First record of *Solea (Microchirus) boscanion* (Osteichthyes: Soleidae) in the Mediterranean Sea, with data on other sympatric soleid species

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The capture of five specimens of *Solea (Microchirus) boscanion* (Osteichthyes: Soleidae), a species previously unrecorded in the Mediterranean, is reported from the Iberian coast (western Mediterranean). The main morphometric and meristic measurements of this species with data of the other sympatric, and morphologically very similar, soleids *Microchirus variegatus* and *Buglossidium luteum* are also given. The record is discussed in relation to climate change and competition between species.

INTRODUCTION

Soleidae can be considered widely represented in the Mediterranean Sea, where 16 species are generally reported (Fredj & Maurin, 1987). The family comprises closely related and poorly defined species, which makes their classification difficult. This may be the origin of some confusion, which has resulted in a poorly established geographical distribution for certain species and, consequently, scarce knowledge of this ichthyofauna in some areas (e.g. the Iberian Mediterranean coast; Matallanas, 1984a). However, recent revisions and descriptions of some genera and species belonging to this family (Desoutter,

1987, 1994; Desoutter et al., 2001) and the use of bottom trawl surveys in the Mediterranean Sea (MEDITS programme; Bertrand et al., 2000) have started to improve our knowledge of their classification.

METHODS AND RESULTS

During these surveys in 1997, 1998 and 1999, a total of 308 hauls were carried out between 30 and 800 m depth along the whole Iberian coast (western Mediterranean). Five specimens of *Solea (Microchirus) boscanion* Chabanaud, 1926 (Osteichthyes: Soleidae) were captured in three hauls

Table 1. *Morphometric and meristic data of five specimens of Solea (Microchirus) boscanion captured off the Iberian coast (western Mediterranean).*

Number of specimen:	1	2	3	4	5
Date of capture	08/05/98	05/05/99	05/05/99	05/05/99	11/05/99
Morphometric (cm)					
Standard length (SL)	9.7	8.6	7.6	7.3	7.9
Head length (HL)	22.2	19.5	16.9	16.8	17.8
Maximum height (H)	34.5	32.3	27.7	26.4	29.3
Eye diameter (E)	5.1	4.0	3.5	3.5	3.5
Eye-dorsal fin (E-D)	1.2	1.2	1.1	1.0	1.2
Pectoral fin eye (PE)	7.5	5.8	4.5	6.0	5.9
Pectoral fin blind (PB)	6.0	4.1	3.5	3.7	3.9
Caudal peduncle (CP)	8.9	8.0	7.1	6.3	7.2
Thickness (T)	7.0	6.8	5.7	5.1	5.9
Meristic					
Dorsal fin rays (DR)	74	74	74	75	73
Anal fin rays (AR)	56	59	58	58	60
Pectoral eye rays (PRe)	5	5	5	5	6
Pectoral blind rays (PRb)	4	4	4	4	5
Lateral line scales (LL)	70	74	72	72	73
Eye-dorsal fin scales (EDE)	4	3	2	2	2

Figure 1. Cluster from morphometric and meristic data of *Solea* (*Microchirus*) *boscanion*, *Microchirus variegatus* and *Buglossidium luteum* specimens measured in this study and data from Desoutter (1994) for *Solea* (*Microchirus*) *boscanion* in the Atlantic and *Microchirus variegatus* in the Mediterranean and eastern Atlantic. BL(T), *B. luteum* from the trawl in this study; BL(S), *B. luteum* from the beach-seine in this study; SB, *S. boscanion* in this study; SB(D), *S. boscanion* from Desouter (1994); MV, *M. variegatus* in this study; MV(D), *M. variegatus* from Desouter (1994).

from the Alboran Sea: (i) one during June 1998 off Almería ($36^{\circ}38.80'N$ $2^{\circ}40.67'W$, 49 m depth); (ii) three during May 1999 off Málaga ($36^{\circ}21.06'N$ $5^{\circ}12.65'W$, 46 m depth); and (iii) one during May 1999 off Almería ($36^{\circ}46.24'N$ $2^{\circ}17.14'W$, 63 m depth). Moreover, the other

morphologically very similar soleids *Microchirus variegatus* (Donovan, 1808) and *Buglossidium luteum* (Risso, 1810) were caught along the whole surveyed area. The number of specimens captured, their frequency of occurrence, total length range and depth range were 75, 7%, 6–19 cm

Table 2. Average morphometric and meristic data of *Solea* (*Microchirus*) *boscanion*, *Microchirus variegatus* and *Buglossidium luteum* specimens analysed in this study. Abbreviations from Table 1.

