Aquatic Mammals 1995, **21.3,** 205–211

Scarring and photoidentification of dugongs (*Dugong dugon*) in Shark Bay, Western Australia

Paul K. Anderson

Department of Biological Sciences, University of Calgary, Calgary, Alberta, Canada T2N 1N4.
e-mail pkanders@acs.ucalgary.ca

Abstract

Use of a large sailing catamaran as a mobile platform made possible close approach and photography of dugongs in Shark Bay, Western Australia. Most adult dugongs were found to carry scars, visible as they surface to breathe, that permit repeated identification of individuals. Nine types of commonly observed scars are described. Paired linear scars seen on known females are attributed to the tusks of males, implying that males use their tusks in intersexual interactions. No scars attributable to boat propellers were observed. Fourteen resightings of five individuals were photographically documented over periods of from 2 to 35 days in small embayments where dugongs were relatively sedentary, but no animals were resighted in more open habitats.

Key words: Dugong, *Dugong dugon*, scars, photoidentification, Australia.

Introduction

Little is known of dugong social behavior: dugongs (*Dugong dugon*) respond to the approach of boats or divers by flight, or by investigative behavior (Anderson, 1982); dugongs spend 99% of their time submerged (Anderson, 1982; Anderson & Birtles, 1978); subsurface visibility is limited in most dugong habitats; there is no sexual dimorphism in body size or in other readily visible characteristics; and dugongs frequent open water coastal habitats and (unlike manatees) do not concentrate in tiny thermal refugia.

Although photoidentification has become a standard technique for study of marine mammals (Hammond *et al*., 1990) sirenians have no dorsal fins or dorsal color patterning. Scars (many caused by contact with boat propellers) have, however, provided a basis for individual identification of West Indian manatees (*Trichechus manatus*) (Beck *et al*., 1982; Hartman, 1979; Reid *et al*., 1991). Although an attempt to document individual dugong movements and associations by underwater photography of scarred animals (Anderson, 1982) resulted in some resightings, the method was not efficient enough to produce more than anecdotal data. In the present study, I attempted to overcome some of the obstacles to observation and individual identification of dugongs by using a sailing catamaran as a mobile platform to which dugongs might habituate and from which they could be observed and photographed as they surfaced to breathe.

Study areas and methods

Shark Bay supports a dugong population estimated at over 10 000 individuals (Marsh *et al*., 1994). It is a favorable environment for study of dugong behavior because of its relatively clear waters, the result of maximum spring tides of around 1.3 m and a virtual absence of terrigenous runoff (Logan & Cebulski, 1970).

Dugongs were observed and photographed from the deck of the 10 m sailing catamaran, 'Nortrek', between 7 February and 29 October 1989 in three distinct habitats, reflecting seasonal shifts in dugong distribution and activity (Fig. 1). In late summer (between 7 and 24 February, and 15 March and 18 April), we worked in a sub-embayment of the Gladstone basin in eastern Shark Bay referred to hereafter as North Cove. North Cove lies at the lip of the delta of the normally dry Wooramel River and opens to the south. It has an area of 4.6 sq. km. Over approximately half of this area there is a dense subtidal meadow of the seagrass *Halodule uninervis* at depths of 1.5 to 3 m. In late summer cohesive herds of dugongs forage on this seagrass meadow (Anderson, 1986), raising clouds of suspended sediment that limit subsurface visibility to <2 m.

Herds abandon the Gladstone basin in fall and winter (Anderson, 1986; Marsh *et al*., 1994), moving to more open waters in the northern and

