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Predation of *Myrmeleon obscurus* (NAVAS, 1912) (Neuroptera: Myrmeleontidae) on the ground ant *Myrmicaria opaciventris* EMERY (Formicidae: Myrmicinae)

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ABSTRACT

The analysis of the morphology of the mandibles of a predatory ant lion larva makes easier the comprehension of the feeding behaviour of this pit building sit-and-wait predator. The predatory behaviour observed after a 24-hour starvation, pointed out that a 3rd instar larva of *Myrmeleon obscurus* (NAVAS, 1912) needs 90.7±2.54 min for its first predation on the ground ant *Myrmicaria opaciventris* EMERY (Formicidae : Myrmicinae). For the following ones, only 54.83 ± 12.9 min is allocated to the predation on a single prey. The predation is made up of 4 main steps: capture and subduing, suction, removal of mandibles and abandonment of remains of the prey. Maximizing predation is a strategy for these seasonal insects to store energy that might help them to survive during the unfavourable rainy season.

Keywords: Ant lion larvae, Cameroon, mandibles, feeding behaviour, handling time.

INTRODUCTION

In dry tropical sub-Saharan areas, some of the most common insects occurring in the dry season are ant lions. These seasonal insect are inactive during rainy season (Erasmus et al., 2000; Michel and Letourmy, 2007). Larvae of these insects are very frequent, building pits in dust. They therefore invest energy in building and maintaining conical pit traps in fine-particulate substrate (Philip et al., 1999). Pit building ant lion larvae are typical sit-and-wait predators described mostly as energy-maximizers and not time-minimizers as wide forager animals (Bell, 1992; Scharf and Ovadia, 2006). The energy or relative amount of time invested by the predator at each step of the predation is largely specific. Concerning the sit-and-wait animals, the amount of time and energy invested in search, pursuit, and handling is less investigated (Whittington, 2002). Moreover, concerning ant lions, adults are well known, to our knowledge, less is published on the larvae of ant lions in sub-Saharan region.

The best evidence to link a larvae to the adult it grows into could be found in the silk cocoon where the remains of aged larva is found. The elaboration of adult integument do not use that of larva, therefore, in this cocoon, the shedding of its skin remaining can exhibit some majors morphological larval characters. In this respect, mandibles morphology can be

analysed. The present work focuses on the morphology of the mandibular hooks of larvae and on the analysis of the predatory behaviour of one of the most frequent ant lion of northern Cameroon.

MATERIAL AND METHODS

Presentation of the sampling site

The occurrence of ant lion depends on season and habitats; in savannah area landscape with trees and shrubs are the most interesting ones (Gusten, 2002). The sampling site was at Ngaoundéré (07°27 310N and 13°03 105E) in the Adamaoua region of the Republic of Cameroon at an altitude of 1120 m above sea level. Rain fall here is around 900 mm *per annum*.

In the dry season in April 2008 a data logger HOBO Onset H8 indicated the mean diurnal temperature of 27 ± 5 °C and the mean diurnal hygrometry 30 ± 7%. On the site, 14 *Manguifera indica* (Anacardiaceae) and 7 *Ecalyptus saligna* (Myrtaceae) trees were present. These big trees were more than 15 years old and were planted in lines and more than 20 meters from each other. Larvae of ant lion were sampled from dust under these trees.

Observation of *Myrmeleon obscurus* mandibles

A total of 70 larvae were collected at the sampling site and reared separately in laboratory conditions. Each larva was introduced alone in a 25 centilitres plastic cup filled with dust from the sampling site. They were fed *ad libitum* receiving by direct introduction a daily diet of 3 to 5 ants served one after another. At the end of the larval stage appeared the cocoon which was extracted from the dust. Each one was observed till hatching, each in its cup covered with gauze and maintained firmly by a rubber. The adults emerging were noted and sent to Dr André PROST and Bruno MICHEL (CIRAD / France) for identification.

