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MERLUCCIUS HUBBSI (TELEOSTEI: MERLUCCIIDAE): STOCK IDENTIFICATION BASED ON REPRODUCTIVE BIOLOGY IN THE SOUTH-SOUTHEAST BRAZILIAN REGION

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ABSTRACT

The Argentine hake, *Merluccius hubbsi*, a demersal-pelagic species found from Rio de Janeiro, Brazil to the Tierra del Fuego, Argentina, has become an important target of the Brazilian bottom-trawler fleet since 2001. Earlier studies focusing on the species have suggested that more than one stock might occur off the Brazilian coast, in accordance with environmental features. In order to evaluate this hypothesis, fish were collected from four different areas in the Brazilian waters in which the hake is distributed, during the summers and winters of 1996-2001 and 2004, the females being used to analyze and compare spatial-temporal variations in ovarian maturation. Gonad indexes were also applied for the same purpose. Results indicate a north-south spawning gradient occurring as from summer at around 21°S to winter near 34°S, leading to the identification of two distinct stocks: one located between 21°S and 29°S (Southeastern stock) and the other between 29°S and 34°S (Southern stock), this latter shared with Uruguay and Argentina. Brazilian stocks present clear signs of overexploitation, the situation calling for an urgent solution.

RESUMO

A merluza *Merluccius hubbsi*, espécie demerso-pelágica distribuída desde o Rio de Janeiro, Brasil, até a Terra do Fogo, Argentina, tornou-se alvo das frotas de arrasto de fundo da região Sudeste-Sul do Brasil desde 2001. Estudos anteriores sobre a biologia da espécie sugeriram a existência de mais de um estoque em águas brasileiras, relacionados a características ambientais. Para verificar esta hipótese, exemplares oriundos de quatro áreas em águas brasileiras foram coletados durante o verão e o inverno nos períodos 1996-2001 e 2004, sendo as fêmeas utilizadas para analisar variações espaço-temporais na maturação gonadal. Para corroborar estas análises também foram aplicados índices gonadais. Os resultados mostraram a ocorrência de um gradiente norte-sul para a desova, que é mais intenso no verão em 21°S e no inverno em 34°S. Foram identificados dois estoques: um denominado Sudeste, que se distribui entre 21°S-29°S, e outro Sul, entre 29°S-34°S, este último compartilhado com o Uruguai e a Argentina. Os estoques brasileiros apresentam sinais de sobrepesca, situação que merece atenção e medidas apropriadas de gestão.

Descriptors: *Merluccius hubbsi*, Reproduction, Spawning, Stocks, Southeast-South Brazilian Region.
Descritores: *Merluccius hubbsi*, Reprodução, Desova, Estoques, Sudeste-Sul do Brasil.

INTRODUCTION

The Argentine hake, *Merluccius hubbsi* Marini, 1933, is a demersal-pelagic species occurring in the southwestern Atlantic from 21°S (Brazil) to 55°S (Argentina) (FIGUEIREDO; MENEZES, 1978; MENEZES et al., 2003; COUSSEAU; PERROTTA, 2004). In Argentina and Uruguay, where it is a very

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important commercial species (HART, 1948; COUSSEAU; JOHN, 1976; BELLISIO et al., 1978; OTERO, 1980; OTERO et al., 1981; REY; GRUNWALDT, 1986; CSIRKE, 1987; PODESTÁ, 1987; ALHEIT; PITCHER, 1995; REY; ARENA, 1999; AUBONE et al., 2000, 2004; BEZZI et al., 2004), its biology has been studied by authors ever since Angelescu et al. (1958). In Brazil, the larval distribution of the Argentine hake has been studied by Torres-Pereira (1983, unpublished), its feeding habits and reproduction by Haimovici et al. (1993), its general biology by Vaz-dos-Santos and Rossi-Wongtschowski (2005), its reproduction by Vaz-dos-Santos et al. (2005) and Honji et al. (2006), the occurrence of a shared stock with Uruguay and Argentina by Vaz-dos-Santos et al. (2006), its commercial landings by Perez and Pezzutto (2006) and its age and growth by Vaz-dos-Santos and Rossi-Wongtschowski (2007). The most recent studies are a consequence of the abundance detected during the Brazilian Program for the Assessment of the Exclusive Economic Zone (REVIZEE Program, 1996-2006) (MMA, 2006) and because it has become a target species of bottom-trawlers since 2001 (PEREZ et al., 2003; VALENTINI ; PEZZUTTO, 2006).

Although a controversial subject, stock identification has been considered essential for the fishery sciences to provide for proper management of the species. Thus, Csirke (1980) gave support to population dynamics based on homogeneity of groups and Cadrin et al. (2005a) asserted that stock identification is a “prerequisite for the tasks of stock assessment and population dynamics”. All considerations related to the management of fishery resources are based on the stock concept (GULLAND, 1983; HILBORN;WALTERS, 1992; BEVERTON;HOLT, 1993; SPARRE; VENEMA, 1998; QUINN; DERISO, 1999), including the most recent (KRUSE et al., 2005). The FAO’s Code of Conduct for Responsible Fisheries (FAO, 1995) warns that only the best scientific data should be used for management, if the sustainability of the fisheries is to be ensured.

