Three new records of Gobiidae from Malta with morphology, colouration and identification of the smallest known juveniles of two small gobiid species

by

Marcelo KOVAČIĆ (1), Juan Jose BONELLO (2) & Julian EVANS (2, 3)

Abstract. – Individuals of small juvenile gobies, some of them just 10 mm long, were collected during a study on infralittoral cobble bed fauna around the Maltese Islands between July and September 2011. These represent the first records of three gobiid species for Malta, including *Gobius couchi* Miller & El Tawil, 1974 and the smallest known juveniles of *Millerigobius macrocephalus* (Kolombatović, 1891) and *Zebrus zebrus* (Risso, 1827). Morphology and colouration, including diagnostic features and photographs, are provided for these species and the problems of identification of small juveniles are discussed.

Résumé. – Trois nouvelles signalisations de Gobiidae à Malte avec la morphologie, la coloration et l'identification des plus petits juvéniles connus de deux de ces petites espèces.

Des petits juvéniles de gobies, dont certains ne mesuraient que 10 mm, ont été collectés durant une étude de la faune des fonds de galets infralittoraux autour des îles maltaises entre juillet et septembre 2011. Ces derniers représentent pour Malte les premières signalisations de trois espèces de gobies: *Gobius couchi* Miller & El Tawil, 1974, les plus petits juvéniles connus de *Millerigobius macrocephalus* (Kolombatović, 1891) et de *Zebrus zebrus* (Risso, 1827). La morphologie et la coloration, comprenant les caractères utiles à la diagnose et les photographies, sont décrites pour ces espèces et les problèmes d'identification des petits juvéniles sont discutés.

Received: 14 Mar. 2013
Accepted: 2 Jul. 2013
Editor: G. Duhamel

Key words

Gobiidae
Gobius couchi
Millerigobius macrocephalus
Zebrus zebrus
Mediterranean
Malta
Smallest juveniles
New records

Individuals of small juvenile gobies, some of them just about 10 mm long, were collected during a study on infralittoral cobble bed fauna around the Maltese Islands between July and September 2011. Gobies are small teleost fish generally under 100 mm of total length. They include the smallest marine fish species, and some of the smallest freshwater fish species belong to this group, with a mature size of about 10 mm or less (Nelson, 2006). In the Mediterranean the smallest known fish is a goby, *Speleogobius trigloides* Zander & Jelinek, 1976, which has a mature size of 24 mm, while 27% of Mediterranean gobiid species have a total length of less than 50 mm (Kovačić and Patzner, 2011). Identification of many Mediterranean gobiid species is difficult due to the small adult size and some morphological characters that are often difficult to see on small specimens, such as the head lateral line system. The morphology and colouration of gobiid juveniles can differ greatly from the adults, making identification of juveniles difficult (Kovačić, 2004). Papers with published descriptions or just illustrations of early juveniles for European marine gobiid species are rare and restricted to a few common species (summarized in Kovačić, 2004; Monteiro *et al*., 2008), and no data on early juveniles of the present species were available prior to this study.

The family Gobiidae *sensu* Nelson (2006) has the highest species richness among fish families in the Mediterranean, comprising more than 60 species with about 1/10 of all Mediterranean fish biodiversity (Quignard and Tomasini, 2000; Kovačić and Patzner, 2011). However, the patterns of actual species distribution of Mediterranean gobies are still unknown for most species, and the known diversity of Gobiidae along the Mediterranean coasts is continuously increasing, probably being far from the actual species richness (Kovačić and Patzner, 2011). Positive records of Gobiidae in Malta exist only for the ten species listed by Lanfranco (1993).

The aim of the present paper was to 1) provide data on juvenile morphology and colouration of the studied gobiid species, including the smallest known juveniles for two species, 2) discuss diagnostic features and identification of small gobiid juveniles, and 3) report their first records from Malta, based on specimens collected by two of the authors (JJB and JE) during a study on the biocoenosis of infralittoral cobble beds around the Maltese Islands, undertaken between July and September 2011.

(1) Prirodoslovni muzej Rijeka, Lorenzov prolaz 1, HR-51000 Rijeka, Croatia.
(2) Department of Biology, University of Malta, Msida MSD2080, Malta. [juan.bonello@um.edu.mt] [julian.evans@um.edu.mt]
(3) Marine Biology and Ecology Research Centre, University of Plymouth, Plymouth PL4 8AA, UK.
* Corresponding author [marcelo@prirodoslovni.com]

