

Case Report

Recovery from severe cutaneous injury in two free ranging bottlenose dolphins (*Tursiops spp.*)

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Abstract

Bottlenose dolphins (*Tursiops spp.*) inhabiting the Port Adelaide estuary in South Australia have been studied since 1989. Here we present the cases of a female and calf which sustained severe localized burn-like injuries of unconfirmed aetiology. The remarkable recovery of the two dolphins was carefully documented photographically from the time of first sighting (April 11, 2010) through to the present (June, 2014). No invasive tissue sampling to investigate pathology was undertaken, nor was any form of medication administered. This paper chronologically presents images and commentary of the phases of wound healing seen in these two unique cases. The unaided recovery of these dolphins from severe trauma has implications for evaluating the need for veterinary intervention in these animals in certain situations. In addition, the topics of dolphin behaviour and the value of citizen science in documenting the events are discussed.

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Introduction

Bottlenose dolphins (*Tursiops spp.*) inhabit the Port Adelaide estuary in South Australia. These dolphins have been studied since 1989 using photo identification techniques to monitor the behaviour and health of individuals. There are approximately 30 resident dolphins and numerous others that visit the area, which is close to a city of a million people and thus subject to numerous human impacts. These impacts include habitat damage caused by pollution and direct impacts on the dolphins from deliberate attack and accidents. In 2005, the South Australian government declared the waters around the Port Adelaide estuary a dolphin sanctuary. Two of the resident dolphins are an adult female (F351, estimated to have been born in 1992) and her male calf (M501, born in March 2009). F351 had previously given birth to two calves (a male in 2002 and a female in 2006) which have remained in the estuary. F351 is identifiable by the shape

and configuration of her dorsal fin. F351 is known locally as "Wave" and her calf (M501) as "Tallula."

At some time between the 2nd and 11th of April 2010, the two dolphins received severe, burn-like skin injuries, F351 on her right flank and her calf M501 on his left flank. The aetiology of these injuries is unknown, but most marine mammal experts who viewed photographs of the injuries suggested sunburn arising from being stranded as the most likely cause. We have no way of verifying this aetiology but the local geography includes extensive intertidal mudflats which could increase the potential for strandings. Communication with port authorities indicated no evidence of chemical spills or other anthropogenic incidents which might have caused the injuries. The recovery of the two dolphins from this severe trauma was documented photographically from the time of first sighting (April 11, 2010) through to the present (June 2014). However, no invasive tissue sampling to investigate pathology was undertaken, nor was any form of medication administered. This paper documents the phases of wound healing seen in these dolphins.

Dolphins possess remarkable wound healing abilities (1, 4). Many sustain large gaping wounds from boat propeller strikes and predators (1). Nevertheless, even severe wounds exposing deep muscle tissue have been observed to heal almost completely within five months (4). Humans sustaining similar injuries relative to body size would likely encounter serious complications without surgical or therapeutic intervention. The wound healing physiology of the bottlenose dolphin therefore represents an interesting area of inquiry.

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The two dolphins were sighted on April 2, 2010 with no abnormal lesions. Nine days later, on April 11,

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2010, they were observed with marked epidermal sloughing, seen on F351's right flank and on her calf's left flank (Figure 1a and 1b).

