably due to a more intensive feeding period, and in September-October, before the spawning period.

Off southeastern Brazil (23^{o}30'S), the condition factor is high in May, August-October and December, and low in June, November and February, with an overall average of 0.008511. These fluctuations are correlated with the spawning cycle (Isaac-Nahum and Vazzoler, 1983).

- Relation of growth to feeding, spawning, etc.

Fig. 10 shows the relation between the daily rates of feeding and of growth in juveniles of M. furnieri of 10 to 30 g total weight, in temperatures of 10^{o}C to 20^{o}C, caught in Mar del Plata and held in aquaria. The corresponding equation was $y = 0.848 + 0.415\ x$, where y = daily rate of growth and x = daily rate of feeding expressed in percentage of total weight. At temperatures of 15^{o}C to 20^{o}C, the highest rate of feeding and growth was found in the smallest individuals of 4 to 10 g, and the lowest one in the largest individuals of 30 to 63 g total weight (Ciechomski, 1981).

Off the coast of southern Brazil, population I grows faster than population II, but is also shorter-lived.

In the Lagoa dos Patos, Castelo (1986) reported a slower growth rate than in the stock occurring offshore of Rio Grande, probably due to the stress produced by the estuarine environment.

Various authors mention a faster growth rate in females than in males, after they attain sexual maturity (Lowe-McConnell, 1966; Vazzoler, 1971; Haimovici, 1977).

3.4.4 Metabolism

Ciechomski (1981) studied experimentally the food consumption and assimilation of juveniles (10 to 27 g) of M. furnieri caught in Mar del Plata, Argentina. They ingested an average 270 mg wet weight per g total weight per week and presented an average food conversion efficiency factor of 19.45%. The time required for total digestion (leading to an empty stomach) was 22 to 26 hours at 17^{o}C, and 16 hours at 20^{o}C.

3.5 Behaviour

3.5.1 Migrations and local movements (see also 2.2.2)

The fishes of population II off the Brazilian coast migrate southward during summer and northward during winter, according to the dislocation of the subtropical convergence (Vazzoler, 1963). The migration was described by the regression $y = 30.6 = 1.85 \, . \cos 30 \, . (x - 2)$, where y = latitude in ^{o}S and x = month of the year (Vazzoler and Santos, 1965).

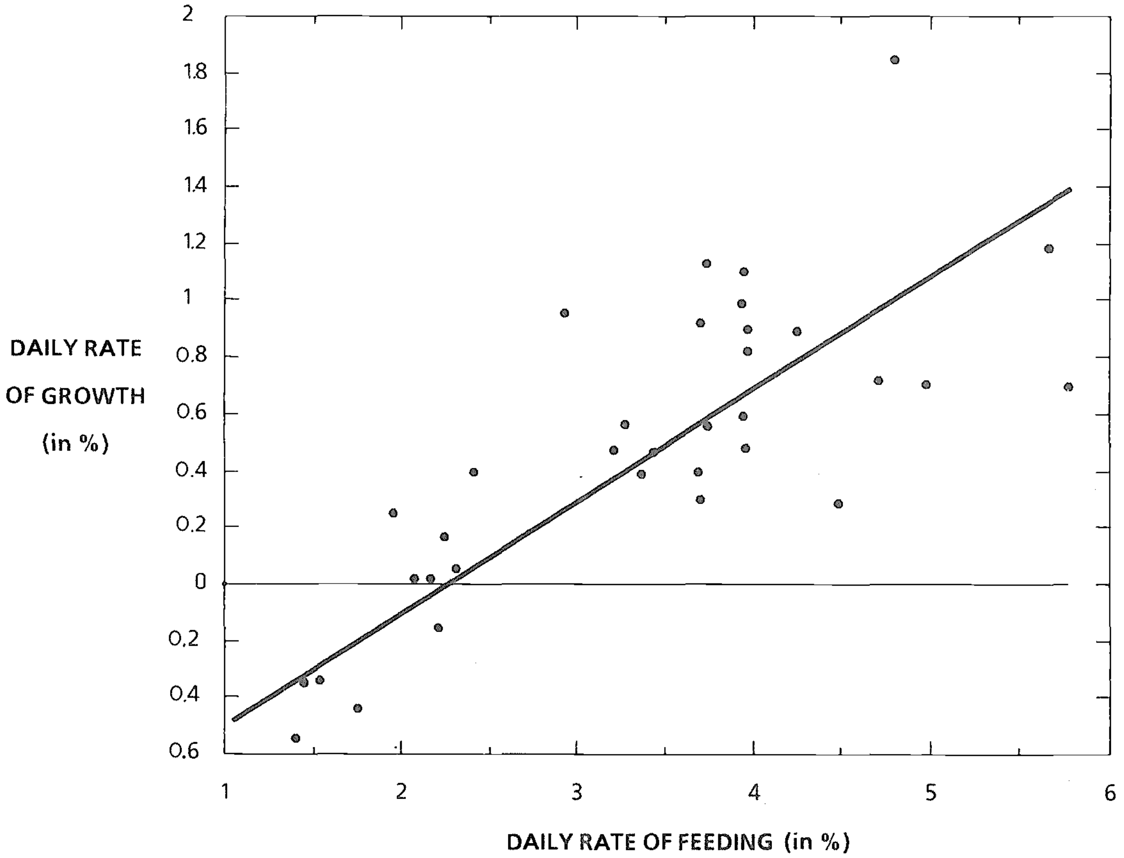


Fig.10 Relation between the daily rates of feeding and growth in juveniles of M. furnieri of 10 to 30 g in temperatures of 10°C to 20°C (from Ciechomski, 1981)

In the Lagoa dos Patos there is probably a spawning migration of mature individuals to offshore areas (Castelo, 1986).

In the Guyana stock, whitemouth croakers is more abundant inshore during the June-July rainy season, and offshore during the windy season from January to March (Lowe-McConnell, 1966).

In the Rio de la Plata, both sexes are segregated before the spawning season. During spring, male schools arrive first at the spawning area in shallow waters, west of Montevideo. The female schools arrive later and then mix with the males for reproduction (Nion, 1985).

3.5.2 Schooling

- Extent of schooling

M. furnieri shows a discontinuous, or patchy distribution. Paiva Filho (1977) reports that the groups are small during autumn and winter, and also located at greater depths; during spring and summer, the species forms larger aggregations.

- Vertical movements

M. furnieri has obligatory demersal habits, and does not present any variations of the relative diversity index over a 24 hour period (Vazzoler, G., 1975).

4. POPULATION

4.1 Structure

4.1.1 Sex ratio

Rodriguez (1968) and Haimovici (1977) found a predominance of females in their samples. Lowe-McConnell (1966) found a sex ratio of approximately 1:1.

4.1.2 Age composition

Age determinations for croakers are based mainly on readings of scales (see 3.4.3).

- Age composition of the population as a whole

Yamaguti, Zaneti and Kawakami (1973), in a study of sciaenids of the southern coast of Brazil and Uruguay, found that 85% of the population was made up of individuals with 2 or 3 growth rings (Fig.11).

- Age distribution of the catch

Ehrhardt and Arena (1977) give the mean annual relative abundance by age classes for the Rio de la Plata (Table VII).

Table VII

Mean annual relative abundance (individuals/h of trawling) by age classes of M. furnieri from the Rio de la Plata region (from Ehrhardt & Arena, 1977)

AGE	YEAR 1967	1968	1969	1975
2	34.45	40.27	117.67	14.60
3	492.70	436.19	307.73	114.15
4	95.76	79.29	87.46	70.89
5	41.30	23.07	19.98	19.71
6	20.18	13.48	10.67	8.47
7	10.43	8.33	8.02	4.43
8	2.67	2.81	2.43	1.88
9	1.74	2.00	2.19	1.15

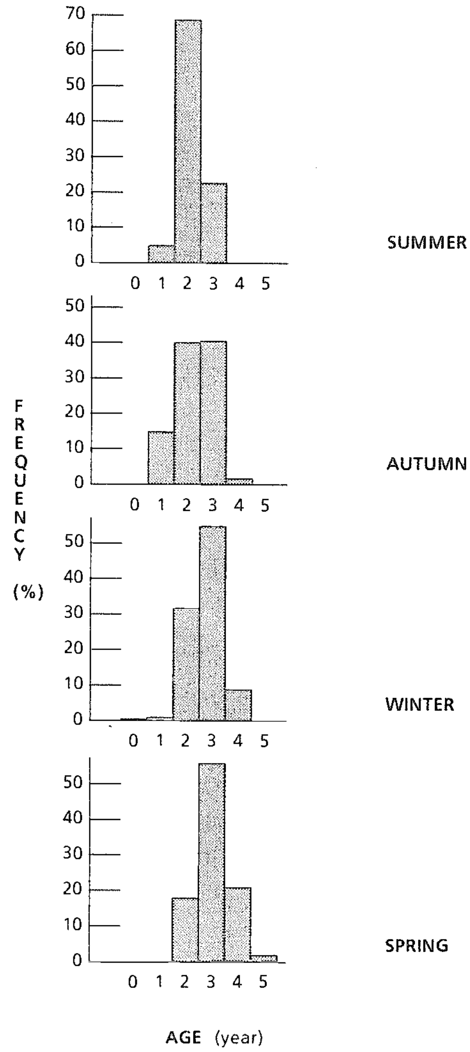


Fig.11 Frequency of M. furnieri with 0 to 5 age rings on scales (from Yamaguti, Zaneti and Kawakami, 1973)

- Variations with depth, etc.

