

1 **Gobies (Perciformes: Gobiidae) in Bolinao, northwestern Philippines**

2 **Running head: Gobies of Bolinao**

3 Klaus M. Stiefel<sup>1,2,\*</sup>, Dana P. Manogan<sup>1</sup>, and Patrick C. Cabaitan<sup>1</sup>

4 <sup>1</sup>The Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines

5 <sup>2</sup>Neurolinx Research Institute, La Jolla, CA, USA

7 \*Corresponding author: Klaus M. Stiefel

8 [klaus@neurolinx.org](mailto:klaus@neurolinx.org)

9 University of the Philippines Diliman, Marine Science Institute

10 P. Velasquez St., Diliman, Quezon City, Philippines 1101

11 phone: +63 2 922 3959

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13 **Keywords:** Bolinao, Coral Reef, Fish, Gobiidae, Philippines

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17 **Abstract:**

18 We conducted a visual and photographic survey of the gobiidae in the Bolinao area of the  
19 Philippines, located on the western tip of the Lingayen gulf, on the west coast of Luzon island. We  
20 identified a total of 40 species, of which 18 are shrimp-associated. One species found (*Myersina*  
21 *lachneri*) constitutes a range expansion into the Philippines. This number of species is in the  
22 expected range compared to other studies of marine goby faunae in the coral triangle, despite the  
23 significant anthropogenic pressures onto the marine ecosystem in the surveyed area.

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## INTRODUCTION

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30 Gobies (Perciformes: Gobiidae) are the largest family of marine fishes, with over 1800 known  
31 species (1834 listed on Fishbase, Froese & Pauly, 2010). In tropical coastal ecosystems, gobies  
32 constitute a significant fraction of all fish species. Many species of gobies are cryptic, living as  
33 epibionts on corals and sponges, or highly camouflaged in the sand. About 120 species of marine  
34 gobies also live in a symbiotic relationship with alpheid shrimp, with which they share a burrow  
35 excavated by the shrimp. In mangrove areas, mudskippers of the genus *Pteriophtalmus* are  
36 amphibious and venture out onto the mud between the mangrove roots. Most species of gobies  
37 are small, with *Schindleria brevipinis* possibly the smallest known vertebrate (7 mm adult length,  
38 Watson & Walker, 2004). Generally, knowledge of the gobiid fauna provides a valuable window  
39 into the fish diversity of a location.

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## MATERIALS & METHODS

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44 We used visual and photographic identification by two or three observers during SCUBA dives  
45 to survey an area of about 75 km<sup>2</sup> around Santiago island east of Bolinao on the western edge of  
46 the Lingayen gulf (Fig. 1; 16° 24' 32" North, 119° 56 '13" East), northwestern Philippines.

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48 The sampling sites were between 1 and 35 meters deep, with the majority of species found  
49 shallower than 18 meters. Habitats included coral reefs, sandy areas adjacent to reefs, sandy/silty  
50 areas not in proximity to coral reefs, as well as seagrass areas. An unusual sampling site is the

51 giant clam ocean hatchery of the University of the Philippines Marine Science Institute, which is  
52 home to several thousand giant clams (*Tridacna* spp.). These clams provide 3-dimensional  
53 structure similar to a coral reef. We excluded estuarine, brackish water and freshwater habitats.

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55 The anthropogenic disturbances of the marine environment in the western Lingayen gulf are  
56 significant, with fish farms introducing a significant amount of nutrients, and strong artisanal and  
57 large-scale fishing operations depleting fish stocks (McManus, 1992; Campos et al., 1994). The  
58 drop in water quality caused by the fish farming on the west side of Santiago Island has led to  
59 coral reef degradation and in some spots to a conversion of former reefs to silty areas devoid of  
60 corals (Cabaitan et al., 2016).

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## 62 RESULTS

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64 We found a total of 40 species of gobiidae, of which 18 were shrimp-associated, 7 were coral  
65 epibionts at least part of the time, 14 were sand-living, 1 found in rubble and 1 in rock crevices  
66 (Table 1, Fig. 2).

