

DIET COMPOSITION OF THE WHIPTAIL STINGRAY *Dasyatis colarensis* SANTOS, GOMES & CHARVET- ALMEIDA, 2004 (CHONDRICHTHYES: DASYATIDAE) IN THE COLARES ISLAND REGION, PARÁ, BRAZIL

Composição da dieta da arraia *Dasyatis colarensis* Santos, Gomes & Charvet-Almeida, 2004 (Chondrichthyes: Dasyatidae) na região da Ilha de Colares, Pará, Brasil

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ABSTRACT

The diet of the Colares whiptail stingray, *Dasyatis colarensis*, was studied from 47 specimens caught off the Colares Island region, Pará (Brazil). The rays were collected in 2006 and stomach contents were analyzed qualitatively and quantitatively. Stomach repletion and item digestion levels were observed. The percentage frequency of occurrence (%F.O.), percentage by number (%N) and by weight (%W), Index of Relative Importance (IRI) and respective percentage (%IRI) were calculated for each item group. The results indicated that most stomachs (87%) were $\frac{1}{4}$ filled with food content and that most food items (59%) were highly digested. Crustaceans were the predominant food item (%IRI = 58) and included species belonging to the Portunidae (crabs), Alpheidae, Penaeidae e Palaemonidae (shrimps) families. Teleosts had an intermediate level of importance (%IRI = 42) in the diet of this species and corresponded to gobiid (Perciformes) species. Annelids and molluscs were rare food items. The results evidenced that this species feeds mainly on crustaceans, but also on fish and occasionally on other food items. The diet of *D. colarensis* was similar to other *Dasyatidae* species.

Keywords: feeding, Colares whiptail stingray, Amazon estuary.

RESUMO

A dieta da arraia-de-Colares, *Dasyatis colarensis*, foi estudada através da captura de 47 exemplares realizada próximas a região da ilha de Colares, Pará (Brasil). As arraias foram coletadas em 2006 e o conteúdo estomacal foi analisado qualitativamente e quantitativamente. Os níveis de repleção estomacal e de digestão dos itens alimentares foram observados. A porcentagem de frequência de ocorrência (%F.O.), porcentagem numérica (%N) e de peso (%W), Índice Relativo de Importância (IRI) e respectiva porcentagem (%IRI) foram calculados para cada grupo de itens. Os resultados indicaram que a maioria (87%) dos estômagos encontrava-se $\frac{1}{4}$ preenchida com conteúdo alimentar e que a maior parte dos itens alimentares (59%) estava bastante digerida. Crustáceos foram os itens alimentares predominantes (%IRI = 58) e incluíram espécies pertencentes às famílias Portunidae (sirís), Alpheidae, Penaeidae e Palaemonidae (camarões). Teleosteos apresentaram um nível intermediário de importância (%IRI = 42) na dieta desta espécie e corresponderam a espécies de gobídeos (Perciformes). Anelídeos e moluscos foram contatados como itens alimentares raros. Os resultados evidenciaram que esta espécie se alimenta predominantemente de crustáceos, mas também de peixes e, ocasionalmente, de outros itens alimentares. A dieta de *D. colarensis* foi similar aquela observada para outras espécies de *Dasyatidae*.

Palavras-chaves: alimentação, arraia-de-Colares, estuário Amazônico.

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INTRODUCTION

Fish are an important vertebrate group that comprises over 30,000 living species (Moyle & Cech, 2000). Among these there are approximately 500 shark species, 600 batoids and 50 chimaeras species (Compagno, 2001; Stevens, 2005; Compagno *et al.*, 2005).

The Rajiformes order is presently divided in 23 families. Six genera and approximately 69 species are included in the Dasyatidae family (Compagno, 2005) but this information may vary (Itis, 2008). There are between 38 (Compagno, 2005) and 42 (Gomes *et al.*, 2000) described species of the genus *Dasyatis*, depending on the genus assignments made by the authors. The Dasyatidae species list is gradually increasing in number and recently two *Dasyatis* species were described from Brazilian waters (southwestern Atlantic Ocean), *Dasyatis colarensis* Santos, Gomes & Charvet-Almeida, 2004 from the north coast and *Dasyatis hypostigma* Santos & Carvalho, 2004 from the south / southeastern region (Santos *et al.*, 2004; Santos & Carvalho, 2004).

