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Prey Choice in Larval Dytiscus harrisii Kirby and D. verticalis Say (Coleoptera, Dytiscidae)

by **R. Leclair Jr., Y. Alarie & J.-P. Bourassa**

Abstract: We have experimentally investigated food preferences in larval *Dytiscus* by offering five types of prey to individuals from syntopic populations of *D. verticalis* Say and *D. harrisii* Kirby and from a distant population of *D. verticalis*. The prey were frog and toad tadpoles, two kinds of caddisfly larvae and a mosquito larvae. *D. verticalis* preferentially fed on tadpoles but interpopulation differences are interpreted as induced preferences owing to corresponding prey frequency differences in natural ponds. On the other hand, preferences of *D. harrisii* for caddisflies are put in relation with morpho-ethological adaptations for handling these prey. It is concluded that larval coexistence of *D. verticalis* and *D. harrisii* rests on resource partitioning.

Key words: Coleoptera Dytiscidae – *Dytiscus* – prey – tadpole – caddisfly – mosquito – aquatic beetles.

Introduction

"An animal does not eat a certain food; it is nutritionnaly best for him; it may be nutritionnaly best for him because he has evolved the most efficient way of utilizing it". This sentence of Dethier (1976) is relevant to the observations we made of some larval dytiscid beetles that starved to death while in presence of plenty of food; but it may not have been the right kind of food. Studies of food preferences of immature stages of dytiscid beetles are few; however, we do know about the mosquito destroying efficiency of many *Laccophilus* species (Service, 1977) and some *Dytiscus* (Nelson, 1977), *Agabus* (Stout, 1982) and *Cybister* (Reed & Lee, 1983) species.

Larval beetles of the genus *Dytiscus* are recognized as efficient predators of Amphibian tadpoles (Balduf, 1935; Young, 1967; Brodie & Formanowicz, 1983). At least two species that feed preferentially on caddisfly larvae are known; one is the palearctic *D. semisulcatus* Müll (Balduf, 1935), the other is the nearctic *D. harrisii* Kirby (this study).

Working with the later species, we were intrigued by the fact that many specimens died rather than eat frog tadpoles. Conversely, many *D. verticalis* Say, which are vigorous tadpole eaters, were unable to exploit trichoptera larvae hidden in their case.

We have experimentally investigated food preference in larval *Dytiscus* beetles by offering five different types of prey to individuals from syntopic populations of *D. verticalis* and *D. harrisii* and from a distant population of *D. verticalis*. The aim of the study was to relate differential predation of the three beetle populations to natural prey occurrence in respective pools.

Material and methods

Immature stages (instars I and II) of *Dytiscus* beetles were dipnetted in two different temporary ponds near Trois-Rivières, Québec (46°18′N; 73°37′W). The first, Sand Pit Pond, is situated at the periphery of a sandy pit near a forest edge and contains abundant submerged shrubs (*Salix* spp.) and herbs as hiding places for predatory insects. Thirteen larvae of both *D. verticalis* and *D. harrisii* from this pond were used as experimental animals. The other site, Clear Water Pond, is located in a red maple woodland, a detailed description of which is given elsewhere (Leclair & Bourassa, 1981). We captured 27 larvae of *D. verticalis* from this second pond, and although *D. harrisii* also in known to occur there no larvae of that species were collected. The specimens were brought into the laboratory (21°C, 16L: 8D) and put in round glass jars containing 300 ml of filtered pond water. All beetles were starved 24 h before experimentation.

The prey were small tadpoles of frog (*Rana sylvatica*) and toad (*Bufo americanus)*, mosquito larvae (instars III and IV of *Aedes atropalpus)*, and two trichopteran species of the family Limnephilidae that differ markedly in larval case structure; the first (type 1) being a tangle of small transversely arranged detrital branches, and the second (type 2), a finer adjunction of elongate pieces of leaves arranged longitudinally with a rooflike projection of one of the pieces over the case entrance. Both species probably belong to the genus *Limnephilus* according to their case morphology (Wiggins, 1977). All prey naturally occur in both ponds except *B. americanus* which is absent from Clear Water Pond.