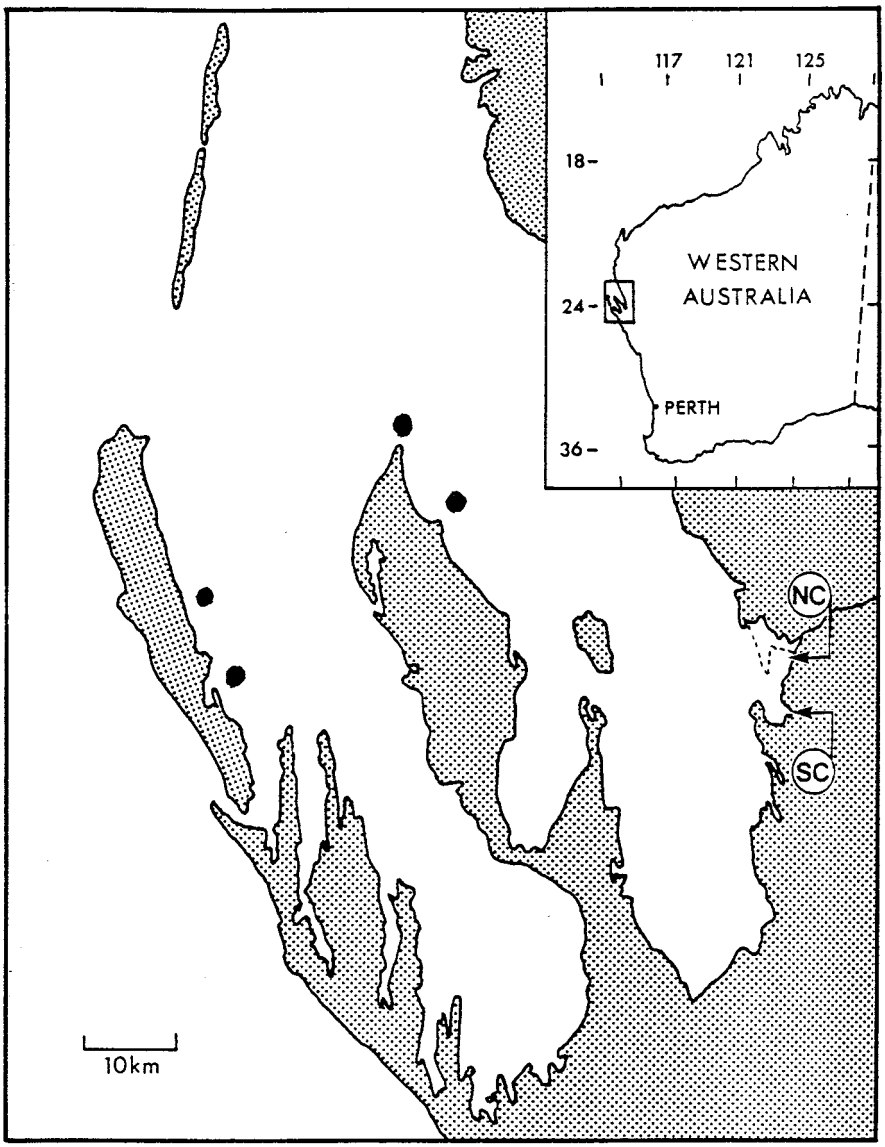

Figure 1. Shark Bay, showing locations where dugongs were photographed in summer in North Cove (NC), during the winter months (dots) and in spring in South Cove (SC).

western Bay where subsurface visibility is typically 5–10 m. Between 14 and 24 May, 2 and 26 June, and 18 and 24 August, we photographed dugongs foraging in loose aggregations of up to 10 individuals along open shorelines in the western Bay where the dominant seagrass is *Amphibolis antarctica* in depths of 2 to 12 m (Anderson, 1982, 1986).

In spring (between 31 August and 29 October), prior to the appearance of herds in North Cove, dugongs were again photographed in the Gladstone area, but in a sub-embayment that I refer to as South Cove. South Cove opens to the north and lies directly south of and is contiguous with North Cove (Fig. 1). The area of South Cove accessible to dugongs is approximately 6.5 sq. km. Depth is generally less than 2.5 m and the water is consistently clear (subsurface visibility 10 m). The pale substratum is readily visible and almost bare of macroscopic vegetation. Scattered algae (*Caulerpa* sp., *Penicillus* sp.) are evident, but seagrass (*Halodule*) is rare, scattered, dwarfed, and so sparse and inconspicuous as to escape all but an intensive

search. Dugongs are easily seen beneath the surface except when visibility is reduced by strong winds and resulting surface turbulence. No herds were seen in South Cove; all dugongs encountered were solitary adults.

