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## Twelve new records of gobies and clingfishes (Pisces: Teleostei) significantly increase small benthic fish diversity of Maltese waters

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### Abstract

Twelve new first records of species from two families are added to the list of known marine fishes from Malta based on laboratory study of material collected during fieldwork over a period of more than twenty years. The three new records of clingfishes (*Apletodon incognitus*, *Gouania wildenowi*, *Opeatogenys gracilis*) double the known diversity of Gobiesocidae for the area; the nine new records of gobies (*Chromogobius zebratus*, *Gobius ater*, *Gobius fallax*, *Gobius gasteveni*, *Gobius roulei*, *Lebetus guilleti*, *Odondebuenia balearica*, *Spelegobius llorisi*, *Vanneaugobius dollfusi*) increase by almost a half the known diversity of Maltese Gobiidae. The most enigmatic species reported is *G. ater*, for which the most recent published record is two decades old and based on specimens that had actually been collected back in the 19th century. Checklists of the Gobiesocidae and Gobiidae of Maltese waters are presented. Biodiversity and biogeographic implications of the present findings are discussed.

**Keywords:** New findings; fishes; Gobiidae; Gobiesocidae; checklists; Mediterranean Sea.

### Introduction

The accurate inventory of the fish species diversity of any area is a necessary prerequisite for the formulation and implementation of conservation actions and fishery management measures. However, often these inventories do not follow the recommended best practice guidelines for accepting species records as valid (Bello *et al.*, 2014), which is certainly the case for Maltese waters. From as early as the 18th century, naturalists, fishers and enthusiasts have compiled lists of the fish fauna of the Maltese Islands and while many such lists are now available, none are really satisfactory as all include doubtful records; this is often because later publications cite preceding ones without verification of doubtful cases, and because some species are included based on very weak evidence (Schembri *et al.*, 2003). The best available list at present is by Lanfranco (1993) with 288 fish species for Maltese waters; subsequent authors have added to this list, e.g. Farrugia Randon & Sammut (1999) and Sammut, (2001), but do not provide information that could be used to independently verify these records (Schembri *et al.*, 2003).

No specific works on the clingfish diversity in Maltese waters have been published up until now, and Cilia (1990) and Kovačić *et al.* (2013) are the only specific works on gobies from the area.

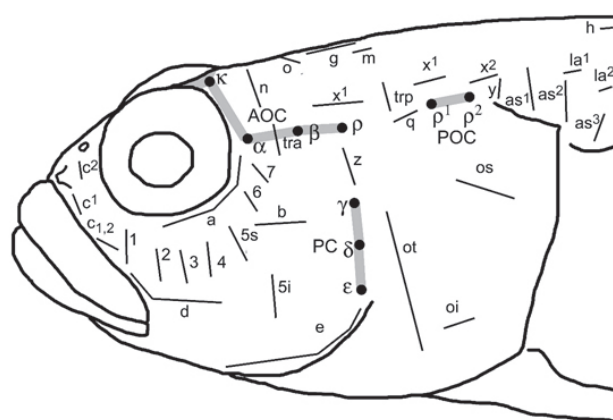
The primary aim of the present study is to report new records of gobies and clingfishes from Maltese waters based on laboratory study of specimens collected during the course of fieldwork over a period of more than twenty years. These collections also included species that had already been reported in the literature for Malta, and which we were able to confirm. Based on these data, the secondary aim of the present work is to provide updated checklists of Gobiidae and Gobiesocidae in the area with a critical assessment of each species' presence.

### Material and Methods

The present study is based almost exclusively on specimens collected as part of projects involving benthic sampling made either for academic research or as part of environmental monitoring programmes or during the course of benthic community mapping. None of these projects was specifically designed to sample fish or any other particular group of benthic organisms. Generally, samples of the benthos were collected using sediment samplers (van Veen grab, box corer), and benthic dredges, and some were collected by a suction sampler or by hand from defined quadrats laid on the bottom. Samples were sorted by hand and preserved in either 10% buffered

seawater formalin or in 70% ethanol. Given the general nature of the samples and the collection methods used, many specimens were damaged and impossible to identify and were discarded. Only specimens which could be identified with certainty are included here.

The length of the specimens is given as standard length + caudal-fin length. The procedures used for meristic data were as follows: scales in transverse series were counted from the anterior origin of the anal fin obliquely upwards and rearwards to the base of the second dorsal fin; scales in lateral series were counted from the pectoral-fin axil along the lateral midline, including the scales on the caudal fin itself; in the second dorsal and anal fins the last bifid ray was counted as a single ray. Morphometric methods, when applied, follow Schliewen & Kovačić (2008). Terminology of the lateral line system of gobies follows Miller (1986) based on Sanzo (1911) (Fig. 1). Terminology for the surface of the sucking disc of clingfishes follows Briggs (1986) and terminology of the clingfish cephalic pore system follows Hofrichter & Patzner (1997). The specimens were reversibly stained in a 2% solution of Cyanine Blue in distilled water (Saruwatari *et al.*, 1997) for studying scales and the head lateral line system. We follow the more rigorous version by Kovačić & Svensen (2018) of the best practice protocol of Bello *et al.* (2014) for first records, which includes diagnoses for each species. The diagnoses presented are the minimum combination of characters that would differentiate the recorded species from other gobiid and gobiesocid fishes known in the CLOFNAM area (Miller, 1986; Briggs, 1986; Hofrichter & Patzner, 1997; Ahnelt