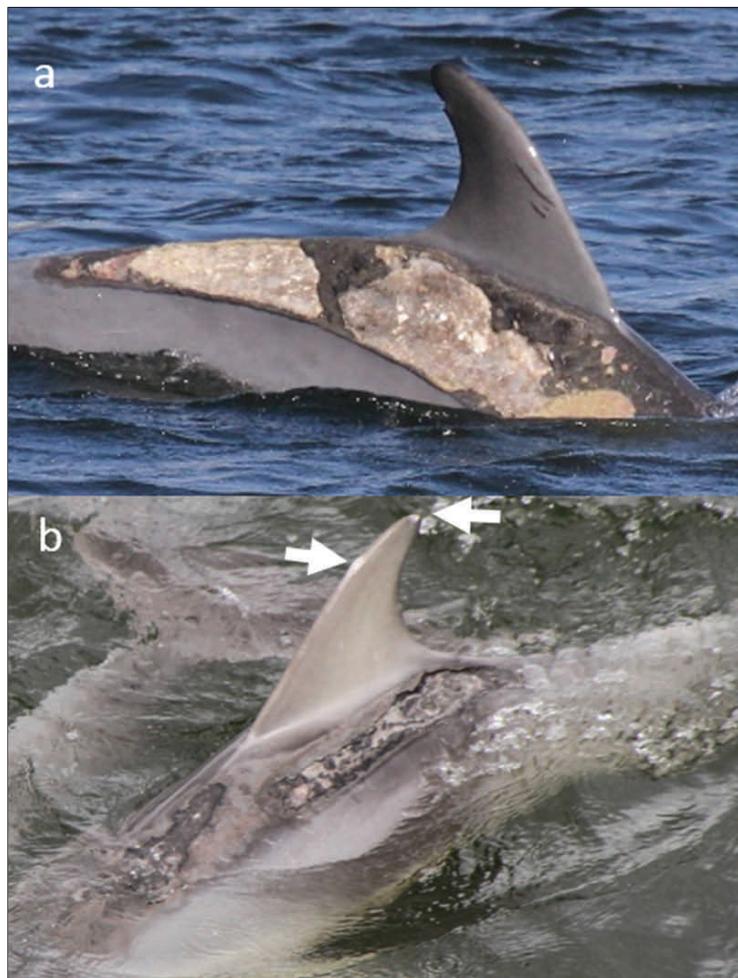


Figure 1: Lesions on April 11, 2010 of (a) mother F351. (b) calf M501. Arrows indicate the position of two small areas of hypopigmentation and thickening on the calf's dorsal fin. Reproduced with permission.

F351's lesions - These appeared more extensive than her calf's. At this time, she had a focally extensive, well demarcated, elliptical lesion that resembled ulceration and necrosis. This spanned across the dorsal third of the body wall on the right side of the midline, and extended cranially to the cervical region, caudally to the peduncle, and tapered at both ends. The lesion was widest beneath the dorsal fin. Epidermis at the lesion borders appeared hyper-pigmented (darkened), and a white layer of what could have been necrotic epidermis, dermis or underlying blubber was exposed (Figure 1a). Two days later, this layer appeared raised and lobulated (Figure 2), and on April 17, 2010, was seen to be



Figure 2: F351's lesion on the 13th of April 2010. This figure depicts the tissue lobulation described. Reproduced with permission.

sloughing from the lesion (Figure 3a). Pink tissue discolouration could be seen caudally. In addition, the cranial aspect had a diffusely nodular appearance (Figure 3b, arrow). By April 21, 2010 all areas that initially appeared necrotizing and pale were now pink, which was likened to the appearance of granulation tissue. Lesion borders remained hyper-pigmented and there was some yellow-brown discolouration to the wound cranially (Figure 3c, arrow).