The opened cocoon was dissected and the shedding of the skin of aged larva present and compacted in it was removed and dissected. The mandible was therefore isolated and described.

Study of the predation

Presentation of the prey used and of the rearing facilities

The prey used in this study was the ant *Myrmicaria opaciventris* EMERY (Formicidae : Myrmicinae) living in polycialic and polygynic colonies. It was collected and served to the reared ant lion larvae.

Description of the predatory behaviour of ant lion larvae

To establish this feeding behaviour, 7 larvae of ant lion having same shape and being at the same larval stage were observed simultaneously. Larvae introduced into the cup with dust built a pit. Thereafter, they were starved for 24 hours. Finally they received by direct introduction successively up to 10 *M. opaciventris* as prey. At each predation, all the steps were noted from the falling of the prey at the bottom of the pit to the ejection of its remains after feeding from the pit.

Evaluation of the handling time of the predation of ant lion larvae on ant

The duration of the predation on one *M. opaciventris* was recorded first. In the case of consecutive predations, this duration was also noted from the first till the fourth one.

RESULTS AND DISCUSSION

Description of the mandibles of larvae of *Myrmeleon obscurus*

One of the most constant structures on *M. obscurus* is the mandibles. They are elongated and have their apex incurved inwards. They are covered on the outer side, on more than ¾ of their length by numerous thin and long setae. On the inner side 3 sclerotised mandibular teeth are present (Figure 1). They are separated by thin setae. From the head capsule to the first tooth there are 8 or 9 inner setae, from the first to the 2nd there are 2 setae, also 2 from that 2nd to the 3rd and finally only one from the 3rd to the end.