	<i>S. boscanion</i> (N=5)			<i>M. variegatus</i> (N=3)			<i>B. luteum</i> (trawl; N=30)			<i>B. luteum</i> (beach-seine; N=9)		
	Mean (SD)	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Min	Max
SL/HL	4.4 (0.1)	4.3	4.5	4.5 (0.1)	4.4	4.6	4.2 (0.1)	3.9	4.5	4.0 (0.1)	3.8	4.1
SL/H	2.7 (0.1)	2.7	2.8	2.8 (0.2)	2.6	2.9	3.0 (0.1)	2.7	3.3	2.8 (0.1)	2.7	2.8
HL/E	4.8 (0.3)	4.3	5.1	4.7 (0.4)	4.5	5.2	4.7 (0.4)	4.0	5.6	4.2 (0.2)	3.9	4.5
HL/E-D	16.3 (1.4)	14.8	18.5	8.4 (1.0)	7.3	9.3	8.7 (0.9)	7.3	11.8	5.7 (0.8)	4.7	6.7
E/E-D	3.4 (0.5)	2.9	4.2	1.8 (0.3)	1.4	2.1	1.8 (0.2)	1.5	2.8	1.4 (0.2)	1.0	1.6
PE/PB	1.4 (0.1)	1.2	1.6	2.0 (0.5)	1.3	2.3	2.0 (0.3)	1.5	3.3	2.2 (0.4)	1.7	2.8
SL/CP	11.0 (0.3)	10.7	11.6	10.1 (0.9)	9.1	10.8	11.7 (0.6)	10.8	12.8	11.8 (0.5)	11.0	12.4
H/T	4.9 (0.1)	4.7	5.2	4.5 (0.4)	4.1	5.0	4.7 (0.3)	4.0	5.4	4.1 (2.3)	4.8	5.8
DR	74 (0.7)	73	75	68.3 (1.5)	67	70	69.8 (1.4)	67	73	69.8 (0.8)	69	71
AR	58.2 (1.5)	56	60	52.3 (1.5)	51	54	54.6 (1.7)	52	59	56.4 (1.7)	54	59
PR _e	5.2 (0.4)	5	6	4 (0.0)	4	4	6.2 (0.8)	5	8	5.7 (0.5)	5	6
PR _b	4.2 (0.4)	4	5	3 (0.0)	3	3	3.2 (1.0)	1	5	3.2 (0.8)	2	4
LL	72.2 (1.5)	70	74	77.3 (2.1)	75	79	62.2 (3.1)	59	69	62.7 (4.0)	59	69
EDE	2.6 (0.9)	2	4	4 (0.0)	4	4	3.5 (0.5)	3	4	3.5 (0.5)	3	4

AR, anal fin rays; CP, caudal peduncle; DR, dorsal fin ray; E, eye diameter; E-D, eye-dorsal fin; EDE, eye-dorsal fin scales; H, maximum height; HL, head length; LL, lateral line scales; N, number of specimens analysed; PB, pectoral fin blind; PE, pectoral fin eye; PR_b, pectoral blind rays; PR_e, pectoral eye rays; SL, standard length; T, thickness. N, number of specimens analysed; SD, standard deviation; Min, minimum; Max, maximum.

Figure 2. Photographs of specimens of (A) *Solea* (*Microchirus*) *boscanion*; (B) *Microchirus variegatus*; and (C) *Buglossidium luteum* captured off the Iberian coast (western Mediterranean).

and 47–647 m for *M. variegatus* and 122, 3%, 7–12 cm and 38–77 m for *B. luteum* respectively.

In addition, other individuals of *Buglossidium luteum* were captured from more inshore waters of the Alboran Sea with beach-seine (118 hauls made between 1980 and 1983 from a depth of 1 to 10 m; Reina-Hervás, 1987) and Agassiz trawl (43 hauls made from October 1996 to October 1997 between depths of 12 and 16 m). The number of specimens captured, their frequency of occurrence, total length range and depth range were 128, 51%, 4–12 cm and 1–10 m for beach-seine and 101, 72%, 2–8 cm and 12–16 m for Agassiz trawl.

In the laboratory, morphometric and meristic characters were measured according to Desoutter (1987, 1994), although the count of fin rays was difficult because they were split. The coloration of fresh individuals was also noted.

To corroborate the systematic position, the standardized morphometric and meristic characteristics of the specimens were compared to the average values for *Solea (Microchirus) boscanion* and *Microchirus variegatus* reported by Desoutter (1994) from the eastern Atlantic and the Mediterranean specimens. The quantitative average taxonomic distance, one of the most common indices utilized in numerical taxonomy (Rohlf, 1992), and the unweighted pair-group method using arithmetic averages (UPGMA) algorithm were used.