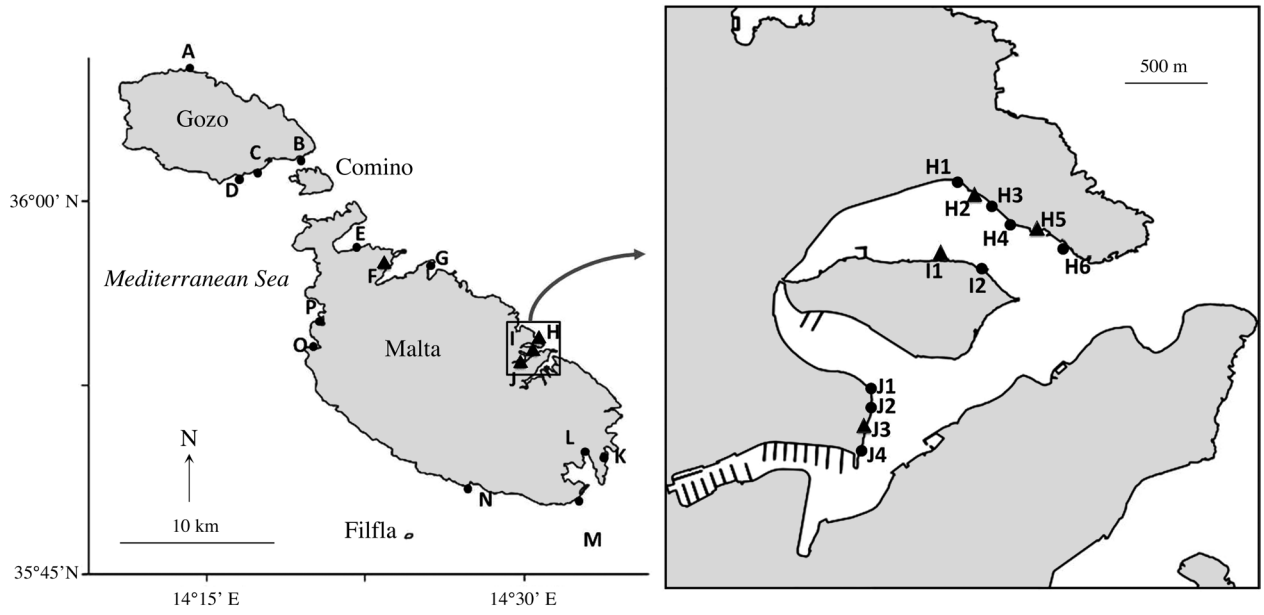

Figure 1. - Map of the Maltese Islands showing the sixteen sampling locations: (▲) sites with gobiid records; (●) sites from where no gobiid species were identified. *Key:* **A**: Wied l-Għasri; **B**: Ħondoq Bay; **C**: Ix-Xatt l-Aħmar; **D**: Mġarr ix-Xini; **E**: Mellieħa Bay; **F**: Mistra Bay; **G**: Qawra; **H1-H6**: Tigné A – Tigné F; **I1-I2**: Manoel Island A – Manoel Island B; **J1-J4**: Ta' Xbiex A – Ta' Xbiex D; **K**: Ħofra ż-Żgħira; **L**: Marsaxlokk; **M**: Wied ix-Xoqqa; **N**: Wied iż-Żurrieq; **O**: Fomm ir-Riħ Bay; **P**: Ġnejna Bay.

MATERIAL AND METHODS

A preliminary survey was carried out along the low-lying coasts of the Maltese Islands to map the presence of shallow-water 'cobble beds', defined as areas of not less than 25 m^2 having continuous cover of pebbles and cobbles. Cobble beds were present at sixteen locations (Fig. 1). A single sampling station was established at the centre of each location, except at Tigné, Manoel Island and Ta' Xbiex, where the presence of much larger beds (> 100 m^2) permitted use of multiple stations (see Fig. 1).

Four random samples of fauna were collected from each station using a 0.1-m^2 circular sampler (see Borg *et al*., 2002) via SCUBA diving. Since the cobble beds were stratified, the top layer of cobbles and pebbles was carefully hand-picked and transferred to a 0.5-mm mesh bag, while a small fine-mesh hand net was used to scoop the basal layer of finer granules. A diver-operated air-lift suction sampler was simultaneously employed to reduce the risk of missing highly motile organisms, thus ensuring quantitative samples were collected. All fieldwork was carried out between July and September 2011.

Samples were subsequently sorted in the laboratory, with any Gobiidae present preserved in 70% ethanol and later identified by one of the authors (MK). The diagnoses presented are the minimum combination of characters that could identify the recorded species among gobiid species known in the CLOFNAM area (Miller, 1986; Ahnelt and Dorda, 2004; Kovačić, 2005 and references therein). Morphometric and meristic methods follow Schliewen and Kovačić (2008), while terminology of lateral-line system follows Sanzo (1911) and Miller (1986). All examined material has been deposited in the Natural History Museum Rijeka (PMR), Croatia.

RESULTS

Gobius couchi Miller & El-Tawil, 1974

Material examined

Juvenile of unidentified sex, PMR VP2884 (Fig. 2A), 18.2 + 4.2 mm, Tigné (H5), Malta, 29 Aug. 2011, coll. J.J. Bonello and J. Evans (Figs 1, 2B).

