Annls Limnol. 27 (2) 1991 : 111-117

Predation by dwarf forms of *Asplanchna sieboldi* (Rotatoria) from a floodplain lake of the Orinoco River (Venezuela)

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Keywords : Predation, *Asplanchna sieboldi,* Rotifera, floodplain lakes, Orinoco River, Venezuela.

Stomach content analyses were performed on dwarf specimens of *Asplanchna sieboldi* collected on different dates in a shallow floodplain lake of the Orinoco River system. The results showed that the dwarf forms of *A. sieboldi* were highly selective on small Brachionids (*Brachionus caudatus* and *Keratella americana*). This observation confirmed on the carnivore status of these forms of the species. Considering the aleatory character of prey capture in rotifers, the high selectivity observed in *A. sieboldi* may be controlled by the abundance of the favoured small-sized prey. Under the conditions of the study, *Asplanchna* may be considered a stenophagous predator. The predation pattern exhibited by the dwarf *A. sieboldi* under our tropical conditions was similar to the pattern exhibited by larger species of *Asplanchna* in temperate regions. In both regions, size and abundance of prey seem to control the food preferences of this planktonic predator.

Prédation par des formes naines d'*Asplanchna sieboldi* (Rotifères) dans un lac d'inondation de l'Orénoque (Venezuela)

Mots clés : Prédation, *Asplanchna sieboldi,* Rotifères, lacs d'inondation, Orénoque, Venezuela.

L'analyse de contenus stomacaux réalisée sur des spécimens nains d'*Asplanchna sieboldi,* à différentes dates, dans un lac peu profond de la plaine d'inondation de l'Orénoque, a montré que les formes naines de cette espèce étaient hautement sélectives sur de petits Brachionides (*Brachionus caudatus* et *Keratella americana*). Cette observation nous a permis de conclure au statut carnivore de ces formes d'*Asplanchna sieboldi.* Considérant le caractère aléatoire de la capture des proies chez les Rotifères, la haute sélectivité observée chez *A. sieboldi* peut être contrôlée par l'abondance d'une proie préférentielle de petite taille. Dans les conditions de cette étude, *A. sieboldi* peut être considéré comme un prédateur sténophage. Le schéma de prédation montré par les formes naines d'*A. sieboldi* sous nos conditions tropicales s'est révélé similaire à celui montré par les grandes espèces d'*Asplanchna* en régions tempérées. Dans les deux régions, la taille et l'abondance des proies semblent contrôler les préférences alimentaires de ce prédateur planctonique.

1. Introduction

In a previous study, we analyzed the morphological variations of *Keratella americana* f. *hispida* from a floodplain lake of the Orinoco River as a possible consequence of predation by *Asplanchna sieboldi* (Vásquez et al. 1991). Our results showed, however, that the observed polymorphism seemed to be independent of the presence and abundance of *A. sieboldi* even though predation was excerted. Measurements on specimens of *A. sieboldi* from the lake revealed their unusually small sizes (mean size : 249.9 μm).

The feeding behavior of *Asplanchna* was reviewed by Gilbert in 1980 and by Salt in 1987. Prey capture in this predator is reported to be aleatory and it depends on the probabilities of encounter between the predator and the prey (Pourriot 1965). Considering our limited knowledge of invertebrate predation in the tropics (Fernando et al. 1990) and the cosmopolitan distribution of *Asplanchna,* we considered of interest to present the results of the analysis of the stomach contents of these dwarf forms of *A. sieboldi* collected in a shallow tropical

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floodplain lake. We also seeked to assess if there were differences in the predation patterns and prey selection between our population of dwarf forms and other larger *Asplanchna* studied in nature in temperate regions.

2. Area of study and methods

A description of Lake Rio Claro is given in Vásquez (1989). This permanent floodplain lake is located on the lower reach of the Orinoco River. It is inundated once per year by river water. In a 24 month observation period, the highest measured water depth of the lake was 2,4 m (July) and the lowest depth was 0.1 m (April). Mean monthly water temperature was 30.2°C (range : 25.5-35°C). Rotifer assemblages from this and other floodplain lakes of the Orinoco were studied by Vásquez (1984). For the present work we examined one zooplankton sample (S1) collected on April 24, 1984, and nine samples collected in 1987 on the following dates : S2 : March 28, S3 : April 23, S4 : April 30, S5 : May 7, S6 : May 11, S7 : May 14, S8 : May 18, S9 : May 21, S10 : May 28.

