# SEA GRASSES AT KHOR UMAIRA, PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN WITH REFERENCE TO THEIR ROLE IN THE DIET OF THE GREEN TURTLE, *CHELONIA MYDAS*

HAROLD F. HIRTH, LIONEL G. KLIKOFF, AND K. T. HARPER[1,2]

## ABSTRACT

Studies were made on the sea grass pastures at Khor Umaira in the People's Democratic Republic of Yemen in July 1972. The standing crop in an equally mixed pasture of *Cymodocea serrulata* and *Syringodium isoetifolium* was greater than that in a pure stand of *C. serrulata*. The average caloric content of the leaves of five genera of sea grasses at Khor Umaira ranged between 4.54 and 4.66 kcal/g dry wt, ash free. These values are similar to those reported for sea grasses in the South Pacific and in the Caribbean. Our results show that the number of calories in the standing crop can be calculated from estimation of percent cover. The role of sea grasses in the management schemes of the green turtle, *Chelonia mydas*, is described.

Sea grass meadows are productive and important marine communities. Besides stabilizing the substrate sea grasses provide cover and are a source of food for a number of marine invertebrates and vertebrates. The leaves also support a variety of epiphytes and the grass debris serves as the energy base for detritus food chains. It is probable that in earlier days large numbers of manatees, dugongs, and green turtles grazed on these submarine pastures, but the sirenians and marine turtles have been so over-exploited that today many marine meadows are virtually ungrazed by any big vertebrate of economic importance to man. The green turtle, *Chelonia mydas*, has been proposed as a candidate for marine ranching by fencing them in underwater spermatophyte pastures (for review of management schemes see Hirth, 1971). The purposes of this paper are to describe some basic parameters of the sea grass pastures at Khor Umaira in the People's Democratic Republic of Yemen and to provide basic data aimed at answering the question, "What are the characteristics of good green turtle feeding pastures?" Khor Umaira has been mentioned as a possible site for a green turtle ranch (Food and Agriculture Organization, 1968).

## THE SITE

Khor Umaira is the name of a bay (an arm of the Gulf of Aden) and village approximately 80 km west of Aden. The bay is almost completely landlocked by a long, narrow sandy spit that extends west-northwest along the coast. The bay itself is about 6.5 km long. Its width varies from about 550 m at the entrance to approximately 3.2 km in the middle. The depth of the water near the entrance is between 1 and 6 m, while the depth inside varies from 1 to 11 m.

Quantitative data were taken inside the bay where a few green turtles are always seen feeding. The grass pasture in the bay was adjudged similar to that off the nearby coast at comparable depths where large numbers of grazing turtles are caught in seines.

## METHODS

Five adult female green turtles, all weighing over 91 kg, were caught on the Ras al Ara pastures (19 km west of Khor Umaira) on 22 July 1972. Their stomachs were full of leaves of sea grasses (chiefly *Syringodium* and *Cymodocea*) along with some stems and a few segments of

[1] Department of Biology, University of Utah, Salt Lake City, UT 84112.

[2] Most of the field work was done by the senior author during his tenure as Marine Turtle Consultant with the Food and Agriculture Organization of the United Nations.

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rhizomes (see Figure 1). Observations made in 1966-67 (Food and Agriculture Organization, 1968) also suggest that green turtles in the vicinity of Khor Umaira eat chiefly the leaves of sea grasses. The local name for all sea grasses is Zawee.

No turtles were observed grazing in the census plots at the time of collection, but substantial amounts of leaves had washed up on the shores of the bay.

The grasses were collected in the middle of what was considered good turtle pasturage on 28, 29, and 30 July 1972. This was during the peak of the Southwest Monsoon which in this area generally prevails from April through September. The collecting sites were approximately 500 to 600 m from the nearest shore. Thirty samples were taken in a homogeneous pasture of *Cymodocea serrulata* and 30 samples from a stand of *C. serrulata* and *Syringodium isoetifolium* adjudged to be equally mixed. The sample quadrats were 1/16 $m^2$. The 60 samples were taken at depths from 0.8 to 2.5 m with 70% of the samples from depths of 1.8 to 2.5 m. The sampling was done at or near low tide. Visibility, as measured with a white Secchi disc 20 cm in diameter, extended to the bottom. Pure stands of *Syringodium* were not seen in the bay but a more detailed census might reveal the presence of such stands.

