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Diet and Feeding Habits of the Southern Stingray Dasyatis americana in the Central Bahamas

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NOTES

DIET AND FEEDING HABITS OF THE SOUTHERN STINGRAY *DASYATIS AMERICANA* IN THE CENTRAL BAHAMAS

D. Gilliam and K. M. Sullivan

Elasmobranchs are one of the most abundant and ubiquitous groups of large predators in marine tropical environments. The southern stingray, *Dasyatis americana* (Dasyatidae), is one of the most common elasmobranchs off the southern coast of Florida and in the Bahamas (Bigelow and Schroeder, 1953). Studies on the diet and feeding habits of these large predators will add to the understanding of their role in the trophic dynamics of an ecosystem.

Most of the previous research on the feeding habits of the southern stingray has been limited to simple descriptions of the prey items found in several stomachs. Bigelow and Schroeder (1953) described the stomach contents of several southern stingrays captured off Bimini, Bahamas. Snelson and Williams (1981) noted the prey items found in three stingrays captured in the Indian River Lagoon System, Florida. Quantitative information on the diet of the southern stingray is very limited. Randall (1967) determined the volumetric importance of prey items in the diet of the southern stingray from his study on the food habits of fishes in the Virgin Islands. A study by Funicelli (1975) discussed the diet and feeding habits of the southern stingray in the Gulf of Mexico. The purpose of this study is to quantitatively describe the diet and feeding habits of the southern stingray in a tropical environment via stomach content analysis. This analysis focuses on the quantitative contribution of fishes and invertebrates to stingray diet as related to time of day and tidal phase.

Materials and Methods

The Exuma Cays Land and Sea Park (ECLSP) is located in the central Bahamas (24°22′N, 77°30′W) along the eastern platform margin of the Great Bahama Bank. The park includes a series of cays extending northwest to southeast, with large channels funneling water between Exuma Sound and the shallow expanse of the carbonate platform. ECLSP was selected as a study site for three reasons: 1) no fishing is allowed in the 180 km^2 park, 2) the park supports a large and visible stingray population concentrated near the cays and 3) the area has a very low year-round human population, thus stingrays were thought to be relying more on natural prey rather than from refuse from fish houses or ships.

Eighteen stingrays were collected within the ECLSP in January 1991 by spearfishing while patrolling throughout the daylight hours. All stingrays were speared in the cranium; thus pithing accompanied by cervical dislocation served as the mode of euthanasia. Stingrays larger than 1.5 m in disc width and those in water deeper than 2 m were not sampled because of safety and handling considerations.

Time, location, sex, and habitat were recorded for each stingray at the time of capture. Disc width, total length, and gape were measured to the nearest millimeter. Total body weight was measured to the nearest 250 g on a hanging scale. The stomach and intestine were removed and injected with Bouins' solution, then wrapped in cheese cloth and preserved in 10% buffered formalin for laboratory analysis.

Laboratory quantitative measurements were made: 1) stomach contents volume: volume of all the contents were measured to the nearest 0.1 ml by water displacement in a graduated cylinder, 2) stomach contents weight: all content items were blotted dry and weighed to the nearest 0.01 g, 3) stomach fullness: relative fullness was measured by dividing the total stomach contents weight of each stingray by its total body weight (g/kg).

Stomach fullness was tested against time of day and tidal cycle using a one way ANOVA. A day was divided into five, 2-h periods: 0700 to 0900, 0900 to 1100, 1100 to 1300, 1300 to 1500, and 1500 to 1700. The tidal cycle was divided into four, 3-h phases: high, ebb, low, and flood.

