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First photographic records of the giant manta ray *Manta birostris* off eastern Australia

We present the first photographic evidence of the presence of the giant manta ray *Manta birostris* in east Australian waters. Two individuals were photographed off Montague Island in New South Wales and off the north east coast of Tasmania, during summer 2012 and 2014, respectively. These sightings confirm previous unverified reports on the species occurrence and extending the range of *M. birostris* to 40ºS. We discuss these findings in the context of the species' migratory ecology, the regional oceanography along the south eastern Australian coastline and local productivity events.

First photographic records of the giant manta ray *Manta birostris* off eastern Australia

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INTRODUCTION

Manta rays (*Manta* spp.) are amongst the largest filter-feeding elasmobranch fishes and have a circumglobal distribution through tropical and temperate coastal waters, off-shore islands and seamounts (Marshall et al. 2009). Manta rays belong to the family Mobulidae, comprising the two genera *Manta* Bancroft, 1829 and *Mobula* Rafinesque, 1810. All mobulid species are epipelagic zooplanktivores that are presumed to be long lived (e.g. >30 years for *Manta* spp.) and have low fecundities (i.e. late maturity, long gestation period and only a single large pup (Couturier et al. 2012). Previously considered to be monospecific (*Manta birostris*), the genus *Manta* was redescribed in 2009 to comprise two distinct species: the reef manta ray *Manta alfredi* (Krefft, 1868) and the giant manta ray *Manta birostris* (Walbaum, 1792), and a third putative species *M.* cf. *birostris* (Marshall et al. 2009). Both recognised species have circumglobal distributions, sympatric in some areas and allopatric in others (Kashiwagi et al. 2011). *Manta birostris* is considered a more oceanic and migratory species, and is found predominantly in cooler, temperate to subtropical waters (Marshall et al. 2011a). *Manta alfredi* displays a high degree of site fidelity in tropical and subtropical waters, but may also undertake local to regional-scale (>700 km) movements and seasonal migrations (Couturier et al. 2014; Couturier et al. 2011; Deakos et al. 2011; Dewar et al. 2008; Jaine et al. 2014; Marshall et al. 2011b).

Both manta ray species and four of the nine described *Mobula* species are reported to occur in tropical to temperate waters of Australia (Last & Stevens 2009; Marshall et al. 2009). While the occurrence of *M. alfredi* has been widely confirmed off the coast of eastern Australia (Couturier et al. 2014; Couturier et al. 2011), the occurrence of *M. birostris* in this region has been lacking photographic validation despite records in literature (Allen et al. 2006; Hutchins &

Swainston 1986; Last & Stevens 2009). The recent separation in the genus *Manta* spp. means that records of *M. birostris* prior to 2009 lacking photographic evidence cannot be validated, as species may have been confused with *M. alfredi* and potentially *Mobula* spp. This paper presents the first photographic evidence confirming the occurrence of *M. birostris* in east Australian waters, with one specimen photographed off Montague Island, New South Wales, in January 2012 and one specimen photographed off the northeast coast of Tasmania in January 2014.

MATERIALS AND METHODS

As part of a larger study, photographs of manta rays were sought from dive clubs, dive instructors, researchers and recreational divers along eastern Australia for photographic identification purposes (see Couturier et al. 2011). Four photographs and two video recordings of a free swimming *M. birostris* were taken by Peter McGee, a recreational diver, off Montague Island (36°15′7.15″S; 150°13′35.19″E; Figure 1) off Narooma in southern New South Wales (Specimen #1, Figure 2a). The individual was sighted near an Australian fur seal *Arctocephalus pusillus* (Schreber, 1775) colony on the 5th January 2012, swimming at a depth of about 13m, in 21°C waters (P. McGee *pers. comm.*).

One photograph of a free swimming *M. birostris* was taken by Leo Miller, a recreational fisherman off the north east coast of Tasmania (40°S; 148°E, no precise location given; Figure 1) on the 26th January 2014 and submitted to the University of Tasmania Institute of Marine and Antarctic Studies' Redmap website http://www.redmap.org.au/ (Specimen #2, Figure 2b).

Characters used to confirm identification of *Manta* spp. were: terminal mouth, broad head and body coloration. Species identification was based on key morphological features provided by Marshall et al. (2009) including (1) distinct shoulder patches with triangular shape, (2) presence of a caudal spine, (3) distinctive dark spots on the ventral side over abdominal region, with no spots present medially between the gills slits, (4) prominent semi-circular marking extending posteriorly from both 5th gills and (5) dark-coloured margin on posterior edges of pectoral fins.

