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1 **First records of the grey nurse shark *Carcharias taurus* (Lamniformes: Odontaspidae)**
2 **from oceanic coral reefs in the Timor Sea**

3

4 PAOLO MOMIGLIANO^{1,2*} AND VANESSA FLORA JAITEH³

5 ¹ Department of Biological Sciences, Macquarie University, Sydney, 2109 New South Wales,
6 Australia

7 ² Sydney Institute of Marine Science, 19 Chowder Bay Road, Mosman, 2088 New South
8 Wales, Australia

9 ³ Centre for Fish and Fisheries Research/Asia Research Centre, Murdoch University,
10 Murdoch, Western Australia 6150, Australia

11

12 *Corresponding author

13 Email: paolo.momigliano@students.mq.edu.au

14 **Running head:** Records of *C. taurus* from oceanic coral reef

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16 ABSTRACT

17 The threatened grey nurse shark (*Carcharias taurus*) is reported for the first time from
18 oceanic coral reefs in the Timor Sea. Generally known from temperate and subtropical
19 coastal reef habitats, this species was encountered by Indonesian traditional fishers on
20 oceanic coral reefs in an area of the Australian Exclusive Economic Zone known as the 1974
21 MoU Box, some 200 km from the Australian mainland. The presence of *C. taurus* on these
22 remote tropical reefs bears important management implications, including the species'
23 protected status in Australian waters and the challenges of regulating catches in areas
24 permitted for traditional Indonesian fishing.

25 **Keywords:** Sand Tiger Shark; IUCN; Threatened; Shark; Traditional Fishery; Distribution

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27 INTRODUCTION

28 Grey nurse sharks (*Carcharias taurus*) are known to occur on coastal reefs of the continental
29 shelf, from the surf zone to depths of about 230 m (Last & Stevens, 2009; Otway & Ellis,
30 2011). They have been reported from inshore regions in temperate to subtropical waters of
31 the Atlantic, Mediterranean and Indo-west Pacific and are generally described as a coastal
32 species (Compagno, 1984; [Ahonen et al., 2009](#)). Within Australia, two main populations of
33 *C. taurus* are recognised: one on the eastern coast and one in Western Australia. The eastern
34 Australian population has a range extending from north of Yeppoon in southern Queensland
35 (Latitude: 22° S) to the southern border of New South Wales (Latitude: 37.5° S) (Otway &
36 Ellis, 2011, Bansemer & Bennett, 2011), while the western population is predominantly
37 found in the coastal waters of south-western Australia, although sightings have been reported
38 from as far north as Exmouth (latitude: 21.5° S) (Chidlow et al., 2005). *Carcharias taurus*
39 has been protected in Australia since 1984, after intense fishing caused severe declines
40 particularly in the eastern population. They are currently listed by the International Union for
41 the Conservation of Nature as Vulnerable globally and as Critically Endangered in eastern
42 Australia and in the southwest Atlantic (Pollard and Smith, 2009).

43 Fishers from the island of Rote in Indonesia's East Nusa Tenggara province have long fished
44 Scott Reef as well as the reefs of Ashmore Island, Cartier Island and Browse Island in the
45 Timor Sea (Fox and Sen, 2002). Now under Australian jurisdiction, an area encompassing
46 these and other reefs known as the Memorandum of Understanding Box (MoU Box) was
47 declared in 1974, allowing traditional fishing with unmotorised vessels by Indonesian fishers
48 in recognition of their traditional fishing grounds (Stacey, 2007). Fishers targeting sharks for
49 local consumption and export of shark fins often sail to Browse Island in the south-eastern
50 corner of the MoU Box, where they catch various species of sharks (Momigliano et al.,
51 2014). Recent fishery surveys (V. Jaiteh, unpublished data) suggested that *C. taurus* forms

52 part of the fishers' catch. Although no surprise to the Indonesian fishers who have fished
53 these waters for centuries, the presence of *C. taurus* on the remote oceanic reefs of the MoU
54 Box was unexpected given the available scientific literature on the distribution of this species.
55 The presence of *C. taurus* on remote tropical reefs within the MoU box is described from
56 four specimens collected by Indonesian fishers. These findings highlight the challenges for
57 the management of this species within the MoU Box, where it may be regularly exposed to
58 fishing pressure.