The catamaran was equipped so as to permit two observers to remain continuously at sea for up to two months. Approaches were minimally intrusive. When dugongs were sighted, the vessel was sailed or motored at slow speed to a position 50 to 100 m distant such that wind or momentum would carry it closer. In North Cove, where foraging herds roved along regular routes, two permanent moorings were established in areas where herds routinely traveled. In South Cove the vessel was sailed or motored around the cove at intervals of several days to enumerate resident individuals, and anchored for up to 5 days at selected sites to allow specific individuals to habituate to its presence.

Dugongs surfacing to breathe within 25 m of the catamaran were photographed using manual-focus 35 mm SLR cameras with 200 mm lenses and ASA 100 color print film. Adult dugongs closely accompanied by calves were inferred to be female. Photographs were identified by film and frame number. Date, location, and time of day were recorded for each photograph. To detect resightings photographs were classified as to whether they showed the body or the flukes, whether head or back predominated, and whether they showed a right side, left side, front, or rear view. All photographs showing the same view were then compared in search of identical scars. Possible matches were examined under $\times 10$ magnification.

Results

Dugong response to the catamaran

Approached as described above dugongs rarely fled from the catamaran in North and South Coves. In North Cove, animals sometimes surfaced repeatedly within 1 m when the vessel was drifting or at anchor. Approaching without inducing a flight response was more difficult in the rougher and more open waters on the winter range (in part because animals were less easily located from a distance). In all habitats the most common dugong response to initial contact was to swim to within 5–15 m of the vessel and 'investigate', swimming back and forth or circling it at a depth of 1–3 m. An investigating dugong often moved away for a few meters before surfacing to breathe. Although it was difficult to anticipate when an investigating dugong would surface, investigative behavior was an important contributor to success in obtaining photographs.

Photography

The catamaran's broad, stable, uncluttered decks provided an eye level 3–4 m above the water surface and made it possible for us to move about freely in order to follow the movements of nearby animals. We attempted to photograph as the maximum area of dorsal surface was exposed, but we often failed to catch the proper moment. We found the use of print film well suited to our purpose. Satisfactory prints were obtained from 278 of 494 negatives.

There was significant heterogeneity among the three habitats in the proportion of satisfactory photographs (contingency Chi^2 5.244 with 4 d.f., $P = <0.05$): the success rate was highest in North Cove (61% of 281 attempts) and lower on the winter range (49% of 75 attempts) and in South Cove (50% of 138 attempts). The most common cause of failure was poor timing. The animal was below the surface in 64% of the cases in a sample of 116 unsatisfactory photographs in which the cause of failure could be determined.

The proportions of prints showing head and back views varied with habitat. There was a statistically significant excess of head views in South Cove contingency Chi^2 61.88, df=1, p=<0.005 in comparison with photographs from the other areas.

Scars

All successful photographs showed an adult dugong (cow-calf pairs commonly surface synchronously). Dorsally, adult Shark Bay dugongs are brown; around 7/6 to 5/8 on the Munsell red hue chart (Sidelinger, 1985). Calves are paler than adults. Very small calves (presumably neonatal) are the color of well-creamed coffee; around 7/2 on the Munsell Yellow Red Hue Chart (Sidelinger, 1985). Seen on these backgrounds scars vary from white through normally pigmented to very dark brown. Superficial scars appear as paler lines or patches. Animals in all three habitats carried scars. Only nine (3%) of the satisfactory photographs of adult dugongs failed to show markings suitable for individual identification. In large (presumably older) individuals irregularities on fluke margins are common. Fluke margins, showing distinctive irregularities, were visible when some large individuals rooted head-down with flukes raised above the surface, or when flukes were lifted above the water as animals dove steeply when feeding in water >7–8 m deep.