In all cases zooplankton samples were collected from an open water section of the lake. Water was filtered through a plankton net (mesh size : 45 μm). The amount of filtered water varied depending on the concentration of the organisms. In the laboratory, we analyzed the stomach contents of 20 *A. sieboldi* taken from each zooplankton sample. Our selection of 20 stomachs per sampling date was based on the observation of Salt (1989) who found that a sample size of 10 *Asplanchna* was the minimum to be used for reliable data. On May 11, however, we examined the only three organisms that were present in the entire sample. Only on this occasion we were lower the limit level. A total of 183 stomachs were analyzed by means of the numerical and occurence methods. The limitations associated to these methods were discussed by Garreau et al. (1988) in the framework of an *Asplanchna* predation study. Ivlev selectivity index was calculated for the two most abundant prey items which met one of the conditions identified by Lechowicz (1982) as a pre-requisite for the calculation of selectivity indeces (in our case, the presence of prey species at all times). In spite of the limitations associated to this and to other indeces (see Lazzaro 1987), we supported our selection of this index on its simplicity and on the fact that Garreau et al. (1988) found similar results for the different indeces applied in their analysis.

3. Results and discussion

Out of the 183 analyzed stomachs of *A. sieboldi*, 66,1 % showed identifiable prey. 39,9 % of the stomacks were either empty (all stomachs in S6 were observed empty) or showed unidentifiable matter. In the first case, all stomachs showed animal preys (Table 1). This observation led us to conclude on the carnivore status of the species. In his study of sympatric *A. girodi* and *A. priodonta*, Salt (1989) found that algae were important food items for both species. Even if present in a lower proportion, Garreau et al. (1988) also found algae in *A. girodi*. In both instances, however, the algae ressources were made up almost entirely of diatoms. In our case, the absence of algal items in the stomachs may be due to the fact that in L. Rio Claro highest phytoplankton abundance at low water is mainly due to Cyanophyta. Considering the negligible role of algae in *A. sieboldi* (Pourriot et al., 1982), we could expect that a rather weak preference for these food items would disappear in the presence of dominant blue-green algae. This observation opens up the possibility suggested by Starkweather & Walsh (1989) in the sense that consumption of Cyanophyta by grazer rotifers (such as *Brachionus calyciflorus*) may lead to direct a portion of blue-green algae production to higher trophic levels by *Asplanchna* predation on these grazers.

Brachionus caudatus and *Keratella americana* represented the basic food item (77,6 %) of *A. sieboldi*. If all Brachionids are considered this figure adds up to almost 100 % (Table I). These results

Table I. Type, number and percentage abundance of identified prey items in the stomachs of *A. sieboldi*.

Type of prey	No prey	%
Brachionus caudatus	101	49.0
Brachionus forficula	5	2.4
Keratella americana	59	28.6
Keratella tropica	7	3.4
Trichocerca similis	2	1.0
Mastax Brachionids	32	15.5

agree with those of studies of *A. girodi* carried out in the field by Garreau et al. (1988) and in outdoor tanks by Commins & Salt (1988). In all these cases, *Keratella* and *Brachionus* represented the most important food item of *Asplanchna*. Or the preyed Brachionids by *A. sieboldi* from L. Rio Claro, 10,2 % were ingested carrying eggs. This means an additional 15-40 % of the rotifer biomass being removed by the predator. *Trichocerca similis* was the only non-Brachionid found in the stomachs. Given its low percentage of occurrence, this species could be regarded as an accesory prey.