Stock identification has been formally discussed in the symposium “Stock identification – Its Role in Stock Assessment and Fisheries Management”, held as a part of the 28th American Fisheries Society´s Meeting, in 1998. A special issue of the scientific journal Fisheries Research (vol. 43, 1999) was prepared based on the discussion of that symposium and some of its general conclusions deserve emphasis: (i) the term stock must obligatorily be applied to a homogeneous population unit and its management (BEGG; WALDMAN, 1999); (ii) a failure in stock identification can lead to its overexploitation (BEGG et al., 1999a) and (iii) genetic and/or environmental differences that persist over time are enough to separate stocks (SWAIN; FOOTE, 1999). After that meeting, Cadrin et al. (2005b) edited a book which discussed the subject, as a consequence of the studies conducted by the ICES Stock Identification Methods Working Group.

Regarding *Merluccius hubbsi* stocks in Uruguay and Argentina, three different groups have been detected between 34°S and 55°S (BEZZI; PERROTTA, 1983; CHRISTIANSEN et al., 1986; PERROTTA; SÁNCHEZ, 1992; GUTIÉRREZ et al., 1995; TORRES et al., 1996; SARDELLA; TIMI, 2004) and have been differentiated by means of various techniques.

On this theme, the identification of *Merluccius hubbsi* stocks along the Brazilian coast was first suggested by Vaz-dos-Santos and Rossi-Wongtschowski (2005) and a detailed analysis of their reproduction is presented here as a tool for the differentiation of two stocks.

MATERIAL AND METHODS

Commercial landings of *Merluccius hubbsi* were obtained from bottom-trawls sampled between 1996 and 2001 and in 2004, complemented with survey samples obtained at the same time using similar fishing gear, at depths of between 40 m and 400 m. The Southeast-South Brazilian coast was divided into four areas: 21°S-24°S (A), 24°S-26°S (B), 26°S-29°S (C) and 29°S-34°S (D) (Fig. 1). Data were selected and analyzed specifically in summer (January, February and March) and winter (July, August and September) based on previous knowledge of the reproductive activity of the species (VAZ-DOS-SANTOS; ROSSI-WONGTSCHOWSKI, 2005), a procedure also adopted earlier by Giussi et al. (1994) in Argentina.

Only females were selected and 533 specimens (LT from 164.00 to 618.00 mm) were used for the analysis of their ovarian maturation, marked in accordance with Honji et al. (2006) who consider five reproductive stages based on detailed histological features: stage A – immature, stage B – maturing, stage C – mature, stage D – spawning, and stage E – spent. The selection took into account the period (summer or winter), the four sample areas (A to D), 30mm total length class and ovarian maturation stages. In this way, samples (LT) were statistically described (TRIOLA, 2005) and the minimum sample size (ε=0.05; $t_{(2),\alpha=0.05}$) was calculated in accordance with Gulland (1966), reinforced by Sparre and Venema (1998), to verify the statistical sufficiency of the data for the subsequent analysis.

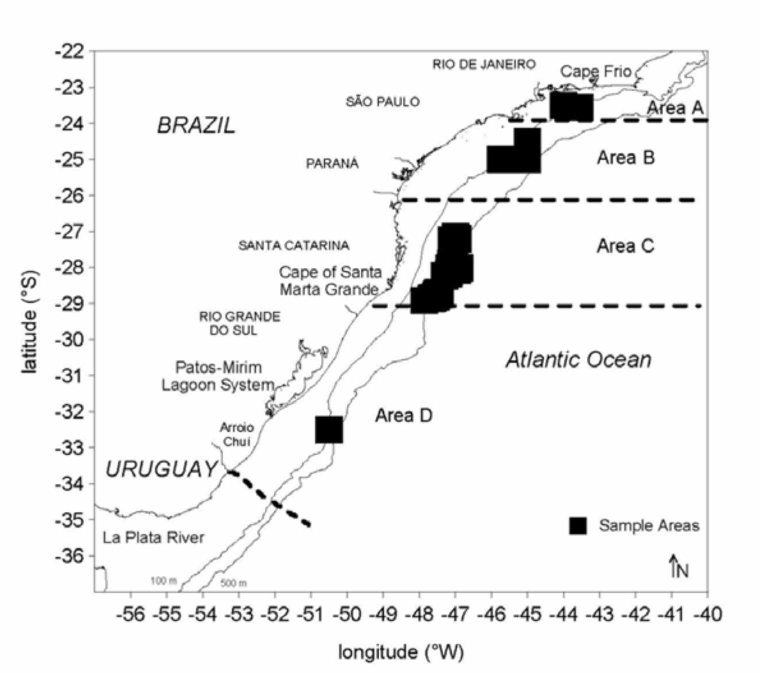

Fig. 1. *Merluccius hubbsi*: samples obtained from commercial bottom-trawls and surveys during summer and winter – 1996-2001 and 2004.

