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Meristic comparison of the whitemouth croaker, *Micropogonias furnieri* (Desmarest, 1823) (Pisces: Sciaenidae) in southwestern Atlantic between 34° 30' and 39° 30'S

Comparación merística de la corvina rubia, *Micropogonias furnieri* (Desmarest, 1823) (Pisces: Sciaenidae) en el Atlántico suroccidental entre los 34° 30' y 39° 30' S

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ABSTRACT

A comparison of six different meristic characters was made for 364 specimens of whitemouth croaker, *Micropogonias furnieri*, in the southwestern Atlantic between 34° 30' and 39° 30' S. Fish were taken from bottom trawls at four sites (Uruguay, Samborombón, cape San Antonio and El Rincón) representing the distribution of the species in Uruguayan and Argentinean waters. A pairwise comparison test showed that individuals sampled from the four locations were significantly different between locations in terms of standard length. A Kruskall-Wallis analysis for six meristic characters between locations showed significant differences in the number of gill-rakers, chin barbels, lateral line scales and longitudinal rows of scales. The pairwise comparisons indicated that of the four locations, no statistical differences in any of the meristics considered were found between Samborombón and cape San Antonio. Analyses of the four meristic characters showing significant variation suggested that the fish caught in Uruguay, Samborombón, cape San Antonio, and El Rincón, could be members of three different fishery- stocks.

Key words: *Micropogonias furnieri*, meristics, Argentine, Uruguay.

RESUMEN

Se realizó una comparación de seis caracteres merísticos en 364 especímenes de corvina rubia, *Micropogonias furnieri*, en el Atlántico suroccidental entre 34° 30' y 39° 30' S. Los peces fueron recolectados con redes de arrastre de fondo en cuatro sitios (Uruguay, Samborombón, cabo San Antonio y El Rincón), que representan la distribución de la especie en aguas uruguayas y argentinas. Un test de contrastes de pares demostró que en relación a la longitud estándar, los individuos muestreados en las cuatro localidades fueron significativamente diferentes entre localidades. Un análisis Kruskall-Wallis realizado para seis caracteres merísticos entre localidades mostró diferencias significativas en el número de branquispinas, barbillas mentonianas, escamas de la línea lateral e hileras longitudinales de escamas. Las comparaciones de pares de medias indicaron que en cuatro localidades, no se encontraron diferencias estadísticas en ningún carácter merístico considerado entre Samborombón y cabo San Antonio. El análisis de los cuatro caracteres merísticos que mostraron variación significativa, sugirió que los peces capturados en Uruguay, Samborombón, cabo San Antonio y El Rincón, podrían corresponder a miembros de tres diferentes stoks o entidades pesqueras.

Palabras clave: *Micropogonias furnieri*, caracteres merísticos, Argentina, Uruguay.

INTRODUCTION

The whitemouth croaker, *Micropogonias furnieri* (Desmarest, 1823) occurs in coastal waters of the Caribbean Sea and eastern South America from the Yucatán Península (20° N) to Golfo San Matías, Argentina (41° S) (Isaac 1988). This species plays a major role in estuarine and coastal ecosystems and supports important local commercial fisheries (García 1984, Haimovici *et al.* 1989, Valentini *et al.* 1991, Manickchand-Heileman & Ehrhardt 1996). It also constitutes one of the most important resources of the soft-bottom demersal fish community in the coastal waters off Uruguay and Argentina (Otero & Ibáñez 1986, Acuña *et al.* 1992).

The abundance of the whitemouth croaker in the Río de la Plata estuary and along the coast of Buenos Aires province in Argentina has decreased since 1986, while the fishing effort to catch the species has increased since 1992, in part due to heavy fishing exploitation (Perrotta *et al.* 1996). The identification of fish stocks is essential to the understanding of fluctuation in overall distribution and abundance. The specific biological characteristics of each stock must be understood if fisheries management policies are to reflect biological realities.