Plankton analysis revealed the presence of some 30 rotifer species out of which eight species showed percentages of abundances ⩾ 10 % (Table II). Frequent and abundant species such as *B. falcatus* and *B. havanaensis, Filinia longiseta* and *Anuraeopsis fissa,* and other frequent but less abundant species (density < 10 %) such as *Polyarthra vulgaris* and *Trichocerca* spp. were never observed in the stomachs of *A. sieboldi*. Neither were observed microcrustaceans, such as nauplii which, in L. Rio Claro, make up the most important zooplankton group in terms of biomass (in prep.). Given the narrow prey spectrum and the relatively high number of potential prey, we could consider *A. sieboldi* from L. Rio Claro as a stenophagous predator.

Along the period of study, the selectivity index of *B. caudatus* and *K. americana* showed values above the level of indifference (*fig.* 1). From these results it became clear that *A. sieboldi* exerted a strong selective predation on these two species in spite of the presence of other potential prey. A similar high degree of selectivity was reported for *A. girodi* by Cummins & Salt (1988). Garreau et al. (1988) and Salt (1989) observed in natural conditions that *A. girodi* and *A. priodonta* consummed a higher array of prey species in comparison to our *A. sieboldi* population. If we consider the aleatory character of the capture of a prey in rotifers (Pourriot 1965), an explanation for the high selectivity of *A. sieboldi* from L. Rio Claro may be found in the presence of a relatively high abundance of favored prey when *A. sieboldi* was present. Except for S1, the ration of prey abundance/predator abundance was high (Table III) suggesting that the selectivity of

Table II. Abundance of rotifers (ind./l) and percentage of abundance of the most important rotifer species (⩾ 10 %) in the plankton of the lake.

Samples	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Abundance of rotifers	**839**	**848**	**365**	**983**	**594**	**736**	**870**	**565**	**466**	**171**
% Abundance per species										
A. fissa										**20.5**
B. caudatus	12.2	35.6	27.1	56.8	21.5	17.1		13.5	56.0	
B. falcatus	29.1		11.2			18.6	10.3	16.1		
B. forficula			**10.7**			12.0	10.3			14.6
B. havanaensis									26.4	10.5
F. longiseta	14.4	21.6								
K. americana		18.3	30.1	14.9	56.2	44.7	61.6	47.6	3.2	32.2
A. sieboldi	13.1									
Others	31.2	24.5	20.9	28.3	22.3	7.6	17.8	22.8	14.4	22.2

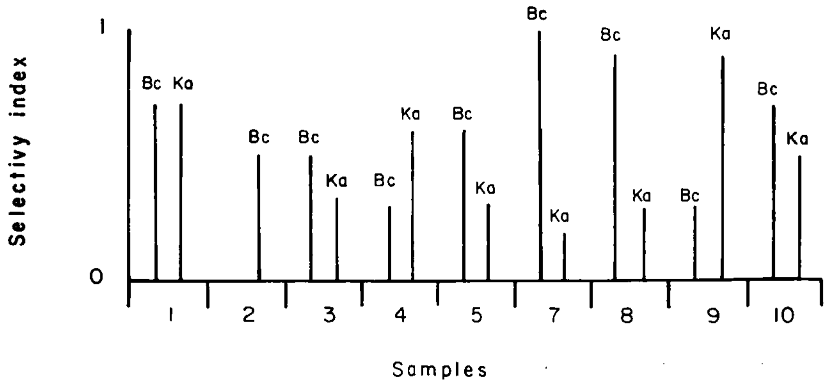

Fig. 1. Mean values of the selectivity index (Ivlev) (S6 excluded given that only empty stomachs were observed). Bc = *B. caudatus* ; Ka = *K. americana.*

Table III. Mean values of the number of prey in the stomach per *A. sieboldi* ; number of *A. sieboldi, B. caudatus* and *K. americana* (ind./l) ; and the ratio of the number of *A. sieboldi* (ind./l)/*B. caudatus* + *K. americana* (ind./l) (Mastaxes of Brachionids were considered as an entire prey) (S6 excluded given that only empty stomachs were observed).

