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Does *Mugil liza* Valenciennes 1836 (Teleostei: Mugiliformes) occur in Argentinean waters?

¿Está presente *Mugil liza* Valenciennes 1836 (Teleostei: Mugiliformes) en aguas argentinas?

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Abstract.- The present paper deals with the occurrence of two nominal species of *Mugil* (*Mugil liza* Valenciennes 1836 and *Mugil platanus* Günther 1880) in Argentinean waters.
The investigation is necessary to clarify the distribution of these species before any regional study on the biology can be made. In Argentinean bibliographies, two members of the familiy Mugilidae are mentioned as living in Argentinean waters, *M. liza* Valenciennes 1836 and *M. platanus* Günther 1880, while recent revisions on the southwestern Atlantic members of this family recognised *M. liza* as living in the Caribbean and northern Brazil and *M. platanus* along the southern coast of Brazil and north of Argentina.
Samples from six coastal localities and from a freshwater lagoon between 36 and 42ºS latitude, comprising a total of 369 individuals were examined and compared with Type specimens of both nominal species and a sample of 38 individuals of *M. platanus* from Río Grande do Sul, Brazil (32ºS). Morphometric and meristic data were recorded: morphometrics was analyzed by normalization of the individuals of each locality followed by principal component analysis and meristics were compared with the values from Types and fresh specimens corresponding to *M. platanus* and *M. liza*. The comparative analysis indicated that *M. liza* does not occur in Argentinean waters, being *M. platanus* the only permanent present species.

Key words: Mugilidae, *Mugil platanus*, taxonomy, identification

Resumen.- El trabajo trata sobre la presencia de dos especies de Mugil (*Mugil liza* Valenciennes 1836 y *Mugil platanus* Günther 1880) en aguas argentinas.
La investigación es necesaria para clarificar la distribución de estas especies antes de realizar cualquier estudio regional sobre su biología. En la bibliografía local se mencionan dos miembros de la familia Mugilidae como habitantes de aguas argentinas, mientras que las revisiones recientes sobre los miembros de esta familia en el Atlántico sudoeste reconocen a *M. liza* como habitante del Caribe y norte de Brasil y *M. platanus* en la costa del sur de Brasil y norte de Argentina.
Se compararon muestras de seis localidades costeras y de una laguna de agua dulce entre 36 y 42º S (N=369), con ejemplares Tipo de ambas especies nominales y con una muestra de 38 individuos de *M. platanus* procedente de Río Grande del Sur, Brasil (32ºS). Fueron registrados datos morfométricos y merísticos; los primeros fueron analizados mediante análisis de componentes principales, y los valores merísticos fueron comparados con los de ejemplares Tipo y frescos correspondientes a *M. platanus* y *M. liza*. Los análisis comparativos indican que *M. liza* no se encuentra en aguas argentinas, siendo *M. platanus* la única especie de presencia permanente.

Palabras clave: Mugilidae, *Mugil platanus*, taxonomía, identificación

Introduction

Mullets (family Mugilidae) are pelagic, coastal fishes, occurring in estuaries and even in freshwater. Although the species of this family are very similar in overall external morphology, features of morphology and morphometry are commonly employed to distinguish species. Other characters used for diagnosis are skeletal and muscular anatomy (Harrison & Howes 1991), protein or enzymes electrophoresis (Herzberg & Pasteur 1975, Menezes *et al.* 1992, Rossi *et al*. 1998), and mitochondrial DNA sequence analysis (Caldara *et al.* 1996).

Mugilidae is well represented in Atlantic coastal waters of South America (Cervigón 1993, Menezes 1983, Carvalho Filho 1999, Keith *et al*. 2000). Two species are reported from Argentina: *Mugil liza* Valenciennes, 1836 and *Mugil platanus* Günther, 1880 (Ringuelet & Aramburu 1960, Ringuelet *et al.*1967, Menni *et al*. 1984, 1995, Almirón *et al*. 1992). However, Ringuelet *et al.* (1967), Menni *et al*. (1995) and López *et al*. (2003) regarded that nominal species of *Mugil* from Argentina are of uncertain identity.

Menezes (1983) in his study of *Mugil* species in Brazilian waters, suggested that only *M. platanus* occurs in Argentina. According to Menezes (1983) and Cervigón (1993), *M. liza* occurs in the Caribbean and northern Brazil. However, Menezes (1983) used a different set of characters compared to Ringuelet *et al*. (1967) to diagnose the species.