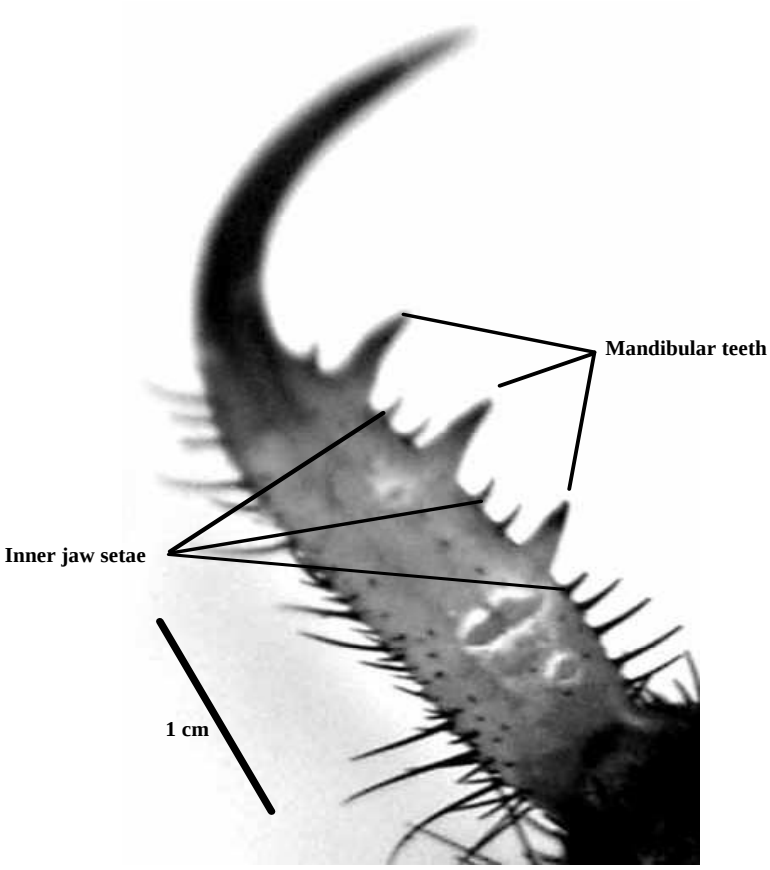

Figure 1: Mandible of *Myrmeleon obscurus.*

Predation of ant lion larvae on ground ants

Predatory behaviour

The capturing of ants by pit fall traps is naturally hazardous and infrequent (Lloyd, 2004). In this respect, to maximise the success of the experiments, preys were directly introduced inside the pit. Immediately, they were seized and subdued. After the seizing, the prey was sucked and finally, the predator removed its mandibles and sent the remaining of the prey out of the pit. After eating a prey, the predator waits for another prey. At the end of predation period, the predator did not clean the pit anymore.

Among the 70 preys that were introduced into the pits, the predators seized 67 and fed successfully on 65 preys (97.02%). To subdue the prey, a predator introduced firmly its mandibles into it and in some cases, shake it strongly (80.6%) or to take it straight deeper under the bottom of the pit (16.42%). Thereafter, the suction was carried out almost immediately (Figure 2). After the suction, the predator removed its mandibles and sent the remains of the prey out of the pit. Extra dust in some cases was removed from the pit before the predation continued (46.27%). Since the pit was built only to capture preys, satiated larvae did not clean the pit.

Handling time of the predation of ant lion larvae

Predation includes searching and handling preys (Ngamo and Hance, 1998). Whereas searching is the process of finding a food resource, pursuing includes chasing down or stalking prey, and handling includes subduing, swallowing, digestive pauses or otherwise, processing food.

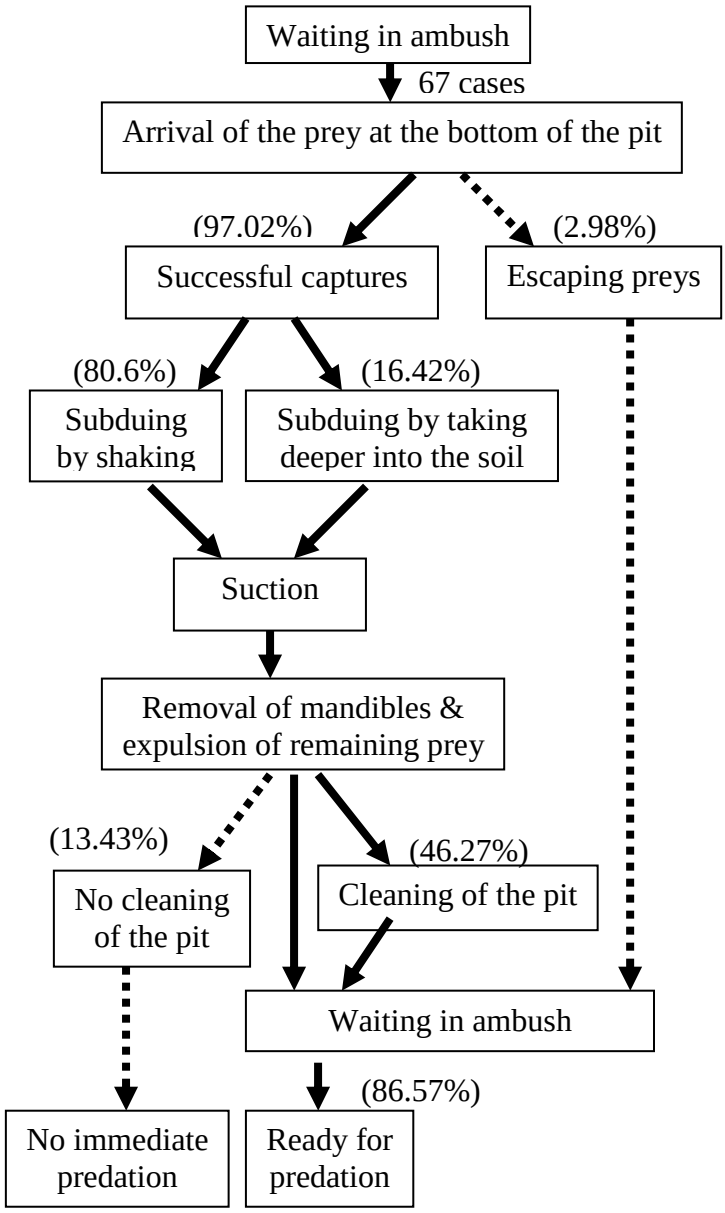

Figure 2: Steps of the predatory behaviour of *Myrmeleon obscurus* larvae feeding on *Myrmicaria opaciventris* workers.