The grasses were harvested at the ground surface and weighed. No attempt was made to separate epiphytic algae from the leaves. Wet weight was obtained after removing the external water by gentle blotting and dry weight was determined by drying to constant weight in an oven at 80°C. Cover was calculated by looking straight down on a 1/16 $m^2$ quadrat and estimating percent coverage to the nearest 10%. Caloric values were determined using a Parr semimicro bomb calorimeter[3] following the procedures of Lieth (1968). However, since some of the techniques with oxygen bomb combustion underestimate ash content (Paine, 1971; Reiners and Reiners, 1972) in a second series of combustions aliquots of the material were ashed at 500°C for 5 h in a muffle furnace for determination of ash content. All caloric determinations are means of three samples and each sample differed by less than 3%. Plant nomenclature and terminology follows den Hartog (1970). Regression procedures follow those given in Steel and Torrie (1960).

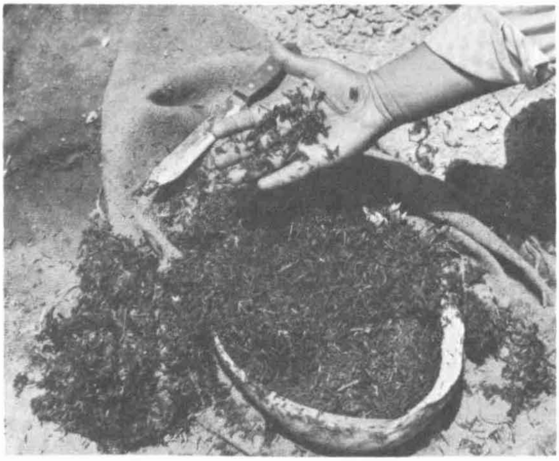

FIGURE 1.—The stomach contents of an adult, female green turtle caught on 22 July 1972 on the feeding pasture near Ras al Ara. The stomach was packed solidly with sea grasses.

## RESULTS AND DISCUSSION

The dry weights of *C. serrulata* along with corresponding cover data are given in Figure 2. All of the leaf blades on the sample plots were less than 20 cm long, with shorter blades associated with shallow water. An average of 84.5% (range 79-90%) of the wet weight was water. As Figure 2 shows, one would expect to find a dry weight of 290 g/$m^2$ in a pasture of *Cymodocea* with 100% cover at Khor Umaira in July. The corresponding wet weight would register about 1,871 g/$m^2$. Gessner (1971) found that leaves of turtle grass, *Thalassia testudinum*, in a dense meadow off Venezuela registered 608 g/$m^2$ dry weight and 2,504 g/$m^2$ wet weight. The mean length of the leaves was 23 cm and the water depth was 60 cm. In two sample plots of *T. testudinum* off the Florida coast, Phillips (1960) recorded dry weight values of about 325 and 98 g/$m^2$. The lower biomass was associated with shallower water.

[3] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

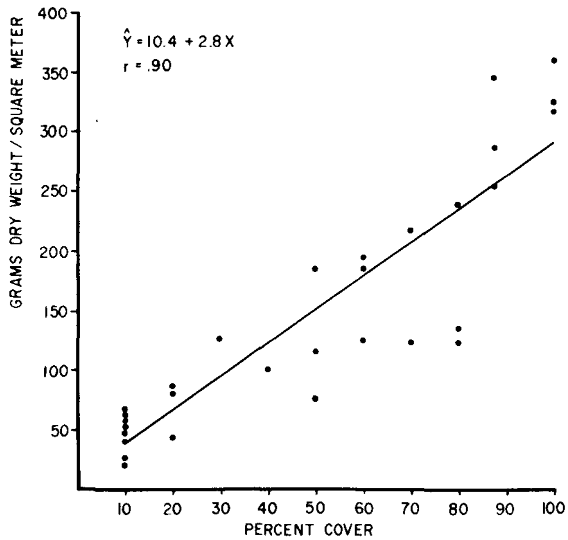


FIGURE 2.—Above-ground dry weight of *Cymodocea serrulata* regressed on field estimates of plant cover made at Khor Umaira.

The standing crop of an equally mixed pasture of *C. serrulata* and *S. isoetifolium* at Khor Umaira can be obtained from cover estimates in Figure 3. Leaf blades of both species here were less than 20 cm. On the average, water amounted to 88.7% of the wet weight of the leaves (range 83-91%).