Scars on the head and body were assignable to nine categories: scarback, blotch, single-linear longitudinal, single-linear transverse, paired longitudinal, paired transverse, spots, flecks, and pock marks. 'Scarback' (Fig. 2a) refers to rough-surfaced patches of white tissue centered along the mid-dorsal ridge midway along the body, varying from a scattering of irregular patches through

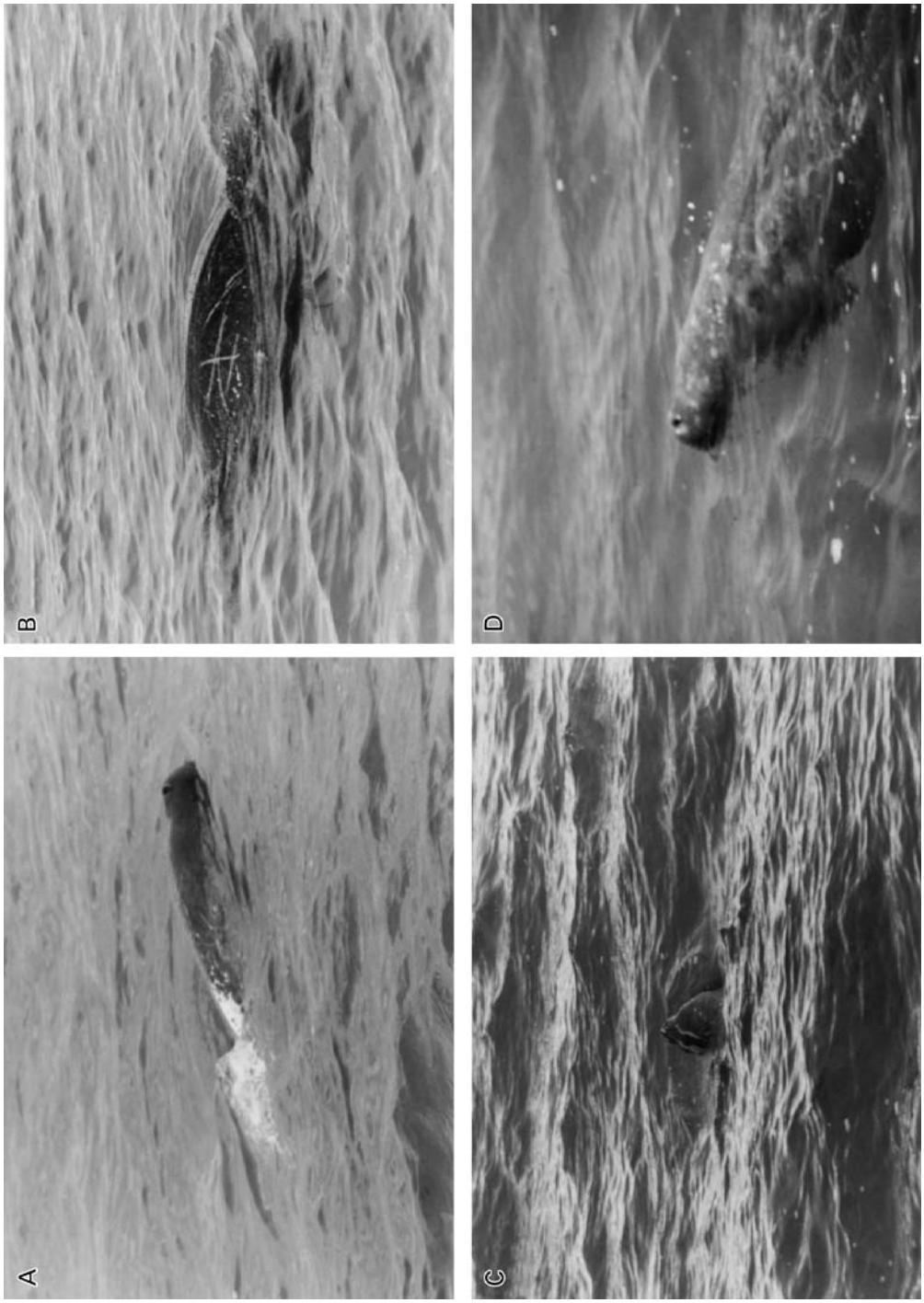

Figure 2. Examples of (a) scarback, (b) unpaired and paired linear scars and flecks, (c) broad paired linear scars, and (d) spots.