Juveniles seem to have a preference for shallow inshore areas (Lowe-McConnell, 1966; Lopez and Castelo, 1968; Sinque, 1980; Barbieri, 1986). Haimovici (1987) presents a relation between depth and size of fishes caught in southern Brazil between 1976 and 1983 (Fig. 12).

- Age at first capture

There is no precise information on this point, but the size of the individuals landed in Brazil indicates an age at first capture between 0 and 1 years for this region. Ehrhardt and Arena (1977) report t_c = 2.5 years for the Rio de la Plata area.

- Age at first maturity

Estimations of the age at first maturity vary from 4 months to 2.5 years for the various populations studied (see Table II).

- Maximum age

The theoretical maximum ages for the various stocks are given in Table VIII, recalculated as $t_{max} = 2.9957/K + t_0$ (Pauly, 1984) from the data and growth parameters given by different authors.

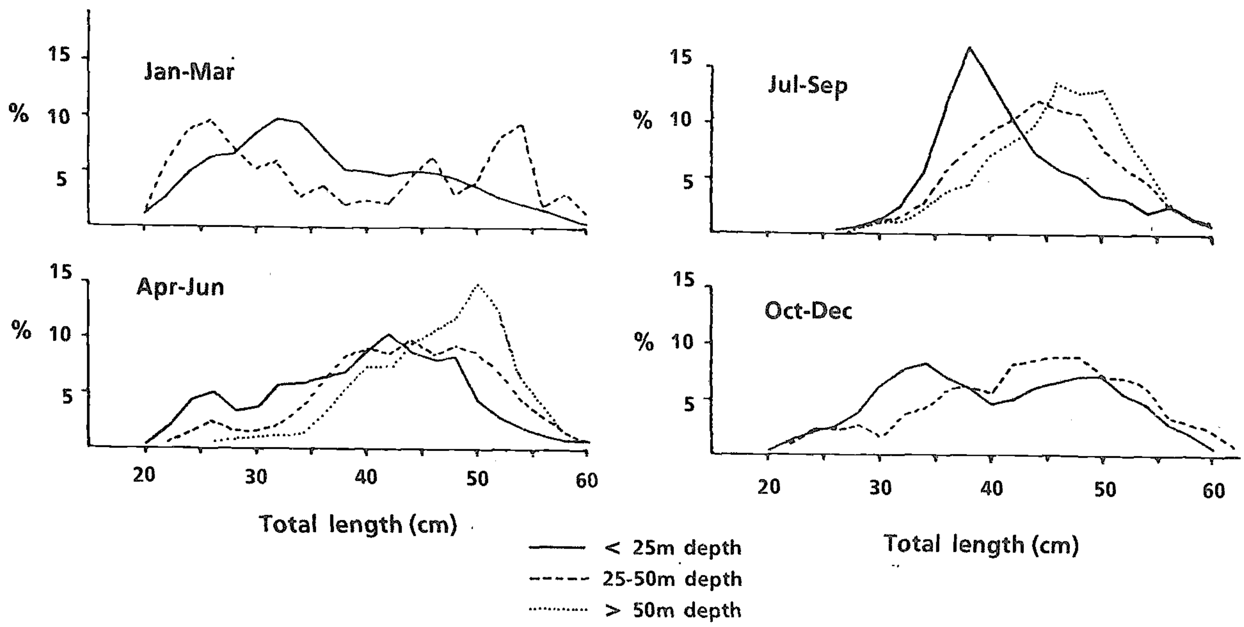


Fig.12 Average length frequency distribution of M. furnieri caught at different depths off southern Brazil from 1976 to 1983 (from Haimovici, 1987)

Table VIII

Theoretical maximal age for various stocks of M. furnieri (according to Pauly's equation, 1984)

AREA	SEX	t_{max} (years)	AUTHOR
41°S-33°S		14	Haimovici, 1977
40°S-34°S		9	Ehrhardt and Arena, 1977
33°S-29°S	M F	35 17	Vazzoler, 1971
29°S-23°S	M F	25 12	Vazzoler, 1971
4°S		16	Rodrigues, 1968

- Length-weight relationship

The length-weight relationships estimated by the different authors are shown in Table IX.

Table IX

Length-weight relationship (cm - g) of M. furnieri

AREA		RELATIONSHIP	AUTHOR
33° to 41° S		$Wt = 0.01248 \cdot Lt^{2.9577}$	Haimovici, 1977
34° to 40° S	F M	$Wt = 0.01089 \cdot Lt^{3.1077}$ $Wt = 0.01566 \cdot Lt^{2.90613}$	Ehrhardt and Arena, 1977
33° to 29°S		$Wt = 0.008968 \cdot Lt^{3.0555}$	Yamaguti, Zaneti & Kawakami, 1973
32°S (Lagoa dos Patos)		$Wt = 0.00551 \cdot Lt^{3.115}$	Castelo, 1986
29° to 23°S		$Wt = 0.010312 \cdot Lt^{2.9996}$	Vazzoler, 1971

4.1.3 Size composition

- Size composition of the catch

Data have been presented for the southern Brazil stock (population II) by PDP/SUDEPE (1981) (Table X).

Table X

Size composition of the landings of *M. furnieri* from southern Brazil between 1977 and 1979 (from PDP/SUDEPE, 1981)

SIZE (cm)	YEAR					
	1977		1978		1979	
	n	%	n	%	n	%
17	2	0.1	11	0.7	-	-
18	3	0.1	45	2.7	3	0.2
19	18	0.8	109	6.7	11	0.8
20	77	3.2	118	7.2	39	3.1
21	184	7.8	119	7.3	53	4.1
22	276	11.7	99	6.0	117	9.2
23	376	15.9	160	9.8	202	15.8
24	291	12.3	145	8.9	156	12.2
25	216	9.1	130	7.9	128	10.0
26	155	6.6	132	8.1	121	9.5
27	133	5.6	144	8.8	85	6.7
28	116	4.9	90	5.5	65	5.1
29	90	3.8	66	4.0	43	3.4
30	97	4.1	44	2.7	38	3.0
31	76	3.2	41	2.5	41	3.2
32	73	3.1	37	2.3	29	2.3
33	56	2.4	25	1.5	40	3.1
34	46	1.9	42	2.6	32	2.5
35	31	1.3	31	1.9	35	2.7
36	26	1.1	24	1.5	198	1.4
37	.12	0.5	13	0.8	14	1.1
38	6	0.3	10	0.0	4	0.3
39	4	0.2	2	0.1	-	-
40	-	-	1	0.1	-	-
41	1	0.04	-	-	-	-
Total	2 365		1 638		1 278	

- Size at first capture

For population II, L_c = 15 cm has been determined from the empirical relation between mesh size and fish perimeter (Richardson and Santos, 1962; PDP/SUDEPE, 1981).

- Size at first maturity

The average size at first maturity (L_{50}) varies between 25.0 and 40.0 cm for the various populations and according to the various authors (see Table II).

- Maximum size

Lowe-McConnell (1966) reported a maximum size of 48 cm total length for the Guyana region. Yamaguti, Zaneti and Kawakami (1973) reported a maximum total length of 59 cm for the waters off southern Brazil and Uruguay. Haimovici (1977) found a maximum length of 67 cm for the Rio de la Plata region. In the Lagoa dos Patos (32°S), individuals of more than 90 cm were found (Chao, pers.comm.).

4.2 Abundance and density of population

4.2.1 Average abundance

Yesaki, Rahn and Siva (1976) estimated the maximum biomass of *M. furnieri* off the Brazilian coast (28°S to 33°S) at 40 000 to 58 000 t for the depth range from 50 to 99 m in autumn of 1973. A calculation based on average individual weights between 600 and 1 200 g (PDP/SUDEPE, 1984) arrived at a stock size between $33 \cdot 10^6$ and $97 \cdot 10^6$ individuals.

Biomass estimates for the population of the Rio de la Plata between 1975 and 1977 are shown in Table XI (Nion, 1985), but according to the author, these values might be underestimates.

Table XI

Biomass estimates (in tons) for the population from the Rio de la Plata between 1975 and 1977 (from Nion, 1985)

SEASON	YEAR		
	1975	1976	1977
Summer	-	39 902	112 916
Autumn	-	-	48 678
Winter	-	-	-
Spring	41 438	44 123	-

4.2.3 Average density

Weiss (1981) recorded a maximum density of 935.7 eggs/100m^3 and 13.7 larvae/100m^3 in summer in the estuarine region of the Lagoa dos Patos.