In order to determine some chemical parameters associated with dense sea grass pasture, water samples were collected just above the leaves of an equally mixed stand of *C. serrulata* and *S. isoetifolium* with 100% cover at a depth of 1.75 m (at low tide) at 0915 h on 30 July 1972. The pH was determined using colorimetric standards and the other chemical parameters were obtained using standard methods for water analyses. The results are as follows: temperature 29.2°C; salinity 36.50‰; chlorinity 20.19‰; pH 8.2; free carbon dioxide 10 ppm; dissolved oxygen 5 ppm; total alkalinity 122 ppm, with 36 ppm as carbonate alkalinity and 86 ppm as bicarbonate alkalinity; magnesium chloride 4,000 ppm; and calcium chloride 999 ppm.

Substrate samples were taken at the same site and at the same time as the water samples. The substrate of this site consists largely of coarse fragments of shells. The bottom sample analyzed was a composite of five samples taken at a depth of 0-2.5 cm. The pH was obtained using a glass electrode, particle size was based on material passing a 2-mm sieve, and the other chemical parameters were determined using standard soil testing techniques. The results are as follows: pH 7.2; sand 97%; silt 3%; clay 0%; phosphorus 0.027 mg/g substrate; calcium 73.5 mg/g substrate.

The regression lines in Figures 2 and 3 show that given equal cover, standing crop is greater in a mixed pasture of *Cymodocea* and *Syringodium* than in a homogeneous stand of *Cymodocea*. This may be due to the close packing of the terete leaves of *Syringodium* in the mixed pasture.

The caloric content of four genera of sea grasses collected in the bay at Khor Umaira and one genus (*Thalassodendron*) collected off the nearby coast at a depth of 4.5 m, are given in Table 1. The data show that the caloric content of the five genera are very similar.

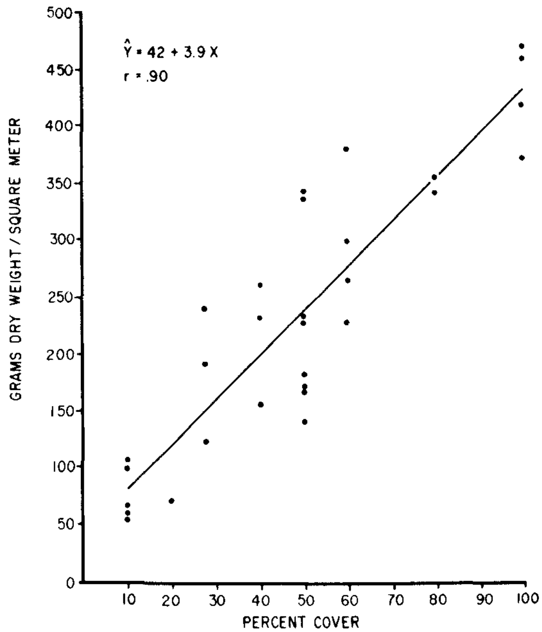


FIGURE 3.—Dry weight of a stand consisting of equal quantities of *Cymodocea serrulata* and *Syringodium isoetifolium* regressed on field estimates of plant cover. All data are from Khor Umaira and include only above-ground tissue.

For comparative purposes, the caloric content of five genera of sea grasses collected in various areas of the world and known to be eaten by green turtles there, are provided in Table 2. All of the samples from the South Pacific were burned according to the methods of Lieth (1968). It is likely that these values would be about 8% higher if independent ash determinations were made with a muffle furnace. Although green turtles were not actually seen feeding around Fulanga in the Lau Group of the Fiji Islands, leaves of *Halodule uninervis* collected in November 1970 around Fulanga registered 4.02 kcal/g dry wt, ash free when combusted by the Lieth (1968) method. *T. testudinum* around Grand Cayman Island is currently collected by a special underwater harvester and along with specially prepared food pellets is fed to captive green turtles in the turtle farm on Grand Cayman. Likewise, on some of the Tonga Islands, *Syringodium* and *Halodule* wrack washed up on the strand in large quantities after storms is fed to captive turtles kept in kraals. The findings reported in Tables 1 and 2 show that the caloric content of leaves of various kinds of sea grass are similar despite the fact the samples were collected at different times of the year and at widely scattered places. However, some inter-area differences are evident in that the energy content of tissue of five genera from the Gulf of Aden (Table 1) averaged about 0.15 kcal/g dry wt, ash free, higher than the four genera from the South Pacific (Table 2) as measured by the Lieth method.