Stomach contents were separated and identified to the lowest possible taxa. The importance of different prey taxa in the diet of the stingray was quantified according to Pinkas et al. (1971), George and Hadley (1979), and Hyslop (1980). Numerical importance (%N), gravimetric importance (%W), volumetric importance (%V), and the frequency of occurrence (%F) of each prey item was measured. The above measurements were used to calculate indices which indicate selectivity in the diet of the stingrays. The relative importance index (RI) of each food type is calculated from the absolute importance index (AI):

$$AI = \%F + \%N + \%W \quad (1)$$

and

$$RI = 100 \times AI / \sum AI \quad (2)$$

and is expressed as a percentage of the diet (George and Hadley, 1979). The index of relative importance (IRI) includes the volumetric importance and is calculated as:

$$IRI = (\%N + \%V) \times \%F \quad (3)$$

where the importance of an item is directly related to the size of the value (Pinkas et al., 1971).

Results

A total of 65 prey categories belonging to 15 families in four phyla were identified (Table 1). Crustaceans were the dominant food group by number (76.4%), wet weight (58.9%), and volume (61.1%), and occurred in 100% of the stomachs (Fig. 1). Teleost were the next most important group in number (10.9%), wet weight (18.3%), and volume (17.5%), and occurred in 83.3% of the stomachs. Molluscs, annelids, and plant material were less important. Indices of importance gave similar results, with crustaceans composing 39.6% (RI) of the stingrays diet and having an index of relative importance (IRI) of 13,603.6. Teleosts were next in importance followed by the molluscs, annelids, and plant material (Table 1).

Among the crustaceans, the most important (RI) families were the Portunidae (24.8%), Penaidae (18.7%), Alpheidae (5.5%), and Albuneidae (4.1%) (Decapoda), and the Squillidae (11.6%), and the Gonodactylidae (6.8%) (Stomatopoda). The important (RI) teleost families included the Labridae (7.2%), Gobiidae (4.3%), and Scaridae (2.5%) (Table 1). Unidentified teleosts represented (15.8%) of the relative importance (RI). The importance (RI) of mollusca were: Bivalvia (6.5%), Gastropoda (1.5%), and the Cephalopoda (6.1%) (Table 1). Unidentified material represented 18.6% (RI) of the contents and was found in all the stomachs.

The number of items per stomach ranged from 3 to 65 with an average of 31: 16% of the stomachs had 0–10 items, 5% had 10–20, 38% had 20–30, 16% had 40–50, 13% had 50–60, 12% had 60–70. No empty stomachs were found.

Stomach fullness measured against time of capture found mean stomach fullness increasing throughout the day: 0700 to 0900 (1.07 $g \cdot kg^{-1}$), 0900 to 1100 (2.31 $g \cdot kg^{-1}$), 1100 to 1300 (2.40 $g \cdot kg^{-1}$), 1300 to 1500 (2.00 $g \cdot kg^{-1}$), and 1500 to 1700 (5.55 $g \cdot kg^{-1}$). However, the difference between these means were not found to be statistically significant (ANOVA, F = 2.00, $P > 0.05$). Stingrays captured during the high tide were found to have the highest mean stomach fullness (4.65 $g \cdot kg^{-1}$) followed by the flood tide (2.46 $g \cdot kg^{-1}$), low tide (1.72 $g \cdot kg^{-1}$), and ebb tide (0.47 $g \cdot kg^{-1}$). The difference between these means was also not found to be statistically significant (F = 1.96, $P > 0.05$).

Discussion

The results of this study generally agree with the limited existing reports on diet of southern stingrays. The current study indicates that southern stingrays in

