

First record of the southern ocean sunfish, *Mola ramsayi*, in the Galápagos Marine Reserve

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Ocean sunfish from the genus Mola, family Molidae, are the world's heaviest bony fish, reaching 2500 kg, primarily on a diet of gelatinous zooplankton. Three molid species are reported to occur in the Galápagos archipelago: Mola mola, Masturus lanceolatus and Ranzania laevis. To date, no genetic analysis of any molid has been conducted in Galápagos. In October 2011, tissue samples were obtained from nine sunfish at Punta Vicente Roca, Isabela Island, genetically analysed and found to be Mola ramsayi—the southern sunfish. This marks the first record of M. ramsayi in Galápagos waters.

Keywords: Molidae, Tetraodontiformes, distribution expansion

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INTRODUCTION

The family Molidae has had a long taxonomic history and currently, three genera with four species are recognized (Parenti, 2003). These include *Masturus lanceolatus* (Liénard, 1840) also called the short-tailed mola; *Ranzania laevis* (Pennant, 1776) known as the slender mola; *Mola mola* (Linnaeus, 1758) the common mola and; *Mola ramsayi* (Giglioli, 1883) the southern mola. Recent genetic work suggests there may be another clade of *Mola* spp. in Japanese waters (Yoshita *et al.*, 2009; Yamanoue *et al.*, 2010).

Noted for their truncated anatomy, molas lack caudal bones, ribs and pelvic fins (Tyler, 1980). With fused backbones and fewer vertebral centra than other fish groups, molas propel themselves primarily with long median fins (Tyler, 1980). Despite these morphological abbreviations, some members reach impressive sizes with the common mola, *Mola mola*, claiming title to the world's heaviest bony fish (approximately 2500 kg) (Carwardine, 1995; Roach, 2003). The common name, ocean sunfish, derives from the molids' habit of basking at the sea surface.

Ocean sunfish boast a wide distribution and can be found in all tropical and temperate ocean basins. They are also renowned for extremely high fecundity, with a single female capable of producing an estimated 300 million eggs

(Schmidt, 1921). Despite their range and reproductive output, surprisingly little is known about the family's natural history and global population status.

Through a voluntary reporting system, researchers, tour guide operators and fishermen have identified regions where populations of ocean sunfish are reliably found worldwide (www.oceansunfish.org). Some of these regions include the waters of California's central and southern coast, South Africa's Cape Town, Bali's Nusa Lembongan, Japan's Kamogawa, Taiwan's Hua Lien, Spain's Malaga, Italy's Camogli and Ecuador's Galápagos Islands—the latter being the focus of this work.

Three species from three molid genera have been reported in Galápagos: *Mola mola* and *Ranzania laevis* by Grove & Lavenberg (1997) and McCosker & Rosenblatt (2010) and most recently *Masturus lanceolatus* by Todd & Grove (2010). *Mola lanceolatus* sightings were confirmed via video identification, however *M. mola* and *R. laevis* await confirmation as no collected specimens can be located from these islands. According to Grove & Lavenberg (1997) one specimen of *M. mola* was collected from the Archipelago in 1898 by Edmund Heller (unpublished field notes) but its whereabouts are unknown. To the best of the authors' knowledge, no *R. laevis* have been collected from the islands.

Detailed knowledge about all marine fauna in this World Heritage Site is vital for proper management of its protected resources. The Galápagos Marine Reserve was created in 1998, and covers an area of over 138,000 km² around the Galápagos Islands, where fishing is limited to approximately 1000 locally-registered small-scale fishers, of which less than

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half are active (Castrejón Mendoza, 2011). Most fishing activity is centred around diving for lobster and sea cucumbers, although hook and line fisheries for both demersal and pelagic species is increasing (Hearn, 2008; Castrejón Mendoza, 2011). Ocean sunfish are not targeted by fishers and have not been reported as by-catch according to the Charles Darwin Foundation and Galápagos National Park Service Fisheries Database. The reserve therefore acts as a refuge for wide-ranging pelagic species such as these, which are vulnerable to fishing gear outside protected waters. Results reported here form part of an ongoing study to determine the movement patterns of a range of highly migratory species in the Eastern Tropical Pacific.

MATERIALS AND METHODS

Site selection

Repeated sightings of ocean sunfish have been recorded since 1999, at Punta Vicente Roca (PVR) at the north-western tip of Isabela Island by National Geographic/Lindblad staff and guests (T.M. Thys, personal communication). These reports guided the selection of PVR as a study site.