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) all three head canals present; (3) scales present on predorsal area; (4) anterior oculoscapular canal with pore *α* at rear of orbit; (5) scales in lateral series on both sides 39 (known species range of scales in lateral series is 35-45, Miller, 1986); (6) pectoral fin 16 (known species range of pectoral fin rays 15-18, Miller, 1986); (7) row *d* divided below row *3*; (8) pelvic fin truncate (known species

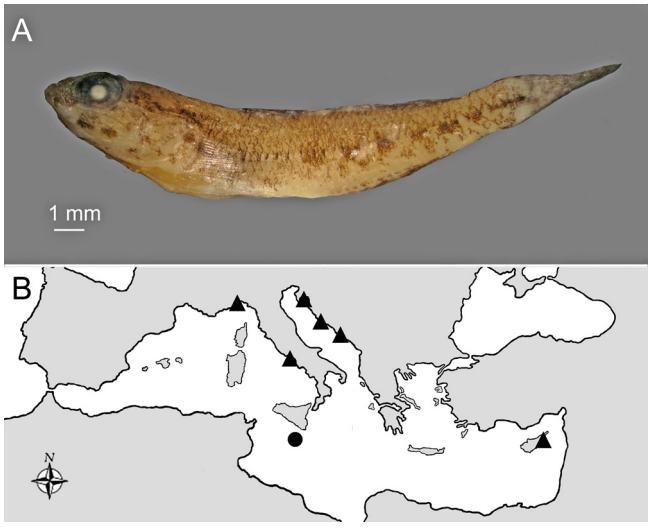

Figure 2. - *Gobius couchi*. **A**: Preserved specimen, PMR VP2884, juvenile of unidentified sex, 18.2 + 4.2 mm, Tigné E, Malta. **B**: Map of the Mediterranean showing previous records (▲) and new finding (●).

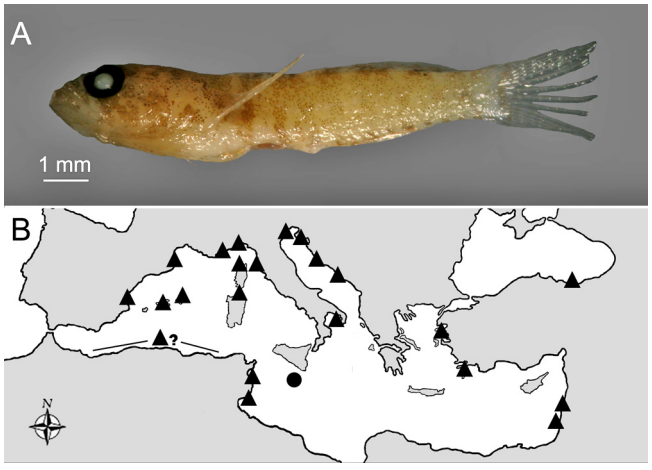

Figure 4. - *Zebrus zebrus*. **A**: Preserved specimen, PMR VP2878, juvenile of unidentified sex, 10.0 + 2.2 mm, Tigné B, Malta. **B**: Map of the Mediterranean showing previous records (▲) and new finding (●).

with rounded to truncated pelvic fins, Miller, 1986).

Description

Anterior nostril short, tubular, with higher posterior rim. Branchiostegal membrane attached to entire side of isthmus. First dorsal fin VI, second dorsal fin I/13, anal fin I/12, caudal fin with 14 branched rays and 16 segmented rays, pectoral fin 16, pelvic fins I/5+5/I. Free tips on pectoral fin rays not visible. Pelvic fin truncate. Anterior membrane height in midline 1/3 length of pelvic fin's spinous ray. Body with ctenoid scales, scales in lateral series 39. Opercle and cheek naked, scales present on predorsal area. Preserved colour: body light brown with reticulate pattern, formed by pigmentation along the margins of most scales. Breast and belly pale. Most distinct marks were about nine darker blotches along lateral midline. Head similar to body, with two dark spots on cheek and dark-pigmented snout. Three longitudinally arranged dark gular spots with fourth dark spot on ventral part of opercle. Dorsal and caudal fins with rows of small dark dots. Anal fin and the bases of anal fin rays pigmented. Pectoral fin with dark mark in upper fin origin, mark deeper than long, another dark mark nearby on upper pectoral base. Pelvic fins pale. Head with anterior and posterior oculoscapular, and preopercular canals, with pores σ, λ, $\varkappa$, ω, α, β, ϱ, ϱ^1, ϱ^2, and γ, δ, ε, respectively. Rows of suborbital papillae of lateral-line system without longitudinal row *a;* six transverse suborbital rows of sensory papillae. Longitudinal suborbital row *d* divided below suborbital row *3*. Oculoscapular anterior longitudinal row x^1 ending anteriorly behind pore β.