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68 We found individuals of all but two species (*Gobiodon* sp., *Gobiodon ceramenis*) multiple times,  
69 indicating that while our sampling of the goby species in the area might not be complete, we had  
70 found all but the most rare species.

71

72 *Gobiodon* sp., a yellow fish with orange facial markings, is likely the undescribed species listed  
73 in Allen & Erdmann (2012). *Myersina lachneri* (Hoese & Lubbock, 1982) is a range expansion

74 for the Philippines, having previously only been reported from Papua New Guinea and Indonesia  
75 (Allen & Adrim, 2003).

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77 Photographs of 31 of the 41 described species are available here:

78 <https://www.flickr.com/photos/pacificklaus/sets/72157685611197132>

79 Video footage of several species featured in the photographs, and two more are available here:

80 <https://www.youtube.com/watch?v=Q4KMPjV0qSg>

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## DISCUSSION

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85 Our survey found 40 species of gobies in an area of about 75 km<sup>2</sup>. This is close to an expected  
86 number of species compared to other surveys of gobbiidae in the Indo-Pacific (see Fig. 3 for a  
87 species-area plot as the basis for this prediction). Surveying an area of a comparable size (40  
88 km<sup>2</sup>), Depczynski & Bellwood (2005) found 30 species around Lizard Island in the GBR.

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90 The goby fauna in the western Lingayen near Bolinao gulf is likely determined by the physical  
91 conditions as well as by anthropogenic disturbance. The area lacks deep walls which are habitats  
92 for hovering gobies (such as *Trimma tevegae*), which are hence absent from the area.  
93 Additionally, the eastern side of Santiago island is swept by powerful currents, known to limit  
94 the occurrence of small marine fishes (Depczynski & Bellwood, 2005). The low number of  
95 gobiid epibionts is most likely a consequence of the limited coral cover and diversity. This might  
96 partially be a consequence of the severe anthropogenic stresses to marine habitats in the region.

97 Nevertheless, a gobiid fauna of 40 species, close to the expected value, indicates that small, often  
98 cryptic, fishes low in the food web could be less likely affected by anthropogenic disturbances  
99 than larger species.

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102

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107 literature.

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138 new paedomorphic species in the family Schindleriidae (Perciformes: Gobioidae).  
139 Records-Australian Museum, 56: 139-142.  
140

141 Table 1. All gobiid species recorded in the vicinity of Bolinao, northwestern Philippines.

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<b>Shrimp-associated gobies</b>		<b>Niche</b>
<b>Genus</b>	<b>Species</b>	
<i>Amblyeleotris</i>	<i>steinitzii</i>	shrimp
<i>Amblyeleotris</i>	<i>fortanesii</i>	shrimp
<i>Amblyeleotris</i>	<i>perioptalama</i>	shrimp
<i>Amblyeleotris</i>	<i>wheeleri</i>	shrimp
<i>Amblyeleotris</i>	<i>guttata</i>	shrimp
<i>Amblyeleotris</i>	<i>gymnocephala</i>	shrimp
<i>Cryptocentrus</i>	<i>ceruleomaculatus</i>	shrimp
<i>Cryptocentrus</i>	<i>leptocephalus</i>	shrimp
<i>Cryptocentrus</i>	<i>sericus</i>	shrimp
<i>Cryptocentrus</i>	<i>strigilliceps</i>	shrimp
<i>Cryptocentrus</i>	<i>cyanotaenia</i>	shrimp
<i>Mahidolia</i>	<i>mystacina</i>	shrimp
<i>Ctenogobiops</i>	<i>crocineus</i>	shrimp
<i>Vanderhorstia</i>	<i>dorsomaculata</i>	shrimp
<i>Vanderhorstia</i>	<i>macropteryx</i>	shrimp
<i>Vanderhorstia</i>	<i>ambanoro</i>	shrimp
<i>Vanderhorstia</i>	<i>ornatissima</i>	shrimp
<i>Tomiyamichthys</i>	<i>oni</i>	shrimp
<i>Myersina</i>	<i>lachneri</i>	shrimp
<b>Non-shrimp associated gobies</b>		
<i>Pleurosycia</i>	<i>michelii</i>	coral epibiota
<i>Bryaninops</i>	<i>yongei</i>	coral epibiota
<i>Gobiodon</i>	sp	coral epibiota
<i>Gobiodon</i>	<i>ceramenis</i>	coral epibiota
<i>Eviota</i>	<i>pellucida</i>	coral epibiota/rock
<i>Eviota</i>	<i>prasites</i>	coral epibiota/rock
<i>Eviota</i>	<i>stigillata</i>	coral epibiota/rock
<i>Trimma</i>	<i>caesuria</i>	rock crevice
<i>Asterropteryx</i>	<i>striatus</i>	rubble
<i>Acentrogobius</i>	<i>nebulosus</i>	sand
<i>Amblygobius</i>	<i>phalaena</i>	sand
<i>Amblygobius</i>	<i>nocturnus</i>	sand
<i>Amblygobius</i>	<i>buanensis</i>	sand
<i>Istigobius</i>	<i>decoratus</i>	sand
<i>Coryphopterus</i>	<i>aureus</i>	sand
<i>Valencienna</i>	<i>puellaris</i>	sand
<i>Valencienna</i>	<i>sexguttata</i>	sand

