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PREFERENCE OF BIOMPHALARIA TENAGOPHILA AMONG MACROPHYTES AND THEIR PERIPHYTONS DETERMINED THROUGH THE DEGREE OF ATTRACTIVENESS

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SUMMARY

In presence of extracts of six flowering plants the **Biomphalaria tenagophila** was more attracted to four them in the following sequence: **Nasturtium pumilum** > **Polygonum acre** > **Commelina** sp. = **Echinochloa crusgalli**. The periphyton of these flowering plants attracted in the same way the **B. tenagophila** but without no preference for either of them. Reporting the results that behavior may be evaluated as a co-evolution between snail and plants.

KEY WORDS: Biomphalaria tenagophila; Macrophytes; Periphyton.

INTRODUCTION

In ecological approaches to the feeding behavior of animals, prominence is given to their ability to spot the food in an attempt to maximize the gain in energy and minimize the loss.

KOHN (1961) extensively reviewed the perception of chemical stimulii in gastropods, documenting mainly the response of sea carnivorous gastropods.

BOVBJERG (1968, 1975), studying the feeding habits of limneides, suggests that the herbivorous molluscs of fresh water, because living in dense vegetation, do not suffer selection pressure to identify food at a distance. Such a condition would favor a randomic finding of food, and recognition would be achieved by contact.

This interpretation was criticized by CROLL (1983), in a broader revision of the chemical perception of gastropds, arguing that selective advantages exist as much for the herbivorous as for the carnivorous in the spotting of food and shelter.

Work with **Biomphalaria glabrata** shows that it presents positive responses to extracts of the plants (MICHELSON, 1960; ETGES & FRICK, 1966; TOWNSEND, 1973a,b; BOUSFIELD, 1979).

This work aimed at verifying whether **B. tenagophila** presents attraction for extracts of macrophytes, through their periphyton or whether the attraction differs among different kinds of macrophytes and among the periphytons.

MATERIAL AND METHODS

Six of the commonest macrophytes found where the molluscs were collected from (chácara Santo Antônio - Núcleo Bandeirantes DF) were

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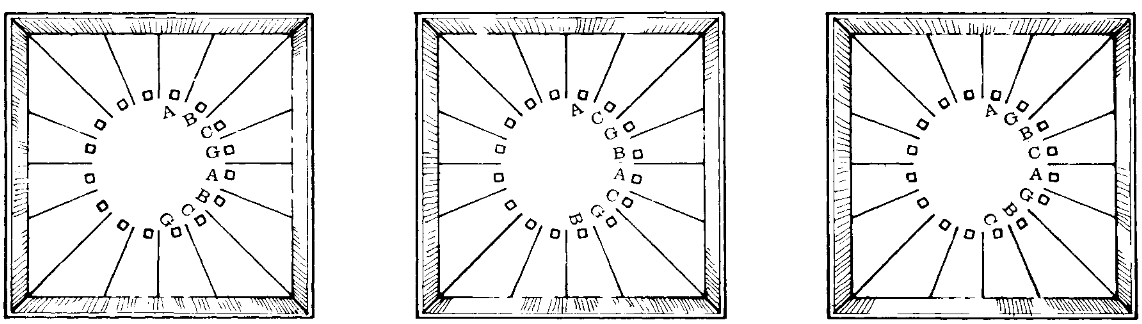
used as baits, that is, **Echinochloa crusgalli, Heteranthera reniformes, Commelina** sp., **Nasturtium pumilum, Hydrocotyle ranunculoides,** and **Polygonum acre**. Twenty grammes of leaves fresh weight of each adult macrophyte without a periphyton was liquified with 150 ml of distilled water. Then the extract was sieved for separating the fibers, and the solution was mixed in 10 ml with 12 g of colorless flavorless jelly. The solution was stored in shallow glass container for 24 hours for solidification. Then the solidified material was cut up into tablets (3.5 cm x 3.5 cm x 0.7 cm).

For control, only jelly tablets were used 12 g of jelly in 250 ml of distilled water. When the bait used was the periphyton of macrophytes, a volume of 30 ml of periphyton prepared in jelly tablets as described above for macrophytes was used.