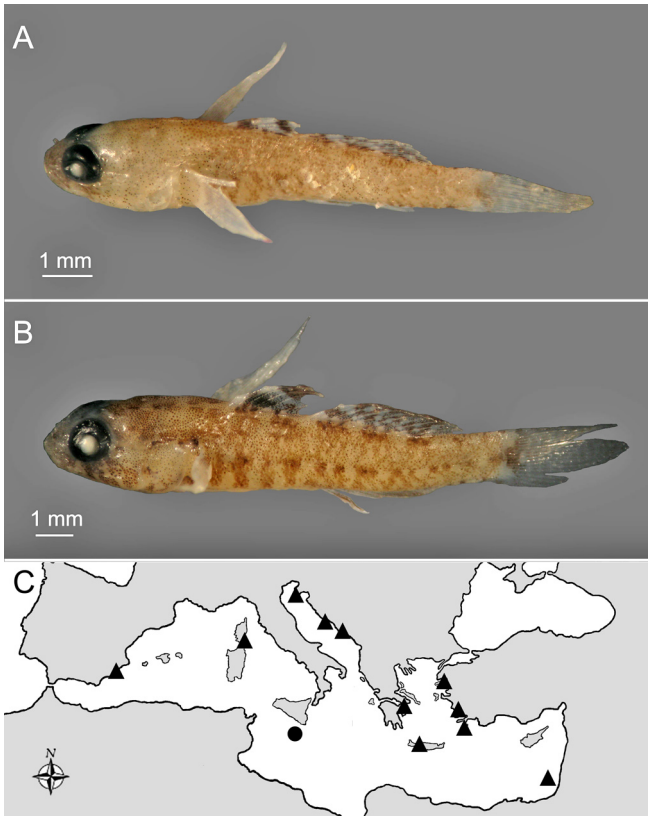

Figure 3. - *Millerigobius macrocephalus*. **A**: Preserved specimen, PMR VP2879, juvenile of unidentified sex, 8.5 + 2.4 mm, Manoel Island B, Malta. **B**: Preserved specimen, PMR VP2881, juvenile of unidentified sex, 11.5 + 2.9 mm, Manoel Island B, Malta. **C**: Map of the Mediterranean showing previous records (▲) and new finding (●).

Geographical and ecological data

This single juvenile was recorded from a depth of 10 m at Tigné (H5) (the north-east coast of Malta Island), where

the habitat was characterised by a gently sloping bottom of gravelly sand and silt with overlying accumulations of cobbles and pebbles that were generally encrusted by coralline algae. The specimen was collected from within the cobble layer.

Remarks

The morphology of the juvenile was developed enough to match diagnostic characters of adults of the species. Visible scales were present on the predorsal area, but the area was not completely scaled. Šanda and Kovačić (2009) reported on the complete absence of scales at the predorsal area in a small juvenile (15.6 + 4.1 mm), but present in a larger specimen of 19.5 + 5.0 mm. The basic adult colouration pattern could be recognised on the juvenile from Malta.

G. couchi is a goby known from Atlantic localities in Great Britain and Ireland and from several localities in the north and eastern Mediterranean (Kovačić *et al*., 2012). The present finding at Malta represents a south-east extension of the known range of this species (Fig. 2B).

***Millerigobius macrocephalus* (Kolombatović, 1891)**

Material examined

Juvenile of unidentified sex, PMR VP2879, 8.5 + 2.4 mm, Manoel Island (I1), Malta, 31 Aug. 2011, coll. J.J. Bonello and J. Evans (Fig. 3A); juvenile of unidentified sex, PMR VP2880, 11.4 + 2.8 mm, Manoel Island (I1), Malta, 31 Aug. 2011, coll. J.J. Bonello and J. Evans; juvenile of unidentified sex, PMR VP2881, 11.5 + 2.9 mm, Manoel Island (I1), Malta, 31 Aug. 2011, coll. J.J. Bonello and J. Evans (Fig. 3B); juvenile of unidentified sex, PMR VP2883, 10.2 + 2.6 mm, Tigné (H2), Malta, 23 Aug. 2011, coll. J.J. Bonello and J. Evans; (Figs 1, 3C).

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior oculoscapular and preopercular canals present, posterior oculoscapular canal absent; (3) pelvic fins forming disc; (4) interorbital papillae present.