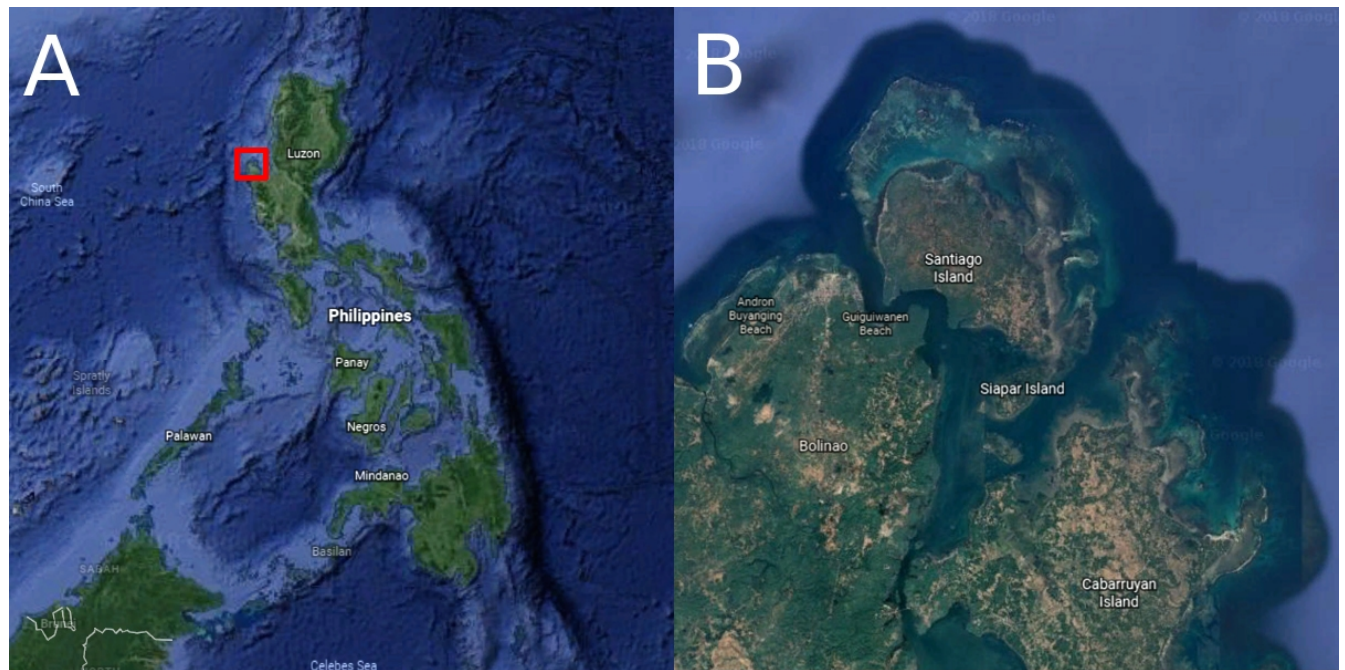


<i>Oplompus</i>	<i>oplompus</i>	sand
<i>Oplompus</i>	<i>caninoides</i>	sand
<i>Heteroplopomus</i>	<i>barbatus</i>	sand
<i>Exyrias</i>	<i>belissimus</i>	sand
<i>Exyrias</i>	<i>puntang</i>	sand/seagrass

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146 Fig. 1. Survey area around Santiago island (B) in the Bolinao region, Pangasinan province,  
147 Luzon island, Philippines (A).

