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Predation in two species of leech under laboratory conditions

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Two 60 day experiments on predation behavior of leeches were conducted concurrently. In the first, medicinal leeches, *Hirudo orientalis* (Utevsky and Trontelj, 2005) were fed to satiation on bovine blood and subsequently transferred into two large opaque plastic containers of equal size but with differing temperatures, 6-7ºC and 23-24˚C, containing starved *Erpobdella octoculata* (L.). At the higher temperature *E. octoculata* rapidly attacked and swallowed juvenile and adult medicinal leeches. This also occurred at the lower temperature but took place more slowly. In the second experiment, under similar physical conditions, starved medicinal leeches and satiated *E. octoculata* were studied. Starved *H. orientalis* attached to and sucked ingested blood from juvenile *E. octoculata* but did not consume them. *H. orientalis* did not feed on adult *E. octoculata.* These observations confirm interspecific predation between two families of leeches, Hirudinidae and Erpobdellidae. Numbers and wet mass of prey leeches decreased rapidly at the higher temperature, especially when *E. octoculata* was the predator. Vol. 1, No. 2, 11-15.

KEY WORDS**:** *Hirudo orientalis, Erpobdella octoculata*, leech, Iran, predation

Introduction

Numerous studies have dealt with predator-prey relationships. An important component is related to the co-evolutionary race between antagonist strategies involving morphological, chemical, and behavioral adaptations (Bronmark and Malmqvist**,** 1984). Another component includes predictions of the behavior of the predator when hunting, the theory of optimal foraging (Bronmark and Malmqvist**,** 1984**)**. The influence of predation on prey populations and entire community structures is a third major area in this field of research (Bronmark and Malmqvist**,** 1984). Little is known of the foraging behavior of freshwater predatory leeches (Davies and Kasserra, 1989). The pharynx of Erpobdellidae has no power to penetrate the skin of a potential host, which is a prerequisite for gaining nutrition through parasitism (Kutschera and Wirtz, 2001). Erpobdellidae are carnivorous predators that are equipped with a powerful muscular pharynx. They swallow small animals such as oligochaetes, insect larvae, and other invertebrates (Kutschera and Wirtz, 2001). Because of their earthworm (lumbriculid)-like habitus, the Erpobdellidae are also known as `worm leeches' (Mann, 1962). Greene (1974) and Elliott (1973) concluded that *Erpobdella octoculata* (L.) is a random wanderer that captures prey by chance, and Elliott (1973) showed that, while *E. octoculata* is negatively phototactic, it has no endogenous rhythm of activity, and its nocturnal periodicity is controlled solely by changes in light intensity. This predatory species seems to be one of the best investigated organisms of bottom fauna in different water bodies (Schenkova et al., 2007). Many studies have been conducted on the feeding habits of *E. octoculata* (see Toman and Dall, 1997). In waters with high organic load, *E. octoculata* is abundant, since its main prey organisms are *Chironomus* larvae and oligochaetes such as *Tubifex* spp. (Elliot, 1973; Toman and Dall, 1997; Kutschera and Wirtz, 2001; Kutschera, 2003). The question of whether interspecific predation occurs in leeches (Hirudinea) is a matter of debate (Kutschera, 2003).

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There have been no records of inter-specific predatory behavior in *Hirudo orientalis* (Utevsky and Trontelj, 2005). The aim of this study was to compare the predation behavior of *E. octoculata* and *H. orientalis* under two temperature regimes. The design was based on observations of predatory behavior of the two species under natural conditions.

Material and methods

Hirudo orientalis and *E. octoculata* were collected from a common habitat in Sangar (37˚27′ N, 48˚35′ E), Guilan Province, Iran. Two large opaque plastic tanks each containing 5 l of water from the natural habitat, were used for each of two experiments. Each tank contained 30 leeches of each species. One tank was maintained at 23-24˚C and the other at 6-7ºC. Two experiments were conducted under similar physical conditions. In the first experiment, *H. orientalis* were fed on bovine liver as a blood source prior to being transferred into a tank containing adult *E. octoculata* previously starved for two months. In the second experiment, juvenile *E. octoculata* were fed on bovine liver as a blood source, while adults were fed on earthworms, *Allolobophora caliginosa* (Savigny, 1826), to take account of age-related feeding preferences. After feeding, the *E. octoculata* were transferred into the tanks containing starved *H. orientalis*.