- Adults

Yesaki, Rahn and Siva (1976) reported the following densities (in kg/ha) for the area between 32°S and 33°S at 50 to 99 m depth:

	AUTUMN	WINTER
1973	21.4 ± 3.8	5.2 ± 1.7
1974	11.3 ± 2.3	0.5 ± 0.2

The density was 0 at depths greater than 100 m.

The changes in CPUE for various stocks are shown in Table XII.

4.2.4 Changes in density

Table XII shows a decrease in the density index for the Rio de la Plata region. No marked tendency regarding density of the southern Brazilian stock has been observed, but a temporary decrease in the southeastern Brazilian stock occurred in the mid-1970s.

Table XII

Catch per unit effort (CPUE) for M. furnieri from various areas

YEAR	AREA		
	34^o to 40^oS (1)	33^o to 29^oS (2)	29^o to 23^oS (3)
1965	260.8	-	-
1966	365.9	-	-
1967	295.2	-	-
1968	289.8	-	-
1969	251.1	-	-
1970	325.8	-	-
1971	321.4	-	-
1972	199.5	-	-
1973	232.0	13.23	154
1974	203.8	10.54	100
1975	170.1	10.82	85
1976	113.9	11.04	85
1977	138.5	31.88	93
1978	120.5	9.80	133
1979	162.9	10.36	113
1980	154.6	14.35	153
1981	122.3	-	123
1982	108.1	-	109
1983	-	-	133

(1) Calculated as kg/h of trawling, (effort of the sister ships) FLORIDA and TACUAREMBO (Ehrhardt and Arena, 1977; Arena, 1984)

(2) Calculated as tons per trip of pair trawls (data of the state of Rio Grande, Brazil; PDP/SUDEPE, 1981)

(3) Calculated as kg per haul of a "medium-sized" pair trawl (data of the state of Sao Paulo, Brazil; PDP/SUDEPE, 1984)

- Seasonal changes

The croaker's southward migration during spring and summer in the southern Brazilian region does not show up in the CPUE statistics until after 1973 (when the introduction of the 200-mile zone prevented Brazilian fishermen from following the stock). It has since been shown that the highest densities off Rio Grande, Brazil, are found during autumn (Vazzoler and Sá, 1963; Yesaki, Rahn and Siva, 1973) (see also 2.2.2).

4.3 Natality and recruitment

4.3.3 Recruitment

In the Lagoa dos Patos (32^oS), an extended recruitment period with two yearly "waves" is observed. Larvae and juveniles enter the estuarine region at the beginning of the summer, associated with the entrance of the sea water. A new wave of recruits is detected at the end of winter (Pereira, 1986). The parental stock of the young fish recruited in winter are probably the fall spawners (February-June) which mature in the Lagoa (with $\approx$ 18 cm), while the parental stock of the young fish recruited in summer are the individuals which spawned in spring (September-December) on the open coast (L_{50} of spawners $>$ 30 cm) (Barbieri, 1986; Chao, 1986).

According to Vazzoler (1971), the young croakers are recruited to the adult stock off the southern Brazilian coast (population II) during summer and autumn, and only during autumn off the southeastern coast (population I). There is no information on intensity of recruitment, nor on annual variations.

4.4 Mortality and morbidity

4.4.1 Mortality rates

The following mortality rates were estimated from data for 1976 through 1979 for the southern Brazil stock: Z = 0.64; M = 0.23; F = 0.41 (PDP/SUDEPE, 1981).

The results of Ehrhardt and Arena (1977) for the Rio de la Plata croaker are given in Table XIII.

Table XIII

Mortality rates of M. furnieri in the Rio de la Plata region

YEAR	Z	q	M	F(Z - M)	F(q . f)
1967	0.74	$1.21 \cdot 10^{-5}$	0.36	0.38	0.44
1968	0.73	$1.21 \cdot 10^{-5}$	0.36	0.37	0.43
1969	0.78	$1.21 \cdot 10^{-5}$	0.36	0.42	0.58
1975	0.92	$1.21 \cdot 10^{-5}$	0.36	0.56	0.61

- Variations in mortality

Beyond the increase in mortality (resulting from an increase in fishing effort) observed in recent years, no further assertions on mortality variations can be made, because the available data are still insufficient and unreliable.

4.4.2 Factors causing or affecting mortality

- Effects of fishing

Fishing is probably the main cause of mortality. After the sardine (Sardinella brasiliensis), the croaker is the species most often caught off the Brazilian coast.

Vazzoler (1962) reports that 33.4%, 57.8% and 56.3% of the individuals landed at Santos (Brazil) in 1958, 1959 and 1969, respectively, had not yet reached maturity.

4.4.3 Factors affecting morbidity

- Parasites and diseases

See 3.3.5.

4.5 Dynamics of population (as a whole)

Studies on the population dynamics of M. furnieri are handicapped by the scarcity of reliable data, the heterogeneity of the fishery and the presence of stocks which encompass wide geographic areas.

For some of the Brazilian stocks, PDP/SUDEPE (1981) has estimated the following figures, based on data for 1973 through 1980:

Population I (southeast): MSY of 6 800 t/year with an equilibrium effort of 5 500 hauls/year.

Population II (south): MSY of 18 500 t/year with 1 500 trips/year. A Beverton and Holt model of this stock (using K = 0.092; L_∞ = 81 cm; L_c = 15 cm; M = 0.23; F = 0.41; Z = 0.64; E = 0.62; C ≈ 0.2; SF = 2.73; mesh size = 55 mm) gives an estimated MSY of 32 250 t/year if the mesh size is increased to 140 mm. The maximum cohort biomass was found at the age of 4.25 years and at 44 cm in size.

Both stocks (and population II in particular) are therefore intensively exploited, and only an increase of mesh size could lead to higher yields. These estimates are merely approximations, however, because of the different measures of fishing intensity used; pair trawling, i.e., is 5 to 10 times more efficient than fishing with simple trawls, and such differences are not accounted for in the various CPUE estimation methods.

Using data collected in the Rio de la Plata area between 1965 and 1975, Ehrhardt and Arena (1977) applied and analytical model with K = 0.335; W_∞ = 1 354 g; b = 2.9061; t_c = 2.5 years; t_{max} = 12 years; 0.1 $\leq$ F $\leq$ 1.0; and M = 0.30, 0.35 and 0.40. The results show that the Rio de la Plata stock is being exploited fully, and might even be slightly overexploited. Using descriptive models, the following results were obtained for the optimum effort (in trawling hours) and MSY (in tons/year): Schaefer model: f_{opt} = 42 892; MSY = 10 254; and Fox model: f_{opt} = 46 334; MSY = 10 056, thus confirming that the stock is fully exploited.

Arena (1984) found an MSY of 38 400 to 58 800 t/year, using the data available from 1965 to 1982 and the same standard effort calculation as Ehrhardt and Arena (op.cit.). Arena (op.cit.) introduced a correlation factor of 11.5, in order to account for the increase in efficiency resulting from pair trawling after 1977, but it is not possible to appraise the validity of this correction factor from the data. Nion (1985) affirms that pair trawls are only 5 times more efficient than otter trawls. On the other hand, the continuous increase in efficiency and effort seriously limits the application of production models.

4.6 The population in the community and the ecosystem

The demersal community of the Brazilian shelf between 29°S and 33°S has been studied by Vazzoler, G., (1975). He found 11 families, 17 genera and 30 species of elasmobranchs, and 57 families, 93 genera and 104 species of teleosts. The Sciaenidae are represented by 8 genera (9 species) and thus constitute the most abundant family, although it is rarely found at depths between 100 and 200 m. The most abundant sciaenids were *Cynosion striatus* (24%), *Umbrina canosai* (20%); *M. furnieri* (17%), *Paralonchurus brasiliensis* (15%), *Macrodon ancylodon* (13%) and *Cynosion petranus* (2.4%); their association is shown in Table XIV.

