

Feeding ecology of the East Pacific green turtle (*Chelonia mydas agassizii*), in Bahía Magdalena, B.C.S. México

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INTRODUCTION

Numerous studies have suggested that lagoons of the Baja California peninsula are important area for the feeding and development of East Pacific green turtles, (black turtles; *Chelonia mydas agassizii*) (Cliffon et al. 1982, Márquez 1990, Seminoff 2000, Seminoff et al. 2002). However, to date most of the information available on black turtle feeding habits comes from studies conducted in the Gulf of California, and generally these data only represent collections from one season (summer). Very little information is available comparing turtle feeding habits in different regions, and no studies have established whether there are seasonal changes in the turtle's use of available food resources. This information is needed to better interpret the biology and ecology of *C. m. agassizii* throughout the region and can promote a better understanding of which resources are most important to the species thereby facilitating identification of its critical habitats.

The objectives of this study were to (1) determine variation of feeding habits among different geographic locations, (2) monitor fluctuation in feeding habits with season, and (3) determine whether turtles are feeding selectively or opportunistically on the available resources within the region.

MATERIALS AND METHODS

Study Site. Bahía Magdalena, a 1390 km² bay is located on the Pacific coast of the Baja California Peninsula, Mexico (24°15'N- 25°20'N and 111°20'W-112°15'W). As a result of seasonal marine upwelling it is a highly productive lagoon that is sheltered from Pacific waters by two barrier islands, Magdalena Island and Margarita Island (Sanchez-Rodriguez 1996). In this area, large seagrass meadows and macroalgae beds are thought to provide a wide variety of food resources for mature and immature black turtles.

Stomach Content Analyses. The feeding habits of black turtles in Bahía Magdalena and the adjacent waters of the Pacific were assessed by analyzing turtle stomach contents obtained as a result of incidental fishing mortality. Comparisons of the stomach contents were performed among locations and seasons. Seasons were defined as follows: Winter- December 21 to March 20; Spring- March 21 to July 20; Summer- July 21 to September 20; Fall- September 21 to December 20. Volume percentages were arcsine square root transformed for statistical analyses and then a two-way ANOVA was conducted between localities and principal diet components. A Tukey HSD multiple comparison test was used when significant differences were detected from the ANOVA.

Vegetation Transects. Each season (summer, fall and winter), the percent bottom cover of the marine vegetation was estimated along three 50-m transects (perpendicular to the coast) at two different locations in a region known as Banderitas, where turtles were commonly present. Along each transect, the vegetation was collected from five randomly selected 0.25 m² quadrants. The biomass and relative percent volume of each plant species was recorded for each quadrant.

Gastric Lavage Samples. In order to confirm that the feeding areas of the turtles caught incidentally by fisheries were similar to the region where the transects were conducted, gastric lavage samples were collected from a small number of live turtles captured in Banderitas in winter as part of a larger monitoring study. Nets were set during a 24-h period once per month from January to March at the same location and physical data

were recorded for each turtle captured. The esophageal flushing of recently ingested food items was performed immediately after capture following protocols described by Forbes and Limpus (1993). All dietary samples were fixed in a 4% formalin solution in clean seawater.

RESULTS AND DISCUSSION

Stomach Content Analyses. Digestive tract contents of 17 black turtles were analyzed; 9 from turtles captured within Bahía Magdalena and 8 from the adjacent waters of the Pacific. Table 1 shows the composition of the diet of each turtle stomach analyzed. The diet of these turtles was made up of 13 different plant species and 1 crustacean species. Similar species of algae were commonly indistinguishable due to maceration so the Gracilariaceae grouping was composed of *Gracilariopsis lemaneiformis* and *Gracilaria pacifica*.

Location Comparison. The stomachs contents from turtles captured in different regions (Pacific and Bahía Magdalena) tended to have different characteristic assortments of species. Significant differences were detected in the mean relative volumes of different food items at the two localities (F=8.72, P<0.0001). In Bahía Magdalena the stomach contents were dominated by the red algae of the family Gracilariaceae (60% of the mean volume of stomach samples), which was absent on the stomachs analyzed from the Pacific. Stomachs collected from turtles in the Pacific waters were dominated by *Phyllospadix torreyi* and the red alga *Gelidium robustum* which accounted for an average of 58.3% and 25.7% respectively (Table 1). Stomach samples from the Pacific waters had significantly greater amounts of the sea grass *P. torreyi* (Tukey HSD test, p=0.005) than samples from Bahía Magdalena, while *Zostera marina* was only found in turtles stomachs from Bahía Magdalena. One of the noteworthy findings from a turtle collected in this region was a stomach that contained more than 82% red crabs (*Pleuroncodes planipes*) (Table 1). To our knowledge, this is the first record of a black turtle (SCL=54.4 cm) is feeding predominantly on crustaceans.