The experiments were conducted in square aluminium trays (52 x 52 x 4.5 cm). The bottom of the container was divided in pencil into four parts. Each part was subdivided into four parts and in each part the position of the baits was determined. The baits were laid out in circles, equally distant from the center of the container of 15 cm (Fig. 1). For each group of baits tested at least three repetitions were carried out, alternating the sequence of the baits in such a way that each bait remained next to a certain kind of bait twice and once farther from this same kind of bait. The change of sequence of the extracts was made to prevent a constant proximity of two baits from affecting the results, whether the baits be mutually attractive or repellent.



Sequence ABCG — Sequence ACGB — Sequence AGBC

□ position of baits

A,B,C and G — refer to the kind of baits used in set 1 (see Table 1)

Fig. 1 — Scheme of the sets of experiments, with the model of the container used, location and sequence of baits.

The molluscs were released at the center of the circle of baits in the experiment - container after one hour without any given food. Melanic molluscs having a shell diameter ranging from 9 to 15 mm were used, collected from the study area. The molluscs were not repeated in the experiments of a same set.

The different set of experiments conducted had the following characteristics:

- Set 1 - Attraction experiment using extracts of the following macrophytes: (A) **Echinochloa crusgalli**; (B) **Heteranthera reniformis**; (C) **Commelina** sp. and (G) Control.
- Set 2 - Attraction experiment using extracts of the following macrophytes: (D) **Nasturtium pumilum**; (E) **Hydrocotyle ranunculoides**; (F) **Polygonum acre** and (G) Control.
- Set 3 - Attraction experiment using the macrophytes which most attracted in sets 1 and 2.
- Set 4 - Attraction experiment using periphyton extract blocks in jell of the following macrophytes: (Dp) **Nasturtium pumilum**; (Ap) **Echinochloa crusgalli**; (Cp) **Commelina** sp; (Fp) **Polygonum acre.**

Data collection and analysis

The molluscs were taken out of the cube soon after they got to the bait (macrophyte or periphyton extract) and the kind of bait which attracted, them as well as the place where it lay were written down.

This procedure was repeated every 15 minutes, during two and a half hours, ten times. After this period, the molluscs which remained either in the center or on the way without scattering, were counted and the figure was written down. To this result was added the ones which had been attracted to each kind of bait the χ^2 test was applied. Three liberty degrees were used when the four baits were compared, 2 degrees when the comparison was made among three baits and 1 degree when two baits were compared. In all of these comparisons the significance level considered was p = 0.05. In each set the three bait sequence were tested with at least two repetitions each and with the average number of 80 molluscs.

RESULTS

The molluscs responded positively to the stimulus from the macrophyte extracts used and from the periphyton extracts.

The results of each set of measurement of **B. tenagophila** attraction are summarized in Table 1.

TABLE 1

Attraction of **Biomphalaria tenagophila** for baits of macrophytes extracts prepared in jelly blocks and bait of macrophyte periphytons Ho — Equality of the number of molluscs to each kind of extract in each set.

Sets		Number of molluscs attracted to each bait	χ^2					Attraction intensity of molluscs for the baits for each set
1	A — **Echinochloa crusgalli**	351						
	B — **Heteranthera reniformis**	200	214,4	52,9	41,3	N.S.	45,2	C = A > B > G
	C — **Commelina** sp.	359	(ABCG)	(ABC)	(AB)	(AC)	(BC)	
	G — Control	81						
2	D — **Nasturtium pumilum**	191						
	E — **Hydrocotyle ranunculoides**	96	79,1	31,2	15,7	5,45	11,0	D > F > E > G
	F — **Polygonum acre**	148	(DEFG)	(DEF)	(DE)	(EF)	(EF)	
	G — Control	61						
3	D — **Nasturtium pumilum**	123						
	A — **Echinochloa crusgalli**	46	54,8	5,8	13,1			D > F > A = C
	C — **Commelina** sp.	46	(DACF)	(DF)	(AF)			
	F — **Polygonum acre**	88						
4	Dp — Periphyton of **N. Pumilum**	111						
	Ap — **Periphyton of E. crusgalli**	117	N.S.					Dp = Ap = Cp = Fp
	Cp — Periphyton of **Commelina** sp.	111	(DpApCpFp)					
	Fp — Periphyton of **P. acre**	127						

Meaningless at the level of p = 0.05.