Table XIV

Coefficients of interspecific association, C (in pairs) and chi-square for some sciaenid species from the coast of southern Brazil (Vazzoler, G., 1975)

Combinations	C	Chi-square
BA	58.59 ***	0.92
AC	20.07 ***	0.43
AD	24.85 ***	0.37
EA	77.48 ***	0.96
FA	0.17	0.07
BC	0.50	0.12
BD	3.25	0.23
BE	86.02 ***	0.71
FB	2.66	-0.43
DC	60.86 ***	0.70
EC	0.05	0.03
FC	0.94	0.23
ED	4.83 *	0.25
FD	0.67	0.15
FE	0.71	-0.20

A = *M. furnieri*
B = *M. ancylodon*
C = *C. striatus*
D = *U. canosai*
E = *P. brasiliensis*
F = *C. petranus*
* - Significance level 5%
** - Significance level 1%
*** - Significance level 0.1%

Fig. 13 shows a frequency histogram of the various food items taken by the above-mentioned species, the staple consisting of benthic invertebrates. The diets of Umbrina canosai and M. furnieri are very similar, while those of the other sciaenids differ in that they also include fishes. If the sciaenids are combined in triads and the interspecific relationships are analyzed according to the association coefficient, it becomes apparent that the whitemouth croaker is associated with all of the most abundant sciaenids (Table XIV, Fig. 14; the arrows indicate the more abundant species). The highest association coefficients were found for the combinations of M. furnieri, and M. ancylodon, and the lowest, for M. furnieri, U. canosai and P. brasiliensis. The study indicates a high degree of overlap, which results in competition for food between M. furnieri and U. canosai, but there is no overlap of dense concentrations of the two species. Nevertheless, the data suggest that these species exploit different trophic levels. The association of M. furnieri with sciaenids other than U. canosai implies little food competition, due to the differences in feeding habits (Vazzoler, G., 1975).

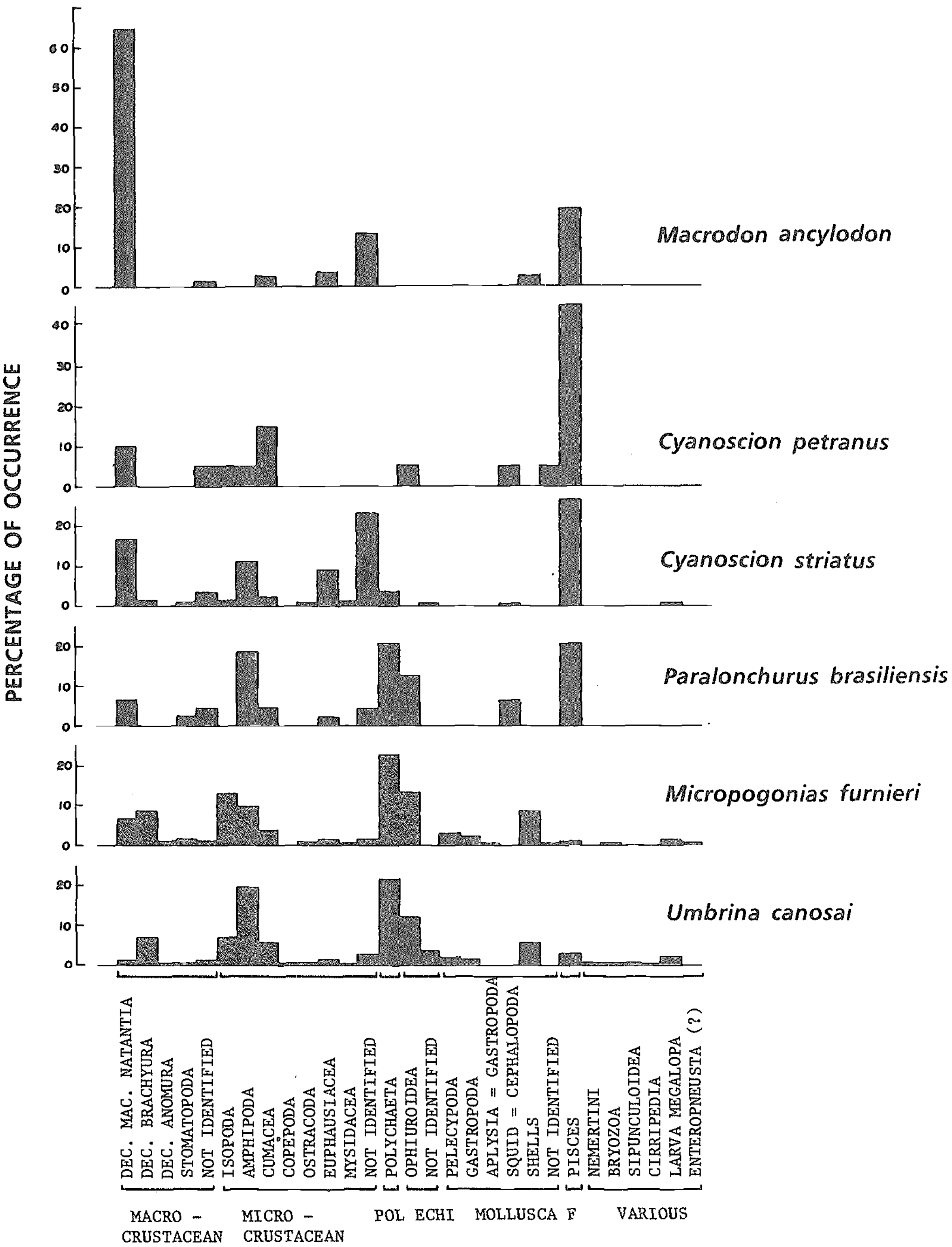


Fig.13 Frequency histogram of the various food items in 6 species of Sciaenidae off southern Brazil (from Vazzoler, G., 1975)

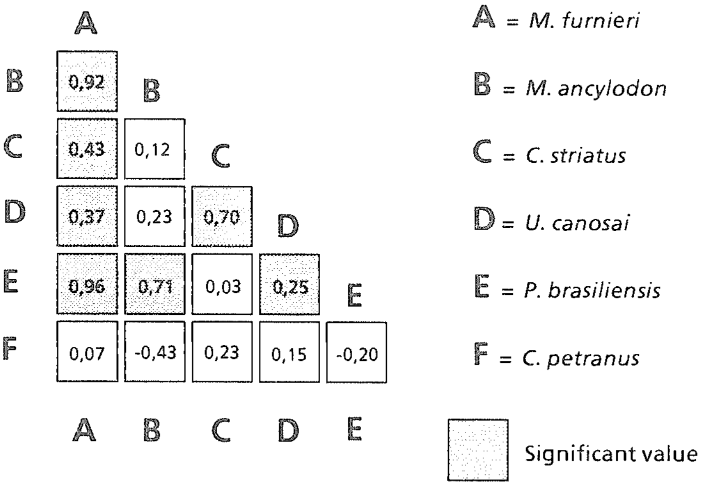
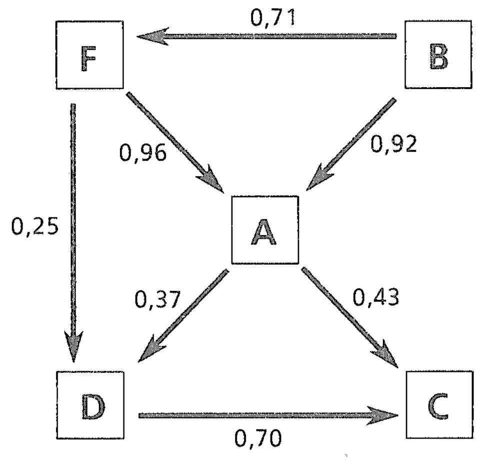


Fig.14 Significance of positive association between 5 species of Sciaenidae from southern Brazil.



Inter-specific association coefficient for 6 species of Sciaenidae (from Vazzoler, G., 1975)

5. EXPLOITATION

Croaker stocks are exploited by artisanal and semi-industrial fisheries. The artisanal fisheries are important in estuarine regions, river mouths and coastal lagoons and represent the only type of exploitation on the northeastern coast of Brazil.

5.1 Fishing equipment

The artisanal fisheries use bottom longlines ("espineles"), gill nets ("redes de enmalhe", "redes de espera"), Chinese seines ("palangres"), and other methods. The semi-industrial fisheries use otter trawls and pair trawls. Pair trawling consists of two boats on a parallel course, each boat pulling on one side of the net; the net opening is adjusted by the distance between the two boats. In shallow water, the pair trawl is preferred due to its efficiency. Otter trawls are more profitable when fishing in deeper waters, and when the density is higher. Most boats can be adapted for both fishing methods (Haimovici and Vieira, 1986).

5.1.1 Gears

The bottom gill nets used in artisanal fishing in the Lagoa dos Patos (Brazil, 32^{o}S) are made of nylon, with 60 to 140 mm mesh size. They may consist of a single net, but often three nets are combined ("transmalles") and operate passively, helped by the tidal currents (Haimovici, 1982; Castelo, 1986). From 1983 onwards, small boats started to operate at the entrance of the estuary with 3 000 to 5 000 m long bottom gill nets, thus significantly increasing the fishing effort on the spawning stock in this region (Haimovici, Pereira and Vieira, 1987).

The otter trawls operating off Rio Grande (Brazil) are also made of nylon, with 24 to 100 mm mesh (see 5.1.2). Pair trawls use the same type of net, but they may be larger.

There have been changes in types of gear during the development of the fishery. The Uruguayan fishery began to modernize in 1974 and switched to pair trawls in 1977. The number of pair trawls in the Brazilian fleet has recently begun to increase. There is no precise information on mesh sizes, but the more modern boats in the commercial fisheries tend toward the use of wider meshes.

