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COMPARISON OF THE CAPABILITIES OF DUGONGS AND WEST INDIAN MANATEES TO MASTICATE SEAGRASSES

Modern members of the two families of sea cows, the dugongs (Dugongidae) and manatees (Trichechidae), have solved the problem of tooth wear very differently. The six to eight cheek teeth that manatees (*Trichechus* spp.) have in each jaw quadrant (Fig. 1) are replaced horizontally in an apparently limitless monophyodont series of supernumerary molars throughout much or all of each animal's life (Domning and Hayek 1984). In addition to their tusks (upper second incisors), which are not used to masticate food, dugongs (*Dugong dugon*) have simple peglike molars, the enamelled crowns of which are degenerate and quickly wear away (Fig. 1). The last two molars exhibit root hypsodonty, and these ever-growing cylinders of dentine constitute the entire cheek dentition of old adults (Marsh 1980). It has been assumed that these flat-crowned teeth are not very efficient at grinding plants and that they were "originally favored by selection only as an alternative to no teeth at all" (Domning 1982).

Although both dugongs (Anderson 1989, Preen 1995) and manatees (Powell 1978) are occasionally deliberately carnivorous and eat epiphytes and invertebrates incidentally (Spain and Heinsohn 1973, Hartman 1979, Marsh *et al.* 1982, O'Shea *et al.* 1991), sirenians are primarily aquatic herbivores. Florida manatees, *Trichechus manatus latirostris,* eat more than 60 species of freshwater, marine, and terrestrial food plants (Hartman 1979, Reynolds and Odell 1991). In contrast, dugongs are essentially seagrass specialists (Johnstone and Hudson 1980, Marsh *et al.* 1982). Manatees also eat seagrasses (Hartman 1979), including some of the same genera that are eaten by dugongs.

We hypothesized that their much more elaborate dentition would enable manatees to masticate seagrass into smaller pieces than dugongs can. This might be one of the factors enabling Florida manatees to breed earlier (2–3 rather than 9–10 yr) and more often (2.5 rather than 3–5 yr) than dugongs (Marmontel 1995, Marsh 1995, O'Shea and Hartley 1995, Reid *et al.* 1995). In this study, we compare the fragment size of the stomach contents of manatees and dugongs feeding on the same genera of seagrasses and conclude that

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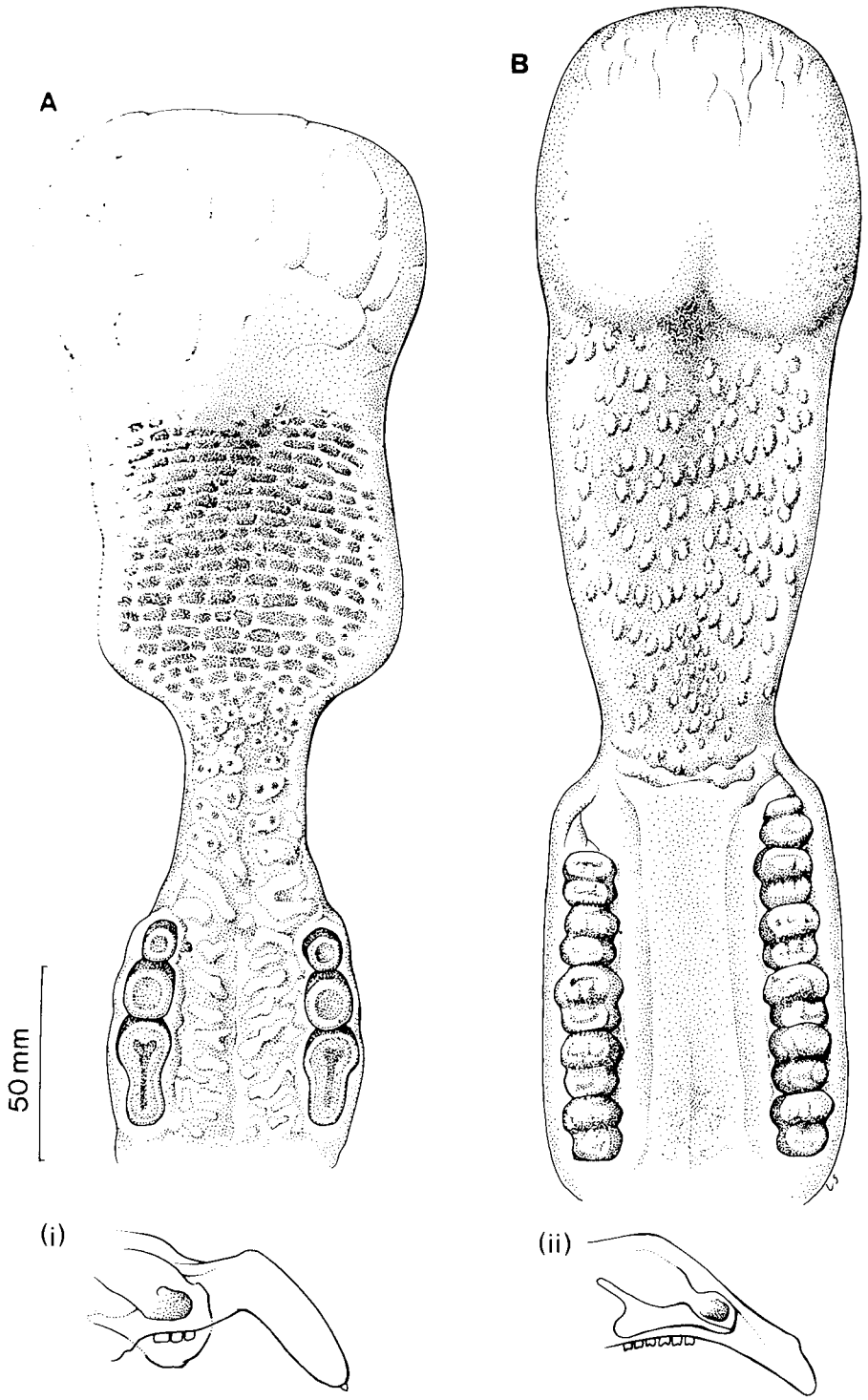
Figure 1. Drawing of upper mouthparts of adult dugong (left) and adult Florida manatee (right) showing horny plate (top of figure), molar teeth, and palate. Note that manatee has five teeth in right upper jaw (left in figure) and six teeth in the left jaw, presumably because it had recently lost the right anterior tooth. Inset shows that maxilla of dugong (i) is much more downwardly deflected than that of manatee (ii). This difference in deflection makes dugongs virtually obligate bottom feeders in contrast to manatees which feeds throughout water column.


