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Short Communication

First reports of proliferative lesions in the great white shark, *Carcharodon carcharias* L., and bronze whaler shark, *Carcharhinus brachyurus* Günther

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The low incidence of reported tumours in elasmobranchs has led to the assumption that the group rarely develops cancerous diseases (Loprinzi *et al.* 2005). This, combined with some studies reporting a therapeutic benefit in cartilage extract (e.g. Cho & Kim 2002), has resulted in a worldwide demand for shark cartilage products for use as alternative therapies (Berzins & Hovland 1999). This demand has, at least in part, increased the pressure on shark populations contributing to their worldwide decline (Ostrander *et al.* 2004). While reported cases are relatively low, both benign and cancerous proliferative lesions have been reported in 21 species of sharks from over 9 families (Ostrander *et al.* 2004; National Cancer Institute 2007).

Cutaneous neoplasms have been reported in a number of elasmobranchs including the tiger shark, *Galeocerdo cuvier* (Müller and Henle) (Ostrander *et al.* 2004), the smooth dogfish, *Mustelus canis* Mitchill (Wolke & Murchelano 1976), and the bull shark, *Carcharhinus leucas* Müller and Henle (Harshbarger 1972). Odontogenic, oral and gingival neoplasms are well documented in bony fish (Harshbarger & Clark 1990; Grizzle & Goodwin 1998) and were reported from sharks including the grey nurse shark, *Carcharias taurus* Rafinesque, and blue shark, *Prionace glauca* L. (*Borucinska et al.* 2004).

Various studies and observations suggest a relationship between tumour development and environmental contamination in other species (McAloose & Newton 2009). Rates of reported neoplasm in marine mammals have steadily increased over the past two decades including newly described and resurging diseases, giving rise to concern whether such tumours could be reflective of environmental distress syndrome triggered by human-related activities (Bossart 2007).

This study describes the first observations of proliferative, possibly neoplastic, lesions in two elasmobranch species: a great white shark, *Carcharodon carcharias* L., and a bronze whaler, *Carcharhinus brachyurus* Günther observed at the Neptune Islands in South Australia. Photographic images of white sharks at the Neptune Islands, South Australia, were obtained by still cameras or through the use of a camera mounted on a hand-held pole, as part of an ongoing photographic identification database program. Each photograph was categorized based on the sex of the shark; approximate size; pigment patterns from the gill, dorsal, ventral fin and caudal fin regions; and permanent markings such as major scars; notches on the dorsal fin; and amputations or mutilations. In addition to its use for identification, the database is also used to document incidences of white shark injuries and to record resighting rates of sharks from year to year.

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An approximately 450-cm TL male great white shark (shark 1) with a mass protruding from the lower jaw was observed and photographed at the Neptune Islands, South Australia, between 16 December 2012 and 18 February 2013. Between 2009 and 2013, a growth on the head of an approximately 200-cm TL male bronze whaler (shark 2) was photographed at the same location during the months of January and February.

Shark 1, a mature male white shark, presented in overall good body condition, with some patches of copepod around the gills and lower head regions. A large, lobulated gingival mass (epulis) was observed on the surface of the lower jaw measuring approximately 30 cm long by 30 cm wide (Fig. 1a). The colour of the nodules was mostly white. The mass appeared to be gingival and protruded extensively beyond the jaw. The teeth were missing or overgrown by the mass in this section of the lower jaw (Fig. 1b).

Shark 2 was observed to be present over four consecutive years with no discernible loss of body condition over time. A raised, irregular, solid mass was observed in year 1 on the dorsal surface approximately 20 cm posterior of the eye. The mass appeared to originate in the subcutaneous tissue with a rigid outline suggestive of solid tissue. Approximately 75% of the surface signature of the mass was covered by the epidermis, and the remaining portion was white in colour (Fig. 1d). The mass did not appear to change in size or shape during the subsequent 3 years of observations. In years 1 and 2, a single mass was observed on the head region on the dorsal surface posterior to the eye. In years 3 and 4, four further white lesions along the dorsal surface of the body were observed, one on the left-hand side and three on the right-hand side – one approximately 30 cm posterior of the main mass, and two located between the first and second dorsal fins around 20 cm apart (Fig. 1c). These lesions were small (about 2–5 cm in diameter) and remained consistent in size, shape and colour from 2012 to 2013.

Neoplastic disease has not been previously reported from either of the species in this study, and this is the first report of possibly neoplastic lesions from the family Lamnidae. While the masses did not appear to be deleterious to the health of either shark at this time, both presenting in good body condition, the consequences of progressive neoplastic disease both at the individual and species level are of concern.