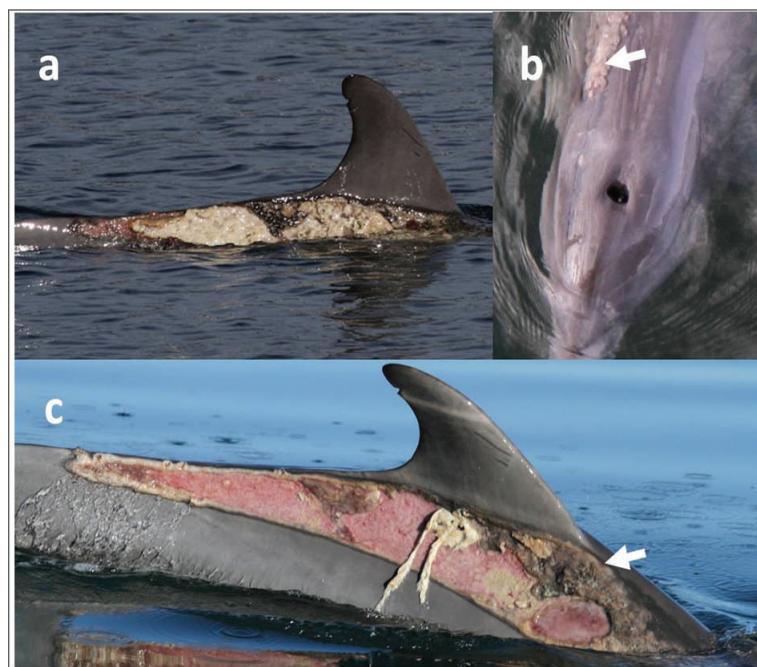


Figure 3: F351's lesions (a) on April 17, 2010 showing sloughing of pale white tissue and caudal granulation. (b) on April 17, 2010 there was a nodular appearance to the cranial aspect of the lesion (arrow). (c) on April 21, 2010 lesion displays border hyperpigmentation, cranial discolouration (arrow), necrotic tissue and granulation. Reproduced with permission.

F351's loss of body condition was apparent as evidenced by prominence of ribs and angular flanks seen on April 26, 2010. Lesion borders now appeared raised and pale grey (Figure 4a and 4b). This tissue had completely extended over the granulation tissue by August 27, 2010, leaving two distinct white scars (Figure 5a). Nodules that had been present cranially completely regressed as the wound contracted (Figure 4c and 4d). Comparison of the images in Figure 4 demonstrates the progression of re-epithelialization and wound contraction.

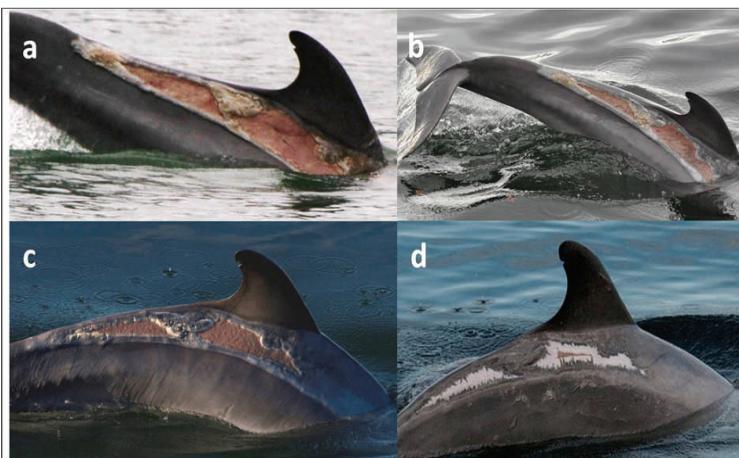


Figure 4: F351's lesion on (a) April 26, 2010. (b) May 7, 2010. (c) May 14, 2010. (d) July 30, 2010. Comparison of the four images demonstrates the progression of re-epithelialization and wound contraction. Reproduced with permission.

In early 2011, F351 sustained an injury resembling tooth raking from another dolphin. In reference to Figure 5b, the scar tissue appeared to be more readily damaged than surrounding epidermis. This minor injury healed without complication. It would appear the existing scar will remain for the life of the animal.

For one year following the appearance of the injury, F351's dorsal fin leaned approximately 10° in the direction of the wound. The fin has since returned to normal. The calf did not display this response.