The first set showed that there existed preference and through the frequency in the distribution of the molluscs in each bait, the following attraction sequence was established in this set: **Commelina** sp. extract (C) had the same power of attraction as the **Echinochloa crusgalli** (A) which attracted more than the **Heteranthera reniformis**, (B), and all of them attracted more than the control (G).

Set 2 — experiments were meaningful and the following order of preference was established, through the frequencies of the attracted molluscs: **Nasturtium pumilum** (D) attracted more than **Polygonum acre** (F), which attracted more than **Hydrocotyle ranunculoides** (E), and the latter attracted more than the control.

In set 3, the four macrophytes which attracted more in sets 1 and 2 were experimented together: D — **Nasturtium pumilum**, A — **Echinochloa crusgalli**, C — **Commelina** sp. and F — **Polygonum acre**. The combinations DACF and the combination AF were meaningful. Thus the following attraction order can be established: **Nasturtium pumilum** (D) attracted more than **Polygonum acre** (F), which attracted more than **Comelina** sp. (C), which had the same power of attraction as **Echinochloa crusgalli** (A) D > F > A = C.

The experiments among the macrophyte periphyton were Dp — Peryphyton of **Nasturtium pumilum** Ap — Periphyton of **Echinochloa crusgalli**, Cp — Periphyton of **Commelina** sp., Fp — Periphyton of **Poligonum acre**. The molluscs were attracted to these baits but they did not show preferences among them.

DISCUSSION

In the present paper, the attraction of **B. tenagophila** for macrophytes and periphyton was emphasized. It is assumed that this attraction is due to stimulii of chemical substances since there is no color discrimination among gastropodes. Their visual perception is limited to different light intensities (PURCHON, 1978): and since the extracts of the plants were used, their shape as a means of shelter was eliminated as an attraction factor.

Several hypothesis have been speculated to explain this attraction phenomenon, in the search for an understanding of both the mediating substance and the adaptive motive for the existence of the attraction. As for the kind of mediating substance, several studies have shown that water vegetables (macrophytes and algae) liberate in the environment, several organic compositions such as amino and imino-acids, small chains of carboxilic and hydroxiatic acids (MAKSIMOVA & PIMENOVA, 1969; CHANG & TOLBERT, 1970; WETZEL & MANNY, 1972; JUTTNER & FRITZ, 1974; PATIENCE et al., 1983).

Studies with **B. glabrata** have demonstrated that this species is sensitive to the chemical stimulii of carboxilic acids and amino acids (THOMAS & ASSEF, 1979; THOMAS et al., 1983). It was also emphasized by THOMAS et al., 1983, that the range of chemical perception is very similar among **B. glabrata, B. straminea, Physela acute, Helisoma duryi, Lymnaea natalensis** and **L. stagnalis** and justified by the similarities in the feeding habits of those species.

Assuming that **B. glabrata** and **B. tenagophila** are similar species, with geographical distribution overlapping in same areas, but without cohabitation in the same habitat, demonstrating that there is kind of competition between them, and that this is probably due to the great niche similarity, one can suppose that the attraction exerted by the macrophytes is due to the liberation of the same products, amino acid, imino acids and carboxilic acids already experimented as attractors to **B. glabrata**.

The difference of attraction among the macrophytes could be linked to a qualitative effect, that is each one would liberate a kind of substance that would have greater or lesser attraction power. We should also take into account the possibility of occurrence of antagonist substances, of a effect detected by BOUSFIELD (1979), which diminish the response of **B. glabrata** to **Apium nodiflorum** (Umbelliferae) and **Roripa nasturtium aquaticum** (Cruciferae) according to the increase in concentration. Extracts of these plants mixed with wheat germ extract which have great attraction power, diminishes its capacity to stimulate the responses of the molluscs to approach the plants or rather, if could just be the quantitative effect in which the attracting substances liberated in greater or lesser concentration would attract the molluscs in different intensities.