While some studies have provided evidence for the existence of two different stock units of *Micropogonias furnieri* in southern Brazil (Vazzoler 1991, Vazzoler & Phan 1989), there is conflicting evidence for the presence of separate stocks along Uruguayan and Argentinean coasts. Alamón (1983)[1] found morphological differences among specimens caught in the Argentinean-Uruguayan Common Fishing Zone, and postulated two populations: one in Uruguay (33° 50'S) and one in Samborombón Bay (35° 50'S). Cotrina (1986) suggested the existence of two groups (Chui, 34° S, and El Rincón, 39° 21'S) with different length structures. Studies dealing with selected meristic and morphometric features (Figueroa & Díaz de Astarloa 1991), the relation between the incidence of pathologies and some environmental parameters (Macchi *et al.* 1992) and differences in sexual maturity and spawning period (Macchi & Christiansen 1992), have supported the existence of two or more populations of *Micropogonias furnieri* in the study area. Although electrophoretic techniques are useful for genetically characterizing individual stocks (Vrooman *et al.* 1981, Epperly 1989), studies on *M. furnieri* have only recently begun and preliminary results only show an intense genetic flow in the surveyed area (Maggioni *et al.* 1994).

The purpose of this study was to examine additional meristic data for evidence of stock discrimination.

MATERIALS AND METHODS

This study was based on 364 specimens of *Micropogonias furnieri* taken from bottom trawls in four different locations along the Southwestern Atlantic between 34° 30'S and 39° 30'S in November 1988 by the RV "Dr. Eduardo L. Holmberg" of the Instituto Nacional de Investigación y Desarrollo Pesquero, Mar del Plata, Argentina (INIDEP). These localities were: 1. Uruguay from 34° 30' to 35° S; 2. Samborombón (35° 50' S and 57° 00'W); 3. cape San antonio and south from 36° 12' to 36° 43' S; 4. El Rincón from 39° to 39° 30' S (Fig. 1). Samples were deep-frozen as soon as possible and stored for further processing in the laboratory. The specimens represented a size range of 230 -

[1] Alamón, M. 1983. Diferenciación del género *Micropogonias* (Pisces, Sciaenidae) dentro de la Subárea Platense. Resúmenes VIII Simposio Latinoamericano Oceanografía Biológica, Montevideo. pp. 2.

530 mm in standard length (SL). This measurement was used as an index of overall body size. A one-way ANOVA test was carried out on specimens by location to determine if visible differences in size were statistically significant and if samples were directly comparable.

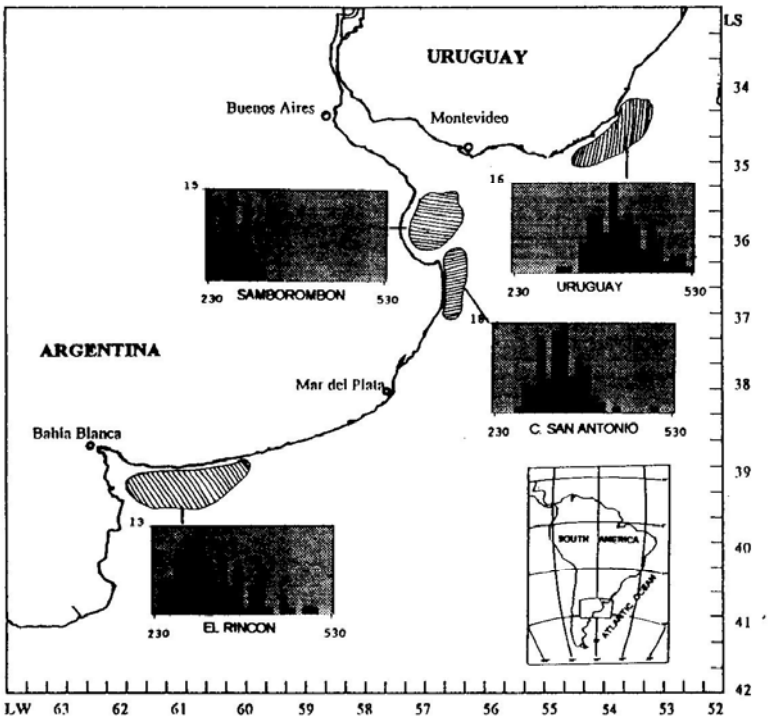

Figure 1. Sampling areas and size-frequency histograms of *Micropogonias furnieri* for four different locations in Uruguayan and Buenos Aires province coasts.

Figura 1. Areas de muestreo e histogramas de frecuencia de tallas de *Micropogonias furnieri* para cuatro localidades de las costas uruguaya y de la provincia de Buenos Aires.