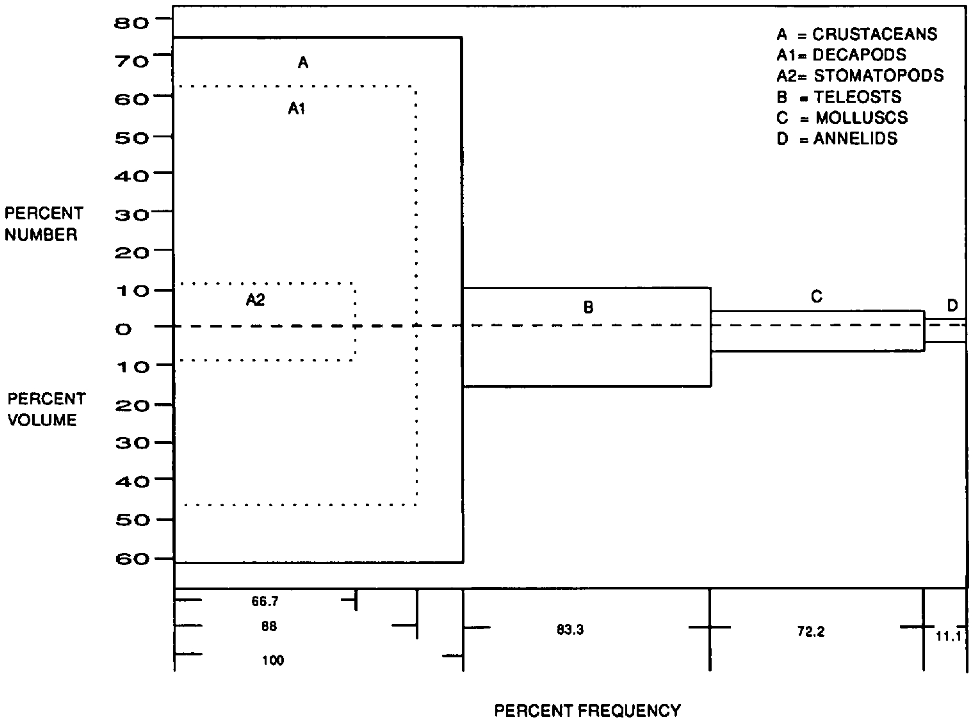

Figure 1. The percent composition of the major prey categories by number, volume, and frequency of occurrence.

the central Bahamas prey upon at least 13 decapod species with 3 species of Portunidae being the most important. Bigelow and Schroeder (1953) found stomatopods, shrimp, crabs, worms, and fishes in the stomachs of southern stingrays captured off Bimini, Bahamas. Randall (1967) found fishes, sipunculids, crustaceans, and polychaetes in the stomachs of stingrays captured in the Virgin Islands. Snelson and Williams (1981) found portunid crabs, shrimp, and teleosts in three southern stingrays from the Indian River Lagoon, Florida.

Other dasyatid stingrays were also found to have similar diets. Stomachs from *Dasyatis sayi* and *Dasyatis sabina* collected in the Indian River Lagoon contained crustaceans and polychaete worms (Snelson and Williams, 1981). Stomach contents from *Dasyatis sayi* and *Dasyatis sabina* from the Delaware Bay revealed similar diets of crustaceans, molluscs, annelids, and teleosts (Hess, 1961). Struhsaker (1969) found that the diet of *Dasyatis centroura* off the southeast United States was mostly crustaceans, molluscs, polychaetes, and nemerteans. *Dasyatis guttata* from the Atlantic coast of South America eats teleosts and molluscs (Thorson, 1983).

The southern stingray is clearly capable of feeding on active prey; 58.4% (RI) of its diet comprises active epibenthic species (i.e., crustaceans and teleosts). The presence of many small prey items in all of the stomachs reveals that stingrays feed on small items throughout the day instead of feeding on larger items infrequently during the day.

The presence of such a large number of prey categories (Table 1) suggests that the southern stingray is an opportunistic feeder. Funicelli (1975) describes *D. sabina* and *D. americana* in the Gulf of Mexico as being opportunistic feeders

Table 1. Summary of prey taxa in the diet of collected stingrays as percent by number (%N), frequency of occurrence (%F), percent by weight (%W), and percent by volume (%V). Relative importance indices (RI), expressed as percent contribution to the diet, and the index of relative importance (IRI) are also shown