A
B
50 mm
(i)
(ii)

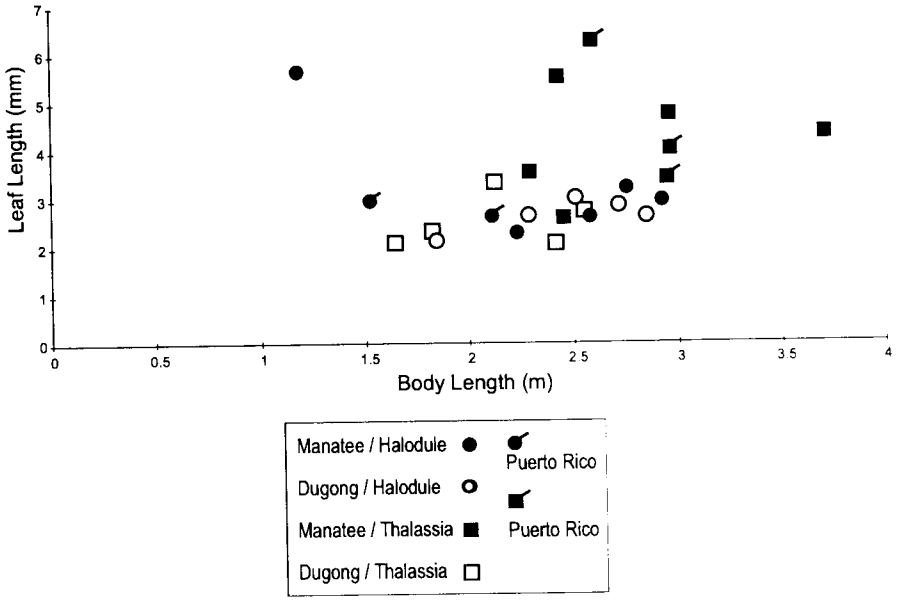


Figure 2. Mean lengths of 60 seagrass leaf fragments from stomachs of 10 individual dugongs (*Dugong dugon*) of various body lengths from Queensland and 10 Florida manatees, *Trichechus manatus latirostris*. Corresponding data from five *T. manatus manatus* from Puerto Rico included for comparison. However, fewer (20, 27, 54) leaf fragments were available for the three Puerto Rican manatees.

contrary to our hypothesis, dugongs masticate seagrasses into significantly smaller fragments than manatees do.

We selected the stomach contents of 10 Florida manatees and 10 dugongs for study based on the results of quantitative analyses of their formalin-fixed stomach contents (Marsh *et al.* 1982; Beck, unpublished data). Five individuals of each species had been feeding on *Halodule* and five on *Thalassia*. The samples were labelled with random numbers so that they could be examined without knowledge of the specific identity of the animals from which they came. The length and width of 60 identified leaf fragments from each stomach were measured to the nearest 0.1 mm with an eyepice micrometer. This sample size was shown to be robust on the basis of a pilot study. In addition, the length and width of 60 fragments of rhizome were measured from each of the samples from dugongs and Florida manatees that had been eating *Halodule*. There were almost no rhizomes in the samples from dugongs or manatees that had eaten *Thalassia*.

The effect of sirenian species and seagrass genus on the average length and average width of stomach contents was tested using analysis of variance. Sirenian species and seagrass genus were fixed factors; the response was the mean fragment size per individual sirenian, because we assumed that the sizes of fragments within a single animal would not be independent.

Domning (1982) observed that the dentition of adult manatees from Florida

Despite its simple dentition, the dugong is clearly as effective at masticating seagrasses of the genera *Thalassia* and *Halodule* as the Florida manatee. However, this does not necessarily mean that the teeth of dugongs are as effective as those of manatees in masticating seagrasses. The dentition of both dugongs and manatees is only part of their masticatory apparatus. Members of both sirenian families have well-developed horny pads at the front of the mouth (Fig. 1; Murie 1872, Gohar 1957). In addition, the palate of the dugong (but not the Florida manatee, Fig. 1) is modified into regions of horny papillae and folds (Marsh and Eisentraut 1984) that may assist in mastication. Thus, the sizes of the fragments in sirenian stomachs reflect the relative effectiveness of their entire masticatory apparatus rather than the teeth *per se.*

Of course, our results reveal nothing about the relative effectiveness of dugongs and Florida manatees at masticating forage other than the seagrass genera *Thalassia* and *Halodule.* Domning (1982) suggested that the manatee's elaborate system of molar replacement evolved in response to the tooth wear caused by siliceous phytoliths in the true grasses (Gramineae). Together with its more horizontal mouth (Fig. 1), the more elaborate dentition of the Florida manatee may be one of the factors enabling it to exploit a wider variety of food plants than the dugong. However, both dugongs and Florida manatees clearly masticate seagrasses effectively.

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