Individual leeches were weighed to the nearest 0.01 g with an electronic balance after removal of water from the body surface, and prey were counted at 4 day intervals. The experiment was carried out for 60 days (15 intervals). Predation behaviors of both species were photographed. Survival rate (%) was calculated in each experiment based on the following formula:

$$\text{Survival Rate} = \frac{\text{Number of prey at the end of the experiment}}{\text{Number of prey at the beginning of the experiment}} \times 100$$

Analyses were done using SPSS 17.0. Normality tests, Komolgrov–Smirnov and Shapiro–Wilk, were applied to the data, and the subsequent analyses conducted accordingly. Significant differences between the slopes of the regression line were assessed by Student's *t* test according to Fowler et al. (1998).

Results

Both species of leech, when starved, were predators of blood satiated prey of the other species. *Erpobdella octoculata* displayed voracious feeding behavior in which it swallowed its prey completely. *Erpobdella octoculata* fed on both juvenile and adult *H. orientalis*, but were unable to consume the largest adults. Feeding duration for *E. octoculata* was 1-2 days at 23-24°C, including grasping the prey, swallowing, digestion, and regurgitating the undigested waste as a twisted, crumpled and elongated mass. Feeding duration at 6-7°C was 4-5 days. Adult *E. octoculata* are not blood feeders (in contrast to juveniles) and were fed on earthworms, *A. caliginosa* (Fig. 3). Adult *E. octoculata* consumed the body fluids of *H. orientalis and* expelled undigested waste by regurgitation. *Hirudo orientalis* attacked only juvenile *E. octoculata* by sucking body fluids, as opposed to consuming the animal (Fig. 4a, b).

Both leech wet mass and prey number declined under both temperature conditions, but decline was slower at the lower temperature for both species. Prey numbers decreased more rapidly with *E. octoculata* as predator. At the higher temperature, while *H. orientalis* was predator, the numbers of *E. octoculata* decreased from the initial 30 to 21 at the 9th interval, remaining at this level to the end of the experiment, with a survival rate of 70%. This pattern, under the same conditions, was more pronounced with *E. octoculata* as the predator. At the higher temperature it devoured *H. orientalis* at a high rate; prey numbers declined from 30 at the beginning to 9 at the end (15th interval), with a survival rate of 30% (Fig. 1). At the lower temperature the feeding rate was reduced. *E. octoculata* decreased the number of *H. orientalis* from 30 at the beginning to 19 at the final (15th) interval with survival rate of 63%. The effect of *H. orientalis* predation at the lower temperature was limited; the number of its prey (*E. octoculata*) decreased from 30 at the beginning to 23 at the 7th interval and remained constant to the end of the experiment with survival rate of 77% (Fig. 2).

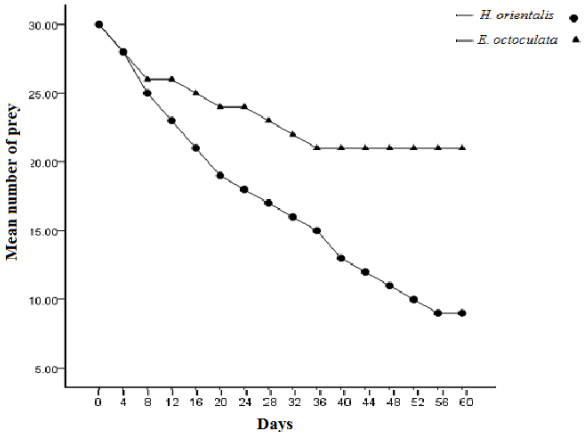

Fig. 1. Decrease in mean number of *E. octoculata* and *H. orientalis* acting as prey at 23-24°C during the experiment.

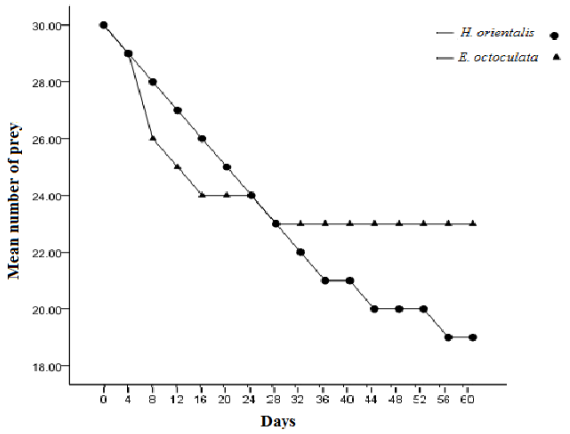

Fig. 2. Decrease in mean number of *E. octoculata* and *H. orientalis* acting as prey at 6-7°C during the experiment.