**Fig. 1:** Schematic drawing of the generalized lateral line system of gobies, black lines for the rows of sensory papillae, head canals grey and pores black. AOC, anterior oculoscapular head canal; POC, posterior oculoscapular head canal; PC, preopercular head canal. The other terminology of the lateral line system of gobies follows Miller (1986) based on Sanzo (1911) with the Greek lettering for head canal pores and the roman lettering and numerals for the rows of sensory papillae. Suborbital transversal rows 1-7 are proliferations of suborbital longitudinal *c* row, so the simpler alternative pattern present in some of gobiid species has longitudinal row *c* instead of transversal rows 1-7 and row *cp* on the place of row 5i.

& Dorda, 2004; Kovačić, 2005; Kovačić *et al.*, 2018 and references therein). The examined material has been deposited in the collections of the Natural History Museum Rijeka (PMR), Croatia, and the PMR reference code is given in the 'material examined' sections below.

## Results

Three species of clingfishes and nine species of gobies were recorded for the first time for Maltese waters:

### Gobiesocidae

#### *Apletodon incognitus* Hofrichter & Patzner 1997

**Material examined.** PMR VP4421, juvenile of unidentified sex, 11.7+2.8 mm, Sikka l-Bajda off NE Malta, Malta, 35.98267° N, 14.45867° E, coll. Patrick J. Schembri, 11 June 1996 (Fig. 2); PMR VP4422, male, 19.5+5.8 mm, off Xrobb l-Ghagin, Malta, 35.84567° N, 14.58417° E, coll. Konrad Pirotta, 5 June 2001; PMR VP4423, juvenile of unidentified sex, 9.1 mm standard length, Mellieha Bay, Malta, 35.9759° N, 14.36162° E, coll. Joseph A. Borg, August 1999; PMR VP4424, juvenile of unidentified sex, 8.3 mm standard length, caudal fin damaged, St. Thomas Bay, Malta, 35.85548° N, 14.57353° E, coll. Joseph A. Borg, August 1999; PMR VP4425, juvenile of unidentified sex, 7.6 mm standard length, caudal fin damaged, St. Thomas Bay, Malta, 35.85548° N, 14.57353° E, coll. Joseph A. Borg, August 1999; PMR VP4426, juvenile of unidentified sex, 7.5 mm standard length, caudal fin damaged, White Rocks, Malta, 35.93895° N, 14.46538° E, coll. Joseph A. Borg, August 1999; PMR VP4427, juvenile of unidentified sex, 8.5 mm standard length, caudal fin damaged, Mellieha Bay, Malta, 35.97883° N, 14.36417° E, coll. Joseph A. Borg, 15 September 1998; PMR VP4428, juvenile of unidentified sex, 9.4 mm standard length, caudal fin damaged, Mellieha Bay, Malta, 35.97883° N, 14.36417° E, coll. Joseph A. Borg, 1 September 1998.

**Diagnosis.** (1) three lachrymal canal pores; (2) three mandibular canal pores; (3) dorsal and anal fins normal, with strong rays; (4) dorsal fin rays 4-6, anal fin rays 4-6 (present material dorsal fin 4-5, anal fin 4-5); (5) no spine in subopercular region; (6) row of papillae present on central part of anterior half of sucking disc from region A to region C.



**Fig. 2:** *Apletodon incognitus*, PMR VP4421, juvenile of unidentified sex, 11.7+2.8 mm, Sikka l-Bajda off NE Malta, Malta. Photo: M. Kovačić.

Geographical and ecological data. The specimens were collected off the northern and eastern coasts of Malta, on various type of bottoms including sand with rhodoliths, maerl, coarse gravel and *Posidonia* meadows, at a depth range of 10-54 m.

Remarks. The present report represents the southernmost record of this species in the central Mediterranean. Up till now, *A. incognitus* has been reported from the eastern Atlantic (Azores, Madeira, Canary Islands), and along the northern and eastern Mediterranean coasts to Antalya Bay in the Levant (Bilecenoglu & Kaya, 2006).

#### *Gouania wildenowi* (Risso, 1810)

Material examined. PMR VP4374, male, 41.1+5.8 mm, Wied il-Ghasri, Gozo, 36.07883° N, 14.22843° E, coll. Julian Evans, 16 September 2011 (Fig. 3); PMR VP4375, two juveniles of unidentified sex, 11.1+2.0 and 10.8+2.1 mm, Qawra (Ta' Fra Ben), Malta, 35.95932° N, 14.42618° E, coll. Julian Evans, 22 July 2011.