Description

Anterior nostril tubular, long, reaching upper lip, without process from rim. Posterior nostril slightly raised. Branchiostegal membrane attached to entire side of isthmus. First dorsal fin VI; second dorsal fin I/10; anal fin I/9; caudal fin with 12-13 branched rays and 16-17 segmented rays; pectoral fin 15-16; pelvic fins I/5+I/5. Pelvic fins forming disc, with anterior transverse membrane. Body with ctenoid scales, scales in lateral series 28-31. Head, predorsal area and breast naked. Preserved colour: Specimen PMR VP2881 (Fig. 3B), 11.5 + 2.9 mm with body yellowish brown. About seven vertical dark brown bands on the body, darkest anteriorly, posteriorly, bands lighter and blurred, present along lateral side below dorsal fins. About nine dark lateral midline spots present at vertical bands, posteriorly on caudal peduncle bands no longer visible. Reticulate pattern, formed by dark markings along the scale margins, visible. Pectoral fin base, isthmus and breast pale compared to rest of body, but pigmented. Belly unpigmented. Head unequally pigmented, with palest part behind eye at level of pupil and on opercle. Specimens PMR VP2880, 11.4 + 2.8 mm, PMR VP2883, 10.2 + 2.6 mm and PMR VP2879 (Fig. 3A), 8.5 + 2.4 mm with body greyish brown, dominated by grey-brown melanophores. Vertical dark bands and dark lateral midline spots on the body indistinct. Reticulate pattern, formed by dark markings along scale margins, visible in PMR VP2880, 11.4 + 2.8 mm, but still not developed in specimens PMR VP2883, 10.2 + 2.6 mm and PMR VP2879, 8.5 + 2.4 mm. Pectoral fin base, isthmus, breast and belly pale compared to rest of body, unpigmented in PMR VP2879, 8.5 + 2.4 mm, and pigmented in specimen PMR VP2880, 11.4 + 2.8 mm. Head colouration pattern also dominated by densely scattered grey-brown melanophores. Fin colouration similar in all specimens. First dorsal fin with one transparent longitudinal band at middle of fin and two broad dark bands above and below it. Second dorsal fin with irregularly scattered bright dots; in smallest specimen PMR VP2879, 8.5 + 2.4 mm with two dark longitudinal bands. Dark brown 3-shaped mark present on origin of caudal fin, reaching caudal peduncle at midline and leaving pale areas at upper and lower caudal fin base, indistinct in smallest specimen PMR VP2879, 8.5 + 2.4 mm. Anal fin pigmented. Pectoral and pelvic fins pale. Head with anterior and preopercular canals, with pores $\sigma, \lambda, \varkappa, \omega, \alpha, \beta, \varrho$ and $\gamma, \delta, \varepsilon$ respectively, except in specimen PMR VP2879, 8.5 + 2.4 mm where parts of both canals are present as open furrows. Rows of sensory papillae: No suborbital row *a*. Seven transverse suborbital rows of sensory papillae. Row *b* anteriorly beginning below rear border of eye. Two or four interorbital papillae present behind pore λ.

Geographical and ecological data

Four individuals of *M. macrocephalus* were collected in all, three from Manoel Island (I1) (depth: 6 m) and one from Tigné (H2) (depth: 10 m), both localities placed at the north-east coast of Malta Island. All four specimens were found within a cobble habitat similar to that found at Tigné (H5), described above.

Remarks

The morphology of all four juveniles was developed enough to match diagnostic characters of the species in adults. The basic colouration pattern of the adults could be recognised on the juvenile PMR VP2881, 11.5 + 2.9 mm (Fig. 3B), but was still not developed in three other early

juveniles (specimens PMR VP2880, 11.4 + 2.8 mm, PMR VP2883, 10.2 + 2.6 mm and PMR VP2879, 8.5 + 2.4 mm, (Fig. 3A). The present findings are the smallest known specimens of this species. All previously published records of *M. macrocephalus* (Fig. 3C) were of significantly larger males or females, except in Kovačić *et al*. (2011), who reported slightly larger juveniles (of unidentified sex, 12.1 + 2.9 mm and 12.2 + 3.1 mm) with the diagnostic characters of *M. macrocephalus* and with a photo of a smaller specimen with recognisable adult colouration pattern (Fig. 8 in Kovačić *et al*., 2011). *M. macrocephalus* is a small Mediterranean cryptobenthic gobiid species known from Mar Menor (Spain) in the west, along the north coast of the Mediterranean to the Levant (Israel) in the east (Kovačić *et al*., 2012). The present finding at Malta represents a south-east extension of the known range of this species (Fig. 3C).

*Zebrus zebrus (*Risso, 1827)

Material examined

Juvenile of unidentified sex, PMR VP2878 (Fig. 4A), 10.0 + 2.2 mm, Ta' Xbiex (J3), Malta, 15 Aug. 2011, coll. J.J. Bonello and J. Evans; juvenile of unidentified sex, PMR VP2882, 9.4 + 2.3 mm, Mistra, Malta, 28 Jul. 2011, coll. J.J. Bonello and J. Evans; (Figs 1, 4B).

Comparative material of *Z. zebrus*

One juvenile of unidentified sex, 11.9 + 3.5 mm, PMR VP2778, Kupari, Dubrovnik, southern Adriatic Sea (42°37'10.7''N; 18°11'28.8''E), 14 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella; 1 juvenile of unidentified sex, 10.4 + 2.7 mm, PMR VP2779, beach between Slano and Trsteno, Dubrovnik, southern Adriatic Sea (42°37'10.7''N; 18°11'28.8''E), 15 Sep. 2011, coll. M. Kovačić, M. Kirinčić and D. Zanella.

Diagnosis

(1) Suborbital papillae of lateral-line system without longitudinal row *a*; (2) predorsal area naked; (3) transverse suborbital rows 7; 4) pelvic fins forming disc; 5) interorbital papillae absent; (6) scales in lateral series 29-30 (the known species range of scales in lateral series is 29-38, Miller, 1986).