59 MATERIALS AND METHODS

60

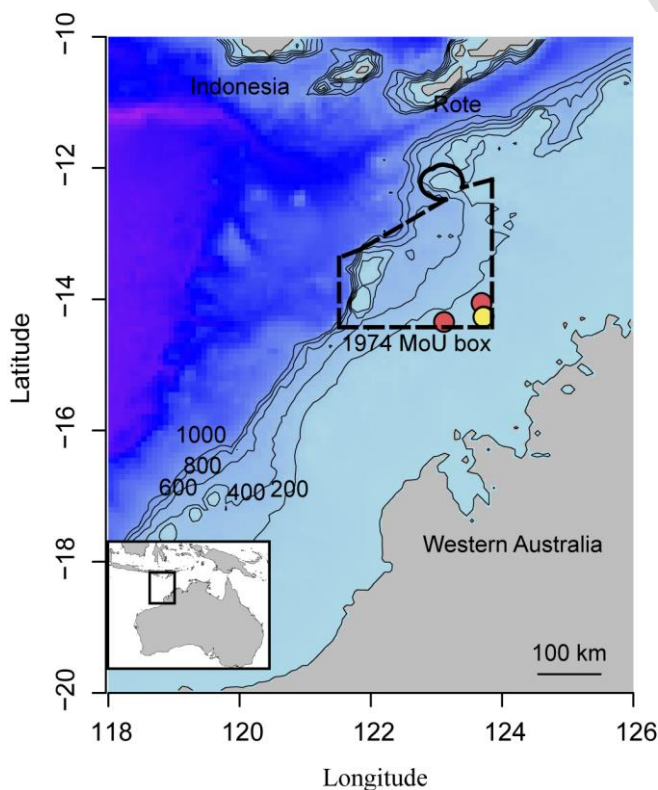


Fig. 1: Map showing locations (red circles) where *Carcharias taurus* (n=4) were caught in the 1974 MoU Box, an area opened for Indonesian traditional fishing within the Australian Exclusive Economic Zone. Red circles indicate locations where one shark was caught, the yellow circle represents two individuals. Bathymetric lines at intervals of 200 m are shown.

12

73 Tissue samples were collected in the 1974 MoU Box by fishers from the island of Rote,
74 Indonesia (Figure 1) between June and November 2013. All samples were collected from
75 sharks caught on baited demersal longlines during the fishers' normal fishing activities and

76 immediately stored in a NaCl saturated solution containing 20% dimethyl sulphoxide and
77 0.25 M ethylenediaminetetraacetic acid; no animals were caught specifically for this study.
78 Fishers also recorded sex, total length and fork length for each specimen. Longline sets that
79 included catches of *Carcharias taurus* had soak times of 10 – 12.5 h and were baited with
80 various species of demersal reef fish. Fishers recorded the GPS location and water depth at
81 each location where sharks were caught.

82 DNA was extracted from fin clips of four specimens that were identified by the fishers as *C.*
83 *taurus* following a chelex extraction protocol (Walsh *et al.*, 1991). A 652 bp fragment of the
84 Cytochrome Oxidase 1 gene was amplified following the protocol outlined by Ward *et al.*
85 (2008). The obtained sequences (GenBank accession numbers: KR003980-KR003983) were
86 matched with sequences deposited in the Barcode of Life Data System (BOLD,
87 <http://www.boldsystems.org/>) database using the BOLD Identification System (IDS).
88 Furthermore, the sequences from these specimens were aligned with sequences from closely
89 related species of the same family (Odontaspidae) obtained from BOLD to construct a
90 Neighbor-Joining phylogeny using the Kimura's two parameter model (Kimura, 1980) and
91 1000 bootstrap pseudo-replicates using the software MEGA 5 (Tamura *et al.*, 2011).

92 RESULTS AND DISCUSSION

93 Four individuals of *Carcharias taurus* (three females and one male) were caught in the
94 approximate vicinity of Browse Island (14°6'30"S, 123°32'50"E) in the south-eastern corner
95 of the MoU Box (Table 1 and Figure 1), on demersal longlines set at depths of 50 - 90 m.
96 Fishers identified the sharks as *hiu lapis gigi* which translates to 'layered tooth shark', and
97 matched the species to *C. taurus* when shown an identification guide (Last & Stevens, 2009).
98 Total lengths ranged from 209 cm (the only male specimen) to 273 cm (Table 1), suggesting
99 all individuals were adults (Bansemer & Bennett 2011).

100 Table 1: Sex, lengths and geographical coordinates for each recorded specimen of *C. Taurus*
 101 in the MoU Box, Timor Sea.