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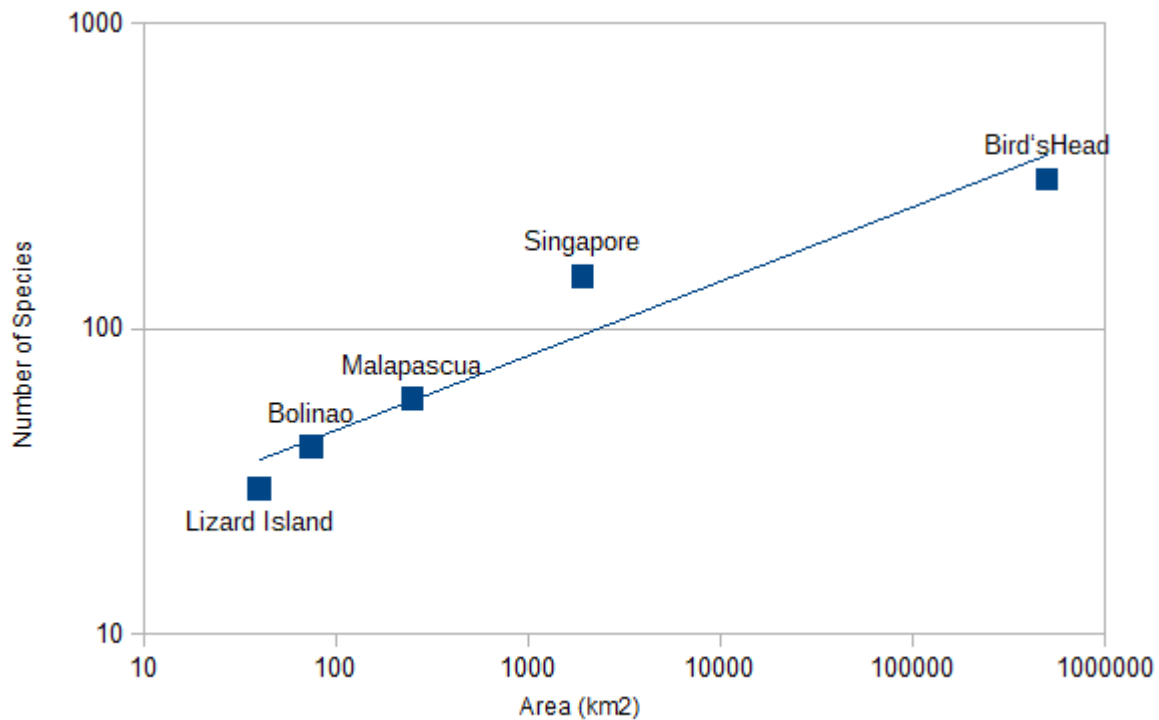
150

151 Fig. 2. Photographs of several species encountered in the Bolinao area (top to bottom, left to  
152 right): *Mahidolia mystacina*, *Amblyeleotris fortanesii*, *Myersina lachneri*, *Amblygobius*  
153 *buanensis*.



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156 Fig. 3. Species – area relationship for marine gobies. Plotted are the number of species against  
157 the estimated survey area from this study (~ 75 km<sup>2</sup>, 40 species), a study of the gobies of Lizard  
158 Island (~ 40 km<sup>2</sup>, 30 species), of Malapascua, Cebu province, Philippines (~ 250 km<sup>2</sup>, 59  
159 species), of Singapore (~ 1925 km<sup>2</sup>, 149 species) and the Papuan Bird's Head Peninsula (~50 000  
160 km<sup>2</sup>, 308 species).

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