Tissue sampling

Between 26 and 28 September 2011, nine ocean sunfish were sampled at PVR by a team of three snorkellers that captured the sunfish at the sea surface. Sizes ranged from 98 to 165 cm total length. A complete meristic analysis was not completed. All fish had a fin clipping (1 cm²) taken from a pectoral fin and were preserved in 90% EtOH. Of the nine fish sampled, two were also double-tagged with fast-loc GPS tags (Wildlife Computers, Redmond, WA) and acoustic tags (Vemco, Halifax, Nova Scotia). Three fish were tagged with only acoustic tags. Handling of the live animals was kept to a minimum and no animals were sacrificed or collected.

Genetic analysis

The 5' end of the mtDNA control region was amplified in two reactions using three primers. One primer, Manchor-F, matches a conserved region in both *Mola mola* and *Mola ramsayi*. Two other primers, MmolaR and MramR, are *M. mola* and *M. ramsayi* species-specific primers, respectively. With these primers, *M. ramsayi* produces a 359 bp fragment and *M. mola* produces a 250 bp fragment and the species can be easily determined via agarose gel electrophoresis (i.e. presence or absence of the appropriate sized fragment). Species identifications were confirmed by sequencing the fragment from two individuals and comparing the sequences to previously identified *Mola* spp. (Bass et al., 2005).

RESULTS

All of the *Mola* sp. from the Galápagos produced polymerase chain reaction fragments using the MramR forward primer but not with the MmolR primer, consistent with them being *Mola ramsayi*.

DISCUSSION

Our work marks the first record of *Mola ramsayi*, the southern sunfish, in the Galápagos Islands. *Mola ramsayi* can be confused with *Mola mola* in the field (Bass et al., 2005); however, morphological differences do exist and have been described by Fraser-Brunner (1951). *Mola mola* have rougher skin and a reduced band of denticles running between their dorsal and anal fins along the pseudotail known as a clavus (Figure 1). This band is not present in *M. ramsayi*. In *M. ramsayi*, the clavus region is supported by 16 fin rays, 12 of which bear ossicles while in *M. mola* the clavus has 12 fin rays, eight of which bear ossicles. *Mola ramsayi*'s ossicles are situated close together and broader than the

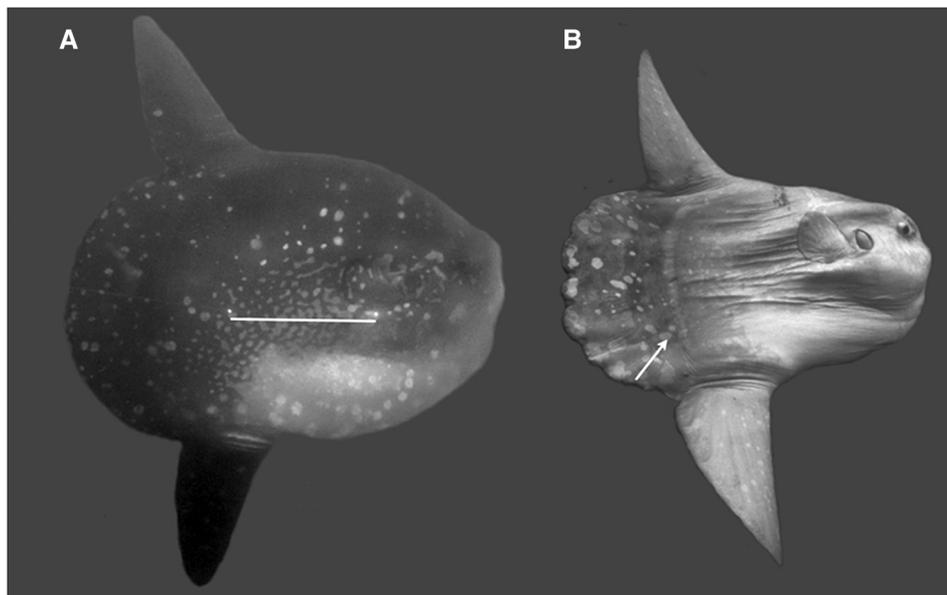


Fig. 1. (A) *Mola ramsayi* from Punta Vicente Roca. Scale bar, 50 cm; total length, 144 cm (photograph: Alex Hearn); (B) *Mola mola* from California waters. Arrow points to band of reduced denticles (photograph: Mike Johnson).

spaces between them while those of *M. mola* are widely separated and less broad than the spaces between them. A full list of meristic differences can be found in Matsuura (2002). Future work will include the collection and analysis of additional samples to deduce from which global population the Galápagos molas stem coupled with a complete meristic analysis.