Specimen	Sex	Total Length (cm)	Fork Length (cm)	Latitude	Longitude
GN 1	F	273	223	14° 16' 16" S	123° 42' 56" E
GN 2	F	231	198	14° 3' 27" S	123 41' 16" E
GN 3	M	209	178	14° 20' 44" S	123° 6' 55" E
GN 4	F	270	213	14° 15' 5" S	123° 43' 12" E

102
 103
 104 The obtained sequences were unambiguously identified as *Carcharias taurus* by the BOLD
 105 search engine, yielding matches with sequences of *C. taurus* deposited in BOLD ranging
 106 from 99.66% to 100%. The final alignment used for phylogenetic reconstruction included 591
 107 unambiguously aligned positions, including 96 variable sites and 95 parsimony informative
 108 sites. Within the phylogenetic reconstruction all individuals were grouped with 100%
 109 bootstrap support with other *C. taurus* sequences (Figure 2).

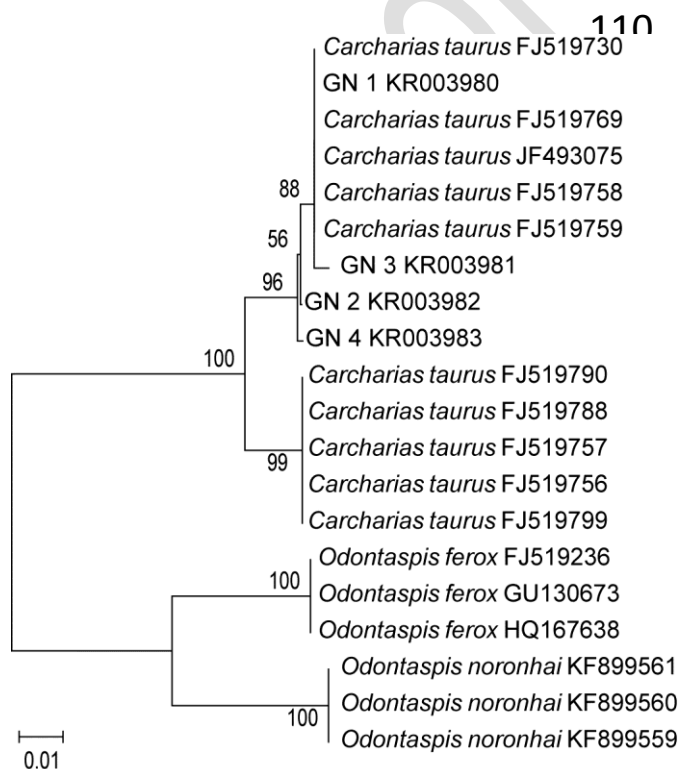


Fig. 2: Neighbour-Joining tree showing the placement of *Carcharias taurus* samples within a phylogeny of the family Odontaspidae. All sequences obtained in this study are nested within sequences of *Carcharias taurus* and are grouped with sequences of this species with 100% bootstrap support. Internal branch support values represent 1000 bootstrap pseudo-replicate datasets. The tree was mid-point rooted for purposes of clarity. Scale bar represents number of changes per base pair.

122 *Carcharias taurus* is listed as Vulnerable globally, as Near Threatened in Western Australia
123 and as Critically Endangered in eastern Australia (Pollard & Smith 2009). The New South
124 Wales government declared *C. taurus* a protected species in 1984, making it the first shark
125 species in the world to be legally protected. *Carcharias taurus* is now protected in all
126 Australian states through fishery legislations and in Commonwealth waters via the
127 Environmental Protection and Biodiversity Conservation Act (1999). The MoU Box forms
128 part of Australia's Commonwealth waters and as such falls under the jurisdiction of the
129 federal government. Since *C. taurus* is a protected species in Australian waters, their
130 protection should extend to the remote reefs of the MoU Box. As with the species recently
131 listed on Appendix II of the Convention on International Trade in Endangered Species of
132 Wild Fauna and Flora (the portbeagle, oceanic whitetip and hammerhead sharks and manta
133 rays), ensuring the protection of this species in the MoU Box will present challenges not only
134 due to the remoteness of the reefs, but also because of the agreement with Indonesia that
135 allows traditional fishing by Indonesian fishers.

136 It is unknown whether *C. taurus* within the MoU box are part of the Western Australian
137 population or whether they belong to a separate demographic stock. Previous population
138 genetic studies on *C. taurus* suggest that there is negligible migration between the
139 populations along the eastern and western coasts of Australia (Stow *et al.*, 2006; Ahonen *et*
140 *al.*, 2009). Within eastern Australia however, individual *C. taurus* have been observed
141 undertaking large-scale unidirectional movements of over 1,100 km (Bansemmer & Bennett,
142 2011). If the individuals to the far north of Western Australia are part of a separate,
143 geographically isolated demographic unit, there would be reason for concern over their
144 conservation status given the species' heavily K-selected life history with only two pups
145 every other year (Bansemmer & Bennet 2009) and regular fishing pressure at Browse Island
146 and surrounding reefs (Momigliano *et al.*, 2014). An assessment of the genetic population

147 structure of *C. taurus* on the western coast of Australia is recommended to provide insight on
148 the appropriate spatial scale of management for this species in Western Australia's exclusive
149 economic zone.