- Use of echosounding for fish detection

Most of the boats operating off the Brazilian coast have echosounders, but their use appears restricted to the determination of water depth.

5.1.2 Boats

- Types, size, power

The demersal trawling fleet on the Brazilian and Uruguayan coasts consists of very different units. The otters are flat and made of wood (maximum weight of 450 kg), or V-shaped and made of metal (maximum weight 600 kg). Vazzoler and Vazzoler (1969) classified the fleet operating out of the port of Santos (Brazil, 24^{o}S) in the late 1960s as follows:

1. Small pair trawlers. Under 10 m in length, nets of 36 mm mesh size. Operation restricted to the vicinity of Santos.

2. Medium-sized pair trawlers. Between 10 and 20 m in length, 36 mm mesh size.

3. Large pair trawlers, 27 m long, 68 mm mesh size. They operate throughout the south-central coast of Brazil and (until 1973) off Uruguay.

4. Small otter trawlers. Under 10 m long, 24 mm mesh size. They operate in the vicinity of Santos.

5. Medium-sized otter trawlers. Ten to 20 m length, 37 mm mesh size. They operate throughout the south-central Brazilian coast.

6. Large otter trawlers. More than 20 m long, 37 mm mesh size. Throughout the south-central coast of Brazil.

During the last decade, the pair trawlers landing at the port of Rio Grande (Brazil) had a power between 119 and 700 HP. The average power was 346.5 HP in 1976, 399.7 in 1980 and 318.2 in 1984. The power of otter trawlers ranged between 310 and 680 HP, averaging 447.6 in 1976, 512.7 in 1979 and 465.3 in 1984. Boat length varied from 20 to 35 m and storage capacity from 20 to 120 m.tons. The catch was stored in crushed ice without previous selection nor evisceration. Therefore, the maximum duration of fishing trips was 15 days (Haimovici and Vieira, 1986; Haimovici, 1987).

From 1979 to 1983, the 74 otter trawlers which operated in the Rio de la Plata had a power between 110 and 1 560 HP. Seventy-two boats operated as pair trawlers, but many of them worked with both methods. Table XV shows the principal categories, power and capacity of those boats (Nion, 1985).

Table XV

Number, power and capacity averages of the Uruguayan trawling fleet operating in Rio de la Plata region between 1979 and 1983

CATEGORY	OTTER TRAWL			PAIR TRAWL		
	N	HP	BRT	N	HP	BRT
I	6	130.83	37.20	12	224.83	41.56
II	9	225.67	32.87	19	342.87	63.84
III	18	351.61	78.59	2	403.50	105.70
IV	10	433.40	121.37	3	866.67	256.10
V	31	846.29	358.55	-	-	-

- Changes in the number of boats during the development of the fishery

The trawling fleet of the port of Santos (Brazil) consisted of 11 small and 4 medium pairs (30 boats) in 1944; 8 small, 38 medium and 3 large pairs (98 boats) in 1970; and about 70 boats operating in pairs in 1981 (PDP/SUDEPE, 1981).

The fleet of Río Grande do Sul, Brazil, began in 1947 with two trawlers working as a pair. A second pair joined them the following year. In 1952, 6 boats began operating as otter trawlers and 4 converted from the previous pair to otter trawling as well. The number of otter trawlers increased to 12 by 1969 and to 38 by 1973. The number of pairs was 11 (22 boats) in 1973 (Yesaki and Bager, 1975), and has increased further in the last few years; this last method presents a number of advantages when fishing in shallow waters; it consumes less fuel with respect to the area swept, and the vertical opening of the net is larger. Otter trawls are more profitable in deep water, in bad weather and in areas where fish densities are higher. Many of the boats from Rio Grande do Sul operate in pairs during summer and autumn, switching to otter trawls in spring (Haimovici, 1982). Pair fishing may be five to ten times more efficient than single trawling (Vazzoler, 1965; Nion, 1985).

Until 1973, the Uruguayan fleet consisted of small and very old wooden boats which had not been designed for fishing and lacked cold storage facilities (see also 5.1.1; Ehrhardt and Arena, 1977; Arena, 1984).

No data are available on the Argentine trawling fleet, nor on the fishery off the northern coast of South America.

5.2 Fishing areas

5.2.1 General geographic distribution

M. furnieri is exploited throughout its area of distribution, but with different intensities.

5.2.2 Geographic ranges

M. furnieri is intensively exploited south of 21°S on the Brazilian coast, on the coast of Uruguay, in the Rio de la Plata and in the surroundings of Mar del Plata (Argentina), but it is not caught south of Bahia Blanca (41°S) (Ehrhardt and Arena, 1977). On the Brazilian northeast coast, there is only an artisanal fishery (Rodrigues, 1968). There is no precise information on fisheries for the species north of Brazil.

5.2.3 Depth range

Rarely caught in water deeper than 50 m. On the coasts of Guyana and Brazil, the whitemouth croaker is mostly caught in 30 to 50 m of water. In the Rio de la Plata estuary, it is usually fished in less than 20 m depth.

5.2.4 Conditions of the grounds

M. furnieri is almost exclusively fished on muddy or sandy grounds.

5.3 Fishing seasons

The croaker is fished throughout the year, but catches may fluctuate seasonally as a result of the species' migratory behaviour. On the coast of Rio Grande de Sul, Brazil, the largest catches are made during autumn (Yesaki, Rahn and Siva, 1976). Siri, Arena and Decuadra (1971) mention that the larger catches in the Rio de la Plata area are taken during autumn and summer.

5.4 Fishing operations and results

5.4.1 Effort and intensity

The bottom trawl fishery in Brazil is typically multispecific. M. furnieri, Umbrina canosai, Cynoscion striatus and Macrodon ancylodon constitute 80% of the catches of the demersal fishery in southern Brazil (Haimovici, Pereira and Vieira, 1987).

- Units of effort

Hours of trawling, number of hauls, number of trips are used as units of effort. The duration of the trips is limited by the storage capacity of the boats and the conservation of the catch.

- Landings per unit of fishing effort

The catch per unit of effort for the various areas is shown in Table XII. The different measures of fishing effort and the unreliability of the collected data make it difficult to interpret effects on the exploited stocks, but many authors agree that the stocks off Brazil, Uruguay and Argentina are reduced due to the intensive fishing (Ehrhardt and Arena, 1977; Haimovici, Pereira and Vieira, 1987).

- Fishing effort per unit area, and total fishing intensity

Vazzoler and Sá (1963) computed the effort by squares of 1° (3 600 square miles) for the period from 1959 to 1962, arriving at the conclusion that most of the effort was directed at areas in which the density of croakers was below average.

Due to the various types of gear of different efficiency employed, it is difficult to estimate the real effort of the fishery as a whole.

5.4.2 Selectivity

The fishing gear used takes a large number of small individuals without commercial value.

Fig. 15 shows an experiment comparing the size of M. furnieri caught with a shrimp otter trawl (10 mm), an artisanal pair trawl (24 mm) of the estuarine region of the Lagoa dos Patos, and a commercial trawl operating in open coastal waters off southern Brazil (60 mm).

Although the commercial fishery generally does not have discards for M. furnieri (Haimovici and Perez Habiaga, 1982), Castelo (1986) mentioned that small fishes caught in the Lagoa dos Patos could be discarded or used for meal production.

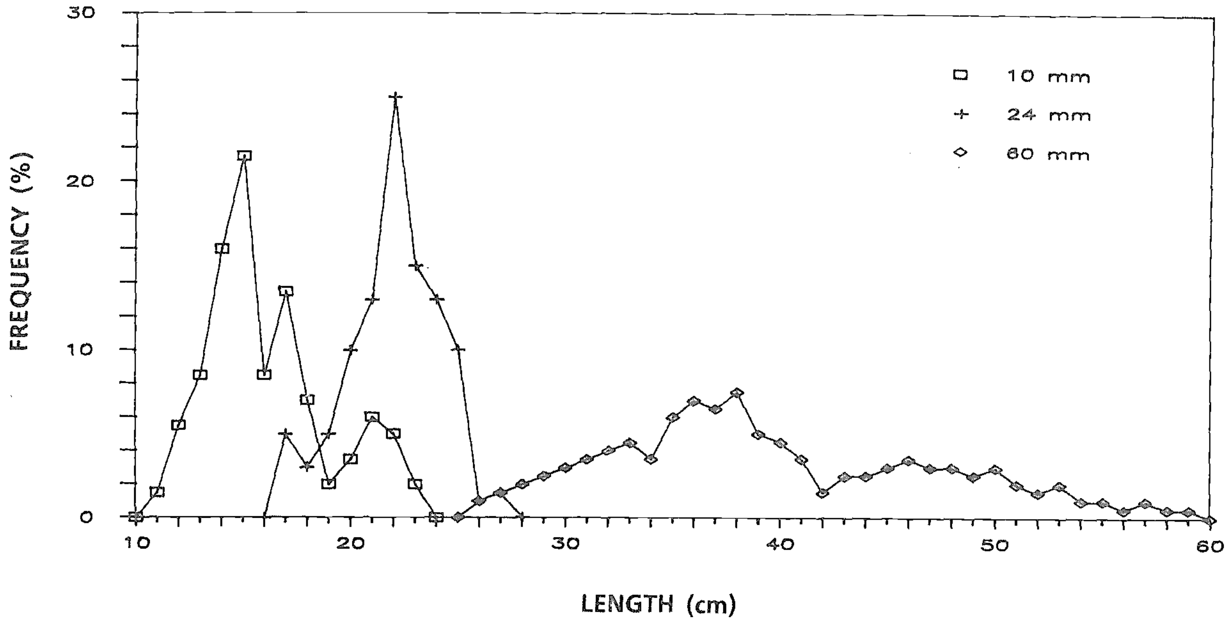


Fig.15 Length-frequency distribution of M. furnieri off southern Brazil caught with a shrimp otter trawl (10 mm), an artisanal pair trawl (24 mm) and a commercial trawl (60 mm) (from Castelo, 1986)