Handling a prey is the step in this feeding behaviour which is less investigated. For a sit-and-wait predator it includes subduing, and swallowing (Griffiths, 1980).

Handling time for 4 successive predations

Record of the time spent by an ant lion larva from the capture of the prey till the release, to the rejection of the remains of the prey out of the pit was made. It appears that in a set of successive predations, the first one was significantly longer that the following ones. Table 1 gives evidence that the predator needed 90.7 ± 2.54 min for the first predation and an average of 53.9 ± 11.16 min for the second, 56.7 ± 12.79 and 53.9 ± 14.75 for the fourth. The first predation lasts longer than the following ones ($p<0.001$).

Larvae feeding on its first prey after a 24-hour starvation handled the prey for a longer period; this may be a strategy for energy maximizer to empty completely the resource. The time spent to consume the following prey is shorter, this must come from learning or because the first predation strengthens it enough to be most efficient.

Contribution of each predation step to the handling process

Obviously the first predation is longer than successive ones. The handling process is, in any of the predation, made of 3 main events: shaking to subdue, suction and release. Table 2 shows that for the first predation ant lion larvae needed 90.7 ± 2.54 min, and to achieve following predations, it needed 53.9 ± 14.75 min. In both cases, the most important step having the longest duration is the suction, significantly higher in both cases. In second position is the release process duration. In the first predation, this duration is significantly higher than that of the subdue process but in other predations the subdue process is significantly shorter.

The effect of food availability and successful predation was investigated (Griffiths, 1991), it has direct impact on fat content of pit digging ant-lion larvae mostly those subject to stress in food poor habitat and while in the food rich habitat they maximize predation to accumulate fat as resources for starvation during rainy periods.

Table 1: Duration of predation of *Myrmeleon osbcurus* larvae on workers of *Myrmicaria opaciventris* during 4 successive predations.

	Predations observed			
	First	**Second**	**Third**	**Fourth**
min	78	41	34	40
max	103	65	80	87
Mean*	**90.7 ± 2.54 a**	**53.9 ± 11.16 b**	**56.7 ± 12.79 b**	**53.9 ± 14.75 b**

* Mean values followed by the same letter do not differ significantly at p<0.001 (ANOVA I analysis couple with the Duncan's test)

Table 2: Duration (minutes) of each of the main steps of the handling process in feeding behaviour of *Myrmeleon obscurus* larvae on *Myrmicaria opaciventris*

	First predation			**Following predations**		
	Minimum	**Maximum**	**Mean***	**Minimum**	**Maximum**	**Mean***
Subduing	2	20	8.56 ± 5.77 b	1	9	2.96 ± 2.10 c
Suction	60	85	76.4 ± 7.21 a	29	67	42.96 ± 11 a
Release	2	9	5.44 ± 5.21 b	2	22	8.14 ± 5.10 b

* In the same column, values followed by the same letter do not differ significantly (p<0.005 Fisher LSD test)

Conclusion

The pit building larva of the ant lion *M. obscurus* is well equipped to seize and kill its preys. The mouth hooks and especially the mandibles have, in their inner jaw, setae and teeth that pierce and seize the prey during the whole handling process. This very sophisticated seizing strategy contributes to the good achievement of the predation during favourable season. This contributes to gather energy that helps them to survive during unfavourable rainy season.

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