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Diversity of pit building antlions (Neuroptera: Myrmeleontidae) and their potential preys in the sudano Guinean zone of Cameroon

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Abstract
In Ngaoundere, within the sudano Guinean highlands, during dry season, some xerophilous insects are abundant. These insect may play a role as bio indicator to characterize the global warming. The present investigation in among preliminary steps to identify insects adapted to survive in dry season and some environmental factors impacting their presence. Using pit builder ant lions as model, the present research pointed out that 4 pit builder ant lions species occurred in the studied area: *Myrmeleon quinquemaculatus* (Hagen, 1853), *Myrmeleon obscurus* (Rambur, 1842), *Hagenomyia tristis* (Walker, 1853) and *Myrmeleon* sp. The most abundant specie was *H. tristis* representing 60.34% of the adults emerging from larvae collected and reared. These larvae are abundant when the weather is hot and dry and also when the day length increases. Use of pit fall trap to investigate potential prey of these sit and wait predators released that among the terrestrial fauna, the ant *Myrmicaria opaciventris* (Emery, 1893) is the main potential prey of ant lion larvae representing 40% of the overall preys trapped.

Keywords: pit building, ant lion, Cameroon.

1. Introduction
Myrmeleontidae are one of the many families of the order Neuroptera, constituting a remarkable component of the fauna in arid environments. Ant lions are drought-tolerant insects adapted to arid conditions and thus are capable of overcoming the harmful effects of global warming [1]. They are mostly known in the tropics by their larvae that build funnel traps in soil [2].

The ant lion larva is carnivorous a nd builds hollow traps in sandy soil. Such a trap is a smart tool to catch small insects. Using the funnel trap ant lions are capable of colonizing dry ecosystems with a sandy substrate [3]. Funnel constructing ant lion larvae are popular, adults are less known and few studies have been carried out on them to fill this gap: raising the larvae to identify adults which they become [4].

The ant lions build well traps that do not exceed the size of the prey they can physically capture [5, 6, 7]. Proposed a model of costs and returns for the construction of funnels. [3] Showed that the funnel of an ant lion larva is similar to an optimal structure. The prey which it captures theoretically has no chance to escape [3]. With all the recent advances in this trap, the diversity of ant lion larvae's preys is not established in the tropics. This work, in addition to studying the diversity of ant lion larvae rearing also account for the determination adults from which they are derived. Also on the sites of occurrence of these larvae, prey capture at ground level serves to establish the prey range of these larvae in such areas. Achieving this goal requires a larval collection phase on-site during the entire period of their presence. That is, the dry season followed by progressively rearing larvae under laboratory conditions following their collection. During the same period of larval presence, soil fauna had being inventoried. The data collected will had be analyzed according to variations with the most influential climatic conditions on the development of ant lions larvae.

2. Material and methods
Dang and Mardock are localities found in Ngaoundere Sub-division in the Vina Division of the Adamawa region. This is in the domain of the Sudano Guinean high lands of Cameroon. In this area, average annual precipitation ranges from 900 mm to 2000 mm. The rainy season is longer than the dry season (from March to October) [8]. The average monthly temperatures

range from 20-28 °C [9]. The dominant soils are poorly developed lateritic red soils on ancient granitic rocks and basalts. On these soils, grow high Guinean savannah and dry forests.

The collection site was found between Latitude 07 °19.402 and 07 ° 19.474 North and Longitude 13 ° 19.474 and 13°34.315 34.150 East. Four tree species are abundant on this site namely:

The mango, *Mangifera indica* (L.) (Anacardiaceae): a plant cultivated tropically primarily for its fruits. It grows up to a height of 20m and 90cm in diameter.

The scot pine, *Pinus sylvestris* (L.) (Pinaceae): a plant that is grown for its wood and fits almost all climatic conditions, its height is around 45m.

The senna: *Senna javanica* (L.) (Fabaceae) is an ornamental plant.

The flamboyant, *Delonix regia* (Bojer ex Hook) (Fabaceae) is an ornamental plant whose height and the maximum diameter are respectively 18m and 2m, it is one of the most used ornamental plant species

The specimens considered in this study were at least 15m in height and 30cm diameter at breast height. In addition, in their shade, there must be at least 30 funnels.