larger lichen-like aggregations to a single massive spindle-shaped longitudinal white area with irregular margins extending over the middle third of the dorsal ridge and laterally for up to a third of the dorsal surface. Scarback was seen both on cows accompanied by calves and on unaccompanied adults, but only on larger (presumably older) individuals and never on calves. Linear scars ranged from short faint lines to striking lines 3–5 cm in width and 30–40 cm in length. Paired linear scars were seen on both heads and backs as parallel straight, curved or wavy lines (Fig. 2b, c). They were seen on 50% of known females. Blotches, spots, and flecks were all pale markings. Blotches were single large pale patches with irregular margins. Spots were numerous with more or less rounded pale patches 2–4 cm in diameter (Fig. 2d). Flecks were numerous smaller white spots with angular outlines. Pock marks were more or less circular depressions up to several cm deep. One individual, seen but not photographed, had a deeply scarred area perhaps 30 cm in diameter that might have been the result of attack by a large shark or by a killer whale (Anderson & Prince, 1985). Another had a deep curving linear scar approximately 50 cm long. No animals were seen with serial propeller slashes similar to those commonly seen on manatees in Florida (Beck *et al*., 1982; Reid *et al*., 1991).

Resightings

A cow with a large calf first photographed in North Cove on 29 March was photographed again on 12 April (Fig. 2b). By that date, she had acquired an additional set of parallel scars. An unaccompanied scarbacked adult with broad white parallel scars along the left side of the head from the nostril to the shoulder (Fig. 2c), first photographed in North Cove on 29 March, was repeatedly sighted over the next three days and photographed again on 31 March. Another unaccompanied adult, with an irregular white blotch on the head, was first photographed in North Cove on 22 February and photographs showing this blotch were obtained on 16, 19 and 29 March.

In South Cove, an individual recognizable by pale spots over the head and neck regions (Fig. 2d), was first encountered on 15 September and first photographed on 19 September. This individual was visually identified on 18 of the following 35 days. Photographs of the left side of its head, confirming continued residence of the same individual in the same part of the cove, were obtained on 22, 26 and 29 September and 9, 12 and 20 October. Another resident of South Cove, identifiable by three small white marks on the left side of the head and a long deep dark scar on the right side of the neck, was first photographed on 17 October. Resightings were confirmed by photographs taken on 22, 25 and 28 October.

In summary, in the restricted habitats of North and South Coves, five individuals were photographed on two or more days, and a total of 14 resightings were photographically documented. All resightings were in the same habitat where the individual was first photographed. No animal photographed on the winter range was resighted.

Discussion

Approaching and photographing surfacing dugongs

The catamaran was essential to successful observation and photography, making possible relatively non-intrusive approaches and habituation of the animals, and enabling a photographer to move about to follow their movements. The primary sources of difficulty were our limited ability to predict when and where an individual would surface and the short time dugongs spend on the surface (<2 sec). Autofocus cameras might have appreciably improved our success rate by enabling us to concentrate more fully on the animals' movements and better anticipate the moment of surfacing.

Variation in our ability to observe, photograph, and make repeated identifications of individuals among the three habitats was influenced by local conditions and by dugong behavior. In both North and South Coves we were able to remain continuously at sea in protected areas of relatively limited extent and allow animals to habituate to the vessel. Because groups in North Cove moved along predictable routes as they foraged the vessel could be placed so as to intercept their expected movement. As dugongs foraging in North Cove often surfaced repeatedly near the catamaran, and because their backs were exposed as they rolled to dive as described by Anderson and Birtles (1978), it was relatively likely that a good photograph could be obtained despite poor subsurface visibility, and photographs showing back views predominated. In South Cove, the clear shallow water made it possible to follow an individual's movements continuously, but animals typically exposed less of the body above the surface and head views were more common because dugongs there did not roll to dive. On the winter range, photography was more difficult because animals disappeared from view when diving in deeper water and because we were unable to maintain contact with groups or individuals over more than a few hours and attempt to habituate individuals to the vessel. Further, groups ranged widely, and sea conditions often made it difficult or unsafe to maintain position in open water for long periods. Despite these difficulties, I believe a persistent and intensive

effort would produce worthwhile data on social relationships and movement even in this more open environment.