Description

Anterior nostril short, tubular, no visible tentacle from inner part of rim. Branchiostegal membrane attached to entire side of isthmus. First dorsal fin VI; second dorsal fin I/11; anal fin I/9; caudal fin with 13 branched rays, 16 segmented rays; pectoral fin 17; pelvic fin I/5+I/5. Uppermost rays of pectoral fin still not free from membrane. Pelvic fins forming disc. Body with ctenoid scales, scales in lateral series 29-30. Head and predorsal area naked. Colour preserved: body yellowish brown, brown melanophores on the body arranged in vertical bands, darker and more intensive on anterior part of body, paler posteriorly (Fig. 4A). Vertical bands more visible in the larger PMR VP2878 10.0 + 2.2 mm and less distinguishable in the smaller PMR VP2882 9.4 + 2.3 mm. Breast and belly pigmented. Head pigmented with brown melanophores, underside whitish, but with melanophores. Predorsal area densely pigmented. Dorsal and anal fins pigmented, fin membranes too damaged to determine colouration pattern. Caudal fin lightly pigmented, with brown vertical band present on the origin of caudal fin. Pectoral fin pigmented on upper bases of rays, rest of fin colourless. Pectoral fin base pigmented, more intensive dorsally. Pelvic fins colourless. Head with anterior oculoscapular and preopercular canals, with pores σ, λ, $\varkappa$, ω, α, β, ϱ, and γ, δ, ε, respectively. Posterior oculoscapular canal still not developed or present only as an open furrow. Rows of sensory papillae: No interorbital rows. No suborbital row *a*. Seven transverse suborbital rows.

Geographical and ecological data

This species was recorded from within cobbles at two sites, Ta Xbiex (J3) and Mistra, both located at the north-east coast of Malta Island. The former site is characterised by a habitat similar to that found at Tigné (H5), described above, and the specimen was collected from a depth of 5 m. The habitat at Mistra consisted of patches of cobbles and pebbles found interspersed with *Posidonia oceanica* beds at shallow depths of 1-2 m.

Remarks

The presently recorded juveniles are the smallest known specimens of this species. The smallest juvenile (14.5 + 3.7 mm) already having recognisable adult colouration pattern and morphology was reported by Kovačić and Engin (2009), with a photo of the specimen included as their Fig. 2. Contrary to that record, the present juvenile specimens are without posterior oculoscapular head canal or free tips of uppermost pectoral rays and tentacle on the anterior nostrils. In the comparative material of *Z. zebrus* (10.4 + 2.7 mm, PMR VP2779 and 11.9 + 3.5 mm, PMR VP2778), the posterior oculoscapular canal is still not developed in the smaller specimen (10.4 + 2.7 mm, PMR VP2779), but it is visible in the larger one; both specimens have free tips to the uppermost pectoral rays, but both lack the tentacle on the anterior nostrils. The body colouration pattern of the present juvenile specimens with vertical bands resembles the known pattern of adults (Fig. 4A). Nevertheless, to ensure positive species identification of the present juvenile specimens, the following additional characters were added to the diagnosis to distinguish these specimens from the known Mediterranean gobiid species having anterior oculoscapular and preoper-

cular canals present and lacking the posterior oculoscapular canal: pelvic fins forming disc *vs*. pelvic fins almost separate in *O. balearica* and *Vanneaugobius* species; interorbital papillae absent *vs*. interorbital papillae present in *M. macrocephalus*; 7 transverse suborbital rows *vs*. 6 transverse suborbital rows in *Didogobius schlieweni* and *D. splechtnai*; scales in lateral series 29-30 in the present material vs. scales in lateral series more than 41 for *Chromogobius zebratus* and more than 56 for *C. quadrivittatus*. *Z. zebrus* is a small cryptobenthic goby widespread in the Mediterranean and also recorded in the Black Sea (Kovačić *et al*., 2012). The present record of *Z. zebrus* from Malta connects the previously known distributions of this species in Western and Eastern Mediterranean (Fig. 4B).

DISCUSSION

Mediterranean gobies have high species diversity (Quignard and Tomasini, 2000; Kovačić and Patzner, 2011). However, significant proportions of these fish species are of small size, and many gobies are exclusively or predominantly of cryptobenthic occurrence. Thus many of them are still poorly known and, until recently, considered to be extremely rare (Patzner, 1999; Kovačić and Patzner, 2011). *G. couchi* was for the first time recorded in the Mediterranean in 1999 (Stefanni and Mazzoldi, 1999) and the known number of records of this species and *M. macrocephalus* is still limited (Figs 2B, 3C). The collection of small cryptobenthic fishes requires special methods, differing from the usual collecting gear for marine fishes. The use of SCUBA diving combined with use of anaesthetic, handnets, suction samplers and careful checks of small hidden habitats should be suitable to collect these fishes (Patzner, 1999). The methods used in the study on infralittoral cobble beds fauna of the present research enabled this collection of very small juvenile gobies, some of them just 10 mm long, in cryptobenthic habitats.