Counts on the six different meristic characters used in the statistical analysis were made for each specimen, as follows: second dorsal-fin rays (DO), pectoral-fin rays (PE), gill-rakers (GR), barbels on chin (BA), lateral-line scales (LL) and longitudinal rows of scales from lateral line to dorsal profile (LR). DO counts included the first spine. The last dorsal ray is forked from its base and is consequently counted as a single element. LL counts did not include scales on the caudal fin. All counts on paired structures were taken from the left side.

Data were analized with BMDP (1992) by geographic areas. A Wilks test for normality was used for all meristic characters and a Wilcoxon rank test for equality of means was performed between males and females. If differences were found between sexes, males and females were considered separately. A Kruskal-Wallis analysis was applied to meristic characters to test for group differences (Hoaglin *et al.* 1991). Initially, sexes were compared using the whole data set. Secondly, a Kruskal-Wallis analysis was performed between locations for each meristic character. Finally, contrast comparisons between groups were made using a Wilcoxon rank test with those characters that showed significant differences in the Kruskall-Wallis analysis. In all statistical tests, the probability of a Type I error was set equal to 0.05.

RESULTS

Table 1 shows numbers of fish of each sex examined from each location. On average, females were larger than males, except at C. San Antonio where whitemouth croaker females were slightly smaller than males, even though female fish at cape San Antonio had a maximum length of 502 mm in comparison with the maximum length of 408 mm for males.

Table 1. Number of females and males of *Micropogonias furnieri* examined from each location. Standard length mean (X) and range are given in mm.

Tabla 1. Número de hembras y de machos de *Micropogonias furnieri* examinados en cada localidad. La longitud estándar media (X) y el rango están expresados en mm.

	Females			Males		
Location	X	Range	n	X	Range	n
Uruguay	426.0	330-530	65	393.8	308-475	35
Samborombón	275.2	230-330	43	272.6	239-306	23
C. San Antonio	344.7	280-502	75	347.8	286-408	23
El Rincón	340.5	244-494	71	306.8	242-452	29

The ANOVA of whitemouth croaker standard lengths against locations was highly significant ($F_{3,360}$= 150.09, P<0.0001). A pairwise comparison test showed that the data sets for the four locations were significantly different from each other in terms of standard length (Table 2). Samborombón location showed the concentration of juvenile specimens, as was also pointed out by Díaz de Astarloa *et al.* (1997). No significant differences were found between sexes in any of the meristics considered (P>0.05) and the test for normality showed highly significant differences for all meristics considered (Table 3). The Kruskall-Wallis analysis showed significant differences among samples for four of the six characters (P<0.05) (Table 4). The mean counts of DO and PE were not significantly different among the four groups.

Table 2. Pairwise comparisons of standard lengths grouped by locations. * significant (P≤0.05). ** highly significant (P≤0.01).

Tabla 2. Contrastes de a pares de las longitudes estándares agrupados por localidades. * significativo (P≤0,05). ** altamente significativo (P≤0,01).

Comparison	Diff. of means	t-values	P-values
Uruguay vs.			
Samborombón	140.5	25.7	<0.00001**
Cape San Antonio	69.3	11.8	<0.0001**
El Rincón	84.0	11.7	<0.0001**
Samborombón vs.			
cape San Antonio	-71.1	-15.2	<0.0001**
El Rincón	-56.4	-9.1	<0.00019**
Cape San Antonio vs.			
El Rincón	14.7	2.2	0.026*

Table 3. Wilcoxon rank test for equality of means between males and females for each meristic character and Wilks statistic test for normality (W-Stat) for all meristics. ns: nonsignificant (P>0.05). ** highly significant (P≤0.01).

Tabla 3. Test de Wilcoxon para la igualdad de medias entre machos y hembras, para cada carácter merístico y test de normalidad de Wilks (W-Stat) para todos los merísticos. ns: no significativo. (P>0,05). ** altamente significativo (P≤0,01).