There are no other studies on this subject in Argentina. The diagnostic characters presented by Ringuelet *et al.* (1967) were based on the examination of few individuals, but have been followed by several subsequent authors with no further revisions. The objetive of the present paper is to evaluate the presence/ absence of *Mugil liza* in Argentinean waters.

Materials and methods

Material examined

Specimens of *Mugil platanus* were collected from six coastal localities situated between 36º and 42ºS latitude in Argentina (Bahía Samborombón, San Clemente, Mar Chiquita, Viedma, Bahía Blanca and Puerto Madryn/ Golfo San José) and from the freshwater lagoon of San Lorenzo, 90 km from the sea, to which it is connected via the Salado River, which flows into the Bahía Samborombón (Fig. 1, Table 1). Samples comprised 369 individuals, from 216 to 500 mm standard length. Additionally, 38 specimens of *M. platanu*s were collected from Rio Grande do Sul, Brazil. Additional material included alcohol-preserved specimens of *Mugil spp.* curated in fish collections as follows. Institutional acronyms follow Leviton *et al*. (1985).

1) *Mugil liza* Valenciennes, 1836

Muséum National d´Histoire Naturel (París, France) **(**MNHN) A 4659. Lectotype; 484 SL; Martinica Island (Antillas). MNHN A 4642. Paralectotype (specimen

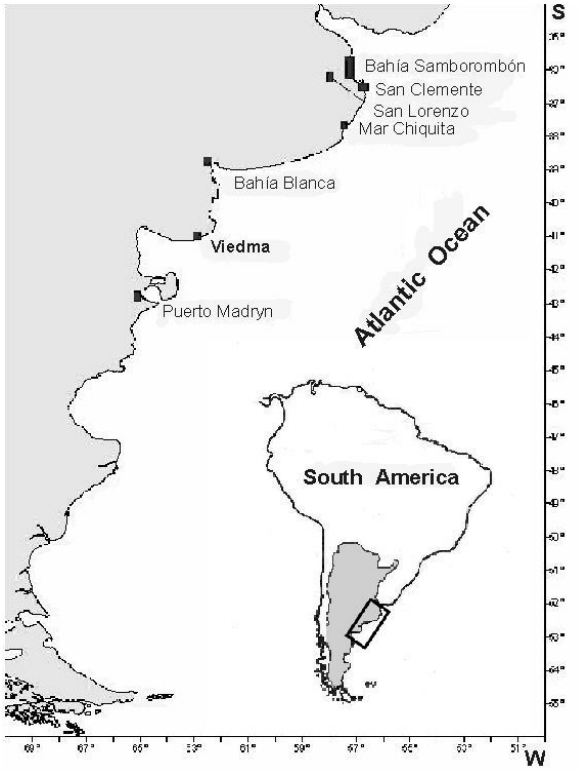

Figure 1

Localities of *Mugil platanus* samples from Argentina

Localidades de procedencia de las muestras de *Mugil platanus* de Argentina

Table 1

Data of *Mugil platanus* fresh samples

Datos de las muestras de *Mugil platanus* analizadas en fresco

Locality	Fishing gear	Size range (mm)	n
Bahía Samborombón	Bottom trawl	253-527	127
San Clemente	Monofilament gill net	304-580	31
Mar Chiquita	Monofilament gill net	216-590	94
Viedma	Bottom trawl	395-489	42
San Lorenzo	Monofilament gill net	240-585	29
Bahía Blanca	Bottom trawl	315-500	29
Puerto Madryn and San José G.	Bottom trawl	277-443	17
Brazil (Río Grande)	Bottom trawl	312-600	30
Total			399

dry, a label reads Type); 223 mm SL; Venezuela MNHN A 4656. Paralectotype (specimen dry, a label reads Type); 331 mm SL. Venezuela. MNHN A 4657. Paralectotype (specimen dry and setted, a label reads Type); 363 mm SL Venezuela. MNHN A 1050. Paralectotype (specimen dry and setted, a label reads Type); 560 mm SL; French Guiana, British Museum of Natural History London, United Kingdom (BMNH) 1993.6.29.39. 604 mm SL. Itacuruça River, Sepetiba Bay, RJ, Brazil.