Samples	Prey per stomach (sd)	Asplanchna per liter	B. caudatus per liter	K. americana per liter	Prey/predator
1	1.9 (1.0)	110	103	13	1.1
2	1.3 (0.5)	5	302	155	91.4
3	1.9 (0.9)	5	99	110	41.8
4	1.5 (0.5)	9	558	146	78.2
5	1.0 (0.0)	3	130	334	154.7
7	1.9 (1.1)	9	0	536	59.6
8	1.8 (1.0)	18	76	269	19.2
9	2.0 (1.1)	12	261	15	23.0
10	2.0 (1.0)	4	15	55	17.5

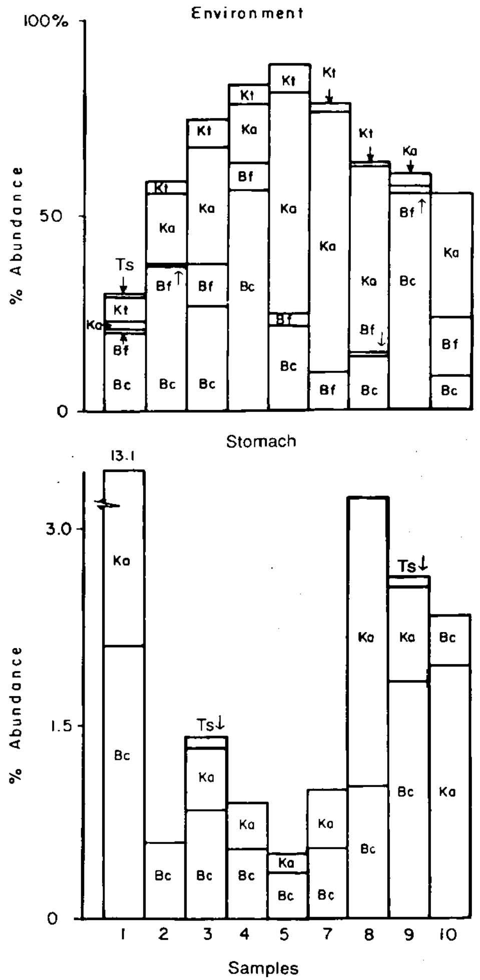

Fig. 2. Percentage abundance of prey species and of *A. sieboldi* in the plankton and percentage of occurrence of prey in the stomachs of *A. sieboldi* (S6 excluded given that only empty stomachs were observed). Bc = *B. caudatus* ; Bf = *B. forficula* ; Ka = *K. americana* ; Kt = K. tropica ; Ts = T. similis.

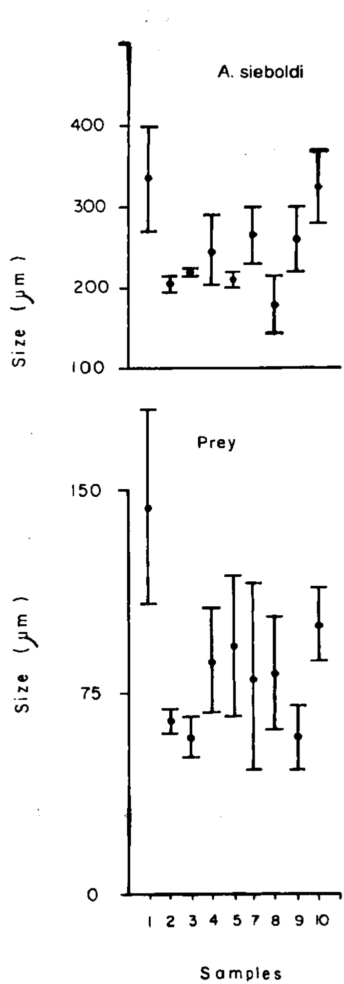

Fig. 3. Mean size of *A. sieboldi* and of the prey during the period of study (S6 excluded given that only empty stomachs were observed).

A. sieboldi was enhanced by the presence of high numbers of favored prey (*fig.* 2). On this regard, Commins & Salt (1988) found *K. cochlearis* to be the favored food item of *A. girodi* when the prey was present in sufficient numbers.