Stomach content analyses are widely used to evaluate the diet composition in fish ecology studies (Hyslop, 1980). Method revisions point toward a consensus that more than a single index should be used in feeding studies. This favors the achievement of more consistent results and reduces isolated index analysis bias (Hynes, 1950; Windell, 1968; Pinkas *et al.*, 1971; Hyslop, 1980; Cortés, 1997).

Elasmobranch diet and feeding habit studies are essential to the understanding of the ecological role of this group in the ecosystem, its trophic dynamics and also for their conservation (Hess, 1961; Gilliam & Sullivan, 1993).

One of the pioneer studies regarding the feeding habits of a dasyatid was carried out by Gudger (1912). In this study the author made observations on the reproduction and feeding of *Dasyatis sayi*, in the Beaufort region, United States of America. Historically, another important contribution to feeding studies was made by Bigelow & Schroeder (1953), involving rays captured off Bimini Island, Bahamas. Furthermore, Hess (1961) determined the feeding habits of *D. sayi* e *Dasyatis centroura*, in the Delaware Bay, USA. The diet of *D. centroura* in the southeastern coast of the United States was determined by Struhsaker (1969) while investigating the biology and distribution of this species. Observations on the register of occurrence and feeding of *Himantura schmardae* off Venezuela were made by Fernández-Yépez & Espinosa (1970). Later on, while studying *Dasyatis guttata* in three Central and South American

countries, Thorson (1983) carried out observations on the feeding habits of this species.

In Brazil, studies on dasyatid feeding are still scarce and mainly focused on *D. guttata* (Silva *et al.*, 1998; Silva *et al.*, 2001).

The main purpose of the present study is to provide data on the diet composition of *D. colarensis* in order to contribute to the understanding of the ecology and conservation of this recently described species.

MATERIAL AND METHODS

The specimens were captured off Colares Island (0°56'23" S - 48°17'10" W, State of Pará, Brazil) in July and October (dry season) of 2006. Captures were carried out by a research team with the help of local fishermen. Bottom longlines were the fishing gear used.

The stingrays died after boarded and were eviscerated when landed. A ventral semi-circle was cut on the abdominal region, below the scapulocoracoid cartilage. The stomachs had their extremities firmly tied prior to being removed in order to avoid content loss and were fixed in a 10% formaldehyde solution buffered with sodium tetraborate. The material was taken to the Ichthyology Laboratory at Museu Paraense Emílio Goeldi (MPEG). There, it was rinsed in water to eliminate excessive formaldehyde and was kept in ethanol 70% to be analyzed.

Later the stomachs were open and all its contents were placed in a Petri dish. Excessive liquid was absorbed with paper towels. Analyses were made under a stereomicroscope (Nikon, SMZ-10) and a precision scale was used to weight the food items.

Stomach repletion levels were registered. The following values were used to indicate stomach repletion as: 0 = empty; 1 = ¼ full; 2 = half full; 3 = ¾ full and 4 = full. Empty stomachs were not considered in the analysis since the method used takes into account the presence of food items and the respective values for percentage frequency of occurrence, percentage by number and by weight.

The food items digestion level was also observed according to the following scale (Zavala-Camin, 1996): 1 = undigested item; 2 = external parts partially digested; 3 = external parts and muscle tissue partially digested; 4 = only the axial skeleton and muscle tissue undigested; 5 = only fragments left.