2) *Mugil platanus* Günther, 1880

BMNH 1993.6.29.38. 661 mm SL. Itacuruça River, Sepetiba Bay, RJ, Brazil. MNHN A 6307. Paralectotype (I. J. Harrison, 1993, listed this as *M. cephalus*); 331 mm SL; Buenos Aires, Argentina. BMNH 1878.5.16: 19. Sintype: 367 mm SL; La Plata River, Buenos Aires, Argentina. BMNH 1878.9.10:1-4. Sintypes (a label reads Types). Four specimens: 213 – 300 mm SL. La Plata River, Buenos Aires, Argentina. Non type specimens examined. La Plata Museum, (La Plata, Argentina) (MLP) 6345 *: 198 mm SL; Magdalena, La Plata River. MLP 6074: 198 mm SL; Punta Lara. MLP 6294: 166 mm SL; Punta Lara. MLP 6303: 133 mm SL; Punta Lara. MLP 6216: 163 mm SL; Punta Piedras. MLP 6307/1-2. Two specimens: 173 and 196 mm SL; Punta Piedras. MLP 5639: 58 mm SL; Canal 15, Buenos Aires Province. MLP 7913.1/2. Two specimens: 189 and 196 mm SL; Mar Chiquita Lagoon. MLP 6161.2/7. Two specimens: 213 and 190 mm SL; Quequén Grande River. MLP 3911: 209 mm SL; Quequén Salado River.

Methods

Specimens collected from Argentina and Brazil as part of this study, were sexed and measured fresh. The two localities with the highest number of samples (Samborombón and Mar Chiquita) were chosen to perform a comparison of the parameters for allometric ratios between sexes (comparison coefficients Fisher test).

Eight morphometric characters were measured on the left side of Types of *Mugil platanus* and *Mugil liza*, fresh and MLP specimens to the nearest 0.5 mm with dial calipers. Methods for taking morphometrics follow Cervigón (1980).

Morphometric data registered for each specimen were: standard length (SL), predorsal distance (pDd), prepectoral distance (pPd), preventral distance (pVd), preanal distance (pAd), head length (HL),, pectoral fin length (PL), and length of the axillar scale of pectoral fin (EaxL).

Morphometric characters were organized by category. A normalization technique to scale the data that exhibit an allometric growth was used according to Lleonart *et al*. (2000). This method was derived from the theoretical equations of allometric growth and completely removes all information related to size, not only scaling all individuals to the same size, but also adjusting their shape to a standard form according to allometry. In the particular case of isometry, this normalization coincides with ratios (one of the most common methods but only valid in this particular case).

Standard length was considered the independent variable, whilst the remaining seven characters were considered dependent variables. The parameters of the allometrics ratios between independent and dependent variables were calculated as follows:

$$Yij = ai\ SLj \exp bi \quad (1)$$

where: *SL*j is the individual's standard length *j*, *Y*ij, is the *i* variable of individual *j* and *a*i and *b*i represent the parameters of allometric ratio between total length and variable *i*.

The normalization procedure of individual's data from each locality was done separately, according to the equation:

$$Yij^* = Yij\ (SL0 / SLj) \exp bi \quad (2)$$

where: Yij* is the value of variable Yij once it has been transformed, *SL*0 represents a reference value of size (300 mm in this paper) to which all individuals are reduced (or amplified) (Lombarte & Lleonart 1993, Ibañez-Aguirre & Lleonart 1996). This transformation of data removes all the size effects due to allometric growth (Lleonart *et al*. 2000). After this transformation, a new matrix with the normalized results was done (containing the corrected matrices), and a principal component analysis (PCA) was performed. Two PCA were done: the first one including preserved specimens (Types and MLP specimens), and the second with the above mentioned plus fresh specimens from Argentina and Brazil.

Meristic data were also considered for each specimen. Meristic abbreviations are as follows: number of lateral series scales (S.lat.) from the dorsoposterior opercular membrane, continued on a

posteroventral diagonal to the tip of the pectoral fin and then in a straight line along the midline of the body to the posterior edge on the hypural plate, determined externally; number of spines and rays of first dorsal, second dorsal, pectoral, pelvic and anal fins.

Meristic characters were compared to those expected for *Mugil platanus* and *Mugil liza*, following Menezes (1983) and Cervigón (1993), respectively.

Presence or absence of teeth, scales morphology and colour pattern were also considered in the analyses.

Results

Results of the parameter calculations for allometric ratios between sexes for Mar Chiquita and Samborombón localities are shown in Table 2. The Fisher coefficients comparison test revealed no differences between sexes for both localities. According to these results, the specimens were no discriminated by sex.