Even though highest *Asplanchna* abundance coincided with a relative decrease of prey items in the environment (probably as a result of predation) it is interesting to note that the abundance of *A. Sieboldi* did not seem to be affected by food levels. Except for S1, the abundance of *B. caudatus* and/or *K. americana* outweighted the abundance of the predator (Table III). In this case, the regulation of the abundance of *A. sieboldi* in the lake is most likely the result of low fertility (one embryo per female in 8,2 % embryo carrying females) and of predation by other organisms.

Mean size of *A. sieboldi* from L. Rio Claro was 249,9 μm (N = 63 ; sd = 68 ; range = 125-433,2 μm). Mean total length of *B. caudatus* was 79.9 μm (N = 66 ; sd = 38.3 ; range = 32.3-208.3 μm) and that of *K. americana* was 85.1 μm (N = 34 ; sd = 23.3 ; range = 38.4-113.1 μm). The number of animal prey in the stomach per *A. sieboldi* ranged from 0 to 4 with a mean from 1 to 2 (Table III). The index of the predator mean size/prey mean size was approximately 3 for the two favored prey. In the temperate population of *A. girodi* studied by Garreau et al. (1988) the size of the most favored items of the predator (size range : 600-800 μ) had a mean size lower than 320 μm. If we take both extremes of the predator size, the index predator size/mean prey size would range from 1.9 to 2.5. For both dwarf tropical and temperate populations the index would then range from 1.9 to 3. Considering the relative mean size of both predator and prey, our observationns confirm the conclusions of Garreau et al. (1988) concerning the fact that *Asplanchna* will generally select prey of smaller size than the maximum size of the items the predator is capable of ingesting. In other words, larger predators will be able to est larger prey items (*fig.* 3). We found a significant relationship between predator size and mean size of predators in the stomachs per *Asplanchna* (N = 10 ; r = 0.52 ; $p < 0.05$). The complete absence in the stomachs of *A. sieboldi* of potential prey such as nauplii may be the result of their larger size in relation to the small predator size. This may also be the case for other potential prey such as *B. falcatus* and *B. havanaensis* which, by the presence of anterior and posterior spines have larger sizes and could scape predation.

4. Conclusions

Studies to assess the role of predation in aquatic food web components of the Orinoco River floodplain system are very scarce (Twombly & Lewis 1989). In this system, intrazooplankton predation deserves attention on a long-term basis considering that a fraction of cyanobacterial primary production may be utilized by prey items of *Asplanchna.* To this species we may add other predators of rotifers through whom blue-green algae productivity may also be channelled to higher levels. In L. Rio Claro dwarf *A. sieboldi* was found to be a stenophagous predator on small sized Brachionids (*B. caudatus* and *K. americana*). This high selectivity of *Asplanchna* seemed to be enhanced by the relative high availability of its favoured prey in the environment. Considering that a predator relies on chance encounters for catching its prey, then prey size (preference for smaller prey) and abundance are major factors involved in the ability of *A. sieboldi* to selective. On this regard, the predation pattern exhibited by our population of dwarf *Asplanchna* was similar to that observed in temperate populations. In both natural conditions, prey selection by *Asplanchna* is controlled by the abundance of a favoured small sized prey. When a favored prey is present in high concentrations, *Asplanchna* becomes highly selective. However, if the favoured prey is absent or less abundant, *Asplanchna* will expand its food niche to incorporate less favoured species. Under the latter circumstances, *Asplanchna* may become a generalist and opportunistic predator such a that reported by Garreau et al. (1988). On long-term studies of zooplankton from floodplain lakes of the Orinoco, we have observed that rotifer abundance far outweights the abundance of other zooplankton groups (in prep.). Under these conditions the carnivore, stenophagous character of *Asplanchna* will most likely persist.

Acknowledgements

We are deeply grateful to Dr Roger Pourriot, Université Paris 6, for providing us with useful references and for his careful reading and comments to the manuscript. We are also grateful to Dr Walter Koste, Quakenbrück, Germany, for his help in the identification of *A. sieboldi*. The manuscript was written during a visit by one of the authors (E.V.) to the laboratory of Dr. Jeanne Rey, Université Paul Sabatier, Toulouse, France, to whom we express our gratitude for her highly valuable support.

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