The size and position of the mass of the white shark, if progressive, could interfere with feeding and potentially lead to debilitation or death. The loss of teeth may affect the shark's ability to successfully capture and consume prey. It is not known whether the shark had sustained trauma and the masses had formed in response, although tumours have been linked to traumatic injury in teleosts species (Hayes & Ferguson 1989; Francis-Floyd *et al.* 1993) and in the grey nurse shark

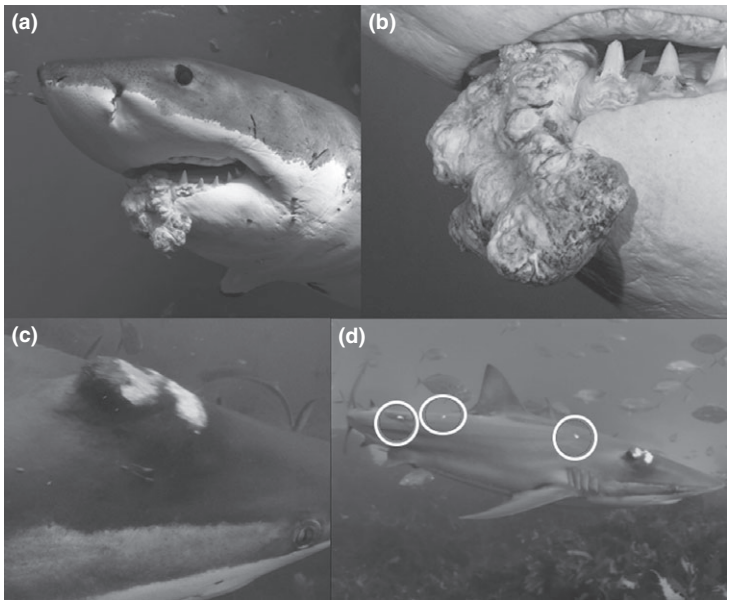

Figure 1 (a) Neoplasm on the lower jaw of a 450-cm TL male great white shark. (b) Close-up view of the gingival neoplasm. (c) Neoplasm on the head of a 200-cm TL male bronze whaler shark with secondary lesions circled. (d) Close-up view of primary cutaneous neoplasm on head of bronze whaler. Photographs by A. Fox (a,c, d) and S. Cahir (b).

(Campbell *et al.* 1994). It is also possible that this mass is a keloid, formed in response to trauma, as described by Smith & Hartley (1976) in the grey reef shark *Carcharhinus amblyrhynchos* Bleeker. However, based on the advanced condition and size, the mass is more likely to be a true neoplasm (J. Borucinska, pers. comm).

The lesions along the body of the bronze whaler shark in the third and fourth years of observation could be signs of secondary tumours. Waldoch *et al.* (2010) described a similar progression in a lesion on the caudal fin of a captive grey nurse shark. After a 5-year history of very little neoplastic growth, the tumour enlarged as a consequence of a purported unrelated illness, and further lesions appeared on the back, sides and ventrum of the abdomen and along the tail. They hypothesized that both the tumour growth and the secondary lesions developed as a result of stress and illness (Waldoch *et al.* 2010). Immunosuppression has been strongly correlated with neoplasms in other species (Cray *et al.* 2001), so this reportedly unrelated ailment may have been linked to the neoplasm. The secondary lesions observed in this study may be suggestive of malignancy or may be indicative of declining health in this individual.

High cancer incidence has been reported in marine animal populations that inhabit waters heavily contaminated with anthropogenic chemicals (Bossart 2007). Cancer is the second leading cause of death in beluga whales living in waters polluted with effluent from aluminium smelting plants (Martel *et al.* 1986). The prevalence of neoplasms in green turtles inhabiting inshore waters in Florida is associated with heavily polluted areas, areas of high human density and habitat degradation (Foley *et al.* 2005). Chemically polluted habitats have been linked to lip neoplasms and squamous cell carcinoma in other fish species (Harshbarger & Clark 1990). Unlike smaller fish, fat stores of apex predators such as sharks can accumulate high levels of toxins that may be released during periods of high physiological or pathological demand (Bossart 2007), which in turn may make them more susceptible to neoplastic growth (Borucinska *et al.* 2004). The possibility that the neoplasms of the sharks in this study are anthropogenically induced and indicative of environmental distress syndrome should be further investigated.

The examples described here add to the growing evidence of proliferative, possibly neoplastic lesions, in various species of sharks, further debunking the myth of cancer resistance in elasmobranchs. Although non-lethal diagnosis of disease in free-swimming shark populations is challenging, monitoring and investigation focused on understanding the histology and potential causes of proliferative lesions are needed to further our understanding of tumours in sharks and to determine the effects on the species. If indicative of increased exposure to pollutants, lesions in sharks may be important indicators of ecosystem health.

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