Examination of museum and fresh specimens

Results obtained from the comparison of museums and fresh specimens, related to characters employed by Ringuelet *et al.* (1967) in order to identify *Mugil liza* and *Mugil platanus* in Argentinean waters are summarized in Table 3.

Table 2

Fisher test coefficients comparison between sexes employing data of two coastal localities

Comparación de coeficientes de la prueba de Fisher entre sexos con datos de dos localidades costeras

	μ statistic values	
Variable	Mch (n=94)	Samb (n=127)
SL	0.200	0.00971
HL	0.591	0.02077
S	2.104	1.60925
pDd	2.742	0.17209
dPd	2.435	2.54975
PL	0.162	1.41517
EaxL	0.515	0.07065

Mch: Mar Chiquita; Samb: Samborombón; SL, standard length, HL, head length, S, snout, pDp, pre-dorsal distance, dpP, pre-pectoral distance, PL, pectoral fin length, EaxL, length of the axillar scale of pectoral fin

Table 3

Statistical values for Type specimens (*Mugil platanus* and *Mugil liza*), La Plata Museum (MLP), and fresh specimens of Argentina and Brazil, corresponding to number of scales of lateral series and diagnostic characters mentioned by Ringuelet *et al.* (1967)

Valores estadísticos para especimenes Tipo (*Mugil platanus* y *Mugil liza*), Museo de La Plata (MLP), y ejemplares frescos de Argentina y Brasil, correspondientes al número de escamas de la serie lateral y los caracteres diagnósticos señalados por Ringuelet *et al.* (1967)

Species		*M. liza*	*M. platanus*			
Category		Types	Types	MLP	Argentine fresh	Brazilian fresh
N		6	7	14	72	38
Lateral series scales	Mean	31.40	36.43	37.31	36.56	36.61
	Mode	32	36	38	36	
	SD	1.34	1.27	1.32	1.35	1.20
	Range	29-32	35-39	35-39	34-39	33-39
Body height/ Standard length	Mean	5.47	3.98	3.99	4.21	4.31
	Range	4.8-6.2	3.5-5.0	3.32-4.65	3.5-5.0	3.8-4.9
Pectoral length/ Axilar scale length	Mean	2.78	2.45	2.72	2.30	2.24
	Range	1.8-3.9	2.0-3.5	2.31-3.36	2.0-2.82	1.9-2.5
Pectoral lenght/ P-D distance	Mean	13.85	17.92	21.87	25.13	17.26
	Range	3.4-9.2	2.0-5.7	2.1-6.9	2.0-8.7	1.8-6.4

Morphometrics

Figures 2 and 3 show the results of principal component analysis and variables-components correlation for Types and La Plata Museum (MLP) specimens. Clear differences bettween *Mugil liza* Types and *Mugil platanus* (Types and MLP specimens) can be observed. Figure 4 shows the results of principal component analysis of Types, La Plata Museum (MLP) and fresh specimens from Argentina and Brazil. *M. platanus*, represented by preserved (BMNH and MLP) and fresh specimens are clearly differenciated from *M. liza*.

In both analyses, body height (BH) was loaded heavily with the second axis (PC2) (Fig. 2) and third axis (data not shown) respectively, suggesting that BH is the most important morphometric variable for the differentiation of both species.

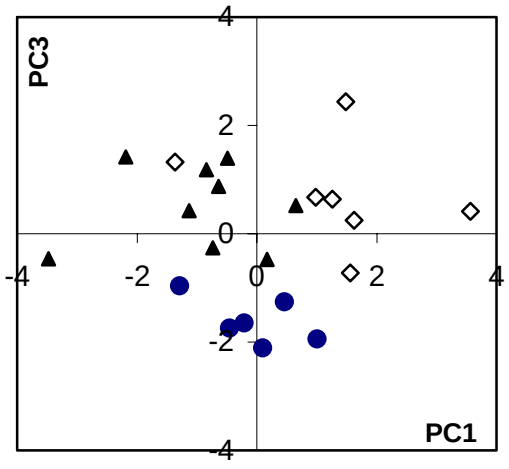

Figure 2

Principal component analysis of the normalization of Types (*Mugil platanus* and *Mugil liza*) and La Plata Museum (MLP) specimens. Symbols: circles, *M. liza* Types; diamonds, *M. platanus* Types; triangles, (MLP) specimens

Análisis de componentes principales de la normalización de los especimenes Tipo (*Mugil platanus* y *Mugil liza*) y del Museo de La Plata (MLP). Símbolos: círculos, Tipos de *M. liza*; diamantes, Tipos de *M. platanus*; triángulos, ejemplares (MLP)