Each test, conducted over a five day period, consisted of maintaining permanent contact between the beetle and two different types of prey at a time. Each type of prey was replaced by another type after 36 h if not eaten by the beetle, or sooner if it was consumed within this time. The five types of prey were presented at least three times during the 5 days. Tadpoles and mosquito larvae normally were offered five at

a time while limnephilid larvae were offered singly. No trophic interaction was noted between any of the prey types when put together in a jar. Checks were regularly made to observe beetles feeding on prey or to detect missing prey. All prey were of suitable dimension for instars I and II of both *Dytiscus* species. Since food types were presented by pairs, a one-tailled binomial test (ZAR, 1974) was applied on each frequency of predators that fed on a particular type of prey; we used a theoretical proportion of binomial distribution of 0.5 assuming for each type of prey an equal chance of being captured although there was variations in body weight, body profil and mobility of prey.

Results

Results are expressed as percentages of larval beetles that fed on a particular type of prey. It is evident from figure 1 that *D. verticalis* from Sand Pit Pond prefered the species of Amphibian tadpoles; mosquito larvae also were eaten readily by more than 60% of these beetles while type 1 *Limnephilus* sp. was rarely caught and none of the type 2 was eaten. All individuals of the syntopic *D. harrisii* (B in figure 1) fed on the caddisfly larvae; *Rana* tadpoles were more acceptable to them than *Bufo* tadpoles while mosquito larvae were not eaten. *D. verticalis* from Clear Water Pond preferentially fed on *Rana* tadpoles but surprisingly did not

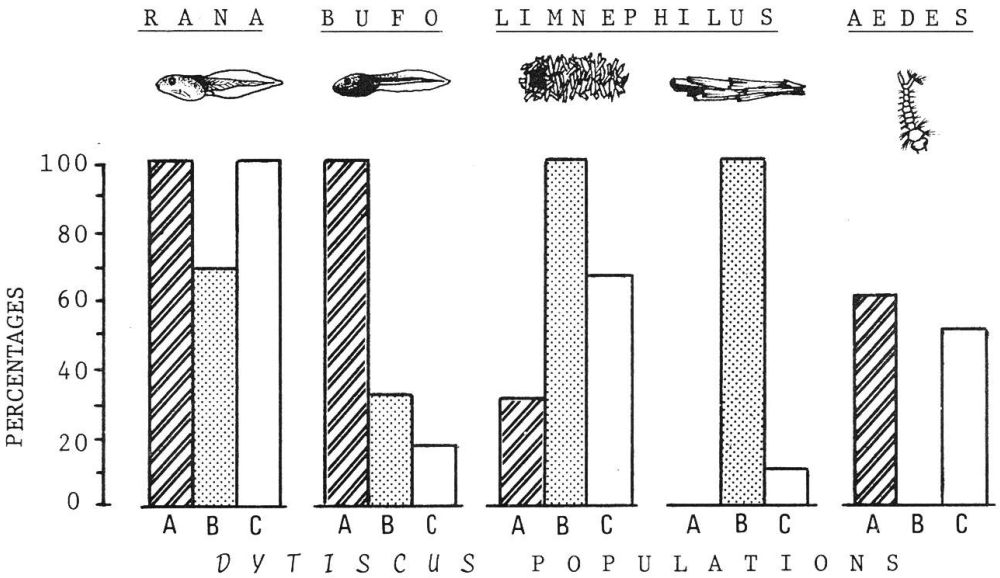

Fig. 1: Percentages of larval dytiscid beetles that accept to feed on different types of prey. A) *Dytiscus verticalis* in Sand Pit pond, B) D. harrisii in Sand Pit pond, C) *D. verticalis* in Clear Water pond.

appreciate *Bufo* tadpoles. Again, *Limnephilus* of type 1 were more vulnerable to predation than those of type 2. Mosquitoes were acceptable as food for about 50% of *D. verticalis*. In brief, highly significant preferences were recorded: *D. verticalis* from Sand Pit Pond for both anuran tadpoles, *D. harrisii* for both kinds of caddisfly, *D. verticalis* from Clear Water Pond for *Rana* tadpoles. Highly significant ($P<0.001$) "rejections" were: *D. verticalis* from Sand Pit Pond for type 2 limnephilids, *D. harrisii* for mosquito larvae, and *D. verticalis* from Clear Water Pond for *Bufo* tadpoles ($P<0.002$) and type 2 limnephilids.