SYSTEMATICS

Order RAJIFORMES Berg, 1940

Family MOBULIDAE Bonaparte, 1838

Genus *Manta* Bancroft, 1829

Manta birostris (Walbaum 1792)

(Figures 2-3)

Brachioptilon hamiltoni Newman, 1849 (see Beebe and Tee-van 1941, as *Manta hamiltoni*); *Ceratoptera ehrenbergii* Müller and Henle, 1841.

RESULTS AND DISCUSSION

Key morphological features, including terminal mouth, broad head, distinctive ventral and dorsal coloration, and presence of caudal spine, could be distinguished from photographs of Specimen #1 (Figure 2a). Together these features allow the specimen to be identified as *M. birostris* and positively differentiated from *M. alfredi* and, also known to occur in east Australian waters (Couturier et al. 2011). The distinctive dorsal coloration of Specimen #2 was the only observable morphological feature identifying this individual as *M. birostris* (Figure 2b).

The occurrence of *M. birostris* off Montague Island at ~36°S in east Australia is consistent with records in south western Pacific Ocean where the species occurs up to 36°S (Duffy & Abbott 2003; Kashiwagi et al. 2011) and in the south western Atlantic where it occurs up to 34°S (Marshall et al. 2011a). Manta ray sightings off Montague Island have been reported in a scuba divers guide (Byron 1986) and in anecdotal reports (N. Coleman & J. Van Der Westhuizen *pers. comm.*). Manta rays are also commonly advertised as possible diving encounters during austral summer by most dive operators using this dive site (e.g. Narooma Charters, Islands Charters). The occurrence of *M. birostris* at this site may be linked to regional circulation patterns and exceptional oceanographic events during summer. The East Australian Current (EAC) flows pole-ward along the east Australian coast and its main EAC jet bifurcates abruptly to the east at~32°S. About a third of the main EAC jet continues south into the Tasman Sea, towards Montague Island, as a series of dynamic eddies (Ridgway & Godfrey 1997; Roughan et al. 2011). Enhanced nutrient concentrations and upwelling processes have been documented during austral spring and summer south of the separation point where Montague Island is located (e.g. Oke & Middleton 2001; Ridgway 2007; Roughan & Middleton 2004). *Manta birostris* may thus occur in this area during warmer months to exploit local productivity events. Similarly, *M. birostris* and several *Mobula* spp. commonly occur during summer months off North East New Zealand which coincide with the path and flow of the East Auckland Current (Duffy & Abbott 2003).

The occurrence of *M. birostris* off north east Tasmania at ~40°S is the newly-extended southern-most record for the species. This sighting may be linked to exceptional oceanographic conditions occurring in the area at the time of the sighting or a response to warming waters by climate-driven change. South-east Australia is a global warming hotspot (Poloczanska et al. 2012;

Wu et al. 2012) and southward range extensions have already been reported for plankton communities, macroalgae, macro-invertebrates and fish (Johnson et al. 2011).

Based on our observations, we confirm the presence of *M. birostris* for the first time in east Australian waters, increasing the known range of the species. The scarcity of recorded observations of *M. birostris* compared to *M. alfredi*, despite vibrant diving and boating activities along the ~4,000 km east Australian coastline, suggests that the species is rare in the area. It is also possible that the species occupies and traverses areas that are not exploited by fisheries and/or tourism and thus remain undetected.