Mola ramsayi, first described by Giglioli (1883), was originally named *Orthrorogiscus ramsayi*. The common name, southern ocean sunfish, stemmed from the belief that this species occurred only in the southern hemisphere replacing *Mola mola* in these waters (Fraser-Brunner, 1951). Our previous genetic work confirms that *M. ramsayi* does in fact co-occur with *M. mola*, at least, in South African waters (Bass *et al.*, 2005). Furthermore, several recent reports have widened the distribution of *M. ramsayi* into the northern hemisphere in the Sea of Oman (Al Ghais, 1994; Jawad *et al.*, 2012) and Indian waters of Chennai (Mohan *et al.*, 2006). As such, the common name of southern ocean sunfish is no longer appropriate.

Little is known of the natural history of *Mola ramsayi*. The majority of sightings have been recorded from the Chilean coast (Brito, 2003) as well as Australian, Tasmanian (Last *et al.*, 1983; Hutchins & Swainston, 1986; Gomon *et al.*, 1994) and South African waters (Smith & Heemstra, 1986). Within Galápagos, PVR is the most frequently sighted location for molids—most likely of the species *M. ramsayi*. Commercial dive operators and ship owners report less frequent sightings from other regions in the Archipelago, such as Gordon Rocks off Isla Santa Cruz and Cabo Marshall off Isabela Island (Scuba Iguana staff and Lenin Cruz, captain of RV 'Pirata', personal communications).

The attraction of PVR is likely due to its use as a parasite cleaning station. *Mola* spp. are known to play host to at least 54 species of parasites (Moser & Love, 1983) and are encountered at cleaning stations worldwide, e.g. California, (Myers & Wales, 1930); and Indonesia (Konow *et al.*, 2006). Using SCUBA, on 29 September 2011, our team observed approximately two dozen putative *M. ramsayi* at PVR between 20 and 30 m in characteristic cleaning postures; hanging nearly motionless with heads pointed upwards. Juvenile hogfish, *Bodianus diplotaenia*, were picking parasites off their flanks.

Whether or not PVR and the Galápagos in general are important spawning regions for ocean sunfish remains to be seen. According to Nathalia Tirada, formerly of the Charles Darwin Foundation, no larvae of any ocean sunfish species were reported from open water plankton sampling work conducted twice a year in each bioregion of the Galápagos Marine Reserve between 2005 to 2007 (personal communication). Additionally no molid larvae were detected in any coastal water samplings surveys conducted twice a year between 2005 and 2008 and once a year from 2009 to 2012. These surveys used a ZP net of 333µm mesh size and 60 cm diameter towed vertically to a maximum depth of 100 m.

Mola ramsayi is not a targeted catch in Galápagos or eastern Pacific waters; however, it is taken as by-catch elsewhere. California, South Africa and Spain are areas noted for high mola by-catch of primarily *Mola mola* (reviewed in Pope *et al.*, 2010). Off the Peruvian coast, *M. mola* has been reported as by-catch in the longline and drift-net *Coryphaena* sp. and shark fisheries (Alfaro-Shigueto *et al.*, 2010); however, this by-catch is likely a combination of both

M. mola and *M. ramsayi*. Exact numbers of individuals are not yet available. By-catch is likely sizeable given that the number of hooks and nets used by small-scale fisheries in Peru, an estimated 80 million hooks and 100,000 km of fishing nets, equates to one-third of the fishing effort reported by the entire global swordfish longline fishery (Lewison *et al.*, 2004) and is comparable to the now closed Taiwanese high-seas drift-net fleet targeting squid (Northridge, 1991).

Our research provides the first reports of *Mola ramsayi* in Galápagos; none of the samples collected were *Mola mola*. It is likely that this species has been observed in Galápagos in the past, but misidentified as *M. mola* due to the similar morphologies between species. It is not clear at this point whether both species co-exist in Galápagos, or whether this misidentification extends to the entire population of *M. mola*. Until a specimen can be collected or identified from a prior collection, the presence of *M. mola* in Galápagos must remain questionable. While the genetic techniques used in our paper are a definitive method of identification, it is likely that careful meristic analysis in the field would enable accurate distinction of these two co-occurring species. Since accurate species identification is essential for biology and conservation, we recommend that such efforts be made in Galápagos, and worldwide, in all studies of ocean sunfish.

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