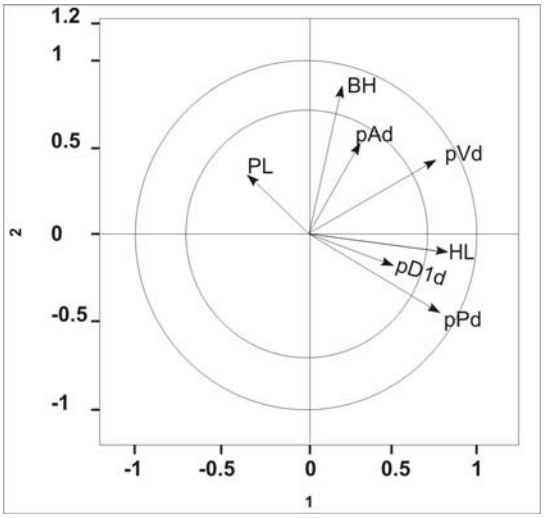

Figure 3

Variables and components correlation (first, second) corresponding to PCA of Type and La Plata Museum (MLP) specimens

Correlación entre variables y componentes (primera, segunda) correpondiente al ACP de los especimenes Tipo y del Museo de La Plata (MLP)

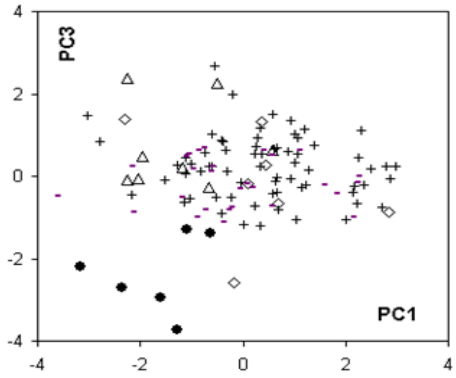

Figure 4

Principal component analysis of the normalization of Types (*Mugil platanus* and *Mugil liza*), La Plata Museum (MLP) and fresh specimens of Argentina and Brazil. Symbols: solid black circles, *M. liza* Types; diamonds, *M. platanus* Types; triangles, (MLP) specimens; cross, Argentinean specimens; hyphen (-), Brazilian specimens

Análisis de componentes principales de la normalización de los especimenes Tipo (*Mugil platanus* y *Mugil liza*), Museo de La Plata (MLP), y ejemplares frescos de Argentina y Brasil. Símbolos: círculos negros, Tipos de *M. liza*; diamantes, Tipos de *M. platanus*; triángulos, ejemplares (MLP); cruces, ejemplares de Argentina; guión, ejemplares de Brasil

Meristics

With respect to meristic characters, the number of spines and rays of first dorsal, second dorsal, ventral and anal fins, were not considered in the analysis because they did not show any variability between both species. Only the number of scales of lateral series was considered useful. The range, mean and mode of this meristic character (Table 3) were different between *Mugil platanus* and *Mugil liza* Types specimens. t-Test showed significant differences between lateral series scales mean values of both Types (Table 4). The MLP preserved and the Argentinean and Brazilian fresh specimens fitted the range of lateral series scales corresponding to *M. platanus* Types (t-test revealed no significant differences between lateral series scales mean values for samples and Types of *M. platanus*) (Table 4).

Other observations

Teeth. One row of small unicuspid teeth and several inner rows of bicuspid teeth in upper jaw. No teeth in orobranchial cavity or tongue.

Scale morphology. Adults with ctenoid scales, only one straight mucus canal.

Colour pattern. Pale grey body, darker in dorsal region, with 5-7 dark grey longitudinal stripes.

Discussion

The samples studied in this research represent the whole distribution range area of grey mullets in Argentina. As a result of a comparison of the preserved and fresh specimens from Argentina with *Mugil platanus* types and with specimens of *Mugil platanus* collected from Brazil, no differences have been found either in morphometric nor in meristic characters.

Ringuelet *et al.* (1967), in their key for Mugilidae species living in Argentina employed three morphological measurements to diagnose species. According to Ringuelet *et al.*'s key*:* 1) the axilar scale length is less than half the pectoral fin length in *M. liza* and more than half in *M. platanus*; 2) the distance between pectoral fin and first dorsal fin is less than half the pectoral fin length in *M. liza* and more than half in *M. platanus*; and 3) the body height relative to length is smaller in *M. liza* (4.4-4.8) than in *M. platanus* (3.6-3.8). Ringuelet *et al.* (1967) examined four specimens identified as *M. liza* and two as *M. platanus*. In this paper, we could observe only one of those specimens (indicated by asterisk in material examined), another was damaged and the others have been lost.