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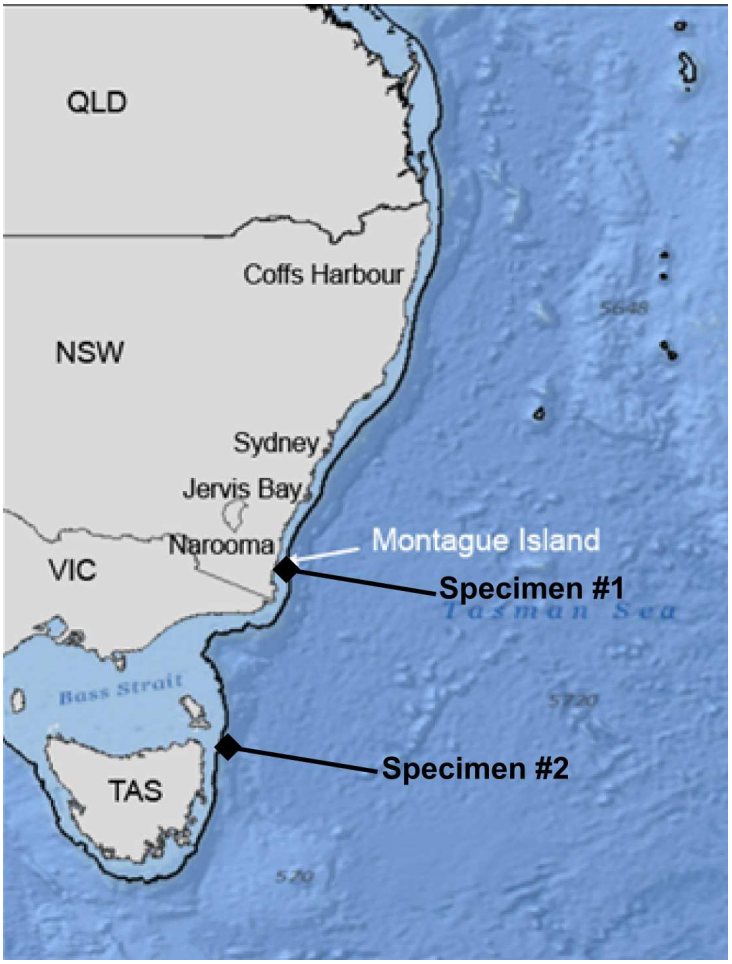

174 **Fig. 1.** Map of south east Australia showing location of sighting of specimen #1 (Montague
175 Island) and specimen #2 (north east Tasmania)