150

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160 REFERENCES

161 Ahonen H., Harcourt R. and Stow A. (2009) Nuclear and mitochondrial DNA reveals
162 isolation of imperilled grey nurse shark populations (*Carcharias taurus*).
163 *Molecular Ecology*, 18, 4409–4421.

164

165 **Bansemer C.S. and Bennett M.B.** (2009) Reproductive periodicity, localised movements
166 and behavioral segregation of pregnant *Carcharias taurus* at Wold Rock, southern
167 Queensland, Australia. *Marine Ecology Progress Series*, 374, 215-227

168

169 **Bansemer C.S. and Bennett M.B.** (2011) Sex- and maturity-based differences in movement

170 and migration patterns of grey nurse shark, *Carcharias taurus*, along the eastern coast of
171 Australia. *Marine and Freshwater Research*, 62, 597-606

172

173 **Chidlow J., Gaughan D. and McAuley R.** (2005) Identification of Western
174 Australian Grey Nurse Shark aggregation sites. *Final Report to the*
175 *Australian Government, Department of the Environment and Heritage,*
176 *Canberra, ACT Australia.*

177

178 **Compagno L. J. V.** (1984) FAO Species Catalogue, Vol. 4. Sharks of the World. An
179 annotated and illustrated catalogue of shark species known to date. Part 1, Hexanchiformes
180 to Lamniformes. *FAO Fisheries Synopsis* 125, Vol 4, Part 1, 249 pp

181

182 **Fox J. and Sen S.** (2002) A Study of Socio-Economic Issues Facing Traditional Indonesian
183 Fishers Who Access the MOU Box. *A Report for Environment Australia. Environment*
184 *Australia, Canberra, ACT Australia.*

185

186 **Kimura M.** (1980) A simple method for estimating evolutionary rates of base
187 substitutions through comparative studies of nucleotide sequences. *Journal of Molecular*
188 *Evolution*, 16, 111–120.

189

190 **Last P.R. and Stevens J.D.** (2009) *Sharks and rays of Australia*. Collingwood: CSIRO
191 Publishing.

192

193 **Momigliano P., Jaiteh V.F. and Speed C.W.** (2015) Predators in danger: shark conservation
194 and management in Australia, New Zealand, and their neighbours. *In*: Stow, A., Holwell, G.
195 & Maclean, N. (Eds). *Austral Ark*. Cambridge: Cambridge University Press pp. 467–491.
196

197 **Otway N. M. and Ellis M. T.** (2011) Pop-up archival satellite tagging of *Carcharias taurus*:
198 movements and depth/temperature-related use of south-eastern Australian waters. *Marine and*
199 *Freshwater Research*, 63, 607-620
200

201 **Pollard,D. and Smith A.** (2009) *Carcharias taurus*. The IUCN Red List of Threatened
202 Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on 07 November 2014.
203

204 **Stacey N.** (2007) *Boats to Burn: Bajo fishing activity in the Australian fishing zone*.
205 Canberra: Asia–Pacific Environment Monograph, ANU E Press.
206

207 **Stow A., Zenger K., Briscoe D., Gillings M., Peddemors V., Otway N. and Harcourt R.**
208 **(2006) Isolation and genetic diversity of endangered grey nurse shark (*Carcharias***
209 ***taurus*) populations. *Biololy Letters*, 2, 308–311.**
210

211 **Tamura K., Peterson D., Peterson N., Stecher G., Nei M. and Kumar S.** (2011). MEGA5:
212 molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance,
213 and maximum parsimony methods. *Molecular Biology and Evolution*, 28, 2731–2739.
214

215 **Walsh P.S., Metzger D.A. and Higuchi R.** (1991) Chelex 100 as a medium for simple
216 **extraction of DNA for PCR-based typing from forensic material. *BioTechniques* 10, 506–513.**
217

218 **Ward R.D., Holmes B.H., White W.T. and Last P.R.** (2008) DNA barcoding Australasian
219 chondrichthyans: results and potential uses in conservation. *Marine and Freshwater*
220 *Research*, 59, 57–71.

221 **Correspondence to be addressed to:** Paolo Momigliano, Department of Biological
222 Sciences, Macquarie University, Sydney, 2019 New South Wales, Australia

223 email: paolo.momigliano@students.mq.edu.au

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