2.1 Method of sampling and rearing of ant lion larvae

Larvae collection occurred from October 2014 to April 2015. Either in open air or under trees with funnels in their shade, the larva was removed from its funnel using a spatula. The larva collected was put in a plastic film box with dry soil from its site of collection. The box was labelled, and brought back to the laboratory where the larva was farmed. The label of each box contained the following information: The site and date of collection, sample number, location coordinates and the name of the plant from which it was collected. Meteorological data of the study area were obtained from www.acuweather.com and cross referenced with those provided by www.dataclimate.eu.

The larvae were brought to the laboratory where they were farmed individually in two-thirds cut 1.5L mineral water plastic bottles. Each bottle was filled with 650 g of sandy dust sieved with a 0.5 mm mesh sieve. The larva when introduced into the breeding site built a funnel in a relatively short time.

After the construction of the funnel, larva was fed daily with termites (*Heterotermes aureus* SNYDER) as prey. It received two preys a day: one in the morning and another in the afternoon. In the following days, the maintenance of the funnel was followed up. If after three days the funnel is not maintained and there is no predation, there might have been either a moult or the formation of a cocoon, the sand of the box was thus sieved. If the cocoon was formed, it was extracted and put under observation in the same box closed by white fabric gauze until hatching. If there was no cocoon but just a moult, the larva was continuously bred and fed daily.

2.2 Access of the diversity and numerical importance of adult ant lions

The recognition of adults as soon as they emerged was made thanks to the identification key [10]. Reference was also done to specimens identified by André Prost in reference to the collections of the Museum of natural history of Paris and the Royal Museum of Central Africa in Tervuren (Belgium). The workforce was assessed by species, emergence, date and the larva collection site.

2.3 Research of the diversity of ant lion preys

In areas of high ant lion larvae abundance, pit fall traps were set to catch small terrestrial arthropods, potential ant lion larvae preys. These traps consisted of two-thirds cut 1.5L plastic mineral water bottles cut at the base to hold about half a litre of water. These half-cylinders were buried in the ground so that their edges were around 5mm above the soil surface. The trap was filled with soapy water. One pit fall trap was buried per locality. Every 3 days, from January to April 2015, insect collection was performed simultaneously with the renewal of the soap and water. All catches by these traps were filtered and returned to the laboratory where they were sorted and grouped according to the taxa of the animals caught and identified, counted and preserved in 90% alcohol.

3. Results and discussion

3.1 Diversity of ant lions

Table 1 shows the number of larvae brought into the laboratory of Entomology, University of Ngaoundere for rearing. During the dry season from November 2014 to May 2015, 700 ant lion larvae were collected from the shade of trees and open environment and put into laboratory for rearing. This led to the emergence of 362 adults of all the species combined. The four species of trees present in the study area had a constant presence of ant lions but their larvae in their shades. These larvae collected presented very low survival chances in the laboratory. Averagely less than a quarter successfully hatched in the laboratory. The open areas larvae were more numerous and the success rate of their breeding was more important.

Table 1: Cocoons and ant lion adults obtained in laboratory

Samples Sites			larvae reared in laboratory	Silk cocoons obtained	adults obtained	Rate of success (%)
Under trees	1	*M. indica*	72	41	25	34.72%
	2	*P. sylvestry*	97	53	48	49.48
	3	*S. javanica*	82	39	34	41.46
	4	*D. regia*	49	20	9	18.37
In open area	1	Dang	364	332	222	66.87
	2	Mardock	36	28	24	85.71
Total			700	513	362	51.71

3.2 Diversity and numerical importance of adults

Table 2 shows the specific diversity and the size of adult emergences under laboratory conditions. It appears that *Myrmeleon sp.* is the most abundant species, representing 66.39% of adults obtained, followed by *M. obscurus* with 24.59%, *H. tristis* with 8.19% and finally *M. quinquemaculatus* with 0.81%. The higher rate of emergence of *Myrmeleon sp.* could be explained by the simple fact that these larvae were encountered in the study area during the six months of our study period, occurring on all collection sites in open air as well as under trees. This presence shows that this species has the ability to adapt to different climatic and environmental conditions. This can be explained by its presence in several countries in Africa namely Cameroon [1], South Africa [11], Mali, Nigeria [12] and Tunisia [13]. The lower number of *M. quinquemaculatus* could be explained by the

fact that these larvae are only present on the site only in the month of April. Recent work in Cameroon on *M. quinquemaculatus* [1]. Cited this species as the most frequent and characteristic in areas with high rainfall with shrubby and herbaceous vegetation, and described this species as unique to dry and humid environments characteristic of the Sudano Guinean zone; suspected the point of being a bio indicator. It is therefore understandable that this insect is not abundant in open environments where the temperature is very high.