	Numerical importance		Frequency of occurrence		Gravimetric importance		Volumetric importance			
Prey taxa	N	%N	F	%F	Wt. (g)	%W	Vol.(ml)	%V	RI	IRI
Teleost	61	10.90	15	83.30	76.87	18.28	398.48	17.50	18.94	2,364.08
Labridae	12	2.20	6	33.30	30.89	7.34	158.80	7.20	7.21	312.08
Gobiidae	10	1.80	4	22.20	6.17	5.28	55.30	1.50	4.29	72.27
Scaridae	3	0.50	2	11.10	13.89	2.64	53.93	2.80	2.52	36.64
Unidentified teleost	30	5.40	15	83.30	22.31	19.81	203.15	6.00	15.82	948.65
Crustacea	427	76.40	18	100.00	247.55	23.78	1,301.41	61.10	39.61	13,603.38
Decapoda	350	62.60	16	88.80	178.02	21.11	1,000.40	44.80	32.62	9.347.16
Portunidae	231	41.30	14	77.80	119.46	18.50	707.20	30.90	24.84	5,667.02
Portunus depressifrons	148	26.50	13	72.20	60.07	17.17	412.76	13.50	18.71	2,887.20
Portunus ordwayi	57	10.20	10	55.50	60.13	13.20	290.32	13.20	13.47	1,298.16
Portunus anceps	35	6.30	6	33.30	6.08	7.92	106.56	3.10	6.90	311.72
Penaeidae	81	14.50	16	88.80	32.01	21.11	295.70	7.60	18.67	1,917.38
Metapenaeopsis goodei	71	12.70	13	72.20	31.06	17.17	259.70	7.40	15.53	1,452.15
Trachypenaeus contrictus	6	1.10	2	11.10	0.87	2.64	23.09	0.20	2.08	14.23
Alpheidae	22	3.90	5	27.80	4.37	6.61	71.46	1.00	5.52	138.47
Alpheus schmitti	21	3.80	4	22.20	4.34	5.28	63.10	1.00	4.55	106.11
Processidae	3	0.50	3	16.70	0.09	3.97	25.17	0.10	2.91	10.79
Processa guyanae	1	0.20	1	5.50	0.16	1.31	8.39	0.02	0.96	1.22
Hippolytidae	1	0.20	1	5.50	0.03	1.31	8.14	0.02	0.96	1.11
Tozeuma carolinense	2	0.40	2	11.10	0.03	2.64	16.25	0.02	1.93	4.23
Pasiphaeidae	1	0.20	1	5.50	0.06	1.31	8.17	0.02	0.96	1.10
Leptochela (Probo-loura) carinata	1	0.20	1	5.50	0.06	1.31	8.17	1.80	0.96	1.11
Albuneidae	4	0.70	4	22.20	5.13	5.28	52.69	0.96	4.06	55.12
Albunea gibbesii	2	0.40	2	11.10	2.81	2.64	27.70	0.81	2.08	14.61
Albunea paretti	2	0.40	2	11.10	3.65	2.64	26.67	0.42	2.06	12.96
Raninoidae	2	0.40	1	5.50	1.91	1.31	15.50	0.42	1.06	4.32
Ranilia muricata	2	0.40	1	5.50	1.91	1.31	15.50	0.04	1.06	4.32
Majidae	1	0.20	1	5.50	0.68	1.31	8.38	0.04	0.96	1.22
Mithrax hispidus	1	0.20	1	5.50	0.15	1.31	8.38	0.04	0.96	1.22