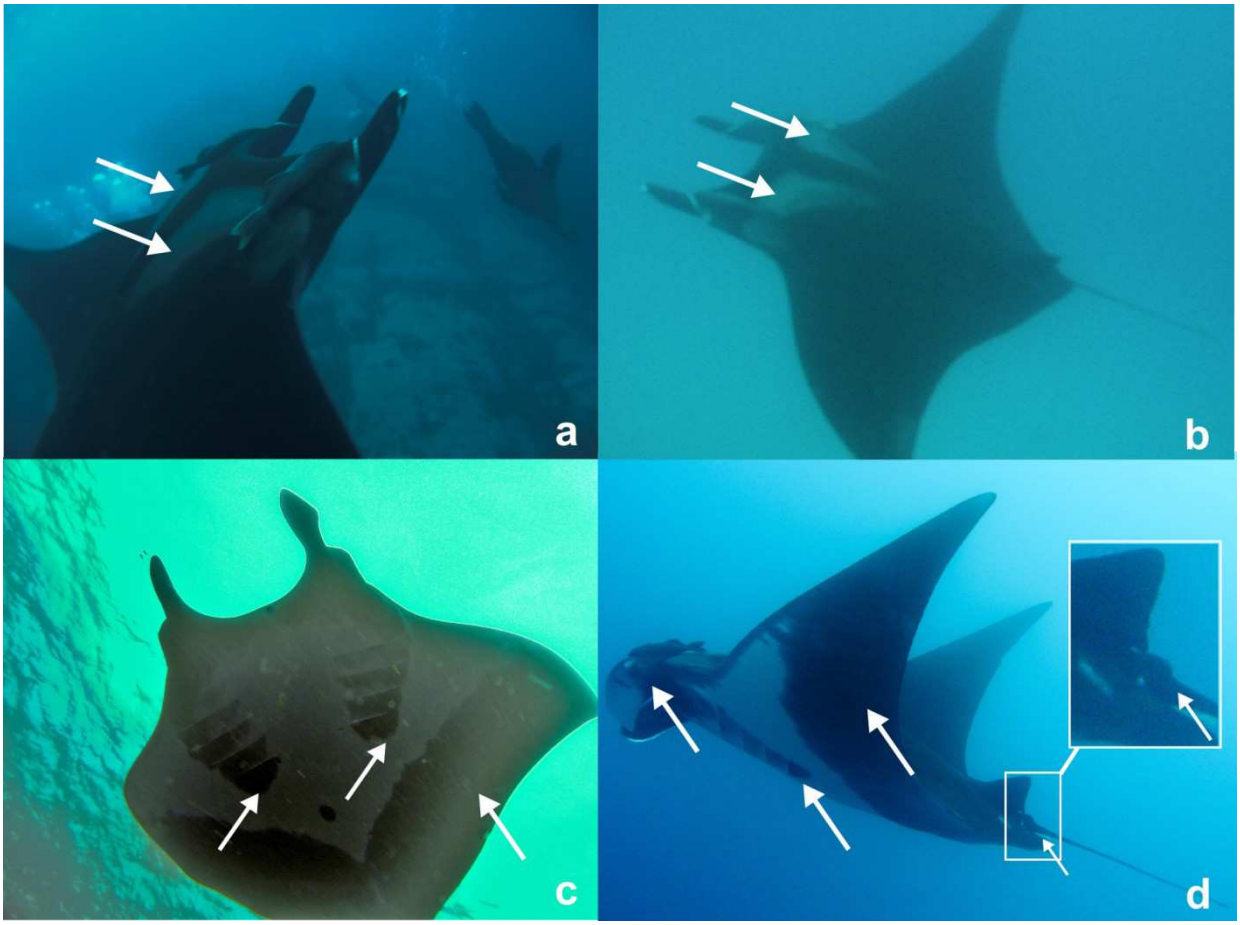

Fig. 2. Photographs of a *Manta birostris* (specimen #1) taken at Montague Island on the 5th January 2012 by Peter McGee. White arrows indicate key characters for *M. birostris* as described in Marshall et al. (2009): (a) and (b) show distinctive dorsal coloration with white shoulder patches with their anterior margins extending medially from spiracles in an approximately straight line parallel to the edge of the mouth; (c) and (d) shows large semi-circular spots posterior to the fifth gill slits and grey V-shaped margin along posterior edge of the pectoral fin and (d) shows dark coloration around mouth and calcified mass with reduced caudal spine covered with skin layer immediately posterior to the dorsal fin (white box)

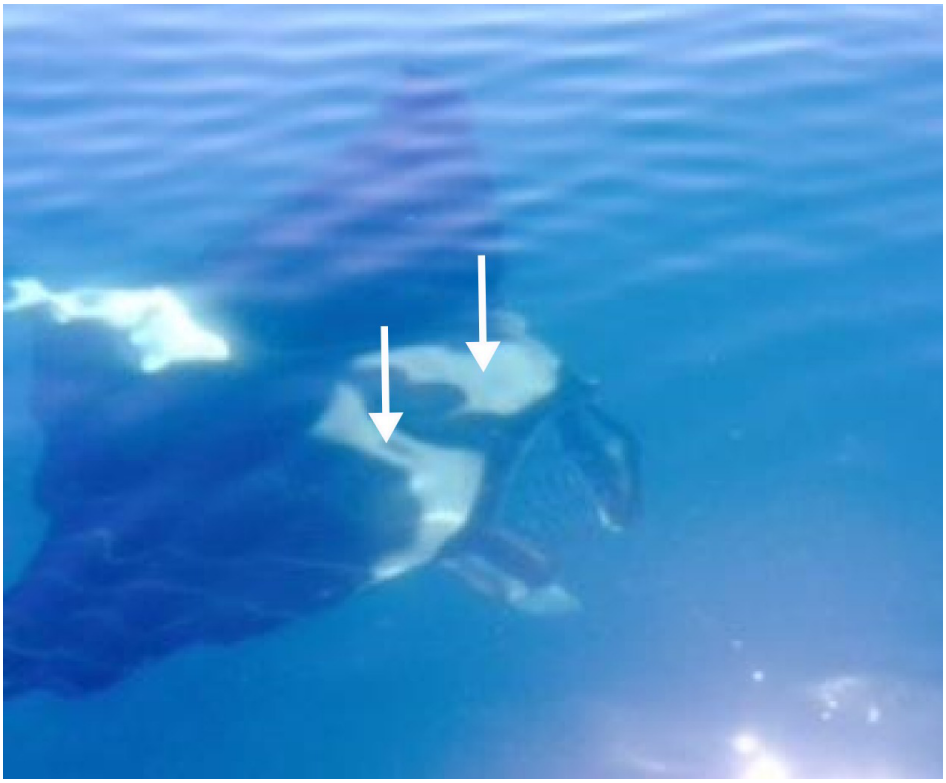

Fig. 3. Photographs of a *Manta birostris* (specimen #2) taken off the north east coast of Tasmania on the 26 January 2014 by Leo Miller. White arrows indicate distinctive dorsal white shoulder patches with their anterior margins extending medially from spiracles in an approximately straight line parallel to the edge of the mouth, as key character of the dorsal colouration of *M. birostris* as described in Marshall et al. (2009).