Diagnosis. (1) dorsal and anal fins reduced to low ridges extended from the caudal fin, with very weak rays; (2) disc small, length 5.3-6.3 in standard length (present material 5.6-6.0).

Geographical and ecological data. The specimens were collected from north Gozo and north Malta from infralittoral pebble beds at 1 m depth.

Remarks. The present report represents the southernmost record of this species in the central Mediterranean. The species is present along the north Mediterranean coasts from the Western Mediterranean to the Levant (Briggs, 1986).



**Fig. 3:** *Gouania wildenowi*, PMR VP4374, male, 41.1+5.8 mm, Wied il-Ghasri, Gozo, Malta. Photo: M. Kovačić.

#### *Opeatogenys gracilis* (Canestrini, 1864)

Material examined. PMR VP4388, male, 17.8+3.6 mm, Mellieha Bay, Malta, 35.9759° N, 14.36612° E, August 2000 (Fig. 4); PMR VP4389, juvenile of unidentified sex, 8.8+1.9 mm, Mellieha Bay, Malta, 35.9759° N, 14.36612° E, August 2000; PMR VP4390, juvenile of unidentified sex, 9.9+2.5 mm, Mellieha Bay, Malta, 35.9759° N, 14.36612° E, August 1999; PMR VP4391, juvenile of unidentified sex, 9.8+2.3 mm, Mellieha Bay, Malta, 35.9759° N, 14.36612° E, August 1999; PMR VP4392, male, 10.9 mm standard length, caudal fin damaged, White Rocks, Malta, 35.93895° N, 14.46538° E, August 1999; PMR VP4393, male, 18.3+3.8 mm, White Rocks, Malta,



**Fig. 4:** *Opeatogenys gracilis*, PMR VP4388, male, 17.8+3.6 mm, Mellieha Bay, Malta. Photo: M. Kovačić.

35.93895° 56.337° N, 14.46538° E, August 1999; PMR VP4394, juvenile of unidentified sex, 8.5+1.6 mm, Ramla Bay, Gozo, 36.06848° N, 14.28225° E, August 1999; all coll. Joseph A. Borg.

Diagnosis. (1) dorsal and anal fins normal, with strong rays; (2) strong subopercular spine present.

Geographical and ecological data. The specimens were collected from north Gozo and north Malta from *Posidonia* meadows at 6-11 m depth.

Remarks. The present report represents the southernmost record of this species in the central Mediterranean. It is otherwise known from southern Portugal in the Atlantic, along the north Mediterranean coasts to the Adriatic Sea and also from Cyprus in the Levant (Gonçalves *et al.*, 2005).

#### Gobiidae

##### *Chromogobius zebratus* (Kolombatović, 1891)

Material examined. PMR VP4376, male, 26.3+6.7 mm, Mellieha Bay, Malta, 35.97883° N, 14.36417° E, coll. Joseph A. Borg, 1 September 1998 (Fig. 5).

Diagnosis. (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) seven transverse suborbital rows; (3) interorbital papillae absent; (4) anterior oculoscapular and preopercular head canals present, posterior oculoscapular canal absent; (5) pelvic fins complete, rounded; (6) scales in lateral series 40-52 (present material 40 and 41, left and right side respectively).

Geographical and ecological data. The specimen was collected off the north Malta coast from a *Posidonia* meadow at 10 m depth.

Remarks. The present report represents the southernmost record of this species in the central Mediterranean. It is otherwise known from Cadiz Bay in the Atlantic, and along the north Mediterranean coasts to Turkey in the east (Engin & Dalgıç, 2008).



