- Gobies (Perciformes: Gobiidae) in Bolinao, northwestern Philippines
- 2 Running head: Gobies of Bolinao
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13 **Keywords:** Bolinao, Coral Reef, Fish, Gobiidae, Philippines

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

28 INTRODUCTION 29 Gobies (Perciformes: Gobiidae) are the largest family of marine fishes, with over 1800 known 30 species (1834 listed on Fishbase, Froese & Pauly, 2010). In tropical coastal ecosystems, gobies 31 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 are small, with Schindleria brevipinis possibly the smallest known vertebrate (7 mm adult length, 37 38 Watson & Walker, 2004). Generally, knowledge of the gobiid fauna provides a valuable window 39 into the fish diversity of a location. 40 41 42 **MATERIALS & METHODS** 43

We used visual and photographic identification by two or three observers during SCUBA dives to survey an area of about 75 km<sup>2</sup> around Santiago island east of Bolinao on the western edge of

the Lingayen gulf (Fig. 1; 16° 24' 32" North, 119° 56 '13" East), northwestern Philippines.

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

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giant clam ocean hatchery of the University of the Philippines Marine Science Institute, which is home to several thousand giant clams (Tridacna spp.). These clams provide 3-dimensional structure similar to a coral reef. We excluded esturine, brackish water and freshwater habitats. The anthropogenic disturbances of the marine environment in the western Lingayen gulf are significant, with fish farms introducing a significant amount of nutrients, and strong artisanal and large-scale fishing operations depleting fish stocks (McManus, 1992; Campos et al., 1994). The drop in water quality caused by the fish farming on the west side of Santiago Island has led to coral reef degradation and in some spots to a conversion of former reefs to silty areas devoid of corals (Cabaitan et al., 2016). **RESULTS** We found a total of 40 species of gobiidae, of which 18 were shrimp-associated, 7 were coral epibionts at least part of the time, 14 were sand-living, 1 found in rubble and 1 in rock crevices (Table 1, Fig. 2). We found individuals of all but two species (Gobiodon sp., Gobiodon ceramenis) multiple times, indicating that while our sampling of the goby species in the area might not be complete, we had found all but the most rare species. Gobiodon sp., a yellow fish with orange facial markings, is likely the undescribed species listed 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). 76 Photographs of 31 of the 41 described species are available here: 77 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: https://www.youtube.com/watch?v=Q4KMPjV0qSg 80 81 82 83 **DISCUSSION** 84 85 Our survey found 40 species of gobies in an area of about 75 km<sup>2</sup>. This is close to an expected number of species compared to other surveys of gobbiidae in the Indo-Pacific (see Fig. 3 for a 86 species-area plot as the basis for this prediction). Surveying an area of a comparable size (40 87 km<sup>2</sup>), Depczynski & Bellwood (2005) found 30 species around Lizard Island in the GBR. 88 89 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 the occurrence of small marine fishes (Depczynski & Bellwood, 2005). The low number of 94 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 cryptic, fishes low in the food web could be less likely affected by anthropogenic disturbances 98 than larger species. 99 100 101 **ACKNOWLEDGMENTS** 102 We would like to thank our colleagues at the University of the Philippines, Diliman, Marine 103 Science Institute, especially Renato Adolfo for help in sampling, Dr. Cecilia Conaco and 104 105 Timothy Quimpo for helpful discussion. We also thank Andreas Völkers and Dr. Brett Tibbatts for help with fish identification, and Dr. Rene Abesamis for discussion and pointers to the 106 107 literature. 108 109 REFERENCES 110 ABAN SM, GARCIA AC, MERCADO RA, FERRER MM. 2017 Resource assessment of 111 112 Tambac Bay in Western Pangasinan, Philippines, Pangasinan State University Journal of 113 Natural and Allied Sciences, 1: 23-31. ALLEN GR & ADRIM M. 2003. Coral reef fishes of Indonesia. Zoological Studies, 42(1):1-72. 114 ALLEN GR & ERDMANN MV. 2009. Reef fishes of the bird's head peninsula, West Papua, 115 Indonesia. Check List, the journal of biodiversity data, 5(3): 587-628. 116 ALLEN GR & ERDMANN MV. 2012. Reef fishes of the East Indies. Conservation International 117 118 Foundation, 1292 pp. CABAITAN PC, GOMEZ ED, YAP HT 2016. The spaghetti sponge Callyspongia samarensis 119 120 (Wilson, 1925) provides temporary habitat for reef fish recruits. Marine Biodiversity, 46: 121 541-542. CAMPOS WL, DEL NORTE-CAMPOS AGC, MCMANUS JW. 1994. Yield estimates, catch, 122 effort and fishery potential of the reef flat in Cape Bolinao, Philippines. Journal of 123 124 Applied Ichthyology, 10: 82-95. DEPCZYNSKI M & BELLWOOD DR. 2005. Wave energy and spatial variability in community 125 structure of small cryptic coral reef fishes. Marine Ecology Progress Series, 303: 283-126 127 293.

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new paedomorphic species in the family Schindleriidae (Perciformes: Gobioidei).

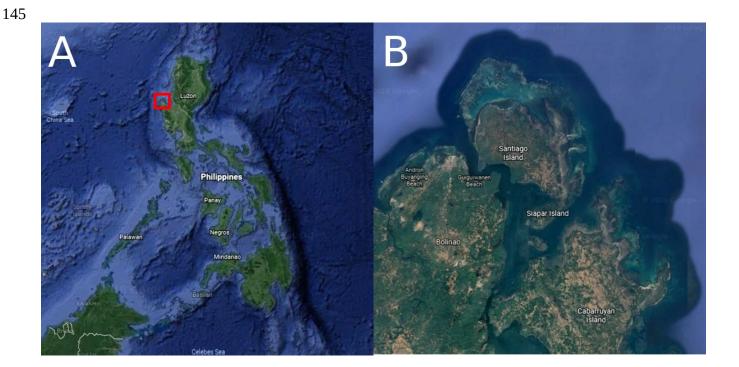
Records-Australian Museum, 56: 139-142.

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

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

| Oplompus       | oplompus   | sand          |
|----------------|------------|---------------|
| Oplompus       | caninoides | sand          |
| Heteroplopomus | barbatus   | sand          |
| Exyrias        | belissimus | sand          |
| Exyrias        | puntang    | sand/seagrass |



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

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









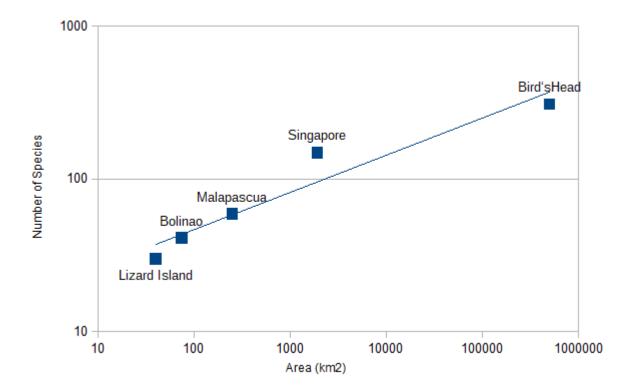


Fig. 3. Species – area relationship for marine gobies. Plotted are the number of species against the estimated survey area from this study (~ 75 km², 40 species), a study of the gobies of Lizard Island (~ 40 km², 30 species), of Malapascua, Cebu province, Philippines (~ 250 km², 59 species), of Singapore (~ 1925 km², 149 species) and the Papuan Bird's Head Peninsula (~50 000 km², 308 species).