M501's lesion - The calf was a dependent 13 month-old (born March, 2009) when injured, yet the stages and timing of wound healing appeared similar to F351's. On April 11, 2010, the calf had an irregular oblong streak resembling ulceration and necrosis dorsally, spanning from the blowhole to the caudal insertion of the dorsal fin, situated along the midline cranially, and curving to the left of the midline caudally (Figure 6a). This lesion was not as sharply demarcated

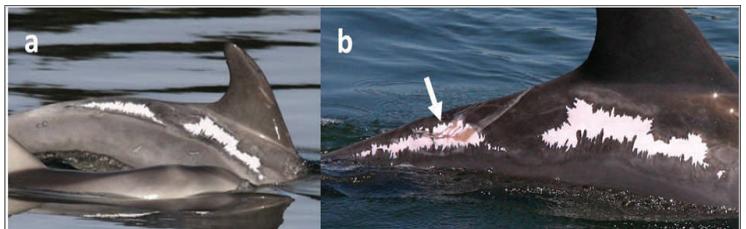


Figure 5: (a) F351 on August 27, 2010 shows two distinct scars have resulted along the right flank. These have remained similar in appearance to date (June 2014). (b) A minor injury that F351 sustained in early 2011 (arrow) depicts the relative weakness of the scar to surrounding normal tissue. Reproduced with permission.

as F351's. While F351's dorsal fin appeared normal, the calf had two small focal areas of hypopigmentation and thickening (interpreted as dermal sloughing) on his dorsal fin (Figure 1b, arrows; 6b). Like F351, hyper-pigmentation was observed along the borders of sloughed and un-sloughed epidermis (Figures 1b, 6a, 6b), and a yellow-brown discolouration became progressively evident over the surface of ulcerated tissue (Figure 6b, arrow). By April 22, 2010, tissue resembling blubber in the caudal aspect of the lesion was slightly protruding from the level of surrounding healthy epidermis and appeared broadly lobular (Figure 6c). There was also a focal area of papular appearance cranially (Figure 6c, arrow). By May 22, 2010, the entire lesion had almost completely contracted, with pale grey discolouration remaining on the affected regions for the remainder of the year (Figure 6d). Scarring did not occur in the same manner as with F351.

Behaviour and reproduction

F351 had regularly exhibited a behaviour known as "tail walking" since 2008, a behaviour that appears to have been learned from another local dolphin who had spent time in a local dolphinarium. This was a high energy behaviour which involved rising out of the water until only her flukes were submerged and then crashing back onto the water surface dorsal side first. She did not perform this behaviour for three months after acquiring her injury. While activities such as feeding did not seem to change, certain social activities may have also been altered as neither dolphin presented with raking (markings from social scraping of the teeth by other dolphins) throughout the duration of their healing processes. The minor lesion previously discussed (Figure 5b) was the first potential raking since the major injury, which had by then reduced to a scar. There did not appear to be a change in home range or frequency of

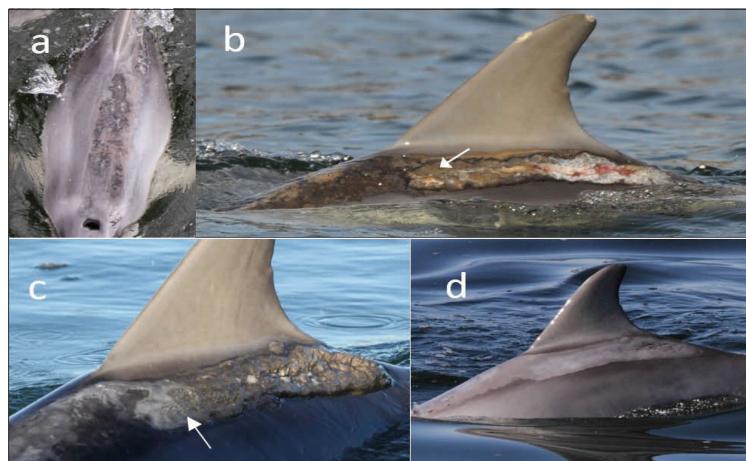


Figure 6: Appearance of M501's lesion on (a) April 11, 2010. (b) April 6, 2010 showing hyperpigmentation of lesion borders and yellow-brown discolouration of ulcerative tissue (arrow).

(c) April 22, 2010 showing an area of papular appearance (arrow) and protruding blubber. (d) May 22, 2010. Reproduced with permission.

bow riding associated with the injury.