In several studies, including the present, the attracting factors are chemical. Thus, the chemical studies of extracts and experiments for the verification of the behavior of the mollusc before isolated substances will be carried out for the confirmation of these hypothesis.

The hypothesis proposed to explain the reason for the attraction are:

1. Feeding — it has been observed that organic compositions liberated by water vegetables are assimilated by invertebrated (SEPERS, 1977). The importance of amino butiric acid, pro-

duced by the algae, in the induction of the metamorphosis in larvae, of **Haliotis rufensis** was made clear. It was also observed that the **B. glabrata** is capable of assimilating amino acids in solution, (GILBERTSON & JONES, 1972) and iron GAZINELLI et al., 1970). Thus the necessity of some organic compositions take out of the water to their metabolism could attract the molluscs to the source of production, that is macrophytes and algae.

2. Symbiosis relationship with macrophytes — THOMAS (1982) and THOMAS & TAIT (1984) have suggested a symbiosis relationship between macrophytes and molluscs. The cost of production and liberation of the organic compositions invested by the macrophytes would be compensated by the following benefits obtainable from the molluscs (a) getting rid of the periphytons, (b) increasing the nutrient circulation tax through fezes and dead mollusc, (c) CO_2 and ammonia liberated by the molluscs as excretion products would be used as nutrients by the plants. For the molluscs there would be the following benefits: a) the macrophytes would protect the animals from factors like bright light and high temperature through their shade and water current; b) they would serve as laying sites; c) they are substracts to the periphyton development; d) they liberate O_2 during the day, for the breathing of the molluscs; e) they remove ammonia and CO_2, substances toxic to the molluscs; f) they would function as shelter to prevent predation.

3. To avoid competition — the reason for attraction differences among plants, or difference in the chemical perception of each kind of macrophyte could be related to the necessity of avoiding competition with other species of molluscs PIP & STEWART (1976) have verified that the maximum concentration of **Physa gyrina** and of the **Potamogeton pectinatus** coincides with the period in which hydrocarbons dilluted as fructose and glucose are at maximum concentration in the tissues of the plants. Pears of association of **L. stagnalis** with the plant **Potamogeton richardsonii** on the other hand, coincides with the period in which sacarose concentrations is at its maximum. The authors suggest that the molluscs are attracted for specific plants to prevent the inter-specific competition for food. As the **B. tenagophyla** is almost always associated to other kinds of molluscs like **Physa** and **Lymnaea**, and other periphyton eaters, such a hypothesis deserves verifying.

As the three hypothesis raised are not mutually exclusive, more detailed studies could verify the existence of all those forces acting in the adaptation process and in the co-evolution in the relationship between molluscs and macrophytes.

As for the attraction exerted on the molluscs, it can also be accounted for by the activity of chemical substances liberated by the algae, as it has been discussed for the macrophytes.

According to PORTER (1977) non-selective eating on the periphyton favors the coexistence of algae competing with less competitive ones, maintaining all of them in low density and preventing the competitive exclusion among them.

Thus, we can suppose that the attraction of the periphyton on eating organisms is exerted by the algae or organisms with low competitive potential. Besides, the hipothesis of symbioses to account for the relationship mollusc x periphyton, in spite of the predation suffered by the latter, is supported by the works of CALOW (1974) and HUNTER (1983), which demonstrated that the substance excreted by molluscs would serve as manure (Chiefly P and N) to the periphyton, increasing its production by up to 88%.

All this adaptability explains in terms the success of this specie in water environment, mainly in small reservatories and irrigation canals.

In fact, this considerations become important to decide about this habitat management aiming the vector control, and also to rear these snails in laboratory.

RESUMO

Atração da Biomphalaria tenagophila **por extratos de macrófitas**

Em presença de extratos de seis macrófitas a **Biomphalaria tenagophila** apresentou maior

atração por quatro delas, na seguinte ordem: **Nasturtium pumilum** > **Polygonum acre** > **Commelina** sp. = **Echinocloa crusgalli**. Para o perifíton destas macrófitas a **B. tenagophila** foi atraída, sem mostrar preferência entre eles. Na discussão, tal comportamento é avaliado sob o ponto de vista da co-evolução entre moluscos e plantas.

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