**Fig. 5:** *Chromogobius zebratus*, PMR VP4376, male, 26.3+6.7 mm, Mellieha Bay, Malta. Photo: M. Kovačić.



Material examined. PMR VP4403, male, 31.7+8.1 mm (Fig. 6); PMR VP4407, male, 49.3+11.0 mm and juvenile of unidentified sex, 26.5 mm standard length, caudal fin damaged; PMR VP4408, male, 41.9+10.3 mm; PMR VP4409, female, 31.3+8.0 mm; PMR VP4410, male, 41.6+10.5 mm; PMR VP4411, three females, 28.5+7.2 – 29.0+7.1 mm; PMR VP4412, two males, 37.0+9.1 and 42.9+11.5 mm; PMR VP4413, three juveniles of unidentified sex, 20.9+5.9 – 21.6+5.6 mm; PMR VP4414, two males, 43.9+10.5 and 48.6+10.2 mm; PMR VP4415, three females, 39.3+9.6 – 47.4+11.3 mm and juvenile of unidentified sex, 22.8 mm standard length, caudal fin damaged; PMR VP4416, male, 46.9+10.1 mm and juvenile of unidentified sex, 19.8 mm standard length, caudal fin damaged; PMR VP4417, two females, 44.8+9.7 and 45.9+10.7 mm and juvenile of unidentified sex, 18.9 mm standard length, caudal fin damaged; PMR VP4418, two females, 39.7+9.9 and 47.7+11.5 mm, male, 31.8+8.9 mm and three juveniles of unidentified sex, 20.2+5.0 – 25.7+6.2; PMR VP4419, three females, 25.5+8.9 – 44.3+9.9 mm and eight juveniles of unidentified sex, 19.8+4.1 – 22.5+5.8; PMR VP4418, two females, 36.8+8.9 and 45.1+9.8 mm and two juveniles of unidentified sex, 18.9+4.6 and 23.3 mm standard length, caudal fin damaged; all St. Thomas Bay, Malta, 35.85583° N, 14.5705° E, coll. Edwin Zammit, summer 2008. PMR VP4404, juvenile of unidentified sex, 21.0+5.9 mm, Mellieha Bay, Malta, 35.97883° N, 14.36417° E, coll. Joseph A. Borg, 4 September 1998. PMR VP4406, juvenile of unidentified sex, 19.4+5.3 mm, Mellieha Bay, Malta, 35.97883° N, 14.36417° E, coll. Joseph A. Borg, 15 September 1998.

Diagnosis. (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior dorsal row *g* ends posterior to or at lateral end of row *o*; (3) all three head canals of lateral-line system present; (4) anterior oculoscapular head canal with short side branch to pore  $\alpha$  below eye; (5) scales in lateral series 38-40 (present material 38-40); (6) head and nape scaled.

Geographical and ecological data. The specimens were collected off the northern and eastern coasts of Malta from *Posidonia* meadows at a depth range of 3-10 m.

Remarks. This elusive species described 130 years ago is still known from a total of only seven localities including the present records: Balearic Islands (Lozano y Rey (1919), Nice (Bellotti, 1888), Sardinia (Tortonese & Chessa (1982), Sicily (Gramito, 1993), Malta (present



**Fig. 6:** *Gobius ater*, PMR VP4403, male, 31.7+8.1 mm, St. Thomas Bay, Malta. Photo: M. Kovačić.

results), Adriatic Sea (Ahnelt, 2001) and Peloponnesus (Miller, 1986). The present report represents the southernmost record of this species.

*Gobius fallax* Sarato, 1889

Material examined. PMR VP4395, two juveniles of unidentified sex, 25.8+6.1 mm (Fig. 7) and 25.9 mm standard length, caudal fin damaged; PMR VP4396, juvenile of unidentified sex, 23.6+6.3 mm; PMR VP4397, juvenile of unidentified sex, 22.5+5.9 mm; PMR VP4398, juvenile of unidentified sex, 24.8+6.3 mm. All St. Thomas Bay, Malta, 35.85583° N, 14.5705° E, coll. Edwin Zammit, summer 2008.

Diagnosis. (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior dorsal row *g* ends posterior to or at lateral end of row *o*; (3) oculoscapular row *x'* ending forward behind pore  $\beta$ ; (4) suborbital row *d* divided; (5) all three head canals of lateral-line system present; (6) anterior oculoscapular head canal with pore  $\alpha$  at rear of orbit; (7) pelvic fin emarginated about 1/5 of its length (vs. 1/2-2/3 in *Gobius auratus*); (8) scales in lateral series 40-46 (present material 41-46); (9) head and nape scaled; (10) preserved specimen with blotches along lateral midline (vs. no blotches in preserved specimens along lateral midline in *Gobius xanthocephalus*).

Geographical and ecological data. The specimens were collected off the east coast of Malta from *Posidonia* meadows at a depth of 3-5 m.

Remarks. The present report represents the southernmost record of this species in the central Mediterranean. It is otherwise known from the Canaries in the Atlantic, along the north Mediterranean coasts and from Cyprus in the Levant (Kovačić *et al.*, 2011).



**Fig. 7:** *Gobius fallax*, PMR VP4395, juvenile of unidentified sex, 25.8+6.1 mm, St. Thomas Bay, Malta. Photo: M. Kovačić.

*Gobius gasteveni* Miller, 1974

Material examined. PMR VP4373, juvenile female (Fig. 8), 27.8+7.5 mm and juvenile of unidentified sex, 20.8+5.3 mm, off Zonqor Point, Malta, 35.88667° N, 14.66° E, coll. Joseph A. Borg June 2008.

Diagnosis. (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior dorsal row *g* ends posterior to row *o*; (3) suborbital row *d* divided; (4) oculoscapular row *x'* ending forward behind pore  $\beta$ ; (5) all three head canals of lateral-line system present;

(6) anterior oculoscapular head canal with pore  $\alpha$  at rear of orbit; (7) pectoral fin rays 19-21 (present material 19 and 21); (8) pelvic fin rounded, truncate to emarginated less than 1/8 of its length (present material truncate); (9) scales in lateral series 37-45 (present material 42-44); (10) predorsal area scaled.