The caloric content of sea grasses reported in this paper are very similar to the value of 4.41 kcal/g dry wt, ash free reported for *Phyllospadix scouleri* by Paine and Vadas (1969). The caloric values are also similar to some of the benthic marine algae collected off the coast of the State of Washington where the modal values of green, red, and brown algae were respectively, 4.90, 4.75, and 4.45 kcal/g dry wt, ash free (Paine and Vadas, 1969). For 32 samples of aquatic monocotyledons, Cummins and Wuycheck (1971) give a mean of 4.77 kcal/g dry wt, ash free and for 359 samples of aquatic algae they list a mean of 4.63 kcal/g dry wt, ash free, but none of their samples were sea grasses.

The number of calories in the standing crop of sea grasses at Khor Umaira can be estimated by referring to the regression lines in Figures 2 and 3. For example, assuming that leaves of *C. serrulata* represent 3.01 kcal/g dry wt (Table 1) then a pasture with, say, 50% cover contains about 453 kcal/m$^2$ (Figure 2).

There are extensive sea grass pastures in some shallow coastal waters (for distribution see den Hartog, 1970) but before turtle ranching can become a reality, studies are needed on the energy provided by epiphytes and animal prey. It is likely that green turtles obtain some nutritional value from the epiphytic organisms on the sea grass leaves. Allen (1971) has provided detailed information on the energetics of epiphytic algae and bacteria in a lake ecosystem. Further, the digestive processes of green turtles ought to be examined in relation to the protein content of sea grasses and other food. Occasionally, it has been observed that

TABLE 1.—Caloric values of sea grasses (leaves only) at Khor Umaira. The plants were collected on 28, 29, and 30 July 1972.

| Species | kcal/g dry wt | Ash % | kcal/g dry wt, ash free[1] |
|---|---|---|---|
| *Halophila ovalis* | 3.07 | 33 | 4.58 (4.21) |
| *Cymodocea serrulata* | 3.01 | 34 | 4.56 (4.19) |
| *Halodule uninervis* | 3.09 | 32 | 4.54 (4.23) |
| *Syringodium isoetifolium* | 3.12 | 33 | 4.66 (4.29) |
| *Thalassodendron ciliatum* | 3.11 | 33 | 4.64 (4.27) |

[1] Caloric values in parentheses were obtained using methods of Lieth (1968). The corresponding ash free caloric values are based on independent ash determinations; see text for explana-

TABLE 2.—Caloric values of sea grasses (leaves only).

| Species | Local name | Locality | Date collected | kcal/g dry wt, ash free[1] |
|---|---|---|---|---|
| *Halodule wrightii* | Sigret | Masirah Isl., Arabian Sea | 15 June 1972 | 4.54 (4.13) |
| *Halophila ovalis* | Sigret | Masirah Isl., Arabian Sea | 15 June 1972 | 4.51 (4.10) |
| *Thalassia testudinum* | Turtle grass | Grand Cayman Isl., Caribbean Sea | 24 May 1972 | 4.59 (4.24) |
| *Halodule uninervis* | Herbe á tortue | Noumea, New Caledonia | 25 Nov. 1970 | (4.07) |
| *Cymodocea serrulata* | Herbe á tortue | Noumea, New Caledonia | 25 Nov. 1970 | (4.09) |
| *Halophila ovalis* | Vutia | Suva, Fiji Isl. | 10 Nov. 1970 | (4.07) |
| *Syringodium isoetifolium* | Vutia | Suva, Fiji Isl. | 10 Nov. 1970 | (4.10) |
| *Halodule uninervis* | Limu | Nukualofa, Tonga Isl. | 24 Oct. 1970 | (4.07) |
| *Syringodium isoetifolium* | Limu | Nukualofa, Tonga Isl. | 24 Oct. 1970 | (4.11) |

[1] Caloric values in parentheses were obtained using methods of Lieth (1968). The other three caloric values are based on independent ash determinations: see text for explanation.

adult green turtles have eaten invertebrates (viz. crustacea, snails, jellyfish, sponges). The importance of these animals to the nutrition of green turtles has yet to be determined. Studies on the effect of different intensities of turtle grazing on the sea grass community are also needed, especially if under high grazing pressure the entire plant is pulled up. In regards to the regrowth of sea grass, Phillips (1960) has demonstrated that *T. testudinum* off the Florida coast will regrow to normal height in about 3 mo after being cut to ground level. Taylor, Saloman and Prest (1973) have recently shown that *T. testudinum* suffered no damage when the leaves were harvested twice during a 6 mo growing season in Tampa Bay, Fla., and they postulated that in deeper or warmer waters where the growing season is protracted three or more cuttings per year may be possible.

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