Coloration, scars and scar origins

The brown color of Shark Bay dugongs contrasts with reports in the literature in which adult dugongs are reported to be slate colored (Husar, 1975). The significance of these conflicting color descriptions is unclear.

As in the West Indian manatee (Beck *et al*., 1982) new scar tissue is white, but it appears that many scars darken with age. The roughly symmetrical white 'scarback' tissue along the mid-dorsal line is probably permanent, but I suspect that either peripheral healing or additional exposure to causative agents may change the outlines. Scarback may indicate advanced age, but its origin is unclear. The mid-dorsal area could be sunburned if an animal was temporarily stranded in shallow water. Stranding of dugongs has been reported following cyclonic storms (Marsh, 1989), but it seems unlikely that dugongs so stranded would survive to comprise a significant portion of the Shark Bay population. Females have been reported to enter very shallow water to calve (J. Bradley, pers. comm.; Macmillan, 1955; Marsh *et al*., 1984b), thus females might strand long enough to expose these areas to sunburn. Scarback is seen most commonly on large animals and on those body parts which are most exposed to air and to solar radiation over the dugong's lifetime. Although observers in aircraft have referred to dugongs as resting on the surface or 'basking' (Bayliss, 1986), my experience is that healthy dugongs almost never float or travel at the surface with the back exposed. Backs are, however, exposed briefly as animals roll to dive. Scarback was never seen on calves. I suggest that if sunburn is the initiating factor in scarback, and scarback is due to exposure while rolling to dive, the condition may occur in either sex and characterize older dugongs. Data from carcass studies might confirm this and indicate the age at which it first develops.

Linear scars could result from accidental or intentional contact with sharp inanimate objects, from social interactions involving males, or from interspecific contacts. Paired parallel scars tend to be about equal in length and most are separated by a distance which approximates that between the short tusks that erupt in males at ages of 12 to 17 years (Marsh *et al*., 1984a). Although tusks may erupt in a few very old females (Marsh, 1984b), most paired linear scars must originate as wounds inflicted by tusks of adult males. The rostral area seems to play a role in fighting among males (Preen, 1989). Paired parallel scars have been reported on carcasses of dugongs of both sexes (Marsh, *et al*., 1984b). The observation that paired scars occur frequently on known females implies that tusks are also used in intersexual interactions.

The absence of obvious propeller scars probably reflects the current low density of boats in Shark Bay. Periodic photoidentification studies might serve to detect problems resulting from local or regional increases in boating activity.

Photoidentification

Photography of heads and backs of surfacing dugongs proved to be a practical means of confirming individual identifications. With the use of autofocus cameras and an expanded library of photographs, it should be possible to effectively study dugong social patterns on a larger scale. Some of the marks carried by animals could be readily detected by observation with the naked eye or with the aid of binoculars, but photography provided a permanent record of briefly glimpsed scars, and permitted later resolution of uncertain sightings. Over the term of the present study, repeated photographs of the same individuals showed that minor abrasions which merely scraped away the pigmented epidermal layer persisted over at least two weeks. Deeper scars can be expected to last indefinitely, although they may or may not be repigmented. Assuming deeper scars are permanent, many of the scars we observed could serve to identify individuals over periods of several years or throughout the remaining life of the individual.

Although flukes showed distinguishing shapes and scars, the 'flukes-up' feeding mode was rarely encountered in North Cove, it was restricted to a few large individuals that may have been seeking more deeply buried plant parts or rooting for burrowing invertebrates (Anderson, 1989). The raised flukes of dugongs diving in water 8 m deep or more, though difficult to photograph, may provide another means of identification under favorable sea conditions.