Geographical and ecological data. Two specimens were collected 6 km offshore from Zonqor Point, east Malta, at 77 m depth on a soft bottom of coarse sand and gravel.

Remarks. The present report represents the easternmost record of this species otherwise known only from the northeastern Atlantic and western Mediterranean (Ahnelt *et al.*, 2011).



**Fig. 8:** *Gobius gasteveni*, PMR VP4373, juvenile female, 27.8+7.5 mm, off Zonqor Point, Malta. Photo: M. Kovačić.

#### *Gobius roulei* de Buen, 1928

Material examined. PMR VP4378, male, 47.7+11.1 mm, November 2004 (Fig. 9); PMR VP4379, female, 34.1+9.2 mm, November 2005; PMR VP4380, male, 46.2+11.8 mm, April 2003. All off St. Paul's Islands, Malta, 35.97693° N, 14.42405° E, coll. Joseph A. Borg.

Diagnosis. (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) anterior dorsal row *g* ends posterior to or at lateral end of row *o*; (3) six transverse suborbital rows; (4) all three head canals of lateral-line system present; (5) head and nape naked.

Geographical and ecological data. All specimens were collected 6 km off St. Paul's Islands, north Malta coast, at a depth of 48 m on a soft bottom of fine sand.

Remarks. The present report represents the southernmost record of this species in the central Mediterranean. It is otherwise known from off the south-west coast of Portugal in the Atlantic, along the north Mediterranean coasts, and from Cyprus in the Levant (Liu *et al.*, 2009).



**Fig. 9:** *Gobius roulei*, PMR VP4378, male, 47.7+11.1 mm, off St. Paul's Islands, Malta. Photo: M. Kovačić.

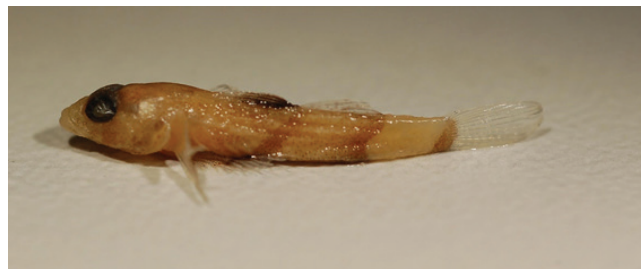
#### *Lebetus guilleti* (Le Danois, 1913)

Material examined. PMR VP4383, female, 11.6+3.3 mm, off St. Paul's Islands, Malta, 35.97693° N, 14.42405° E, coll. Joseph A. Borg, April 2003 (Fig. 10); PMR VP4384, male, 9.8+2.7 mm, off Il-Hofriet, Malta, 35.83° N, 14.5765° E, coll. Joseph A. Borg, June 2008; PMR VP4385, female, 9.0+2.6 mm, off Zonqor Point, Malta, 35.89462° N, 14.70676° E, coll. Joseph A. Borg, June 2010.

Diagnosis. (1) suborbital papillae of lateral-line system with longitudinal row *a*; (2) head canals of lateral-line system absent; (3) second dorsal fin rays I/7-9; anal fin rays I/4-6 (present material second dorsal fin I/7; anal fin I/5); (4) pelvic fins united into a disc and without an anterior membrane.

Geographical and ecological data. The specimens were collected 6 km off St. Paul's Islands, north Malta, off Il-Hofriet, and off Zonqor Point, east Malta, at depths ranging between 48 m (off St. Paul's Islands) and 69 m (off Zonqor Point) on soft bottoms of fine sand (off St. Paul's Islands), coarse sand (off Il-Hofriet) and coarse sand and gravel (off Zonqor Point).

Remarks. The present report represents the southernmost record of this species in the Mediterranean. The species is known from the North-Eastern Atlantic and from four Mediterranean records along the north Mediterranean coasts (Engin *et al.*, 2015).



**Fig. 10:** *Lebetus guilleti*, PMR VP4383, female, 11.6+3.3 mm, off St. Paul's Islands, Malta. Photo: M. Kovačić.

#### *Odondebuenia balearica* (Pellegrin & Fage, 1907)

Material examined. PMR VP4399, female, 16.9+4.6 mm, off Qawra Point, Malta, 35.97048° N, 14.44555° E, coll. Joseph A. Borg, November 2000 (Fig. 11); PMR VP4400, male, 20.2+5.2 mm, Sikka l-Bajda off NE Malta, Malta, 35.98267° N, 14.45867° E, coll. Patrick J. Schembri, 23 July 1996; PMR VP4401, female, 19.7+5.8 mm, off Qawra Point, Malta, 35.97048° N, 14.44555° E, coll. Joseph A. Borg, October 2012; PMR VP4402, male, 25.0+6.6 mm, off Il-Hofriet, Malta, 35.83° N, 14.5765° E, coll. Joseph A. Borg, June 2008; PMR VP4429, two juveniles of unidentified sex, 14.1+4.3 and 10.6+2.7 mm, Sikka l-Bajda off NE Malta, Malta, 36.0165° N, 14.41583° E, coll. Patrick J. Schembri, 6 April 1996; PMR VP4430, juvenile of unidentified sex, 11.0+2.7 mm, Sikka l-Bajda off NE Malta, Malta, 35.98267° N, 14.45867° E, coll. Patrick J. Schembri, 7 April 1996; PMR VP4431, two females, 13.3+3.9 mm and 12.53 mm standard length, cau-