The slopes of the regression lines between wet mass of leeches and time intervals were significantly steeper at the higher temperature (in *E. octoculata,* t = 15.65, $p < 0.01$, Y = 179.26 (±2.1) X-2.8 (±0.239); in *H. medicinalis,* t = 2.37, $p < 0.05$, Y = 136.14 (±1.72) X-6.16 (±0.195). There were significant differences between the slopes of the linear relationships between mean leech wet mass and time intervals at both lower and higher temperatures. Decrease in wet mass of leeches showed a close relationship with predator species. *Erpobdella octoculata*, as a predator, had more impact on prey wet mass (prey density) than did *H. orientalis*. Predator species affected the mean wet mass of prey at both thermal conditions (lower temperatures t = 5.4, $p < 0.01$; higher temperatures, t = 10.8, $p < 0.01$) (Fig. 5a, b). Wet mass of leeches of both species was normally distributed.

Discussion

According to Cross (1976), predation or consuming other organisms is one of several means by which organisms interact to transmit energy. This study revealed that both species of leech would attack and feed on the other following food deprivation.

In competition for survival where no other source of food is available, avoidance and the ability to kill more of a potential predator is important. Since the results revealed that *E. octoculata* may devour both juvenile and adult *H. orientalis*, it appears to be the superior competitor with ability to reduce the density of medicinal leeches at both high and low temperatures. *Hirudo orientalis* fed only on juvenile *E. octoculata*, and those attacked by *H. orientalis* died after losing body fluids. Kutschera (2003), in an experiment on feeding strategies of *E. octoculata,* mentioned that the adults of the species swallowed the soft parts of its prey with the aid of the unarmed pharynx, but the young *E. octoculata* are blood-suckers. Apparently, *E. octoculata* is an attractive prey for *H. orientalis* only when satiated with blood. According to Utevsky and Trontelj (2005) this species is a close relative of *H. medicinalis* and shows blood-sucking behavior at all stages of its life.

Differing temperature conditions demonstrated that leeches were more active in warm conditions and fed more vigorously. Wet mass of *E. octoculata* gradually decreased over the first 30-40 days (depending on temperature) and then stayed relatively constant. This may be the result of a decline in the number of juvenile *E. octoculata* available or suitable as prey for *H. orientalis*. A clear decrease in *H. orientalis* wet mass indicated that *E. octoculata* was the dominant predator at both temperatures. Patterns of decline in numbers of prey for both species did not closely mirror the decline in wet mass of leeches, particularly at the lower temperature. Since only blood-satiated juvenile *E. octoculata* are suitable hosts for *H. orientalis*, which feeds by

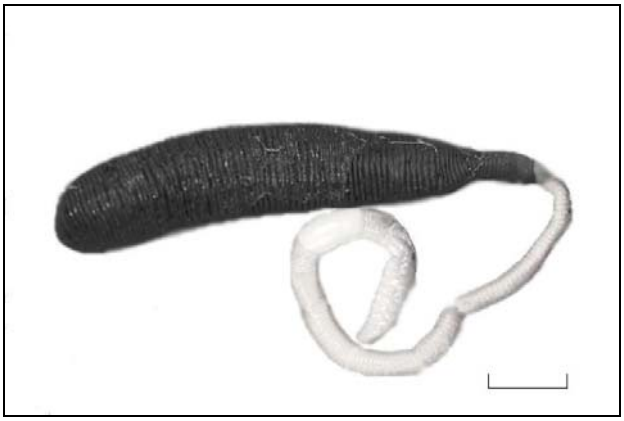

Fig. 3. Adult *E. octoculata* feeding on *A. caliginosa* during the study. Bar = 1 cm.