Spatial and temporal variations on the reproductive pattern were analyzed by two methods: frequency of different maturation stages and gonad indexes (VAZZOLER, 1996; KING, 2007). Considering areas A to D, the frequency of maturation was analyzed, the spawning period being identified by the occurrence of a larger proportion of spawning and spent females. The frequency of *M. hubbsi* maturation stages in summer and winter were compared by a Kolmogorov-Smirnov test (ZAR, 1999; SIEGEL; CASTELLAN, 2006). Once those differences had been identified, this same test was applied for each season separately, the four areas being compared in accordance with the geographical gradient (areas A x B, B x C and C x D). Analyses were also conducted to determine the gonad index (GI) and gonadosomatic index (GSI) values, both calculated for the fish of each distinct area, season and stage of ovarian maturation (VAZZOLER, 1996), by the application of the following equations:

$$GI = Wo / LT^{b} \cdot 10^{6}$$

$$GSI = (Wo / WT) \cdot 10^{2}$$

where Wo is the ovarian weight, LT the total length, WT the total weight and “b” the coefficient of the length-weight relationship, fitted to a power model by the least square method (ZAR, 1999). GI and GSI values were plotted against total length and their correlations were analyzed (Spearman, after the D’Agostino Pearson normality test), independence and no relationship between the variables thus being ascertained, a prerequisite for the application of the indexes (BRAGA, 1986).

After data normality (D’Agostino Pearson) and homocedasticity (Bartlett) verifications, the values of the indexes were compared by season using a Mann-Whitney test. Since differences between seasons were stated, series data of GI and GSI for each season were compared by the Kruskal-Wallis test, taking the factor area into consideration (ZAR, 1999; SIEGEL; CASTELLAN, 2006). If differences were detected, a Student-Newman-Keuls (SNK) test was applied to the data. Comparisons of the indexes taking the ovarian maturation of *M. hubbsi* into consideration were not performed due to the unbalanced design and absence of the data relating to some categories, thus limiting the power of this analysis.

All the statistical analyses took Zar (1999) and Siegel and Castellan (2006) into account, and were carried out with the software Minitab 15® (licensed to the Universidade de São Paulo) and BioEstat 4.0 (free software, AYRES et al., 2005). The significance level adopted was 5%.

Results

The length frequency distribution of the 533 females (164.00 mm < LT < 618.00 mm) analyzed for each area and season is shown in Figure 2. The statistical description of the data is presented in Table 1, as are the results of the normality test and of the application of Gulland's estimate of the minimum sample size, which was sufficient in all cases in view of the variability of the data, even in the winter in area C, where the value obtained was lower than the estimated value. In Area D, due to its low abundance during summer, *Merluccius hubbsi* is not fished as a target by the commercial fleet, so few specimens were obtained from that area in that period.

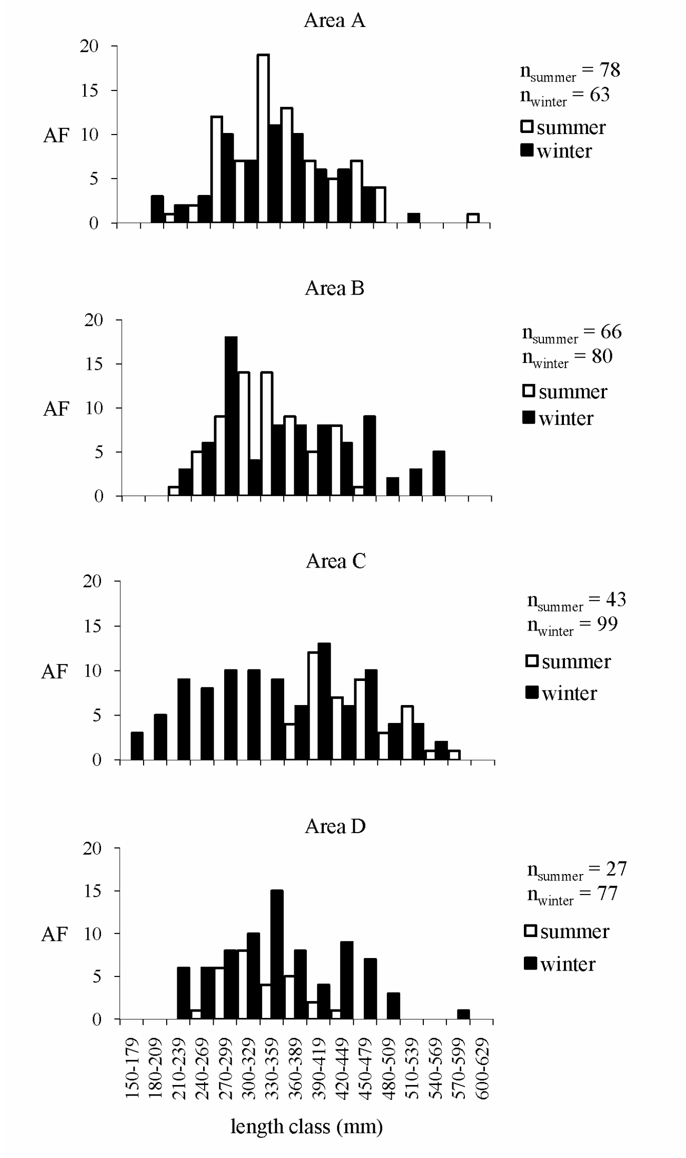

Fig. 2. *Merluccius hubbsi*: number of females (AF – absolute frequency) by class of total length (mm), by area (A to D), and season.

Table 1. *Merluccius hubbsi*: statistical description of the total length, results of the D'Agostino Pearson normality test and number of fish enough ("n calculated") to ensure an adequate statistical sample size (* not normal).