Meristics	Males		Females		P-value	W-Stat	P-value
	Mean (SE)	n	Mean (SE)	n			
Dorsal rays	28.82 (0.085)	110	28.83 (0.075)	254	0.626 ns	0.852	<0.0001 **
Pectoral rays	18.23 (0.063)	110	18.19 (0.044)	251	0.999 ns	0.795	<0.0001 **
Gill rakers	24.94 (0.119)	110	25.0 (0.07)	252	0.432 ns	0.893	<0.0001 **
Barbels	8.67 (0.106)	103	8.62 (0.06)	238	0.854 ns	0.891	<0.0001 **
Lateral-line scales	50.55 (0.088)	106	50.56 (0.065)	250	0.606 ns	0.406	<0.0001 **
Longitudinal rows of scales	6.20 (0.058)	98	6.22 (0.037)	236	0.967 ns	0.691	<0.0001 **

Whitemouth croakers from Samborombón had the greatest mean number of gill-rakers. The mean for the Uruguayan group was significantly lower than that of Samborombón and cape San Antonio (Table 4). There were no differences in the mean number between these last two locations and El Rincón (Table 5).

With regard to chin-barbel numbers, the Uruguayan group had a mean count of 0.40 more than that of Samborombón, a statistically highly significant difference. The mean number of barbels for Uruguay was 0.31 higher than that for cape San Antonio which was statistically significant, and 0.35 higher than that for El Rincón which was highly significant. Samborombón, cape San Antonio and El Rincón groups differed each other by less of 0.10 barbels, which was not statistically significant (Table 5).

Table 4. Descriptive statistics and Kruskal-Wallis analysis between locations for each meristic character. ns: nonsignificant (P>0.05). * significant (P≤0.05). ** highly significant (P≤0.01).

Tabla 4. Estadísticos descriptivos y análisis de Kruskall-Wallis entre localidades para cada carácter merístico. ns: no significativo. (P>0,05). * significativo(P≤0,05). ** altamente significativo (P≤0,01).

	Uruguay			Samborombón			Cape San Antonio			El Rincón			
Meristics	Mean (SE)	Range	n	Mean (SE)	Range	n	Mean (SE)	Range	n	Mean (SE)	Range	n	P-value
Dorsal rays	28.82 (0.104)	26-31	100	28.88 (0.119)	26-31	66	29.0 (0.105)	25-32	98	28.76 (0.085)	27-31	100	0.305 ns
Pectoral rays	18.33 (0.063)	17-20	98	18.21 (0.086)	15-20	67	18.10 (0.078)	15-20	96	18.18 (0.066)	16-20	100	0.209 ns
Gill rakers	24.84 (0.138)	21-29	99	25.28 (0.097)	24-27	67	25.21 (0.084)	24-28	97	25.10 (0.097)	23-28	99	0.050 *
Barbels	8.84 (0.099)	7-12	95	8.44 (0.100)	7-10	66	8.53 (0.108)	6-11	96	8.49 (0.101)	6-11	96	0.049 *
Lateral-line scales	50.55 (0.091)	48-52	98	50.36 (0.109)	48-52	59	50.32 (0.119)	45-52	87	50.80 (0.079)	48-53	97	0.005 **
Longitudinal rows of scales	6.37 (0.061)	5-8	92	6.07 (0.053)	5-7	53	6.10 (0.054)	5-8	92	6.18 (0.061)	5-8	97	0.002 **

Table 5. Pairwise comparisons of meristics grouped by locations. ns: nonsignificant (P>0.05). * significant (P≤0.05). ** highly significant (P≤0.01).

Tabla 5. Contrastes de a pares de merísticos agrupados por localidades. ns: no significativo (P>0.05). * significativo (P≤0.05). ** altamente significativo (P≤0.01).

	Gill rakers		Barbels		Lateral-line scales		Longitudinal rows of scales	
Comparison	Diff. of means	P-values	Diff. of means	P-values	Diff. of means	P-values	Diff. of means	P-values
Uruguay vs.								
Samborombón	-0.44	0.025 *	0.40	0.006 **	0.19	0.253 ns	0.30	0.001 **
Cape San Antonio	-0.37	0.024 *	0.31	0.037 *	0.23	0.410 ns	0.27	0.001 **
El Rincón	-0.26	0.200 ns	0.35	0.016 *	-0.25	0.035 *	0.19	0.024 *
Samborombón vs.								
Cape San Antonio	0.07	0.421 ns	-0.09	0.552 ns	0.04	0.693 ns	-0.03	0.829 ns
El Rincón	0.18	0.227 ns	-0.05	0.736 ns	-0.44	0.001 **	-0.11	0.269 ns
Cape San Antonio vs.								
El Rincón	0.11	0.638 ns	0.04	0.819 ns	-0.48	0.003 **	-0.08	0.323 ns

El Rincón group had the highest mean value for lateral-line scales, 0.48 greater than that of cape San Antonio group, 0.44 greater than that of Samborombón and 0.25 greater than that of Uruguay group. Only the differences between the two central groups (San Antonio and Samborombón) and the southern group (El Rincón) were highly significant statistically (Table 5).