dal fin damaged, off east Comino, Comino, 36.01733° N, 14.38483° E, coll. Patrick J. Schembri, 7 April 1998; PMR VP4432, juvenile of unidentified sex, 11.2+3.0 mm, off St. Paul's Islands, Malta, 35.97693° N, 14.42405° E, coll. Joseph A. Borg, April 2003; PMR VP4433, female, 13.3+3.9 mm, off Zonqor Point, Malta, 35.90917° N, 14.70518° E, coll. Joseph A. Borg, June 2010; PMR VP4434, female, 17.9+4.7 mm and two males, 18.2 mm standard length, caudal fin damaged and 13.9+4.2 mm, off Zonqor Point, Malta, 35.90917° N, 14.70518° E, coll. Joseph A. Borg, June 2008; PMR VP4435, female, 13.9 mm standard length, caudal fin damaged, off Zonqor Point, Malta, 35.89445° N, 14.70677° E, coll. Joseph A. Borg, June 2008; PMR VP4436, male, 13.8+4.4 mm, off Zonqor Point, Malta, 35.892° N, 14.66833° E, coll. Joseph A. Borg, June 2010; PMR VP4437, juvenile of unidentified sex, 12.6+3.6 mm, off St. Paul's Islands, Malta, 35.97693° N, 14.42405° E, coll. Joseph A. Borg, November 2000.



**Fig. 11:** *Odondebuenia balearica*, PMR VP4399, male, 16.9+4.6 mm, off Qawra point, Malta. Photo: M. Kovačić.

**Diagnosis.** (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) transverse suborbital rows six (last one with 1 papilla); (3) anterior oculoscapular and preopercular head canals of lateral-line system present, posterior oculoscapular canal absent; (4) pelvic fins separate; (5) scales on base of caudal fin with lateral ctenii greatly enlarged.

**Geographical and ecological data.** The specimens were collected along the northern and eastern coasts of Malta and eastern Comino on various bottoms ranging from fine sand, coarse sand, and sand with biogenic inclusions to coarse sand and gravel at a depth range of 38-79 m.

**Remarks.** The present report represents the southernmost record of this species in the central Mediterranean; it is present all along the north Mediterranean coasts (Consoli *et al.*, 2019).

#### *Speleogobius llorisi* Kovačić, Ordines, Schliewen 2016

**Material examined.** PMR VP4377, male, 16.1+4.4 mm, off Delimara Point, Malta, 35.8158° N, 14.56833° E, coll. Joseph A. Borg, June 2008 (Fig. 12).

**Diagnosis.** (1) suborbital papillae of lateral-line system with longitudinal row *a*; (2) posterior oculoscapular head canal of lateral-line system absent; (3) preopercular head canal present with pores  $\gamma$ ,  $\delta$ ,  $\epsilon$ ; (4) pelvic fins united



**Fig. 12:** *Speleogobius llorisi*, PMR VP4377, male, 16.1+4.4 mm, off Delimara Point, Malta. Photo: M. Kovačić.

into a disc, posteriorly emarginated and without an anterior membrane; (5) predorsal area scaly.

**Geographical and ecological data.** The specimen was collected from off Delimara Point, east Malta, at a depth of 47 m on a soft bottom of coarse sand.

**Remarks.** The present report is one of only four known records (Balearic Islands, Adriatic Sea, Aegean Sea and Malta) of this recently described species (Kovačić & Glavičić, 2019).

#### *Vanneaugobius dollfusi* Brownell, 1978

**Material examined.** PMR VP4386, male, 21.5+5.7 mm, off Zonqor Point, Malta, 35.892° N, 14.65333° E, coll. Joseph A. Borg, June 2008 (Fig. 13); PMR VP4387, juvenile of unidentified sex, 12.9+3.8 mm, off eastern Comino, Comino, Malta, 36.0295° N, 14.396° E, coll. Joseph A. Borg, November 2011.

**Diagnosis.** (1) suborbital papillae of lateral-line system without longitudinal row *a*; (2) transverse suborbital rows seven (last one with 1 papilla); (3) posterior oculoscapular canal of lateral-line system absent; (4) second dorsal fin rays I/9-10; anal fin rays I/8-9 (present material second dorsal fin I/9 and anal fin I/9); (5) the first dorsal fin spine I the longest; (6) pelvic fin separate; (7) the fifth pelvic fins rays unbranched; (8) scales on base of caudal fin with lateral ctenii greatly enlarged.

**Geographical and ecological data.** The specimens were collected 6 km off St. Paul's Islands, north Malta and off east Comino, both at 65 m depth on soft bottoms of coarse sand and gravel.