Season	Area	n sampled	Mean (mm)	Standard deviation (mm)	Median (mm)	Minimum (mm)	Maximum (mm)	Skewness	Kurtosis	Normality Test (p value)	n calculated (Gulland, 1966)
Summer	A	78	365.36	68.88	352.50	221.00	618.00	0.72	1.21	0.009*	56
	B	66	343.00	54.40	345.00	237.00	458.00	0.30	-0.66	0.278	40
	C	43	451.53	51.07	448.00	368.00	578.00	0.53	-0.37	0.188	22
	D	27	331.89	42.37	321.00	264.00	430.00	0.57	-0.26	0.253	27
	Total	214	371.56	71.48	362.50	221.00	618.00	0.53	0.03	0.124	58
Winter	A	63	346.19	73.46	347.00	189.00	517.00	-0.09	-0.41	0.665	72
	B	80	370.70	83.30	363.50	230.00	558.00	0.38	-0.96	0.106	79
	C	99	348.00	91.60	350.00	164.00	568.00	0.11	-0.89	0.237	109
	D	77	352.82	80.00	345.00	214.00	585.00	0.28	-0.27	0.469	81
	Total	319	354.51	89.55	350.00	164.00	585.00	0.21	-0.59	0.122	100
Total		533	361.35	83.12	355.00	164.00	618.00	0.23	-0.33	0.217	83

The female percentages by ovarian maturation stage in summer are presented in Figure 3 and the sum of spawning and spent for Areas A, B and C, 30.77%, 15.15% and 20.93%, respectively, indicated the presence of spawning females in that area and period, predominantly in Area A. No summer spawning activity was detected in Area D, where the females were immature, maturing or mature and only one was spawning. On the other hand, during winter (Fig. 4), spawning and spent females predominated in Area D (22.08%), being followed by Area C (20.20%) and Area B (7.50%). No spawning females were detected in Area A, where only 6.35% of females were spent.

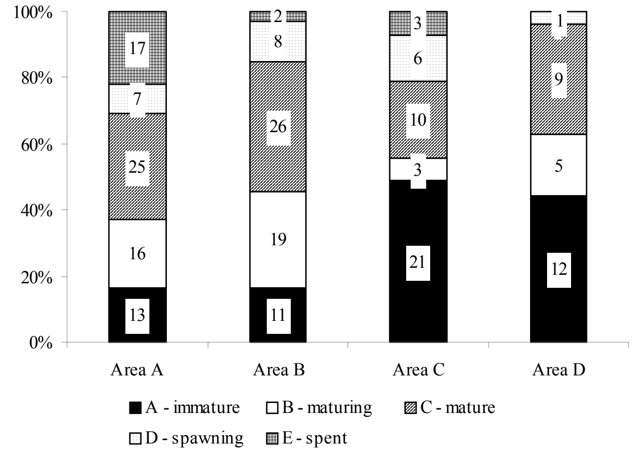

Fig. 3. *Merluccius hubbsi*: relative frequency of females by gonadal maturation stage by area during summer – 1996-2001 and 2004.

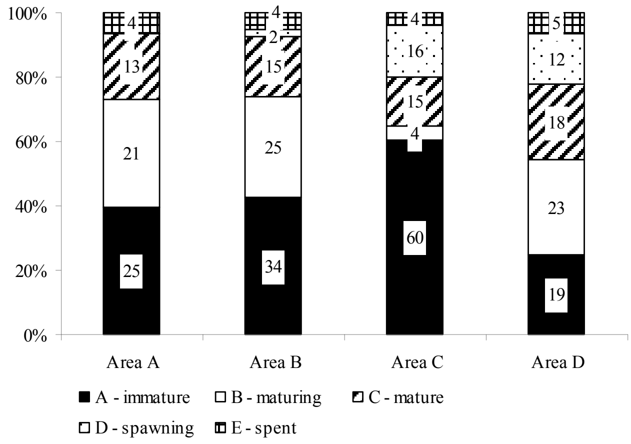

Fig. 4. *Merluccius hubbsi*: relative frequency of females gonadal maturation stage by area during winter - 1996-2001 and 2004.

The female frequencies in the distinct maturation stages during summer and winter were significantly different (X^2_{KS}=19.31; $p < 0.01$). The comparison among areas is presented in Table 2 by season, showing that, during summer, Areas A and B were similar while areas C and D together formed another group. On the other hand, in winter, Areas A, B and C were homogeneous and Area D was markedly different from the other three.

Table 2. *Merluccius hubbsi*: statistics and p value of the Kolmogorov-Smirnov test applied to frequency of maturation (OK) females in areas A to D, in summer and winter.

Areas	Statistic	Summer	Winter
A x B	X^2_{KS}	5.04	1.89
	p value	0.1614	0.1112
B x C	X^2_{KS}	10.78	5.80
	p value	0.0092	0.1100
C x D	X^2_{KS}	1.97	22.37
	p value	0.7474	< 0.001

Prior to the analysis of the indexes, the length-weight relationship was $Wt = 0.000004\ Lt^{3.094}$ (n = 533; r² = 0.974; p < 000.1).

There was no correlation between the fishes´ total length, the gonad index ($r_S = 0.4676$; $p > 0.10$) (Fig. 5) and the gonadosomatic index ($r_S = 0.5436$; $p > 0.10$) (Fig. 6), allowing the use of these indexes to infer the reproductive phase of *M. hubbsi*.