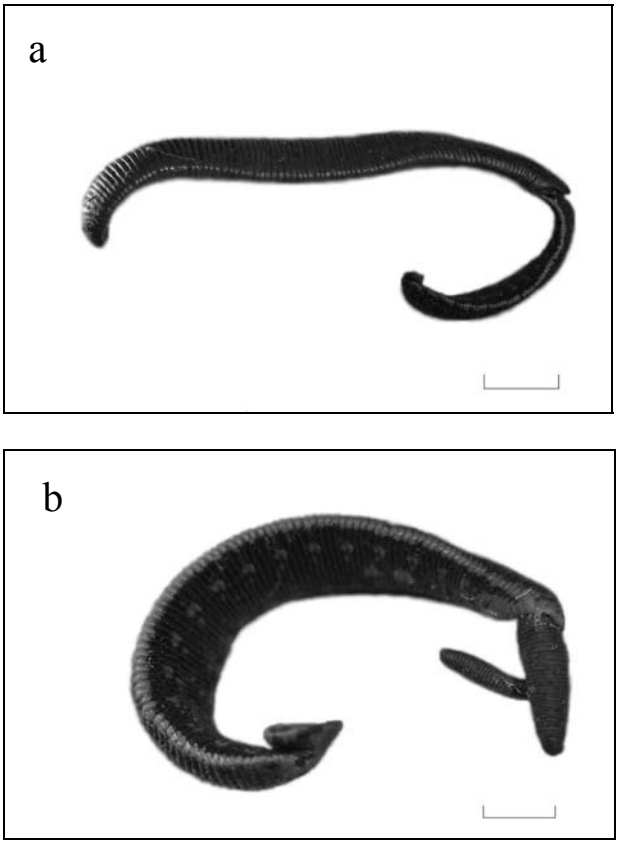

Fig. 4. (a) *E. octoculata* attacking and killing *H. orientalis*, and (b) *H. orientalis*, attacking juvenile *E. octoculata*. Bar = 1 cm

sucking fluids, a constant number of *E. octoculata* adults were present later in the experiments. A decrease in wet mass of the remaining adult *E. octoculata* was due to starvation. A decrease

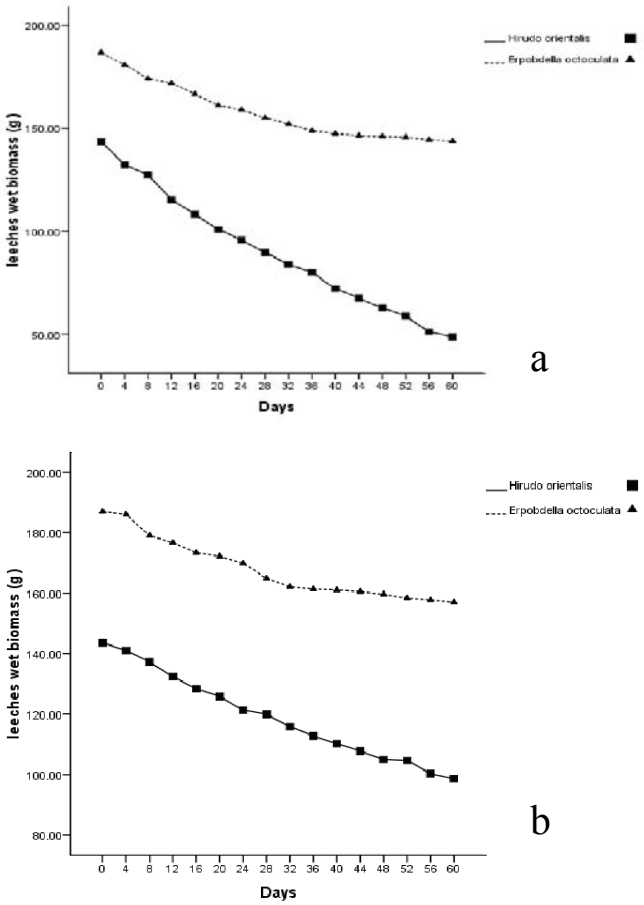

Fig. 5. Decrease in mean wet mass of *H. orientalis* in comparison with *E. octoculata* (a) at 23-24°C, and (b) at 6-7°C, indicating *E. octoculata* as the dominant predator.

in the number of *H. orientalis* as a prey was clearer and followed more closely the decline in the wet mass of this species. Its predator, *E. octoculata*, feeds on both juvenile and adult *H. orientalis* and is not limited to a specific life stage of its potential prey. The survival rates of *E. octoculata* in each experiment at both thermal conditions were higher than those of *H. orientalis*.

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