Selectivity investigations are obviously required for the species; however, in all the cases the yield calculations show that an increase in mesh size to at least 100 mm would significantly increase the yield.

5.4.3 Catches

Landings in Argentina, Uruguay and Brazil were 11 588 t in 1961 and reached a maximum of 64 019 t in 1983. Annual yields for the main stocks are shown in Table XVI. Catches had a decreasing tendency in Brazil and Uruguay.

- Maximum equilibrium yield

See section 4.5.

6. PROTECTION AND MANAGEMENT

6.1 Regulatory (legislative) measures

- By the Government of Uruguay

1. Minimum mesh size 100 mm since 1974.
2. Prohibition of fishing with beach nets.
3. Prohibition of fishing in the area of Montevideo (spawning area) during the summer months.
4. Limitation of operation areas; boats larger than 26 m are not allowed to fish inside the Rio de la Plata and in nursery areas.
5. Total prohibition of pair trawling by boats larger than 26 m throughout the year.
6. The National Fisheries Institute (INAPE) is authorized to establish quotas or mesh size regulations when it is considered necessary.

- By the Government of Brazil

Minimum mesh size 90 mm, beginning in 1983. No other regulations on the whitemouth croaker fishery.

Table XVI

Catches (in metric tons) of the principal commercial fisheries of Micropogonias furnieri

Year	Argentina	Uruguay	Corvina S. Brazil	Brazil	TOTAL
1960	?	?	?	?	?
1961	1 300	2 200	?	8 088	11 588
1962	1 200	2 100	?	6 881	10 181
1963	1 200	2 100	?	7 628	10 928
1964	1 600	2 200	?	9 621	13 421
1965	2 000	2 700	?	11 867	16 567
1966	1 800	2 800	?	18 814	23 414
1967	4 700	2 400	?	18 674	25 774
1968	4 100	2 700	?	17 586	24 386
1969	4 913	3 500	?	22 650	31 050
1970	4 789	3 000	?	24 627	32 427
1971	3 459	2 900	?	30 355	36 755
1972	3 089	2 800	?	28 797	34 697
1973	3 317	2 800	22 052	30 175	36 292
1974	2 680	4 000	18 660	27 129	33 809
1975	3 636	5 600	16 724	21 533	30 769
1976	5 175	9 434	14 149	20 290	34 899
1977	3 955	11 900	19 739	26 834	42 689
1978	4 544	13 900	16 609	26 068	44 592
1979	4 391	25 827	14 462	23 838	54 056
1980	6 518	31 623	17 033	24 301	62 442
1981	13 657	25 913	15 233	20 945	60 515
1982	16 760	20 710	15 636	21 335	58 805
1983	18 159	24 842	15 715	21 018	64 019
1984	5 311	24 246	13 140	19 046	48 603
1985	4 065	19 000	15 455	20 070	43 135

(from Haimovici, Pereira and Vieira, 1987)

7. MISCELLANEOUS

7.1 Physical and chemical composition

The physical and commercial composition of meat fillets of M. furnieri was determined by Mandelli and Lena (1980) as follows:

Physical constitution - head (24.7% and 21.1%), trunk (68.1% and 69.8%) and viscera (7.2% and 9.1%) for females and males, respectively.

Chemical constituents - water (79.1% and 79.1%), fat (1.5% and 1.4%), protein (18.2% and 18.2%) and minerals (1.2% and 1.3%) for females and males, respectively.

The average weight of the fillet was 37% of the total weight. The average fish fillet yielded 67.3 g of protein, 5.6 g of fat, 4.4 g of minerals and 328 Kcal.

7.2 Pond fish culture

Lowe-McConnell (1966) reported that M. furnieri grows in brackish ponds at Onverwagt in Guyana to about 33 cm total length (400 g) in 12 to 16 months. They did not mature in the ponds, although the size at first maturity at sea is smaller.

8. REFERENCES

Arena, G.J., 1984 Estimación del coeficiente de capturabilidad y de la captura máxima sostenible del recurso de corvina blanca (Micropogon sp.) explotado por la flota uruguaya. Montevideo, Instituto Nacional de Pesca, 15 p. (mimeo)

Arena, G.J. and E. Hertl, 1983 Aspectos referentes al ciclo reproductor de la corvina blanca (Micorpogon opercularis) del sub-área platense. Inf.Téc.Inst.Nac.Pesca, Montevid., (36):24 p.

Argentina, Servicio de Hidrografía Naval, 1966 Derrotero de pesca. Publ.Serv.Hidrogr.Nav., B.Aries, (H210):118 p.

Barbieri, L.R.R., 1986 Distribução espacial e temporal de Sciaenideos juveniles no estuário da Lagoa dos patos, R.G., Brasil. MS Thesis. Universidade do Rio Grande, Brazil, 98 p.

Barcellos, B.N., 1962 Anomalías do esqueleto da corvina. Ciênc.Cult., 14(2):111-3

Beverton, R.J.H. and S.J. Holt, 1957 On the dynamics of exploited fish populations. Fish.Invest.Minist.Agric.Fish. Food G.B.(2 Sea Fish.), 19:533 p.

Bonaparte, C., 1831 Saggio d'una distribuzione metodica degli animali vertebrati a sangue freddo. G.Acad.Sci.Lett. Art, Roma, 53:129-209

Carvalho, J. de P., 1941 Nota preliminar sobre a fauna ictiológica do litoral sul do Estado de São Paulo. Bol.Ind.Anim.São Paulo, (3):27-81

Castelo, J.P., 1986 Distribución, crecimiento y maduración sexual de la corvina juvenil (Micropogonias furnieri) en el estuário de la "Lagoa dos Patos", Brasil. Physio, B.Aires (secc.A), 44(106):21-36

Cervigón, F.M., 1966 Los peces marinos de Venezuela. Monogr.Fund.La Salle Cienc.Nat., Caracas, 12(2):449-951

Chao, L.N., 1978 A basis for classifying Western Atlantic Sciaenidae (Teleostei:Perciformes). NOAA Tech.Rep. NMFS Circ., (415):64 p.

__________, 1986 Lagoa dos patos as a nursery ground for shore fishes off southern Brazil. Paper presented at the IOC/FAO Workshop on recruitment in tropical coastal demersal communities. Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986

Chao, L.N. et al., 1982 Relação preliminar dos peixes estuarinos e marinhos da Lago dos Patos e região costeira adjacente, Rio Grande do Sul, Brasil. Atlántica, Rio Grande, 5:67-75

Ciechomski, J. de., 1981 Food utilization by juveniles of some sciaenid fish from coastal waters of Argentina. Rapp.P.-V.Réun.CIEM, 178:389-92

Cotrina, C.P., 1986 Estudios biológicos sobre peces costeros con datos de dos campañas de investigación realizadas en 1981. 2. La corvina rubia (Micropogonias furnieri). Publ.Com.Téc.Mix.Fr.Mar., 1(1):8-14

Cotrina, C.P. and C. Lasta, 1986 Estudio preliminar de la determinación de edad en la corvina (Micropogonias furnieri). Publ.Com.Téc.Mix.Fr.Mar., 1(2):311-8

Cousseau, M.B. et al., 1986 Análisis de datos biológicos de corvina rubia (Micropogonis furnieri) y pescadilla de red (Cynoscion striatus) obtenidos en dos campañas del año 1983. Publ.Com.Téc.Mix.Fr.Mar., 1(2):319-32

Daneri, C., 1957 Contribución al conocimiento del ciclo sexual de la corvina blanca Micropogon opercularis (Quoy y Gaimard). Bol.Mus.Argent.Cienc.Nat., (14):1-24

Desmarest, A.G., 1823 Première décade ichthyologique, ou description complète de dix espèces de poissons nouvelles, ou imparfaitement connues, habitant la mer qui baigne les côtes de l'île Cuba. Mém.Soc.Linn., Paris, 2:163-210

Ehrhardt, N.M. and G.J. Arena, 1977 Dinámica de población de la corvina blanca (Micropogon opercularis) en el Río de la Plata y su frente oceánico. Inf.Téc.Inst.Nac.Pesca, Montevid., (8):43 p.