Table 1. Continued

Prey taxa	Numerical importance		Frequency of occurrence		Gravimetric importance		Volumetric importance		RI	IRI
	N	%N	F	%F	Wt. (g)	%W	Vol.(ml)	%V		
Stomatopoda	62	11.10	12	66.70	40.02	15.86	262.41	9.30	14.70	1,355.98
Squillidae	44	7.90	10	55.60	22.95	13.22	183.53	5.30	11.61	731.63
Alima hyalina	44	7.90	10	55.60	24.80	13.22	183.53	5.30	11.61	731.63
Gonodactylidae	18	3.20	6	33.30	16.47	7.92	105.76	4.00	6.81	238.79
Gonodactylus oerstedi	7	1.30	3	16.70	2.72	3.97	35.01	0.60	3.13	30.45
Pseudosquilla ciliata	11	2.00	5	27.80	14.89	6.61	85.75	3.40	5.61	148.65
Unidentified crustacean	15	2.70	15	83.30	29.51	3.81	189.81	7.00	15.12	869.93
Mollusca	36	6.40	13	72.20	27.72	17.17	216.20	7.10	14.35	975.64
Bivalvia	19	3.40	6	33.30	10.03	7.92	90.63	2.40	6.57	193.15
Gastropoda	1	0.20	1	5.50	13.52	1.31	50.45	3.20	1.50	18.28
Strombidae	1	0.20	1	5.50	13.52	1.31	50.45	3.20	1.50	18.28
Strombus gigas	2	0.40	1	5.50	13.52	1.31	51.63	3.20	1.53	19.27
Cephalopoda	9	1.60	6	33.30	5.39	7.92	67.75	1.50	6.09	104.54
Octopus	3	0.50	3	15.00	0.37	3.97	24.70	0.02	2.92	9.37
Octopus joubini	7	1.30	4	20.00	4.99	5.38	51.01	1.50	4.15	60.76
Annelida	3	0.50	2	11.10	32.91	2.64	112.12	6.00	3.28	72.95
Plant	5	0.90	5	27.80	0.99	0.24	37.64	0.40	4.87	36.55
Unidentified material	16	2.90	18	100.00	31.01	23.78	227.32	7.40	18.56	1,023.04

because they feed on 30 and 10 prey items respectively. *Dasyatis americana* from the Exumas were found to eat 65 different prey types. All the stingrays were captured in soft sediment communities; sandy shoals, algal turfs, or seagrass beds. Several studies have shown that crustaceans dominate macroinvertebrate biomass in tropical soft sediment habitats (Abele, 1974; Virnstein, 1987). Though no quantitative biomass information is available on the prey species in the ECLSP, the results suggest that the stingray is a feeding generalist taking advantage of the most available prey species.

Diana (1979) stated that feeding duration can be determined by examining the frequency of the number of items found in the stomachs. He found that the most common meal of the northern pike, *Esox lucius,* consisted of only one item suggesting that the meal was consumed over a short time period. Cortes (1987) found that most of the lemon shark stomach contents he examined contained only one or two items. Cortes concluded that the lemon shark feeds intermittently. Because 83% of the stingray stomachs contained over 10 items and the average number of items was 31, it can be concluded that feeding is continuous for *D. americana.*

Mean stomach fullness increased through the day again suggesting that the southern stingray feeds continuously throughout the day. No empty stomachs were found in this study. Diana (1979) stated that when fish with diel feeding cycles are collected at different times of the day, a percentage of their stomachs should be empty. However, this may not apply to fish that feed on prey that have hard parts that are difficult to digest such as the crustaceans that *D. americana* feeds upon. The stomach fullness data indicated that *D. americana* may prefer to feed during the high tide perhaps due to prey availability. High tide permits the stingrays to feed over a greater area. A larger sample size is needed to accurately assess subtle differences in feeding periodicity.

The feeding habits of the southern stingray seem to be similar to those of the lemon shark, *Negaprion brevirostris.* This tropical shark is an opportunistic feeder which feeds throughout the day and tidal cycle (Cortes, 1987). In order to grow to a large size and be successful in shallow, tropical marine environments, an apex predator must be a generalist in its diet and feeding habits. The southern stingray has a broad diet and is capable of taking advantage of abundant smaller epibenthic fishes and invertebrates.

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Literature Cited

Abele, L. G. 1974. Species diversity of decapod crustaceans in marine habitats. Ecology 55: 156–161.

Bigelow, H. B. and W. C. Schroeder. 1953. Fishes of the western North Atlantic. Part two: sawfishes, skates, and rays. Mem. Sears Found. Mar. Res. 2: 1–588.

Cortes, E. 1987. Diet, feeding habits, and daily ration of young lemon sharks, Negaprion brevirostris, and the effect of ration size on their growth and conversion efficiency. Unpublished Masters Thesis, Univ. of Miami, Coral Gables, Florida. 129 pp.