Since the morphology of gobiid juveniles can differ greatly from that of the adult stages (Kovačić, 2004), gobiid identification keys that make use of adult characters are not applicable to specimens that have not yet reached a certain size or developmental stage. This issue was not discussed in the identification key for European marine gobies by Miller (1986), but it was noticed as a problem in the identification key for Adriatic gobies by Kovačić (2008). Kovačić (2008) stated that his key could be used to identify adults of both sexes as well as late juveniles of all Adriatic gobiid species, but not the early juveniles that have not yet completely developed the characters used in the key. In addition, no published keys or diagnoses exist for the early juveniles of European marine gobies (Kovačić, 2004). Papers with published descriptions or illustrations of early juveniles of European marine gobiid species are rare (summarized in Kovačić, 2004; Monteiro *et al*., 2008). These data, restricted to a few common species, cannot be used for identification of early juveniles of numerous European marine gobiid species. Published keys and diagnostic characters for larvae (Lebour, 1919; Borges *et al*., 2003) are also restricted to a limited number of species, and make use of a combination of vertebral and fin counts and larval pigmentation which are not applicable to juveniles. Therefore, even in gobiid species where larvae can be identified, an identification gap exists at the early juvenile stages. To confirm morphological results, Monteiro *et al*. (2008) and Šanda and Kovačić (2009) validated the identification of early stages by comparison of DNA sequences with the sequences of positively identified adults.

The present findings with the small (*G. couchi*) or even the smallest known specimens for studied species (*M. macrocephalus*, *Z. zebrus*) offered the chance to check the morphology and identification methods at these specimen lengths. In the case of *G. couchi*, the present specimen showed that juveniles at standard length of about 18 mm and total length of about 22 mm can be identified by the species diagnoses and published identification keys (Miller, 1986; Kovačić, 2008). However, at a standard length of about 16 mm and total length of about 20 mm, the complete absence of visible scales on the predorsal area required a different approach for species identification (Šanda and Kovačić, 2009). *M. macrocephalus* could be identified by species diagnoses and published keys for identifications (Miller, 1986; Kovačić, 2008) at standard length of just about 9 mm and total length of just 11 mm. However, at this size the specimen still had early juvenile colouration, which differs from the later colouration pattern observed in specimens having standard length of about 12 mm and total length of about 14 mm. *Z. zebrus* could be identified by published species diagnoses or identification keys (Miller, 1986; Kovačić, 2008) at a standard length of about 12 mm and total length of about 15 mm, even though the completely developed morphology is attained later in development, at standard length of about 15 mm and total length of about 18 mm (Kovačić and Engin, 2009). However, at standard length of about 11 mm and total length of about 13 mm or smaller, the posterior oculoscapular canal is still not developed and a different approach is required for species identification of specimens at this or smaller lengths. Early juvenile colouration (with vertical bands) at the smallest recorded size of standard length of about 10 mm and total length of about 12 mm already resembles the adult colouration. Knowledge of the minimum size threshold that must be reached to enable positive species identification would help the process of identification of Mediterranean gobiids which, for many species, is difficult enough for adults. However, different intraspecific growth rates of juveniles could pose a problem for using such minimum length limits since there is no published knowledge on growth rates and the early development of morphological characters.

In terms of biogeography, Malta has been placed in different marine biogeographical sectors depending on the organisms being taken into consideration (Bianchi, 2007 and references therein) as it lies at or close to the meeting point between three bioregions: the Tyrrhenian Sea to the north west, the upper Ionian Sea to the north east, and the Gulf of Gabès to Levant Sea area to the south and south east (Bianchi and Morri, 2000; Bianchi, 2007). For the Gobiidae, Kovačić and Patzner (2011) set the border between the northern Mediterranean area rich with gobies (> 40 species) and the species-poor middle southern part of the Mediterranean (12 species) to the north of Malta; therefore Malta was somewhat arbitrarily placed in the middle south part of the Mediterranean. Only ten previously known gobiid species with positive records in Malta (Lanfranco, 1993) support this assignment of Malta into the species-poor middle south part of the Mediterranean by Kovačić and Patzner (2011). However, the present records have extended the south-eastern geographic distribution for *G. couchi* and *M. macrocephalus*. These findings of rarely recorded species (Figs 2B, 3C), restricted until now to the north Mediterranean and the Levant, suggest that the gobiid diversity of Malta could be rich and similar in composition to the northern Mediterranean areas noted by Kovačić and Patzner (2011). Despite this, only additional systematic sampling for all gobiid species in various habitats around the Maltese Islands will provide data for a check-list of gobies from Malta and answer the question concerning the relationship of Maltese gobiid fauna with that of the surrounding mainland coasts. Furthermore, while the present records of rarely recorded species suggest that the Maltese gobiid fauna could be similar to that of the north Mediterranean, the southwards extension of the known range of some species indicates that their distribution is more widespread than previously thought. This suggests that they might also be found from the middle-south part of the Mediterranean if proper sampling for such cryptobenthic species is undertaken.

Acknowledgments. – This research work was partially funded through the European Social Fund under STEPS scheme grants awarded to JJB and JE. We thank Prof Patrick J. Schembri for his interest and help.