The gonad index (GI) and the gonadosomatic index (GSI) values obtained for summer and winter differed significantly (Z(U) = 7.6609; p < 0.001 for GI and Z(U) = 7.7272; p < 0.001 for GSI). Thus, the analyses were conducted for summer and winter separately.

In summer, the median values of GI were 0.1454 for Area A, 0.0977 for Area B, 0.0596 for Area C and 0.04918 for Area D (Fig. 7a). The Kruskal-Wallis test revealed differences among the values of these series (KW = 20.3529; p = 0.0001); the SNK test showed that Areas A and B were similar (p = 0.0911) but different from Areas C and D (p = 0.0722). Special attention must be drawn to the increasing difference between Area A, Area C (p = 0.0073) and Area D (p < 0.0001). On the other hand, the median GI values for winter were 0.04459, 0.03960, 0.0360 and 0.0464 for Areas A to D, respectively (Fig. 7b), these values not being significantly different (KW = 4.1176; p = 0.2490).

The median gonadosomatic index (GSI) values were 3.495 (Area A), 2.436 (Area B), 1.564 (Area C) and 1.143 (Area D) in summer and 1.063 (Area A), 0.980 (Area B), 0.877 (Area C) and 1.118 (Area D) in winter (Fig. 8). In this case, only in summer did the Kruskal-Wallis test also reveal significant differences among the areas (KW = 20.5102; p = 0.0001). The SNK test indicated two similar areas, A x B and B x C (p values > 0.05). The GSI values of Area D were different from those for the other three areas, the smallest difference being observed in the contrast with Area C (p = 0.0344) and increasing northward in comparison with Areas B (p = 0.0027) and A (p < 0.0001). In winter, there was no difference among the values of GSI (KW = 6.0086; p = 0.1112).

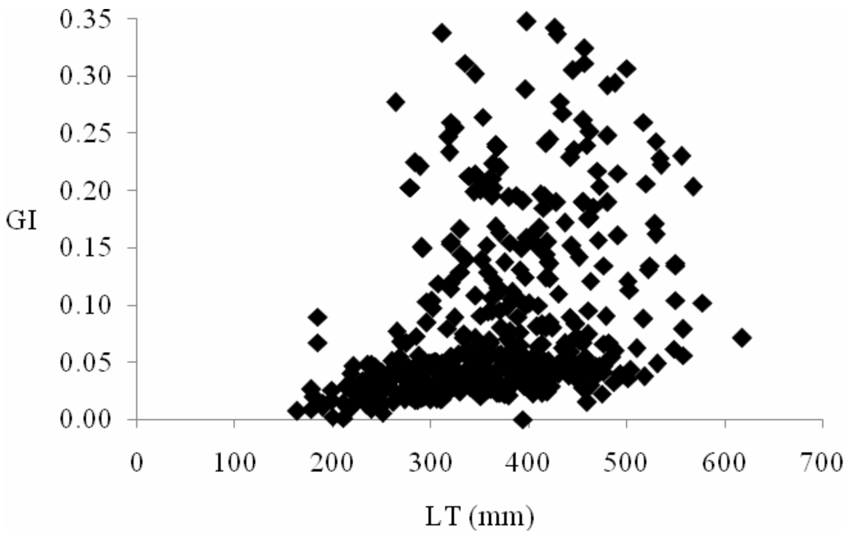

Fig. 5. *Merluccius hubbsi*: values of gonad index (GI) plotted against total length (LT).

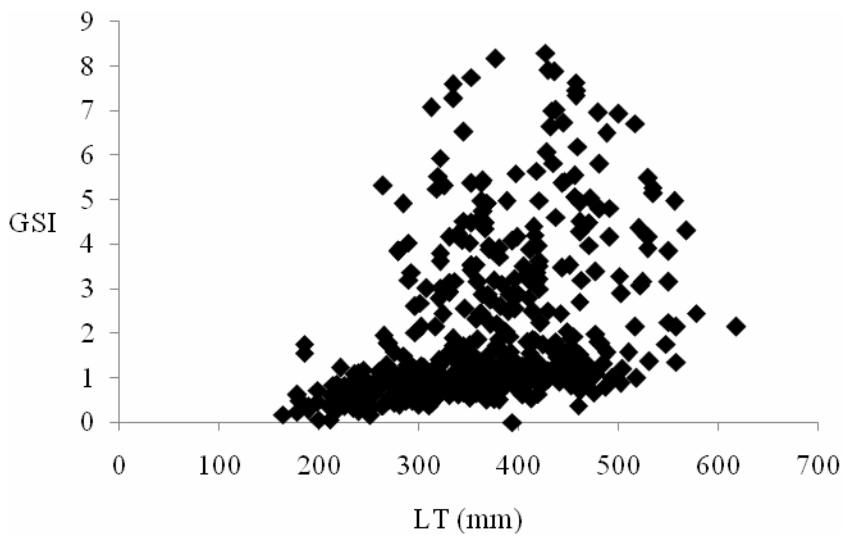

Fig. 6. *Merluccius hubbsi*: values of gonadosomatic index (GSI) plotted against total length (LT).

