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

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

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ABSTRACT

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

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

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

Fishers from the island of Rote in Indonesia’s East Nusa Tenggara province have long fished Scott Reef as well as the reefs of Ashmore Island, Cartier Island and Browse Island in the Timor Sea (Fox and Sen, 2002). Now under Australian jurisdiction, an area encompassing these and other reefs known as the Memorandum of Understanding Box (MoU Box) was declared in 1974, allowing traditional fishing with unmotorised vessels by Indonesian fishers in recognition of their traditional fishing grounds (Stacey, 2007). Fishers targeting sharks for local consumption and export of shark fins often sail to Browse Island in the south-eastern corner of the MoU Box, where they catch various species of sharks (Momigliano *et al.*, 2014). Recent fishery surveys (V. Jaiteh, unpublished data) suggested that *C. taurus* forms
part of the fishers’ catch. Although no surprise to the Indonesian fishers who have fished
these waters for centuries, the presence of *C. taurus* on the remote oceanic reefs of the MoU
Box was unexpected given the available scientific literature on the distribution of this species.

The presence of *C. taurus* on remote tropical reefs within the MoU box is described from
four specimens collected by Indonesian fishers. These findings highlight the challenges for
the management of this species within the MoU Box, where it may be regularly exposed to
fishing pressure.

MATERIALS AND METHODS

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
captured, the yellow circle represents two
individuals. Bathymetric lines at intervals of 200
m are shown.

Tissue samples were collected in the 1974 MoU Box by fishers from the island of Rote,
Indonesia (Figure 1) between June and November 2013. All samples were collected from
sharks caught on baited demersal longlines during the fishers’ normal fishing activities and
immediately stored in a NaCl saturated solution containing 20% dimethyl sulphoxide and 0.25 M ethylenediaminetetraacetic acid; no animals were caught specifically for this study. Fishers also recorded sex, total length and fork length for each specimen. Longline sets that included catches of *Carcharias taurus* had soak times of 10 – 12.5 h and were baited with various species of demersal reef fish. Fishers recorded the GPS location and water depth at each location where sharks were caught.

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

**RESULTS AND DISCUSSION**

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

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Sex</th>
<th>Total Length (cm)</th>
<th>Fork Length (cm)</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>GN 1</td>
<td>F</td>
<td>273</td>
<td>223</td>
<td>14° 16' 16&quot; S</td>
<td>123° 42' 56&quot; E</td>
</tr>
<tr>
<td>GN 2</td>
<td>F</td>
<td>231</td>
<td>198</td>
<td>14° 3' 27&quot; S</td>
<td>123° 41' 16&quot; E</td>
</tr>
<tr>
<td>GN 3</td>
<td>M</td>
<td>209</td>
<td>178</td>
<td>14° 20' 44&quot; S</td>
<td>123° 6' 55&quot; E</td>
</tr>
<tr>
<td>GN 4</td>
<td>F</td>
<td>270</td>
<td>213</td>
<td>14° 15' 5&quot; S</td>
<td>123° 43' 12&quot; E</td>
</tr>
</tbody>
</table>

The obtained sequences were unambiguously identified as *Carcharias taurus* by the BOLD search engine, yielding matches with sequences of *C. taurus* deposited in BOLD ranging from 99.66% to 100%. The final alignment used for phylogenetic reconstruction included 591 unambiguously aligned positions, including 96 variable sites and 95 parsimony informative sites. Within the phylogenetic reconstruction all individuals were grouped with 100% 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 midpoint rooted for purposes of clarity. Scale bar represents number of changes per base pair.
*Carcharias taurus* is listed as Vulnerable globally, as Near Threatened in Western Australia and as Critically Endangered in eastern Australia (Pollard & Smith 2009). The New South Wales government declared *C. taurus* a protected species in 1984, making it the first shark species in the world to be legally protected. *Carcharias taurus* is now protected in all Australian states through fishery legislations and in Commonwealth waters via the Environmental Protection and Biodiversity Conservation Act (1999). The MoU Box forms part of Australia’s Commonwealth waters and as such falls under the jurisdiction of the federal government. Since *C. taurus* is a protected species in Australian waters, their protection should extend to the remote reefs of the MoU Box. As with the species recently listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (the portbeagle, oceanic whitetip and hammerhead sharks and manta rays), ensuring the protection of this species in the MoU Box will present challenges not only due to the remoteness of the reefs, but also because of the agreement with Indonesia that allows traditional fishing by Indonesian fishers.

It is unknown whether *C. taurus* within the MoU box are part of the Western Australian population or whether they belong to a separate demographic stock. Previous population genetic studies on *C. taurus* suggest that there is negligible migration between the populations along the eastern and western coasts of Australia (Stow *et al.*, 2006; Ahonen *et al.*, 2009). Within eastern Australia however, individual *C. taurus* have been observed undertaking large-scale unidirectional movements of over 1,100 km (Bansemer & Bennett, 2011). If the individuals to the far north of Western Australia are part of a separate, geographically isolated demographic unit, there would be reason for concern over their conservation status given the species’ heavily K-selected life history with only two pups every other year (Bansemer & Bennett 2009) and regular fishing pressure at Browse Island and surrounding reefs (Momigliano *et al.*, 2014). An assessment of the genetic population
structure of *C. taurus* on the western coast of Australia is recommended to provide insight on the appropriate spatial scale of management for this species in Western Australia's exclusive economic zone.

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