Qualitative information was gathered while experiments were conducted. Normally, when a type of prey was accepted by all individual beetles of a subpopulation, each prey was entirely consumed. On the other hand, prey caught by a small percentage of a subset of beetles often were only partly eaten. This was especially apparent in the case of *Bufo* tadpoles caught by *D. harrisii* or by *D. verticalis* from Clear Water Pond. Some *D. verticalis* from both ponds tried to attack caddisfly larvae (figure 1) but they were unable to catch type 2 *Limnephilus* sp. This potential prey has its head and front legs protected by the roof-like projection of the case even when walking along a twig. Type 1 *Limnephilus* sp. has a longer part of the body outside the case when moving.

Discussion

Apart from the differential vulnerability of the limnephilid Trichoptera, other reasons can explain the differences in prey preferences between the three subpopulations of *Dytiscus*. First, *D. verticalis* from Clear Water Pond, where *Bufo* tadpoles do not occur naturally, had a slight predatory response in front of these toad tadpoles: only 5 larvae (all instar I) out of 27 would feed on *Bufo*. On the other hand, *D. verticalis* beetles, which occured with toad tadpoles in Sandy Pit Pond all accepted this type of prey. There is apparently an induced prey preference: i.e. the beetle learned to feed on the most abundant prey and developed a strong preference for that prey. Stimuli produced by other prey would become less acceptable by comparison to the most abundant food. Such acquirement of food preferences by exposure to ingestive stimuli early in life is also known to occur in Lepidopterous larvae (Jermy et al., 1968; Schoonover, 1977). So, individuality of *Dytiscus* feeding preference may be more easily understood in terms of foraging behaviors that vary in relation with immediate environment. Accord-

ingly, the preference of *D. harrisii* for Trichoptera can be partly explained by the fact that instar I appears in temporary pond in early spring, before any tadpoles or any syntopic *D. verticalis,* but in synchrony with an abundance of small caddisfly larvae.

Although induced food preference is a reasonable hypothesis to account for the actual intraspecific differences in food choice, morphological and ethological constraints may better explain the interspecific differences in success of predation. The inability of *D. verticalis* to catch caddisfly larvae in their cases may come from possession of inappropriate anatomical structures to handle those Trichopteran cases. By comparison to this beetle species, *D. harrisii* has a proportionally smaller head, stouter mandibles, and a head and a neck region that bend easily at a 90° angle with respect to body axis. These morphological adaptations coupled with an evident ability to manipulate prey with its forelegs allow *D. harrisii* to more catch and consume Trichoptera than *D. verticalis.* The later beetle rarely uses its forelegs to handle tadpoles, but this behavior is necessary to hold Trichoptera while probing with its mandibles through the case in search of the soft animal prey. *D. semisulcatus* which is also known to feed on caddisfly larvae (Balduf, 1935) would have mandibles/head/body proportions similar to those of *D. harrisii* (Nilsson, A., pers. com.), but its prey handling behavior remains unknown.

The above considerations and the phenological relationships between the two beetle species are arguments to conclude that *D. verticalis* and *D. harrisii* have evolved in syntopic situations by partitioning the resources, mostly tadpoles for the former, caddisfly larvae for the later. Induced food preference in this context would prove to be a fine mechanism insuring cohabitation in a temporary pond. Study of preferences of other sympatric *Dytiscus* beetles by serological technique are in progress in our laboratory in parallel with experiments conducted in semi-field conditions.

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