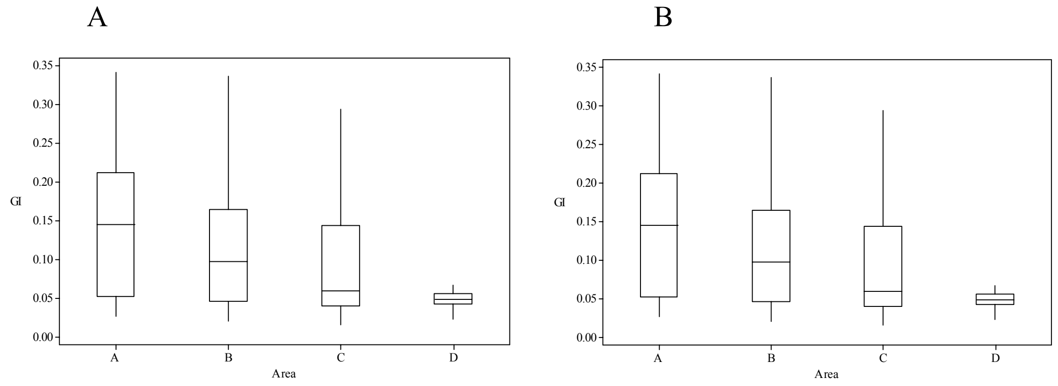

Fig. 7. *Merluccius hubbsi*: median, 1st and 3rd quartiles, minimum and maximum values of gonad index (GI) for areas A, B, C and D during summer (a) and winter (b) - 1996-2001 and 2004.

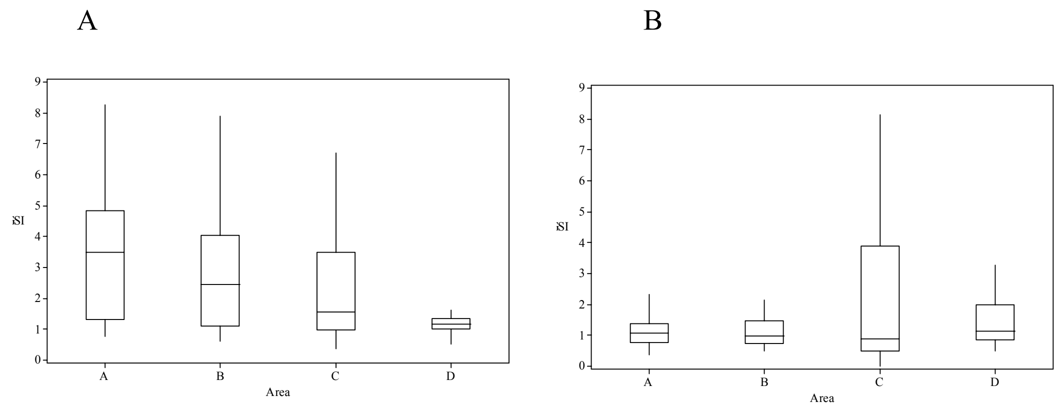

Fig. 8. *Merluccius hubbsi*: median, 1st and 3rd quartiles, minimum and maximum values of gonadosomatic index (GSI) for areas A, B, C and D during summer (a) and winter (b) – 1996-2001 and 2004.

DISCUSSION

Life history characteristics, especially reproduction, are appropriate for the differentiation of stocks, because each group has its own attributes (SWAIN et al., 2005), even though with some measure of discreteness in terms of space and/or time (WALDMAN, 2005). The identification of the temporal and spatial extension of spawning is one of the most important factors for the definition of discrete stock units (BEGG et al., 1999b; BEGG, 2005). On the other hand, the knowledge of the variability among spawning groups gives support to the fishery sciences and general management (WALTERS; MARTELL, 2004; MUNRO et al., 2004; PAYNE et al., 2004; SECOR, 2007).

The Argentine hake’s reproductive biology in Uruguayan and Argentinian waters is well known. Angelescu et al. (1958) were the pioneers in the study of the species` reproduction pattern and they were followed by Ciechomski (1967) with her analysis of its spawning and fecundity and Christiansen´s (1971) and Christiansen and Cousseau´s (1971) descriptions of its gonadal maturation. Many studies have been undertaken since then, including those conducted by Christiansen et al. (1986), Grunwaldt (1986), Simonazzi and Otero (1986), Olivieri and Christiansen (1987), Ubal et al. (1987), Louge and Christiansen (1992, 1993), Di Giácomo and Perier (1992), Bezzi and Dato (1993), Ehrlich and Ciechomski (1994), Portela et al. (1994), Louge (1996), Ruiz and Fondacaro (1997), Cornejo (1998), Bezzi and Tringali (2003), Sabatini (2004), Macchi et al. (2004), Pájaro et al. (2005) and Macchi et al. (2006). Di Giácomo et al. (1993) distinguished the Patagonian stock of *M. hubbsi* from neighboring groups by the species´ spawning time and area. Nowadays, in Uruguay and Argentina, three stocks are recognized: one between

34°S-41°S (called "Bonaerense"), including the Argentinian-Uruguayan Common Fishing Zone (AUCFZ), another south of 41°S (Patagonian) and a third, restricted to the coastal area of the San Matías Gulf (AUBONE et al., 2000; BEZZI et al., 2004).