REFERENCES

AHNELT H. & DORDA J., 2004. - Gobioid fishes from the north eastern Atlantic and the Mediterranean: new records and rarely found species. *Ann. Naturhist. Mus. Wien, Ser. B. Bot. Zool.*, 105: 5-19.

BIANCHI C.N., 2007. - Biodiversity issues for the forthcoming tropical Mediterranean Sea. *Hydrobiologia*, 580: 7-21.

BIANCHI C.N. & MORRI C., 2000. - Marine biodiversity of the Mediterranean Sea: situation, problems and prospects for future research. *Mar. Pollut. Bull.*, 40(5): 367-376.

BORG J.A., ATTRILL M.J., ROWDEN A.A., SCHEMBRI P.J. & JONES M.B., 2002. - A quantitative technique for sampling motile macroinvertebrates in beds of the seagrass *Posidonia oceanica* (L.) Delile. *Sci. Mar.*, 66(1): 53-58.

BORGES R., FARIA C., GIL F., GONÇAVLES E.J. & ALMADA V.C., 2003. - Embryonic and larval development of *Gobius paganellus* (Pisces: Gobiidae). *J. Mar. Biol. Ass. U.K.*, 12: 48-80.

KOVAČIĆ M., 2004. - Unusual morphological and ecological characteristics of hyperbenthic juveniles of *Gobius cruentatus*. *J. Fish Biol.*, 65: 545-558.

KOVAČIĆ M., 2005. - An annotated checklist of the family Gobiidae in the Adriatic Sea. *Ann. Istrian Medit. Stud., Ser. Hist. Nat.*, 15: 1-24.

KOVAČIĆ M., 2008. - The key for identification of Gobiidae (Pisces: Perciformes) in the Adriatic Sea. *Acta Adriat.*, 49: 245-254.

KOVAČIĆ M. & ENGIN S., 2009. - First record of the zebragoby, *Zebrus zebrus* (Gobiidae). *Cybium*, 33(1): 83-84.

KOVAČIĆ M. & PATZNER R.A., 2011. - North-Eastern Atlantic and Mediterranean Gobies. *In:* The Biology of Gobies (Patzner R.A., Van Tassell J.L., Kovačić M. & Kapoor B.G., eds), pp. 177-206. Enfield, NH: Science Publishers; Boca Raton, FL: CRC Press.

KOVAČIĆ M., MILETIĆ M. & PAPAGEORGIOU N., 2011. - A first checklist of gobies from Crete with ten new records. *Cybium,* 35(3): 245-253.

KOVAČIĆ M., ŠANDA R., KIRINČIĆ M. & ZANELLA D., 2012. - Geographic distribution of gobies (Gobiidae) in the Adriatic Sea with thirteen new records for its southern part. *Cybium,* 36(3): 435-445.

LANFRANCO G., 1993. - The Fish around Malta (Central Mediterranean). 143 p. Malta: Progress Press.

LEBOUR M.V., 1919. - The young of the Gobiidae from the neighbourhood of Plymouth. *J. Mar. Biol. Ass. U.K.*, 12: 48-80.

MILLER P.J., 1986. - Gobiidae. *In*: Fishes of the North-eastern Atlantic and the Mediterranean, Vol. III (Whitehead P.J.P., Bauchot M.-L., Hureau J.-C., Nielsen J. & Tortonese E., eds), pp. 1019-1085. Paris: UNESCO.

MONTEIRO J., BORGES R., ROBALO J., ALMADA V.C., HENRIQUES S. & GONÇAVLES E.J., 2008. - Larval development of *Gobius xanthocephalus* with genetic validation of larval identification. *J. Fish Biol.*, 73: 123-138.

NELSON J.S., 2006. - Fishes of the World. 4th edit., 601 p. Hoboken, NJ: John Wiley and Sons, Inc.

PATZNER R.A., 1999. - Habitat utilization and depth distribution of small cryptobenthic fishes (Blenniidae, Gobiesocidae, Gobiidae, Tripterygiidae) in Ibiza (western Mediterranean Sea). *Environ. Biol. Fish.*, 55: 207-214.

QUIGNARD J.P. & TOMASINI J.A., 2000. - Mediterranean fish biodiversity. *Biol. Mar. Medit.*, 7: 1-66.

ŠANDA R. & KOVAČIĆ M., 2009. - First record of *Gobius couchi* (Gobiidae) in the Ionian Sea. *Cybium*, 33(3): 249-250.

SANZO L., 1911. - Distribuzione delle papille cutanee (organi ciatiforme) esuo valore sistematico nei Gobi. *Mitt. Zool. Stn. Neapel*, 20: 249-328.

SCHLIEWEN U.K. & KOVAČIĆ M., 2008. - *Didogobius amicuscaridis* spec. nov. and *D. wirtzi* spec. nov., two new species of symbiotic gobiid fish from São Tomé and Cape Verde islands. *Spixiana*, 31(2): 247-261.

STEFANNI S. & MAZZOLDI C., 1999. - The presence of Couch's goby in the Mediterranean Sea. *J. Fish Biol.*, 54: 1128-1131.