Ehrhardt, N.M. , G.J. Arena and J.G.Menendez, 1976 Edad y crecimiento de la corvina platense M. opercularis (Quoy y Gaimard, 1824) (Unpubl.)

Emilsson, I., 1961 The shelf and coastal waters off southern Brazil. Bol.Inst.Oceanogr., São Paulo, 11(2):101-12

Faedo, J.O. and B. Sierra, 1973 Contribución al régimen alimentario de Micropogon furnieri. Neotrópica, La Plata, 19(60):152-5

Figueroa, D.E., 1985 Análisis de los caracteres morfólogicos, morfométricos y merísticos de la corvina blanca Micropogonias furnieri. B.Sc. Thesis. Universidad Nacional, Mar del Plata, Argentina, 98 p.

Fischer, W. (ed.), 1978 FAO species identification sheets for fishery purposes. Western Central Atlantic (fishing area 31). Rome, FAO, vol.6

Franco, G.T., 1959 Nota preliminar sobre a alimentação de alguns peixes comerciais brasileiros. An.Acad.Bras. Ciênc., 31(4):589-93

Garcia, T., 1979 Desarrollo embrionario y primeros estadios larvales de Micropogonias furnieri obtenidos mediante tratamiento hormonal. Ciencias, (Ser.8 Invest.Mar.), Habana, (46):18 p.

Gomes, V., A.E.A. de M. Vazzoler and V.N. Phan, 1983 Estudos cariotípicos de peixes da família Sciaenidae (Teleostei, Perciformes) da região de Cananéia, SP, Brasil. 1. Sobre o cariótipo de Micropogonias furnieri (Desmarest, 1823). Bol.Inst.Oceanogr., São Paulo, 32(2):137-42

Haimovici, M., 1977 Idade, crescimento e aspectos gerais da biologia da corvina Micropogon opercularis (Quoy e Gaimard, 1824) (Pisces, Sciaenidae). Atlântica, Río Grande, 2(1):21-49

__________, 1982 Estrutura y dinámica poblacional del pargo blanco Umbrina canosai (Sciaenidae, Pisces) del litoral de Rio Grande do Sul, Brasil. Ph.D. Thesis at National University of Buenos Aires, Argentina, 173 p.

__________, 1987 Estrategia de amostragem de comprimentos de teleosteos demersais nos desembarques da pesca de arrasto no litoral sul do Brasil. Atlântica, Rio Grande, 9(1):65-82

Haimovici, M. and R. Perez Habiaga, 1982 Rejeição a bordo na pesca de arrasto de fundo no litoral do Rio Grande do Sul num cruzeiro de primaveira. Doc.Tec.Rio Grande FURG, (2):1-14

Haimovici, M. and P.C. Vieira, 1986 Captura e esforço na pesca industrial de arrasto no litoral do Rio Grande do Sul no periodo 1975-1984. In Anais do 4º Congresso brasileiro de Engenheria de Pesca 29 julio-2 agusto 1985 Curitiba, P.R., Brazil, Associación de Engenheria de Pesca Regional Sul AE/SUL (mimeo)

Haimovici, M., S.D. Pereira and P.C. Vieira, 1987 A pesca dermersal en el sur de Brasil en el periodo 1975-1985. Publ.Com.Téc.Fr.Mar., (in press)

Ihering, R. von, 1897 Os peixes da costa do mar do Estado do Rio Grande do Sul. Rev.Mus.Paul.São Paulo, 2:25-63

Isaac-Nahum, V.J., 1981 Biologia reproductiva de Micropogonias furnieri, (Desmarest, 1823) (Teleostei, Sciaenidae). M.Sc. Thesis at University of São Paulo, Brazil, 157 p.

Isaac-Nahum, V.J. and A.E.A. de M. Vazzoler, 1983 Biologia reproductiva de Micropogonias furnieri (Desmarest, 1823) (Teleostei, Sciaenidae). 1. Factor de condição como indicador do periodo de desova. Bol.Inst.Oceanogr., São Paulo, 32(1):63-9

__________, 1985 Biologia reproductiva de Micropogonias furnieri (Desmarest, 1823) (Teleostei, Sciaenidae). 2. Relação gonadossomática como indicador do periodo de desova. Bol.Inst.Oceanogr., São Paulo, (in press)

Johnson, G.D., 1978 Sciaenidae. In Development of fishes of the mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Vol.IV. Carangidae through Ephippidae. Washington, DC, US Department of the Interior, Fish and Wildlife Service Biological Service Program, FWS/OBS-78/12, Contrib.Cent. Environ.Estaur.Stud.Univ.Maryland, (786):171-250

Lassuy, D.R., 1983 Species profiles: life history and environmental requirements (Gulf of Mexico) - Atlantic croaker. US Fish and Wildlife Service, Division of Biological Service, FWS/OBS-82/11.3, US Army Corps of Engineers, TR EL-82-4:12 pp.

Linnaeus, C., Systema naturae. Tome I. Regnum animale. Vindobonae, 523 p. 12th ed.
1766

Lippson, A.J. and R.L. Morgan, Manual for identification of early stages of fish of the Potomac River estuary.
1974 Annapolis, Maryland, Department of Natural Resources, 282 p.

Lopez, R.B., Recursos acuáticos vivos. Peces marinos de la República Argentina. B.Aires, Consejo Federal de
1963 Inversiones. Eval.Recurs.Nat.Argent., 8:105-219

__________, Problemas de la distribución geográfica de los peces marinos sudamericanos. Bol.Inst.Biol.
1964 Mar., Mar del Plata, 7:57-63

Lopez, R.B. and J.P. Castelo, Corvinas del Rio de la Plata. Bol.Serv.Hidrogr.Nav., B.Aires, 5(1):14-27
1968

Lowe (McConnell), R.H., The sciaenid fishes of British Guiana. Bull.Mar.Sci., 16(1):20-57
1966

Mandelli, M.Q. and F.B. Lena, Composição fisica e composição em princípios químicos imediatos da carne
1981 (filés) en Micropogonias furnieri (Desmarest, 1822). In Annals of the Brazilian Symposium on Aquaculture: Second National meeting of frog culturists. Jaboticabal, Brazil, 1980. Brazilia, Superintendencia do Desenvolvimento da Pesca, pp. 120-1

Menezes, N.A. and J.L. Figueiredo, Manual de peixes marinhos do Sudeste do Brasil. 4. Teleostei (3). São
1980 Paulo, Museu de Zoologia da Universidade de São Paulo, 96 p.

Mermoz, J.F., On the stranding of a bottle-nosed dolphin Tursiops truncatus in the mouth of La Plata River,
1977 Buenos Aires, Argentina. Physis (Sec.C.Contin.Organ.Terr.), 37(93):227-35

Nion, H., Evaluación y perspectivas del complejo pesquero uruguayo. 2. Análisis de la investigación biológico-
1985 pesquera en Uruguay. CIEDUR Ser.Invest., Montevideo, (22):162 p.

Oliver, S.R., R. Bastida and M.R. Torti, Sobre el ecosistema de las aguas litorales de Mar del Plata.
1968 Publ.Serv.Hidrogr.Nav., B.Aires, (H1025):5-45

Paiva, M.P., Sobre um caso de assimetría em ovários de Micropogon furnieri (Desmarest, 1822, Jordan, 1884).
1958 Bol.Inst.Oceanogr., São Paulo, 9(1/2):23-9

Paiva Filho, A.M., Estudo comparativo do aspecto dinâmico da estructura espacial das populações de
1977 Micropogon furnieri (Desmarest, 1822) e Macrodon ancylodon (Block and Schneider, 1801) na costa brasileira entre as latitudes 28°30'S e 33°00'S. Ph.D. Thesis, University of São Paulo, Brazil, 165 p.

Pauly, D., Fish population dynamics in tropical waters: a manual for use with programmable calculators.
1984 ICLARM Stud.Rev., 8:325 p.

