

A note on healing of large wounds in bottlenose dolphins, *Tursiops truncatus*

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Several authors have described the healing patterns of both naturally-occurring and experimental superficial injuries to bottlenose dolphins, *Tursiops truncatus*. Würsig and Würsig (1977) stated that 'pigment' spots and bite marks made by conspecifics ... usually last for only about six months to one year' (p. 755). Lockyer and Morris (1986) reported that tooth rake marks from an unknown odontocete species on a wild, sociable bottlenose dolphin virtually disappeared over a period of five months. Bruce-Allen and Geraci (1985) described the ultra-structure of stages of healing of incisions 10 cm long and 2 mm deep on three captive bottlenose dolphins. It may be important that the last study, as well as some others, were conducted on captive dolphins, and therefore in treated water. The nature of the holding water may affect the process of wound healing, so that observations of wound healing in free-ranging dolphins are potentially valuable.

There is evidence that large injuries are inflicted on delphinids by sharks (Corkeron *et al.*, 1987), but we have been unable to find any accounts of the healing of such large wounds. Caldwell *et al.* (1965) describe (p. 8) a 'fresh but nearly healed scar from the bite of a large shark' on a bottlenose dolphin. This paper reports healing of large wounds inflicted by sharks on a small sample of free-ranging bottlenose dolphins. The affected dolphins were observed with fresh wounds, and during healing over time, in the course of an investigation of the behavioural ecology of inshore delphinids in Moreton Bay, Queensland. Estimates of the rates of healing of wounds could be obtained from these observations.

It was possible to estimate the rate of wound healing of only three dolphins, although 21 instances of animals with fresh wounds were observed. The other 18 animals were not seen sufficiently frequently to allow us to be confident of estimates of wound healing rate. This is thought to be due to the ranging patterns of dolphins in Moreton Bay, and the distribution of sighting effort in the bay (many animals' core areas were sampled infrequently), rather than shark-bite mortality. The fact that 36.6% of dolphins in Moreton Bay show evidence of healed shark attack wounds supports this hypothesis.

Examples of fresh and healed wounds are shown in Figs. 1-4. The healing pattern of animal B 41's wounds, the most severe noted in this study, is of particular interest. Figure 1a shows the wound, as first seen, on January 6th 1986 when the injury can have been no more than 17 days old, and possibly considerably less. By 17 January 1986, 11 days after her wounds were noted initially, and with a maximum possible time of 28 days from her being attacked, the wounds were healed substantially (see Fig. 1b). Healing was complete by 19 August 1986, seven months after the attack. At the time of the attack B41 was nursing a 2-month-old calf (born just prior to 8 November 1985). The calf remained in good health and grew apparently normally, having been seen with B41 on 10 February 1987. Therefore despite the metabolic stress associated with lactation, the massive wounds on this animal healed within seven months.

One animal, number B86, was observed with a fresh bite (see definition in Corkeron *et al.*, 1987) on 27 February 1985 (Fig. 2a). Her immediately previous sighting was on 10 December 1984. As can be seen from Fig. 2b, she had healed completely by 19 August 1985. Note also in Fig. 2b that there is heavy pigmentation in the centre of the wound, but a pale area on either side of it. Examination of other large healed scars showed variation in the degree and pattern of depigmentation (for example see Fig. 3), but it seems that in many instances at least, depigmentation persists for a very long time (see Bruce-Allen and Geraci, 1985 for a brief discussion of this point).

Dolphin B28 was observed with a large wound on 21 March 1986. This was not present when she was seen immediately previously on 20 November 1985; while her wound on 21 March 1986 was classed as 'fresh', it was clearly not as recent as those of B86 or B41 (note presence of some healing on the edges of the bite, Fig. 4). This animal was observed again on 18 April 1986, when field notes recorded that her wound was healed.

The wounds classified as large were inflicted by large sharks: estimates of the size of the wounds measured on photographic images were up to 45 cm



Figure 1a



Figure 1b

Figures 1a & 1b. Healing of large wounds on animal B41 between January 6th–January 17th 1986.



Figure 2a



Figure 2b

Figures 2a & 2b. Healing of a wound on animal B86 between February 27th–August 19th 1986.



Figure 3. Example of de-pigmentation observed in a healed wound on animal B51.



Figure 4. A large wound observed on animal B28 (21st March 1986).

long and 12 cm deep, the gape of the jaws of attacking sharks being up to 60 cm. Some of the wounds were such that extensive haemorrhage would have been expected at the time of the attack, although the fine control of the peripheral circulation in diving mammals may minimise it (see Elsner, 1969).

The dolphins described here were not captured, so details of the process of wound healing were not examined. However, at least the broad principles of wound healing in dolphins can be expected to be similar to those in other species (for a discussion of healing of open wounds, see Peacock, 1976; Johnston, 1981). The blubber, which includes fat and connective tissue, would be expected to heal rapidly and completely following injury. Skin on the other hand is a highly complex organ, which does not possess the power of complete regeneration, so that damaged tissue is replaced by a fibrous scar tissue which, on the surface, is covered by regenerated and remodelled epithelium. During healing of large, open wounds, regeneration of epithelium occurs, a layer of granulation tissue (which must be very extensive in the wounds illustrated here) forms in the bed of the wound, and wound contraction occurs. Depigmentation occurs as in superficial wounds (Harrison and Thurley, 1974), but unlike in the latter it appears to be more or less permanent. Finally a scar with more or less depigmentation and deformation of the adjacent tissues remains. Wounds of the tail stock, in particular, may show extensive deformation upon healing, possibly because the entire region can fit between the jaws of a large shark and more extensive damage is possible. Possibly extensive muscle damage results in deep scar formation in this region, causing deformation.

Complete healing of such large, open wounds appear to occur relatively rapidly. Bruce-Allen and Geraci (1984) were surprised at the rapid rate at which healing occurred in dolphins. They pointed out that a distinguishing feature of healing in the dolphin is the absence of a scab in the traditional sense. Instead, a buffer zone is created by a degenerating layer of cells exposed to seawater. It seems that seawater, in osmotically damaging the exposed cells, actually instigates the formation of the buffer zone which shields the underlying tissue, thereby permit-

ting repair to take place. Repair of the epithelium is rapid because the wound exposes very many dermal papillae because of the extensive folding of the germinal layer. Another factor that possibly aids in tissue repair is the constant, relatively gentle irrigation of the wound.

Acknowledgements

Financial support for this work was provided by the Marine Sciences and Technologies Grants Scheme, Australia (grant to M.M.B.).

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