Diana, J. S. 1979. The feeding and daily ration of a top carnivore, the northern pike, *Esox lucius.* Can. J. Zool. 57: 2121–2128.

Funicelli, N. A. 1975. Taxonomy, feeding, limiting factors, and sex ratios of *Dasyatis sabina, Dasyatis americana, Dasyatis sayi,* and *Narcine brasiliensis.* Ph.D. Dissertation, Univ. S. Miss., Hattiesburg, Mississippi, 258 pp.

George, E. L. and W. F. Hadley. 1979. Food and habitat partitioning between rockbass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieui*) young of the year. Trans. Am. Fish. Soc. 108: 253–261.
Hess, P. W. 1961. Food habits of two Dasyatid rays in Delaware Bay. Copeia 1961: 239–241.
Hyslop, E. J. 1980. Stomach content analysis—a review of methods and their application. J. Fish Biol. 17: 411–429.
Pinkas, L., M. S. Oliphant and I. L. K. Iverson. 1971. Food habits of albacore, bluefin tuna and bonito in California waters. Calif. Dep. Fish Game Fish Bull. 152: 1–105.
Randall, J. E. 1967. Food habits of reef fishes of the West Indies. Stud. Trop. Oceanogr. 5: 665–847.
Snelson, F. F., Jr. and S. E. Williams. 1981. Notes on the occurrence, distribution, and biology of elasmobranch fishes in the Indian River lagoon system, Florida. Estuaries 4: 110–120.
Struhsaker, P. 1969. Observations on the biology and distribution of the thorny stingray, *Dasyatis centroura* (Pisces: Dasyatidae). Bull. Mar. Sci. 19: 456–481.
Thorson, T. B. 1983. Observations on the morphology, ecology, and life history of the euryhaline stingray, *Dasyatis guttata* (Bloch and Schneider) 1801. Acta Biol. Veniz. 11: 95–125.
Virnstein, R. W. 1987. Seagrass-associated invertebrate communities of southeastern U.S.A.: a review. Pages 89–116 *in* M. J. Durake, R. C. Phillips and R. R. Lewis III, eds. Proceedings of the symposium on subtropical-tropical seagrasses of the southeastern United States (1985). Fla. Mar. Res. Publ. 42.

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PREDATION BY THE KING HELMET (*CASSIS TUBEROSA*) ON SIX-HOLED SAND DOLLARS (*LEODIA SEXIESPERFORATA*) AT SAN SALVADOR, BAHAMAS

James B. McClintock and Ken R. Marion

The king helmet *Cassis tuberosa* is distributed throughout the Bahamas and West Indies (Warmke and Abbott, 1961). This species, as well as most other cassids, feeds almost exclusively on echinoids (reviewed by Hughes and Hughes, 1981). Here we report the first quantitative field observation of *C. tuberosa* feeding exclusively on the sand dollar *Leodia sexiesperforata* in a sandy nearshore habitat at San Salvador, Bahamas (original observation by Gerace and Lindsay, 1992). We provide evidence that the king helmet demonstrates highly predictable feeding behaviors when boring into the sand dollar test, ensuring access to the internal tissues. This study also indicates that populations of *L. sexiesperforata* can suffer high levels of localized predation by the king helmet.

LOCATION AND METHODS

The Bahamian Island of San Salvador (24°04′N; 74°35′W) is surrounded by extensive reef and vegetated and unvegetated soft bottom marine habitats. Populations of the sand dollar, *Leodia sexiesperforata*, are common in sandy substrates at Bamboo Beach, located 1 km south of Cockburn Town on the west coast of San Salvador (D. Gerace, pers. comm.). Observations of the king helmet feeding on sand dollars were made during mid-morning hours in July 1992 by swimming parallel to the shore at a depth of 4–5 m. Swimming continued until 10 *Cassis tuberosa* were located. Individuals were turned over, noting whether or not each was feeding on an *L. sexiesperforata*. Sand dollars which