Table 4

Student t- test results for Types (*Mugil platanus* and *Mugil liza*), La Plata Museum (MLP) and fresh specimens of Argentina and Brazil corresponding to number of scales of lateral series and diagnostic characters mentioned by Ringuelet *et al.* (1967). *: significant differences at *P* = 0.05; in bold face: no significant differences at *P*= 0.01

Resultados de la prueba t de Student para especimenes Tipo (*Mugil platanus* y *Mugil liza*), Museo de La Plata (MLP), y ejemplares frescos de Argentina y Brasil correspondientes al número de escamas de la serie lateral y los caracteres diagnósticos señalados por Ringuelet *et al*. (1967). *: diferencias significativas para *P* = 0.05; en negrita: diferencias no significativas para *P* = 0.01

Specimens	df	Lateral series scales	Body height/ Standard length	Pectoral length/ Axilar scale length	Pectoral lenght/ P-D distance
M. liza/ *M. platanus* Types	10	0.0001*	0.0004*	0.3865	0.8328
M. liza Types/ (MLP)	16	0.0000 *	0.0000*	0.8256	0.6489
M. liza Types/ Brazilian fresh	41	0.0000 *	0.0000*	0.0014*	0.5201
M. liza/ Argentinean fresh	75	0.0000 *	0.0000*	0.0002*	0.1097
M. platanus Types/ (MLP)	18	0.1668	0.9310	0.1669	0.2723
M. platanus Types/ Brazilian fresh	43	0.7240	**0.0122**	0.0725	0.7125
M. platanus Types/ Argentinean fresh	77	0.8123	0.0954	0.1208	**0.0171**

Table 3 shows the above mentioned relationships corresponding to the type material of nominal species, some preserved specimens from La Plata Museum (Argentina) and fresh specimens from Argentina and Brazil. The analysis of the information can be summarized as follows:

1) Pectoral fin/axilar scale relationship. In all specimens observed, except one (MNHN 1050) the axilar scale length is less than half the pectoral fin length. Therefore, this relationship is not a valid criterion to separate both species.

2) Pectoral/ first dorsal fin distance. This distance shows difference only between *Mugil liza* Types and fresh specimens of Argentina and Brazil. It could be due to differences in the material preservation because *Mugil liza* Types are mounted and setted specimens. However, the range is always larger than two, in opposition to criterion of Ringuelet *et al.* (1967). Again, this character is not useful to identify those species.

3) Body height/standard length relationship. Values are greater (4.8-6.2) in *M. liza* Types specimens (MNHN) than those of *M. platanus* (Types and MLP) (3.5-5.0), indicating that body of *M. platanus* is higher than that of *M. liza*, as noted by Ringuelet *et al.* (1967). However, the values obtained in this paper for both *Mugil* species are greater than those mentioned by Ringuelet *et al.* (1967): (3.6- 3.8 for *M. platanus* and 4.4 - 4.8 for *M. liza*). Moreover, the Ringuelet *et al.´*s range values are included in those of *M. platanus* Types. Therefore, this character is also not valid.

According to the number of scales of lateral series observed (29-32 in *M. liza* and 33-39 in *M. platanus*), this meristic character seemed to be the best diagnostic feature to differentiate between both species as mentioned by Menezes (1983).

The taxonomic status of *M. platanus* is still under discussion. According to Thomson (1997) and Harrison (2002), *M. platanus* is a junior synonym of *M. cephalus* Linnaeus, 1758. Further investigations will be necessary in order to clarify this taxonomic question.

Conclusions

1. Previous morphological relationships (pectoral fin length/ axillary scale and distance between pectoral and first dorsal fins) used by different authors as diagnostic characteristics have not been usefull for recognizing between *Mugil liza* and *Mugil platanus.*

2. The relation body height/ standard length values obtained for Argentinean specimens fit into the range corresponding to Types of *M. platanus.*

3. The number of scales of lateral series and the body height/total length relationship seemed to be usefull diagnostic characters for the identification of both *Mugil* species.

4. Only one mullet of permanent presence, *M. platanus* Günther, 1880, occurs in Argentinean waters.

5. The comparative analysis indicated that *M. liza* does not occur in Argentinean waters.

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