In Brazilian waters, all studies dealing with *M. hubbsi*'s reproduction have been conducted with samples collected throughout the species´ area of occurrence (Cape Frio, 21°S, to Chuí, 34°S). Vaz-dos-Santos et al. (2005) estimated its first gonadal maturation and Honji et al. (2006) investigated its ovarian development. Vaz-dos-Santos and Rossi-Wongtschowski (2005) confirmed that spawning occurs all year round in the Brazilian South-Southeast region, but called attention to the presence of more than one stock in the area and emphasized the need for a detailed analysis of *M. hubbsi* ´s reproduction during summer and winter.

Olivieri and Christiansen's (1987) analysis shows that *M. hubbsi*'s ovarian maturation is continuous over seven months and that multiple spawning occurs over an interval of four months. Ciechomski (1967) pointed out that the number of spawning and spent females may contribute to the analysis of spawning periods, since the percentages involved in those periods are noteworthy. In Brazil, the spawning and spent female frequencies indicate more intense spawning activity during summer in Area A and in winter in Area D, with areas B and C presenting a north–south spawning gradient, this affirmation being supported by statistical analysis that has shown the existence of two different groups in both seasons.

Gonad and gonadosomatic indexes reinforced the results obtained by the ovarian maturation analysis, being useful tools for the demonstration of the differentiation of *M. hubbsi*´s Brazilian stock. Both these indexes were calculated to provide referential value comparisons with those of other studies and the information they provide does not differ as regards *M. hubbsi*´s reproductive cycle. But the gonadosomatic index, a percentage, is more suitable, and may be recommended for future studies. The values of these indexes indicated ovarian weight variations as a consequence of oocyte maturation and their statistical analysis clarified the similarities and differences of this process throughout the area. In order to identify *M. hubbsi*'s spawning season in the Southern Brazilian area (corresponding to area D of the present study), Haimovici et al. (1993) used the gonadosomatic and condition factor indexes, but a trustworthy analysis was also obtained from the gonadal maturation examination, showing that, in accordance with the results obtained, spawning occurs between August and October.

The use of reproductive indexes is not frequent in Uruguayan and Argentinian studies of *M. hubbsi*'s reproductive cycle. Ciechomski (1967) found no relationship between the condition factor and fecundity, a fact attributed to the variability of values caused by its multiple spawning. Similar results were presented by Christiansen and Cousseau (1971), who analyzed data on *M. hubbsi*'s "Bonaerense" and Patagonian stocks. Nevertheless, recently, Pájaro et al. (2005) applied the gonadosomatic index in an attempt to identify the spawning peak within a spawning period, and obtained consistent results. These results show that reproductive indexes may be helpful in detailing variations within a reproductive period in a specific area, being a tool for the detection of *M. hubbsi*'s spawning peaks. This conclusion depends on the consideration that gonad indexes are good indicators of reproductive events, which reflect weight variations caused by the number and size of the oocytes (SWAIN et al., 2005). Pájaro et al.´s (2005) proposition finds support in the results obtained here, in which index values differ significantly within the area studied.

With regard to the Argentinian-Uruguayan Common Fishing Zone (AUCFZ), Ehrlich and Ciechomski (1986) reported *M. hubbsi*'s winter spawning as taking place from May to August. Ubal et al. (1987) identified spawning during autumn, between 35°-36°S. In the Argentinian sea, Christiansen et al. (1986) found peculiar structures in histological portions of the gonads and muscles of *M. hubbsi* from different geographical areas and concluded that there are different stocks with distinct spawning periods in that area. According to these authors, spawning starts in Uruguay during autumn (first peak) and ends in Patagonian waters in spring-summer (second peak), extending southwards along a north-south gradient. Grunwaldt (1986) also identified different spawning periods, based on fecundity analysis. This reproductive pattern of *M. hubbsi* in Argentinian waters found support in Villarino and Giussi's (1992) study. This data set was reviewed by Louge and Christiansen (1993), Bezzi and Dato (1993) and Ehrlich and Ciechomski (1994), and corroborated by Bezzi et al. (1994), proving that one Argentinian hake stock spawns in winter, between 35°S and 38°S, and another between 43°S and 47°S, mainly in spring-summer. Ehrlich (2000) reinforces the north-south reproductive gradient pattern based on egg and larval distributions. The spawning phenomena of Argentine hake is associated with cold waters, with temperatures ranging f rom 9°C to 18°C (CIECHOMSKI; WEISS, 1973; LOUGE, 1996), the optimum being 9.4°C-13.3°C (BEZZI et al., 2004), recalling that the species is eurithermic, inhabiting waters with temperatures between 7°C and 23°C (PRENSKI; BEZZI, 1991; EHRLICH; CIECHOMSKI, 1994).

The oceanographic characteristics of the Uruguayan and Argentinian sea, a portion of the South-Southeast America Large Marine Ecosystem (SSALME) (BISBAL, 1995), give support to its division into the “Bonaerense” and Patagonian sectors (PIOLA; RIVAS, 1997), due to the flow of the Malvinas (Falkland) Current and its mixing with coastal waters (GUERRERO; PIOLA, 1997). Torres et al. (1996) also found this association by analyzing juvenile otoliths and thus reinforced the stock segregation of *M. hubbsi* in the Argentinian-Uruguayan Common Fishing Zone.