**Remarks.** The present report represents the southernmost record of this species in the Mediterranean. Previous to the present record, *V. dollfusi* has been reported from the Atlantic coast of Morocco, the Strait of Sicily, the Aegean Sea and the Adriatic Sea (Consoli *et al.*, 2019).



**Fig. 13:** *Vanneaugobius dollfusi*, PMR VP4386, male, 21.5+5.7 mm, off St. Paul's Islands, Malta. Photo: M. Kovačić.

## Discussion

Originally, there were only limited records for most of the collected Mediterranean species (e.g. see Miller, 1986), which were consequently considered to be rare or elusive for longer or shorter periods after their first description. Increasingly, records from various localities in the Mediterranean, and studies on community ecology and the biology of the species, showed that some species were not only geographically widespread in the Mediterranean, but were also common in their preferred habitat; for example, *O. balearica* and *C. zebratus* (Kovačić *et al.*, 2012), and *G. roulei* (Kovačić, 2001). The known geographical distribution of some species has recently been extended by new records (e.g. *L. guiletti* and *S. llorisi*; Engin *et al.*, 2015; 2017). Despite increased knowledge on geographical distribution almost nothing is known about the ecology or biology of many of these fishes. The most enigmatic among the presently reported species is *G. ater*, with just a few published records over the 130 years since it was first described, with the most recent being based on the identification of specimens that had actually been collected in the 19th century (Ahnelt, 2001).

The three new records of clingfishes have doubled the known diversity of Maltese Gobiesocidae, and the nine new records of gobies have increased by about half the known diversity of Maltese Gobiidae. The checklists of gobies and clingfishes (Tables 1 and 2) show the total diversity of these fish families in Maltese waters, which now stands at six species of Gobiesocidae and 30 species of Gobiidae. All species in the checklist of clingfishes have been confirmed by examination of actual specimens (Table 1). However, this is not the case for the gobiids since the species listed in Lanfranco (1993) and Farrugia Randon & Sammut (1999) (and repeated in Sammut, 2001) and those from unpublished MEDITS records, include ten species that require positive confirmation, since they were reported with no diagnosis based on actual material, with no photograph, and with no voucher specimens, and are species that can easily be confused and misidentified with very similar or closely related ones (Table 2). Fifteen species can be confirmed since specimens from Malta are available and have been examined and deposited in museum collections; another four species are common and easy to identify and there is therefore little doubt that they occur, while one species is confirmed by the original paper which includes specimen data, giving a total of twenty confirmed species (Table 2). Gobies and clingfishes have regularly

featured in checklists of marine fishes for various areas of the Mediterranean and included in national checklists of fishes for Mediterranean countries. How unreliable are such general lists for small and difficult to identify fishes was shown by Kovačić (2005) in his annotated checklist of gobies of the Adriatic Sea. This work provided evidence for the exclusion of six gobiids previously regularly cited for the Adriatic, due to one source copying the information in other sources without critical assessment or examination of actual specimens. Therefore, the present checklists should only be compared with similar critical works for other Mediterranean islands. Two such lists exist for gobies (Miller, 1977; Kovačić *et al.*, 2011), but there are none for clingfishes. Miller (1977) listed nine gobiids for Rhodes waters, while Kovačić *et al.* (2011) increased the number of confirmed gobiids known for Crete from seven to seventeen on the basis of just one week of fieldwork, in addition to two more species observed but not collected and three unconfirmed gobies reported by Miller (1986). The work by Kovačić *et al.* (2011) demonstrated how even a limited but targeted effort aimed at collecting small benthic fishes can achieve what is not possible to get from the standard fieldwork methods normally used for studying fish diversity.

Malta has been placed in different marine biogeographical sectors depending on the organisms taken into consideration (Bianchi, 2007 and references therein). For Gobiidae, Kovačić & Patzner (2011) arbitrarily set the border between the northern Mediterranean areas rich in gobies (> 40 species) and the species-poor middle-southern part of the sea (12 species) assigning Malta to the latter. The increase in the number of known gobiid species of Maltese waters resulting from the present study shows that gobiid diversity in the Malta area is much higher than that presumed by the Maltese islands' inclusion in the middle-southern Mediterranean sector and could, with additional collecting effort, reach a level of gobiid diversity similar to that of the northern Mediterranean areas (reviewed in Kovačić & Patzner, 2011). These results may even suggest that all species with distributions as far south as the Malta area (Kovačić *et al.*, 2013 and present results) might also be found along the southern coasts of the Central Mediterranean if targeted sampling for such cryptobenthic species is undertaken; all indications are that the reported gobiid diversity of Maltese waters, and maybe also of the central southern Mediterranean coasts, are far below the real species richness.