The diet composition of *D. colarensis* was obtained through the calculation of the relative percentage frequency of occurrence, percentage by number and by weight. These values were calculated according to the following equations:

a) Percentage frequency of occurrence (%F.O.):

$$\%F.O. = 100*(F_i/n)$$

where F_i = number of times the food item was observed and n = total number of stomachs containing food items.

b) Percentage by number (%N):

$$\%N = 100*(N_i/n)$$

where N_i = number of items of each taxon and n = total number of items including all taxonomic categories.

c) Percentage by weight (%W):

$$\%W = 100*(W_i/n)$$

where W_i = total weight of the item of a taxon and n = sum of all stomach content weights.

The Index of Relative Importance (IRI) (Pinkas *et al.*, 1971) was calculated according to Hacunda (1981), where the volume percentage is substituted by weight percentage due to the difficulties in calculating volume of very small items or fragments:

$$IRI = \%F.O.*(\%N+\%W)$$

The IRI value was transformed in percentage (%IRI) for a better interpretation of the results, as proposed by Cortés (1997). The results were noted on a specific spreadsheet. These were then typed and analyzed (Statistica 7.0, Statsoft).

RESULTS

A total of 47 specimens of *D. colarensis* were captured off the Colares Island. The stomach analysis indicated the presence of two empty stomachs, 11 stomachs containing only amorphous substance (impossible to detect the presence of food items) and 34 containing food items.

The stomach repletion levels were represented mainly by the category 1 (1/4 full; 87.2%). On the other hand a small percentage (4.3%) of empty stomachs was observed. No almost full (level 3), or full stomachs (level 4) were registered (Table I).

The food item digestion levels 4 and 5 were more frequent (Table II). Consequently most items analyzed (59.2 %) were already well digested and very difficult to identify at a more specific level.

Table I - Repletion levels observed in the analyzed stomachs of *D. colarensis*.

Repletion levels	Stomachs	
	n	%
0 (empty)	2	4.3
1 (1/4 full)	41	87.2
2 (half full)	4	8.5
3 (3/4 full)	-	-
4 (full)	-	-
Total	47	100

Table II - Digestion levels of the analyzed food items (n = 98).

Digestion level	Number of items	%
1	12	12.2
2	10	10.2
3	18	18.4
4	26	26.5
5	32	32.7
Total	98	100

Due to these advanced digestion levels, the food items were appointed to higher category groups (e.g. crustaceans, fish, annelids and molluscs) for better results interpretation.

The analyses indicated that the item group with the highest percent frequency of occurrence (%F.O. = 88.24) and percentage by number (%N = 68.37) corresponded to decapod crustaceans, represented by the families Portunidae (crabs), Alpheidae, Penaeidae e Palaemonidae (shrimps). The highest weight percentage (%W = 81.51) was detected for the bony fish item group, represented mainly by species of the Gobiidae family. Regarding teleosts, a single catfish (Siluriformes) dorsal or pectoral spine was observed and some highly digested fish muscle fragments were noted too.

The Index of Relative Importance percentage (%IRI) results pointed that *D. colarensis* presents a preference for crustaceans (%IRI = 57.87), as shrimp and crabs, followed by fish of the order Perciformes (%IRI = 42.08), as gobiids (Table III). Other food items, such as molluscs (bivalves) and annelids, were rarely observed among food items.

Table III - Frequency of occurrence, number and weight percentages, Index of Relative Importance and respective percentage results of the analyzed food items groups.

Food item	%F.O.	%N	%W	IRI	%IRI
Annelids	2.94	1.02	0.21	3.63	0.03
Crustaceans	88.24	68.37	18.22	7639.88	57.87
Molluscs	2.94	1.02	0.06	3.17	0.02
Fish	50	29.59	81.51	5555.17	42.08
Total	144.12	100	100	13201.85	100

The tridimensional graphic representation of the %IRI (Figure 1) confirmed that crustaceans and fish are main food items found in the diet of *D. colarensis* in the Colares Island region.