The results obtained in this study for the Argentine hake in Brazil in association with hydrographic information (sea temperature) available for the period of analysis (NOAA, 2005) allows us to give full weight to the evidence that the Southern Brazilian region (Area D) represents an extension of the “Bonaerense” *M. hubbsi* stock, whose spawning peak occurs in autumn-winter, when cold waters predominate. Others authors, such as Ciechomski and Weiss (1974), Torres-Pereira (1983, unpublished), Haimovici et al. (1993) and Torres et al. (1996) have previously presented this hypothesis, now confirmed as correct. The Santa Marta Grande Cape (29°S), a region characterized by a narrow continental shelf with many upwellings (CASTRO et al., 2006), marks the northern limit of the “Bonaerense” stock, where cold waters derived from the Malvinas current mix with those from the La Plata River and the Patos-Mirim Lagoon System, giving rise to an environment with salinity around 33 and temperatures of 12°C-15°C, mainly during winter (PIOLA et al., 1999). These features constitute an ecosystem which exercises great influence on many fish species living there, including *M. hubbsi* (HAIMOVICI et al., 1994; SEELIGER et al., 1998; VOOREN et al., 2005).

On the other hand, in the Southeastern region (Areas A, B and C, 21°S to 29°S), *M. hubbsi* presents a spawning peak in spring-summer, related to the presence of the cold South Atlantic Central Water (6°C < 20°C, 34S < 36S) (SILVEIRA et al., 2000; CASTRO et al., 2006). Upwelling phenomena are usual at 22°52’S (Cape Frio), extending to 23°S-25°S during summer (BRAGA; NIENCHESKI, 2006), influencing the life history of the *M. hubbsi* and other species that inhabit this area (ROSSI-WONGTSCHOWSKI; PAES, 1993).

In relation to stocks, the Argentine hake should be managed in two distinct units: one in the Southeast (between 21°S and 29°S, Areas A to C) and the other in the South (Area D, southward from 29°S), both lying within the SSALME (BISBAL, 1995). The absence of juveniles of the species at 29°S (Santa Marta Grande Cape) (FIGUEIREDO et al., 2002; VAZ-DOS-SANTOS, 2002, unpublished) reinforces this division. According to Vaz-dos-Santos (op. cit.), juveniles concentrate in the Southeastern and Southern regions during spring-summer and autumn-winter, respectively, in agreement with the birth dates attributed to them from daily ring counts in otoliths (VAZ-DOS-SANTOS, 2006, unpublished).

It is also important to consider the hypothesis of the existence of large latitudinal migrations of *M. hubbsi* as indicated by Angelescu et al. (1958) and stressed by Podestá (1990). These displacements have become better understood as a result of numerous studies conducted on the species´ reproductive biology, which have shown that they are regional and related to smaller intra stock groups, as documented for other species (SECOR, 1999). Large displacements between 21°S and 34°S are, thus, improbable. Perez et al.´s (2003) data support this hypothesis, showing that the commercial fishing fleet operates all year round throughout the area of this study, though catches vary according to the season. Partial stock discreteness is usual, all round the world, for the genus *Merluccius.* Casey and Pereiro (1995), based on the reproductive life history and spatial distribution of juveniles, have demonstrated that there are two stocks of *M. merluccius* in the northeastern Atlantic and this has also been found for *M. bilinearis* on the Canadian and American Atlantic coasts (HESLER et al., 1995).

In the southeastern and southern Brazilian areas, there are other species with similar stock patterns (separation at 29°S and partial discreteness): *Cynoscion guatucupa* (HAIMOVICI;MIRANDA, 2005), *Umbrina canosai* (HAIMOVICI et al., 2006), *Macrodon ancylodon* (YAMAGUTI, 1979; CARNEIRO; CASTRO, 2005), *Micropogonias furnieri* (VAZZOLER, 1971; HAIMOVICI; IGNÁCIO, 2005) and *Engraulis anchoita* (CASTELLO, 2005). In the area south of 29°S, these species are also shared, as is *M. hubbsi*, with Uruguay and Argentina and the recognition of this situation is an essential condition for their management (MUNRO et al., 2004; PAYNE et al., 2004). Regarding *M. hubbsi*, *E. anchoita* and *U. canosai*, Vaz-dos-Santos et al. (2006, unpublished) stressed the inconsistency and inefficiency of their present management, due to the fact that their shared stock status is not taken into consideration. These are only a few examples since there are at least forty commercial species shared among Brazil, Uruguay and Argentina (VAZ-DOS-SANTOS et al., 2007), Vasconcellos and Haimovici (2006) being the only ones who have presented suggestions for the management of the shared stock of *M. furnieri*.

The overexploitation of *M. hubbsi* has been affirmed by Aubone et al. (2000, 2004) and Bezzi et al. (2004) for Uruguayan-Argentinian stocks, where the species has been managed. Overexploitation has only recently been detected in

Brazil, by Vaz-dos-Santos and Rossi-Wongtschowski (2005), Vaz-dos-Santos et al. (2006), Perez and Pezzutto (2006), Vaz-dos-Santos (2006, unpublished) and Vaz-dos-Santos and Rossi-Wongtschowski (2007), but so far no regulation of hake fisheries has come into force. Considering the discreteness of the stocks and the fact that the South stock is shared with Uruguay and Argentina, the appropriate management of the species is urgently necessary.

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