Morphometric and meristic data for *Solea (Microchirus) boscanion* specimens (deposited in the Institut de Ciències del Mar Fish Collection) are presented in Table 1. Although *S. boscanion*, *Microchirus variegatus* and *Buglossidium luteum* are morphologically very similar, the cluster dendrogram (Figure 1) distinguished them from each other and confirmed that they belonged to the different species considered. The average morphometric and meristic characters of each species by method of capture are shown in Table 2.

The main characteristics used to distinguish these soleid species were the following: (i) *Solea (Microchirus) boscanion* and *Microchirus variegatus* have a caudal fin completely separated from the dorsal and anal fins, while *Buglossidium luteum* has a thin membrane between the dorsal and anal fins (Quéro et al., 1986); (ii) the distance between the upper eye and dorsal fin in *B. luteum* is greater than in *S. boscanion* (Desoutter, 1987). In addition, *S. boscanion* and *M. variegatus* could be distinguished by their different coloration patterns (Figure 2). *Microchirus variegatus* showed broad dark cross-bands on the body, and on the dorsal and anal fins of the eyed side, whereas *S. boscanion* had smaller dark spots on the edge of the eyed side, as well as on the dorsal and anal fins, and every fourth to sixth finray of these fins were dark. *Buglossidium luteum* showed a more similar coloration to *S. boscanion*, but with every fourth to seventh finray being dark.

DISCUSSION

Solea (Microchirus) boscanion is distributed throughout the eastern Atlantic from the Gulf of Cadiz to the Gulf of Guinea (Fischer et al., 1981; Quéro et al., 1986). It is the first report of the species in the Mediterranean and represents the fourth report of soleid species from the eastern Atlantic recently found in the western Mediterranean.

The first of these species was *Synaptura lusitanica*, reported by Lozano-Rey (1960) off the Central Iberian Peninsula. Subsequently another two species have been reported, *Solea senegalensis* off the Iberian coast (Rodríguez & Rodríguez, 1980), a species which has progressively extended its distribution (Quignard & Raibaud, 1993), and *Microchirus hexophthalmus* (Matallanas, 1984b).

Alien fish species recorded from the Mediterranean Sea have attracted much scientific attention in recent years (Golani et al., 2002), especially the numerous reports of lessepsian migrants (Golani, 1996). Nevertheless, a considerable number of typical Atlantic species has been reported recently in the western Mediterranean, and some authors have speculated that the recent increase in imports of tropical species via Gibraltar is supported by hydroclimatic modifications (Quignard & Tomasini, 2000).

Although other reasons, such as recent taxonomic improvements, can also be considered (Matallanas, 1984a), the above mentioned changes in hydroclimatic conditions could be the origin of the presence of *Solea (Microchirus) boscanion* in the Mediterranean. The fact that specimens have been captured in different hauls and years, supports the idea of possible stable populations of this species in the Mediterranean. This new species in the area, could affect the other sympatric soleid species *Microchirus variegatus* and *Buglossidium luteum*, which are indigenous to the Mediterranean. Therefore, it will be necessary to analyse certain biological aspects of these species in order to determine their degree of niche overlapping or partitioning.

Until now, the geographical distribution of *Solea (Microchirus) boscanion*, *Microchirus variegatus* and *Buglossidium luteum* in the Mediterranean has overlapped in the area closest to the Atlantic ocean: while *S. boscanion* was restricted to the Alboran Sea, *M. variegatus* and *B. luteum* were also caught further north on the Iberian coast. Their bathymetric range also overlaps, with *B. luteum* and *M. variegatus* being the shallowest and deepest species, respectively. Over the continental shelf, both species have been caught with the bottom trawl on coastal detritic muddy and sandy bottoms. *Buglossidium luteum* is additionally captured in inshore areas over *Zostera marina* sea grass meadows on sand and muddy bottoms sampled with the Agassiz trawl and the beach seine. *Microchirus variegatus* shows the widest bathymetric range, as it was additionally caught with the bottom trawl over the continental slope.

Data on the diet and reproduction of *Solea (Microchirus) boscanion* are absent, whereas they are scarce for *Buglossidium luteum* and *Microchirus variegatus* (Quéro et al., 1986; Bauchot, 1987). For this reason, it is difficult to evaluate the colonization success of the Atlantic species and further studies will be necessary. Nevertheless, it must be taken into account that the two Mediterranean species probably exploit the same trophic resources (i.e. small bottom-living organisms of mainly crustaceans, bivalve molluscs and polychaetes) and spawn around the same period (winter–spring), although they are distributed in different habitats, shallower and deeper, respectively. Consequently, the establishment and expansion of *S. boscanion* in the Mediterranean could depend on its capacity to colonize any probable vacant spatial and temporal niche between these native sympatric soleids.

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