Uruguayan group had the highest mean value for longitudinal-scale rows (Table 4). The means for Samborombón and cape San Antonio were significantly less (0.30 and 0.27 respectively) than that of the northern group. This was also the case for El Rincón group when compared to the Uruguayan population (0.19) (Table 5).

There were no significant differences statistically between Samborombón, cape San Antonio and El Rincón groups in the mean number of longitudinal-scale rows (Table 5).

DISCUSSION AND CONCLUSIONS

Understanding the distribution and relationships of stocks is important for the management of the whitemouth croaker. The term "stock" has been applied loosely, but generally implies some genetic contiguity among its members. The concept of stock, as it is used here, follows the definition given by Slobodkin (1966), as an intraspecific group of randomly mating individuals which has a degree of continuity both spatially and through time. This continuity implies that members of each group share properties such as particular age structures, growth and mortality rates, recruitment and fecundity. This concept is consistent with the biological or population definition of Smith *et al.* (1990), where fish stocks are identified as natural breeding units that are mostly reproductively isolated from other similar intraspecific populations.

Evidence of stock discreteness has come from studies using a variety of methods (Ihssen *et al.* 1981a, Templeman 1983). Anatomical characters, such as morphometrics and/or meristics, have traditionally been used in ichthyology and fisheries biology to describe various categories of fish (Meng & Stocker 1984, Epperly 1989, Perrotta *et al.* 1990). Although their application in stock identification is complicated by the fact that phenotypic variation in these characters has not been directly related to particular differences in the genome (Clayton 1981), in certain studies, they provide evidence of stock structure that is concordant with other information (Vrooman *et al.* 1981, Ihssen *et al.* 1981b, Fournier *et al.* 1984).

In this study three distinct stocks of whitemouth croaker were distinguished in the coastal waters of the western south Atlantic between 34° 30' and 39° 30' S:(1) Uruguayan stock, between 34° 30' and 35° S; (2) northern Buenos Aires stock, from Samborombón bay to cape. San Antonio and south (35° 50' - 36° 43'S) and (3) southern Buenos Aires stock (39° - 39° 30'S), in the area called "El Rincón".

The sample of whitemouth croakers from the Uruguayan stock could be identified by its higher mean values for chin barbels (= 8.84) and longitudinal-scale rows (= 6.37) above the lateral line, and lower gill-raker values (= 24.84) in comparison with northern and southern Buenos Aires stocks of whitemouth croakers. A comparison of standard lengths between sampling areas showed that Uruguayan whitemouth croakers were on the average larger than specimens from the other two stocks.

The sample of whitemouth croakers from the southern Buenos Aires stock could be identified by the higher mean value for lateral-line scales (= 50.80) in comparison

with Uruguayan and northern Buenos Aires stocks. The mean standard length value for specimens from El Rincón was 56.4 mm greater than that of Samborombón, but 14.7 mm less than the cape San Antonio material.

The sample of whitemouth croaker from Samborombón to cape San Antonio and south could be distinguished from the El Rincón stock by its significantly lower mean lateral-line scale value (=50.32). Samborombón whitemouth croakers had the lowest mean standard length value for the four areas sampled.

Vertebral counts were not included because they showed no statistical differences among populations and geographic areas (Figueroa & Díaz de Astarloa 1991).

This study produced evidence that individuals living in three areas (Uruguay, Samborombón-cape San Antonio and El Rincón), have recognizable differences in selected meristic values. The differences suggest fish in the three areas could be members of three different fishery stocks. However, the allocation of a single fish to a specific stock may not be possible because intra-stock variation in individual meristic counts can be almost as large as inter-stock variation (Pawson & Jennings 1996).

Our conclusions agree with the findings of Macchi *et al.* (1992) that three stocks exist between 34° and 40° S, and could support the conclusions of Macchi & Christiansen (1992) identifying the existence of different stocks of *Micropogonias furnieri* in the Buenos Aires area, based on maturation differences at different localities.

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