**Table 1.** Checklist of the clingfishes (family Gobiesocidae) of Malta. NHMR - Natural History Museum Rijeka.

Species	Source	Confirmation
<i>Apletodon incognitus</i> Hofrichter & Patzner 1997	present research	Specimen stored at NHMR
<i>Diplecogaster bimaculata</i> (Bonnaterre, 1788)	Lanfranco, 1993	Specimen stored at NHMR
<i>Gouania wildenowi</i> (Risso, 1810)	present research	Specimen stored at NHMR
<i>Lepadogaster candollei</i> Risso, 1810	Lanfranco, 1993	Specimen stored at NHMR
<i>Lepadogaster lepadogaster</i> (Bonnaterre 1788)	Lanfranco, 1993	Specimen stored at NHMR
<i>Opeatogenys gracilis</i> (Canestrini, 1864)	present research	Specimen stored at NHMR



**Table 2.** Checklist of gobies (family Gobiidae) of Malta. NHMR - Natural History Museum Rijeka.

Species	Source	Confirmation
<i>Aphia minuta</i> (Risso, 1810)	Lanfranco, 1993	Common from fishery catches
<i>Chromogobius quadrivittatus</i> (Steindachner, 1863)	Farrugia Randon & Sammut, 1999	<i>Not confirmed</i>
<i>Chromogobius zebratus</i> (Kolombatović, 1891)	present research	Specimen stored at NHMR
<i>Crystallogobius linearis</i> (Von Düben, 1845)	Farrugia Randon & Sammut, 1999	Specimen stored at NHMR
<i>Deltentosteus collonianus</i> (Risso, 1820)	Unpublished MEDITS <sup>(1)</sup> record from 2009	<i>Not confirmed</i>
<i>Deltentosteus quadrimaculatus</i> (Valenciennes, 1837)	Lanfranco, 1993	Specimen stored at NHMR
<i>Gobius ater</i> Bellotti, 1888	present research	Specimen stored at NHMR
<i>Gobius auratus</i> Risso, 1810	Lanfranco, 1993	<i>Not confirmed</i>
<i>Gobius bucchichi</i> Steindachner, 1870	Lanfranco, 1993	<i>Not confirmed</i>
<i>Gobius cobitis</i> Pallas, 1814	Lanfranco, 1993	Common in shallow waters, large and easy to identify
<i>Gobius couchi</i> Miller & El-Tawil, 1974	Kovačić <i>et al.</i> , 2013	Specimen stored at NHMR
<i>Gobius cruentatus</i> Gmelin, 1789	Lanfranco, 1993	Common in shallow waters, large and easy to identify
<i>Gobius fallax</i> Sarato, 1889	present research	Specimen stored at NHMR
<i>Gobius gasteveni</i> Miller, 1974	present research	Specimen stored at NHMR
<i>Gobius geniporus</i> Valenciennes, 1837	Cilia, 1990	Original paper with specimen data
<i>Gobius niger</i> Linnaeus, 1758	Lanfranco, 1993	Specimen stored at NHMR
<i>Gobius paganellus</i> Linnaeus, 1758	Lanfranco, 1993	Common in shallow waters, large and easy to identify
<i>Gobius roulei</i> de Buen, 1928	present research	Specimen stored at NHMR
<i>Lebetus guilleti</i> (Le Danois, 1913)	present research	Specimen stored at NHMR
<i>Lesueurigobius sanzoi</i> (De Buen, 1918)	Unpublished MEDITS <sup>(1)</sup> record from 2000	<i>Not confirmed</i>
<i>Lesueurigobius suerii</i> (Risso, 1810)	Unpublished MEDITS <sup>(1)</sup> record from 2002	<i>Not confirmed</i>
<i>Millerigobius macrocephalus</i> (Kolombatović, 1891)	Kovačić <i>et al.</i> , 2013	Specimen stored at NHMR
<i>Odondebuenia balearica</i> (Pellegrin & Fage, 1907)	present research	Specimen stored at NHMR
<i>Pomatoschistus marmoratus</i> (Risso, 1810)	Farrugia Randon & Sammut, 1999	<i>Not confirmed</i>
<i>Pomatoschistus minutus</i> (Pallas, 1770)	Lanfranco, 1993	<i>Not confirmed</i>
<i>Speleogobius llorisi</i> Kovačić, Ordines & Schliwen, 2016	present research	Specimen stored at NHMR
<i>Thorogobius ephippiatus</i> (Lowe, 1839)	Farrugia Randon & Sammut, 1999	<i>Not confirmed</i>
<i>Vanneaugobius dollfusi</i> Brownell, 1978	present research	Specimen stored at NHMR
<i>Zebrus zebrus</i> (Risso, 1826)	Kovačić <i>et al.</i> , 2013	Specimen stored at NHMR
<i>Zosterisessor ophiocephalus</i> (Pallas, 1814)	Lanfranco, 1993	<i>Not confirmed</i>

(1) MEDITS is the 'International bottom trawl survey in the Mediterranean' conducted since 1994 by Mediterranean EU Member States in compliance with the European framework for the collection and management of fisheries data (Regulation EC 1543/2000) (MEDITS, 2017).

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