Acknowledgements

My wife, Donna Anderson, assisted throughout this study. Financial support for our field work came from the Committee for Research and Exploration of the National Geographic Society, the University of Calgary, the University of Western Australia, the Australian Geographic Society, and personal funds. I gratefully acknowledge logistic support received from the Shire of Shark Bay, the Western Australia Department of Conservation and Land Management, and residents of the Shark Bay area. The manuscript was improved by the comments of an anonymous reviewer.

References

Anderson, P. K. (1982) Studies of dugongs at Shark Bay, Western Australia. II. Surface and subsurface observations. *Aust. Wildl. Res.* **9,** 85–99.

Anderson, P. K. (1986) Dugongs of Shark Bay, Australia—Seasonal migration, water temperature, and forage. *Natl. Geogr. Res.* **2,** 473–490.

Anderson, P. K. (1989) Deliberate foraging on macroinvertebrates by dugongs. *Natl. Geogr. Res.* **5,** 4–6.

Anderson, P. K. & A. Birtles (1978) Behaviour and ecology of the dugong, *Dugong dugon* (Sirenia): observations in Shoalwater and Cleveland Bays, Queensland. *Aust. Wildl. Res.* **5,** 1–23.

Anderson, P. K. & R. I. T. Prince (1985) Predation on dugongs: attacks by killer whales. *J. Mammal.* **66,** 554–556.

Bayliss, P. (1986) Factors affecting aerial surveys of marine fauna, and their relationship to a survey of dugongs in the coastal waters of the Northern Territory. *Aust. Wildl. Res.* **13,** 27–37.

Beck, C. A., R. K. Bonde & G. B. Rathbun (1982) Analyses of propeller wounds on manatees in Florida. *J. Wildl. Mgmt.* **46,** 531–535.

Hammond, P. S., S. A. Mizroch & G. P. Donovan (eds) (1990) Individual recognition of cetaceans: use of photo-identification and other techniques to estimate population parameters. Report of the International Whaling Commission. Special Issue 12, Cambridge. 440 pp.

Hartman, D. S. (1979) Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. Special Publication, Am. Soc. Mammal. **5,** 1–153.

Husar, S. L. (1975) A review of the literature of the dugong (*Dugong dugon*). U.S. Fish and Wildlife Service Wildlife Research Report 4, Washington, D.C. 30 pp.

Logan, B. W. & D. E. Cebulski (1970) Sedimentary environments of Shark Bay, Western Australia. *In* Carboniferous Sedimentation and Environments, Shark Bay, Western Australia (B. W. Logan, G. R. Davies, J. F. Read and D. E. Cebulski, eds) pp. 1–37. Memoir no. 13. American Association of Petroleum Geologists, Tulsa. 223 pp.

Macmillan, L. (1955) The dugong. *Walkabout* **21,** 17–20.

Marsh, H. (1989) Mass stranding of dugongs by a tropical cyclone in northern Australia. *Mar. Mamm. Sci.* **5,** 78–84.

Marsh, H., G. E. Heinsohn & T. D. Glover (1984a) Changes in the male reproductive organs of the dugong, *Dugong dugon* (Sirenia: Dugongidae) with age and reproductive activity. *Aust. J. Zool.* **32,** 721–742.

Marsh, H., G. E. Heinsohn & L. M. Marsh (1984) Breeding cycle, life history and population dynamics of the dugong, *Dugong dugon* (Sirenia: Dugongidae). *Aust. J. Zool.* **32,** 767–788.

Marsh, H., R. I. T. Prince, W. K. Saalfeld & R. Shepherd (1994) The distribution and abundance of the dugong in Shark Bay, Western Australia. *Wildl. Res.* **21,** 149–161.

Preen, A. (1989) Observations of mating behavior in dugongs (*Dugong dugon*). *Mar. Mamm. Sci.* **5,** 382–387.

Reid, J. P., G. B. Rathbun & J. R. Wilcox (1991) Distribution patterns of individually identifiable West Indian manatees (*Trichechus manatus*) in Florida. *Mar. Mamm. Sci.* **7,** 180–190.

Sidelinger, S. J. (1985) Color manual. Prentice-Hall International, London. 122 pp.