Comparing these findings with data from diet samples of black turtles from the Gulf of California (Bahía de los Angeles and the Infiernillo Channel) we can see that Pacific turtles captured outside Bahía Magdalena fed primarily on seagrass similarly to those from the Infiernillo Channel (Felger and Moser 1973). Turtles in the Infiernillo consume large quantities of *Z. marina*, whereas turtles feeding in the adjacent Pacific waters near Bahía Magdalena consume greater amounts of *P. torreyi*. Even though *Z. marina* is abundant in Bahía Magdalena, black turtles within this region fed predominantly on red algae of the family Gracilariaceae similar to turtles from Bahía de los Angeles in the Gulf of California (Seminoff 2000, Seminoff et al. 2002).

Seasonal Comparison. In stomach samples collected from turtles captured within Bahía Magdalena, Gracilariaceae red algae were the dominant food item in every season except Spring (Fig. 1), at which time Gracilariaceae was absent and *Z. marina* was the prevalent diet constituent. No evidence of differences in the consumption of Gracilariaceae was found between the other seasons. In the stomach contents from turtles of the Pacific waters, *G. robustum* was present with the highest relative volumes in Fall and was absent in the other seasons, while *P. torreyi* was the most prevalent species in Winter, Summer and Spring (Fig. 2).

Vegetation Transects. Fifteen plant species were identified along the transects belonging to 3 different taxonomic groups (Chlorophyta, Rhodophyta and Phaeophyta). *Amphiroa* sp. Was dominant during the three seasons, followed by *G. pacifica* during Fall (40%) and Winter (15%). The number of species was higher in Winter (11 species) in which the red algae was the dominant taxonomic group (*Amphiroa* sp., *G. pacifica*, *G. textorii* and *Aspagaropsis taxiformis*).

Gastric Lavage Samples. The dominant species collected in the gastric lavage samples of live turtles captured in the Banderitas channel was *G. textorii* and *G. pacifica*. This was consistent with the stomach contents recovered in winter from turtles captured incidentally in Bahía Magdalena (principally species of the family Gracilariaceae) and the dominant algae observed during the winter quadrants (*Amphiroa* sp., *G. pacifica* and *G. textorii*). Data from other seasons will help us to corroborate whether black turtles within the region are feeding selectively or opportunistically on the resources available.

CONCLUSIONS

Black turtles from Bahia Magdalena and adjacent Pacific waters consume different food resources. The diversity of species consumed in Bahía Magdalena was greater than that of turtles feeding in adjacent Pacific waters. Seasonal variation in the consumption of species was found in Bahía Magdalena and adjacent Pacific waters. Major food items recovered in gastric lavage samples from Banderitas during winter were similar to those found in stomachs from turtles captured incidentally within Bahía Magdalena and were consistent with the algae sampled from quadrants in Banderitas.

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LITERATURE CITED

Ciffton, K., D.O. Cornejo, and R.S. Felger. 1982. Sea turtles of the Pacific coast of México. In: K.A. Bjorndal, ed. *Biology and Conservation of Sea Turtles*. Smithsonian Inst. Press, Washington, D.C. p. 199-209.

Felger, R.S. and M.B. Moser. 1973. Eelgrass (*Zostera marina*) in the Gulf of California: discovery of its nutritional value by the Seri Indians. *Science* 181:355-356.

Forbes, G. and C. Limpus. 1993. A non-lethal method for retrieving stomach contents from sea turtles. *Wildlife Research* 20:339-343.

Márquez, M.R. 1990. FAO species catalogue. Vol.11: Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis. No 125, Vol. 11. Rome, FAO. 81p.

Sánchez-Rodríguez, I., C. Fajardo and O. Pantoja. 1989. Estudio florístico estacional de las macroalgas en Bahía Magdalena, BCS., México. *Inv. Mar. CICIMAR* 4:35-48.