PDP/SUDEPE, Relatório do Grupo de Trabalho e Treinamento (GTT) sobre peixes demersais. Tamandaré (PE),
1981 Brasil, 29 junio-24 julio, 1981 (mimeo)

__________, Relatório da Reunião técnica sobre a pesca de peixes demersais na região Sudeste-Sul do Brasil (in preparation)

Pereira, L.E.D., Variação diurna e sazonal da comunidade de peixes e crustáceos decápodos na entrada do
1986 estuário da Lagoa dos Patos, R.G., Brasil. M.Sc. Thesis, Universidade do Rio Grande, Brazil

Phan, V.N. and A.E.A. de M. Vazzoler, Serological and biochemical studies on populations of Micropogon
1976 furnieri (Desmarest, 1822) and Macrodon ancylodon (Bloch and Schneider, 1801) between Cabo Frio (23°S) and Chuí (33°44'S), Brasil. Rev.Trav.Inst.Pêches Marit., Nantes, 40(3/4):681-2

Pinedo, M.C., Análise dos conteúdos estomacais de Pontoporia blainvillei (Gervais and D'orgigny, 1844) e
1982 Tursiops gephyreus (Lahille, 1908) (Cetacea, Platinistidae e Delphinidae) na zona estuarial e costeira de Rio Grande, RS. Brasil. M.Sc. Thesis, Universidade do Rio Grande, Brazil

Pinedo, M.C. and N.B. Barros, Análises dos conteúdos estomacais do leão marinho Otaria flavescens e do lobo
1983 marinho, Arctocephalus australis na costa do Rio Grande do Sul, Brasil. In Proceedings of the Eighth Latin American Symposium on biological oceanography, Montevideo, Uruguay, 28 November-2 December 1983 (Abstr.)

Puig, P., 1986 Análisis de contenidos estomacales de corvina blanca (Micropogonias opercularis) (Sciaenidae, Perciformes), Verano 1984. Publ.Com.Tec.Mix.Fr.Mar., 1(2):333-40

Quoy, J.R.C. and P. Gaimard, 1824 Voyage autour du monde ... exécuté sur les corvettes de L.M. L'URANIE et la PHYSICIENNE pendant les années 1817-1820. Zoologie, Poissons, Paris, pp. 183-401

Richardson, I.D. and E.P. dos Santos, 1962 Note on the selectivity of meshes used by the Santos fishing fleet. Bol.Inst.Oceanogr., São Paulo, 12(1):33-52

Rodrigues, M.S. de S., 1968 Idade e crescimento da cururuca, Micropogon furnieri (Desmarest, 1822), nas águas cearenses. Arq.Estad.Biol.Mar.Univ.Fed.Ceará, 8(1):7-14

Roux, C., 1973 Résultats scientifiques des campagnes de la Calypso. Fax. X. Poissons téléostéens du plateau continental brésilien. Ann.Inst.Oceanogr., Paris, 49 (Suppl.):23-207

Santos, E., 1952 Nossos peixes marinhos. In Vida e costume dos peixes do Brasil. Rio de Janeiro, Briguiet and Cia, Editoria, 265 p.

Santos, E.P. dos, et al., 1973 . Curva de rendimento da corvina, Micropogon furnieri (Desmarest, 1822), Jordan, 1884, da costa centro do Estado de São Paulo. Bol.Inst.Pesca, São Paulo, 2(5):79-83

Sinque, C., 1980 Larvas de Sciaenidae (Teleostei) identificadas na região estuarino-lagunar de Cananéia. Bol.Zool.Univ.São Paulo, 5:39-77

Siri, M., G.J. Arena and A. Decuadra, 1971 Fluctuaciones de la abundancia estacional de las especies de peces marinos en el Rio de la Plata a través de los desembarques y del esfuerzo de unidades de pesca con artes de puertas (1965-1969). CARPAS Doc.Tec., (33):44 p.

Suzuki, H., A.E.A. de M. Vazzoler and V.N. Phan, 1983 Estudo electroforético de proteínas de músculo esquelético de Micropogonias furnieri (Desmarest, 1823) da costa SE-S do Brasil. 1. Consideracões técnicas. Bol.Inst.Oceanogr., São Paulo, 32(2):153-65

__________, 1983a Estudo electroforético de proteínas de músculo esquelético de Micropogonias furnieri (Desmarest, 1823) da costa SE-S do Brasil. 2. Variacão ontogenética e estudo populacional. Bol.Inst.Oceanogr., São Paulo, 32(2):167-76

Tanji, S., 1974 Estudo do conteúdo estomacal da pescada foguete Macrodon ancylodon (Bloch, 1801) e da corvina, Micropogon furnieri (Desmarest, 1822). Bol.Inst.Pesca, São Paulo, 3(2):21-36

Vannucci, M., 1963 Plâncton e ciclos alimentares. Contrib.Inst.Oceanogr.Univ.São Paulo (Sér.Oceanogr.Fis.), (5):55-70

Vazzoler, A.E.A. de M., 1962 Sobre a primeira maturação sexual e destruição de peixes imaturos. Bol.Inst. Oceanogr., São Paulo, 12(2):5-38

__________, 1963 Deslocamentos sazonais de corvina relacionados com as massas de águas. Contrib.Inst. Oceanogr.Univ. São Paulo (Sér.Oceanogr.Biol.), (5):1-3

__________, 1965 Estimativa da abundância relativa da corvina na costa centro-sul do Brasil. Bol.Inst.Oceanogr. São Paulo, 14:3-12

__________, 1969 Ictiofauna de la Bahía de Santos. 1. Sciaenidae. (Percoidea, Percomorphi). CARPAS Doc. Tec., (15):1-19

__________, 1970 Micropogon furnieri: fecundidade e tipo de desova. Bol.Inst.Oceanogr., São Paulo, 18(1):27-32

__________, 1971 Diversificação fisiológica e morfológica de Micropogonias furnieri (Desmarest, 1823) ao sul de Cabo Frio, Brasil. Bol.Inst.Oceanogr., São Paulo, 20(2):1-70

Vazzoler, A.E.A. de M. and V.N. Phan, 1981 Ocorrência de cataratas em Micropogonias furnieri (Desmarest, 1822), na área entre Cabo Frio e Tôrres (23°S-29°S), Brasil: Investigação de causas e estudo electroforético das proteínas totais dos cristalinos. Bol.Inst.Oceanogr., São Paulo, 30(1):65-76

Vazzoler, A.E.A. de M. and E.M. de Sá, 1963 Análise da pesca da corvina na costa centro-sul do Brasil. Bol.Inst.Oceanogr., São Paulo, 13(2):61-70

Vazzoler, A.E.A. de M. and E.P. dos Santos, Migração da corvina, Micropogon furnieri, na costa sul do Brasil.
1965 Bol.Inst.Oceangr., São Paulo, 14:125-8

Vazzoler, A.E.A. de M. and G. Vazzoler, Relatório sobre os conhecimentos atuais referêntes à pesca marítima
1969 no Estado de São Paulo. Contrib.Inst.Oceanogr.Univ.São Paulo (Sér.Oceanogr.Biol.), (16):1-28

Vazzoler, A.E.A. de M. et al., Micropogonias furnieri (Desmarest, 1823): Estudo quali-quantitativo da variação
1985 ontogenética do padrão electroforético de proteínas gerais do cristalino. Bol.Inst.Oceanogr., S.Paulo, 33(2):121-37

Vazzoler, G., Sobre a biologia da corvina da costa sul do Brasil. Bol.Inst.Oceanogr., São Paulo, 12(1):53-102
1962

__________, Distribuição da fauna de peixes demersais e ecologia dos Sciaenidae da plataforma continental
1975 brasileira, entre as latitudes 29°21'S (Tôrres) e 33°41'S (Chuí). Biol.Inst.Oceanogr., São Paulo, 24:85-169

Vazzoler, G. and M. Iwai, Relatório sobre prospecção e pesca exploratória na plataforma continental do Rio
1971 Grande do Sul. Contrib.Inst.Oceanogr.Univ.São Paulo (Sér.Oceanogr.Biol.), (25):1-79

Vooren, C.M., Seleção pela malha na pesca de arrastro da castanha Umbrina canosai, pescada Cynoscion
1983 striatus e pescadinha Macrodon ancylodon, no Rio Grande do Sul. Doc.Tec.Oceanogr., Rio Grande, (4):1-32

Weiss, G., Ictioplancton del estuário da Lagoa dos Patos, Brazil. Ph.D. Thesis. Universidad Nacional de La
1981 Plata, Argentina

Yamaguti, N., E.M. Zaneti and E. Kawakami, Estudo preliminar sobre o ciclo de vida dos Sciaenidae. 2.
1973 Composição de população em classes de idade e aspectos do crescimento. In Relatório sobre a segunda pesquisa oceanográfica e pesqueira do Atlântico Sul entre Tôrres e Maldonado (29°S-35°S). Programa Rio Grande do Sul II. pp. 293-306

Yesaki, M. and K.J. Bager, Histórico da evolução da pesca industrial em Rio Grande. Doc.Tec.Programa
1975 Pesqui.Desenvolv.Pesq.Bras., (11):15 p.

Yesaki, M., E. Rahn and G. Siva, Sumário das explorações de peixes de arrastro de fundo ao largo da costa sul
1976 do Brasil, 1970-1974. Doc.Tec.Programa Pesqui.Desenvolv.Pesq.Bras., (19):44 p.

ISBN 92-5-102703-X
M-42/S8135/E/1/9.88/1500