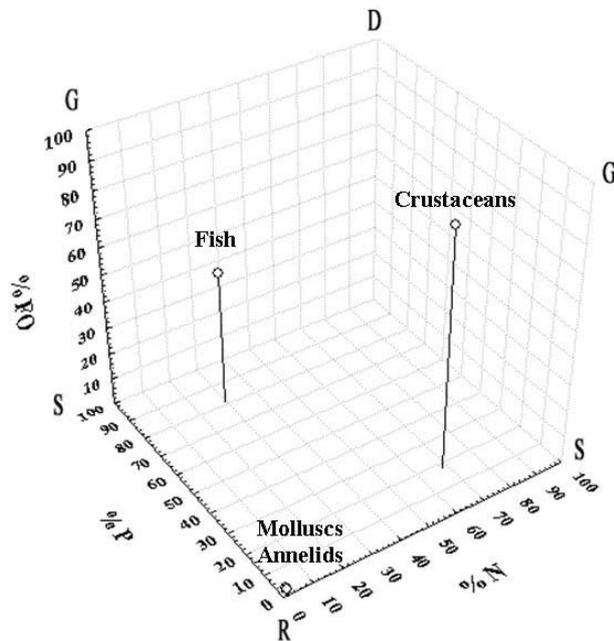


Figure 1 - Three-dimensional graphical representation of *D. colarensis* stomach content data according to the Index of Relative Importance (IRI), where D = dominant, R = rare, G = generalist and S = specialist.

DISCUSSION

The data obtained in the present study regarding stomach repletion and item digestion levels showed that the stomachs had little content and that these contents were in advanced level of digestion. The repletion level results of *D. colarensis* were similar to those reported for *D. guttata* (Silva et al., 2001) where most stomachs analyzed were indicated as only $\frac{1}{4}$ full.

The results on the diet of *D. colarensis* are similar to the ones obtained in other studies regarding the feeding of *Dasyatis* species. Bigelow & Schroeder (1953) noted that *Dasyatidae* stingrays, in general, fed on annelids, molluscs, crustaceans and small fish.

Gudger (1912) observed the presence of two types of worms among the food items of *D. sayi* in the Beaufort region, concluding that this species fed exclusively on benthonic species.

Hess (1961) indicated that in the Delaware Bay *D. sayi* e *D. centroura* has the same feeding habit and prey preferably on crustaceans, molluscs, annelids

and bony fish. Unlike what Gudger (1912) observed, in this region these two stingray species preyed also upon free swimming organisms and not solely on benthonic groups.

D. centroura, in the southeast coast of the United States, was pointed as ingesting crustaceans, worms, cephalopods and bony fish as its preferred food items (Struhsaker, 1969).

When studying the rays from Lake Maracaibo (Venezuela) Fernández-Yépez & Espinosa (1970) concluded that *Himantura schmardae* fed preferably on crustaceans, such as crabs and shrimps.

In Central and South America Thorson (1983) verified that *D. guttata* consumed molluscs and bony fish.

D. guttata was also studied by Silva et al. (1998) in northeastern Brazil (Mucuripe inlet, State of Ceará). They concluded that this species preyed mainly on crustaceans, molluscs and fish. On the other hand, later Silva et al. (2001) presented different results than the previous ones for this same region. They indicated that *D. guttata* had a more diversified diet that included echinoderms, sinpunculids, annelids, molluscs, crustaceans and fish. Since the area of occurrence of *D. colarensis* was stretched up to the State of Ceará (Charvet-Almeida, pers. comm.), it is possible that these differences in results corresponded to misidentification of these two species that are very similar and sometimes difficult to differentiate. Thus it is not impossible that in the sampling of Silva et al. (1998 and 2001) food items from both species (*D. guttata* and *D. colarensis*) were included and analyzed.

Off the Colares Island, type locality of *D. colarensis* (Santos et al., 2004), this species showed a feeding preference for crustaceans (shrimps of the families Alpheidae, Penaeidae, Palaemonidae and crabs of the family Portunidae) and teleost fish (Perciformes of the Gobiidae family). In this region, worms and bivalve molluscs were rarely observed among food items.

The results obtained in the present study indicate that the diet of *D. colarensis* is based on crustaceans and bony fish. These results corroborate with data attained in previous researches by other authors for other *Dasyatidae* species, mainly *Dasyatis*.

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