F351's first three calves, including M501, survived to weaning and are regularly sighted in the dolphin sanctuary today. However, in the years following F351's injury, a fourth calf was born in February 2012 and died five days later. On September 22, 2013, F351 was sighted holding a fifth calf that was likely to have been stillborn or died immediately after birth. It is unknown whether the deaths of F351's calves in 2012 and 2013 were related to the injury described in this paper.

Discussion

This report adds to the small body of literature on the unassisted recovery from severe trauma of bottlenose dolphins in the wild. In addition, it highlights the extraordinary capacity of these animals to not only recover but also manage the extra energy demands of providing for a dependent calf at the same time.

Within the first day of a dolphin sustaining cutaneous injury, blubber from surrounding tissue migrates over the exposed wound surface (4). The blubber consists of many collagen bundles, elastic fibres and adipocytes. It is connected to underlying musculature by the subcutis, a loose layer of connective tissue (3). This blubber layer is a complex structure that undertakes coordinated cellular rearrangements in healing to form new tissue using adipocytes, collagen and elastic fibres (4). Two days after injury, pink

granulation tissue gradually begins to fill the wound in order to aid in volume restoration while reconstructing the blood supply to the site of injury. Within the first week of the injury, non-viable tissues, including the transposed blubber, are naturally debrided (4).

For both dolphins, there was hyper-pigmentation observed along the borders of sloughed epidermis. In terrestrial mammals, this is a result of inflammation involving some degree of chronicity. An abundance of blubber infiltration into the exposed areas of dermis is consistent with normal healing, and would have brought immune mediators to the affected site along with additional insulation and protection to underlying tissue (4). Once the underlying granulation bed was complete, non-viable tissue that had lost vascularity and was necrotizing, including transposed blubber, would be passively sloughed. The aetiology of the yellow-brown discolouration on both dolphins was unknown. It may have been a result of colonization by environmental bacteria, protozoa and/or fungi. The nodular appearance of F351's lesion (Figure 3b, arrow) was also of unknown aetiology. The focal area of papular appearance (Figure 6c, arrow) on M501's lesion may have signified a hyperplastic process or simply finer lobulation of the blubber that appeared broader caudally. Nevertheless, these lesions proceeded to regress without obvious complication or human intervention. Despite exposure to an industrially polluted environment, it appears the dolphins' immune mechanisms against environmental pathogens were adequate.

The lack of pigmentation in F351's scars may predispose her to predation, reduced heat absorption in colder weather, and damaging ultraviolet radiation. Due to the rarity of depigmentation or albinism in cetaceans, it is difficult to ascertain the significance of these risks. The survival of F351 with her dependent calf under the circumstances was remarkable. Given the stress associated with attempting to sample and/or treat free ranging dolphins, these observations suggest close monitoring of injuries should be undertaken and intervention only instigated as a last resort. A case of similar significant skin lesions of unknown aetiology in a wild bottlenose dolphin calf was studied in Monterey Bay (U.S.A.) (2). The Monterey Bay dolphin suffered severe ulcerative tissue necrosis, emaciation and swam abnormally. The calf survived this condition and



appeared to be improving in subsequent sightings, reinforcing the outstanding healing abilities of these cetaceans (2).

Subsequent to the events described above, in December 2013, another dolphin U378, a subadult of unknown gender presented with a set of lesions visually similar, but less extensive, to those described for F351 and M501. The recovery process proceeded along identical lines to that for F351 and M501, and we assume the same aetiology for all three animals.

The unassisted recovery of these dolphins has implications for triage decision making in relation to dolphins suffering natural and anthropogenic injuries and also for decisions concerning the advisability of interventions.

Comprehensive monitoring of the healing process of these dolphins was only possible through the assistance of a group of dedicated volunteer photographers (see acknowledgments section). Their involvement highlights the growing contributions of citizen scientists armed with sophisticated photographic equipment to field research.

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