Seminoff, J.A. 2000. Biology of the East Pacific Green turtle, *Chelonia mydas agassizii*, at a warm temperate feeding area in the Gulf of California, Mexico. Unpubl. Ph. D. Dissertation. University of Arizona. 249 p.

Seminoff, J.A., A. Resendiz, and W.J. Nichols. 2002. Diet of the East Pacific green turtle (*Chelonia mydas*) in the Central Gulf of California, México. *Journal of Herpetology* 36:447-453.

Table 1: Mean percent sample volume (%V) and frequency of occurrence (% F) of prey groups recovered from stomachs analyzed from Bahía Magdalena (n=9) and adjacent Pacific waters (n=8). (T=occurs in trace levels), (* grouping for *Gracilariopsis lemaneiformis* and *Gracilaria pacifica*)

Species	B. Magdalena			Pacific		
	%V	F	%F	%V	F	%F
Rhodophyta						
<i>Gelidium robustum</i>	-	-	-	26	3	38
<i>Pterocladia</i> sp.	-	-	-	10	3	38
Gracilariaceae *	56	7	78	-	-	-
<i>Gracilaria textorii</i>	1.3	1	11	-	-	-
<i>Rhodymenia</i> sp.	T	1	11	-	-	-
<i>Gigartina</i> sp.	3.3	1	11	-	-	-
Chlorophyta						
<i>Codium</i> sp.	6.3	5	56	5.4	2	25
<i>Iridaea flaccida</i>	2.7	1	11	-	-	-
<i>Ulva</i> sp.	T	1	11	T	1	13
Phaeophyta						
<i>Sargassum sinicola</i>	0.7	1	11	-	-	-
Seagrass						
<i>Phyllospadix torreyi</i>	1.4	1	11	58	7	88
<i>Zostera marina</i>	12	4	44	-	-	-
Mangrove						
<i>Avicennia germinans</i>	9.1	2	22	-	-	-
Crustaceans						
<i>Pleuroncodes planipes</i>	9.2	1	11	-	-	-
Unidentified matter	2.1	1	11	-	-	-

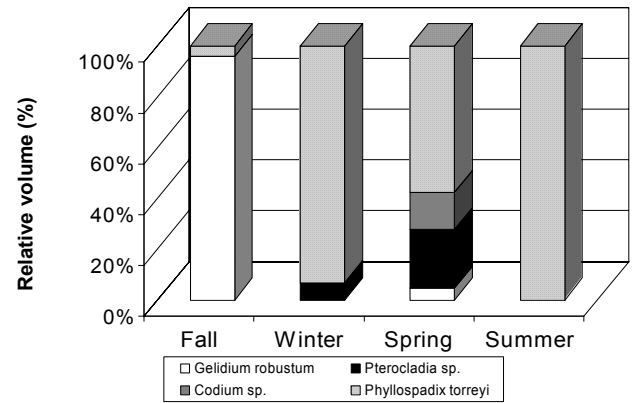


Fig. 1. Seasonal variation in the diet of black turtles captured along the Pacific coast adjacent to Bahía Magdalena, México. Values represent relative volume as a percentage of the total stomach contents. n= 2, 2, 3, and 1, in fall, winter, spring and summer, respectively.

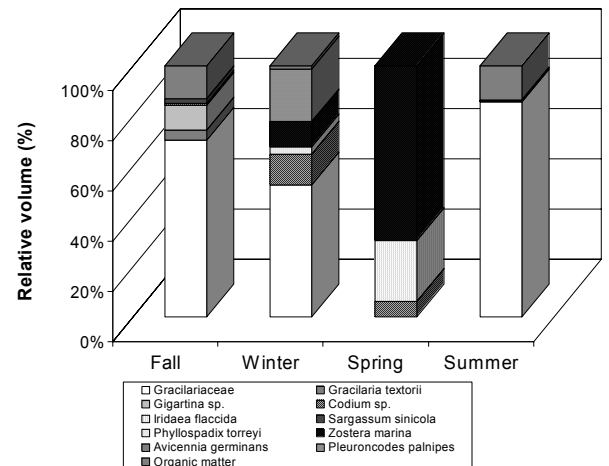


Fig. 2. Seasonal variation in the diet of black turtles captured within Bahía Magdalena, México. Values represent relative volume as a percentage of the total stomach contents. n= 3, 4, 1, and 1, in fall, winter, spring and summer, respectively.