Table 2: Diversity and numerical importance of ant lion adults from larvae collected in the dry season in the Sudano Guinean zone of Cameroon and raised in the laboratory.

	Species of Myrmeleontidae in Ngaoundere*	Number	Percentage (%)
1	*Ceuta sp.* [2]	0	0
2	*Centroclistis rufuscens* (GERSTAECKER, 1885) [1]	0	0
3	*Distoleon sanguinolentus* (NAVAS, 1912) [1]	0	0
4	*Hagenomyia tristis* (WALKER, 1853) [1]	89	8.20
5	*Myrmeleon quiquemaculatus* (HAGEN, 1853) [2]	4	0.81
6	*Myrmeleon obscurus* (RAMBUR, 1842) [2]	29	24.59
7	*Myrmeleon* sp. (HAGEN, 1853) [2]	240	66.40
8	*Palpares papilionoides* (KLUG, 1834) [1]	0	0
9	*Tomatares clavicornis* (LATREILLE, 1829) [1]	0	0

* Two previous captures are taken into account: 1: Ngamo Tinkeu *et al.* (2010); 2: Maogé *et al.* (2014)

The largest number of adult ant lions gotten under the trees is *H. tristis* (Table 3). The species with the least emerged larvae was *M. quinquemaculatus.* Its larvae were found just under two trees: the flamboyant and *S. javanica.* However, no emergence of *M. obscurus* or *Myrmeleon sp*. larvae was observed under the flamboyant. These observations are explained by the affinities that exist between a funnel building species of ant lions larvae and the plant.

Table 3: Relationship between ant lion species and the plant

	M. indica	***P. sylvestry***	***S. javanica***	***D. regia***
M. quiquemaculatus	0	01	0	03
M. obscurus	08	03	04	0
H. tristis	02	39	23	06
Myrmeleon sp.	15	05	7	0
Total	25	48	34	09

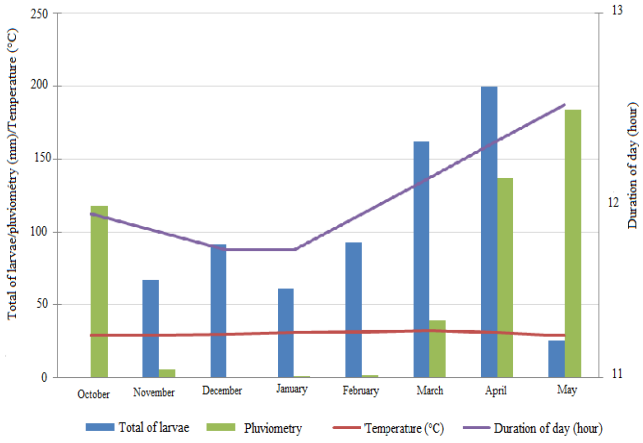

Fig 1: variation of ant lion larval density relative to temperature and rainfall.

3.3 Analysis of relationship among fluctuation in abundance of ant lion larvae and some abiotic factors

Collections made throughout the dry season under the trees show January as the month when very few larvae were sampled. This could be explained by the coldness that prevails in this period; weather condition which disfavours larval activity. In contrast, in the months of March and April more larvae were observed and sampled. These months correspond to the period of great heat in the study area where the maximum temperature reaches 32 °C. These results are in agreement with those [1] who showed that the density of ant lion larvae is higher in the months of March and April. The return of the rains in May will disrupt the activity of the larvae, hence the decline in the number farmed in these months to their complete disappearance in June. Furthermore, [14] and [15] showed that low temperatures and rain prevents the building of funnels and complete shutdown of biological activity.

No emergence of adult ant lions was noted in January because it is at the beginning of this month that the sampling began. The completion of ant lions' development cycles, from larva to the emergence of the adult, under laboratory conditions requires about two months. It is from April that adults began to emerge. The months of May and June were the period of maximum emergence followed by a decrease in July with the return of rain. Rain slows down or even stops certain biological activities of ant lions larvae, including cocoon formation and adult emergence.

Laboratory emergences show that not all species are present in all the months of harvest. *Myrmeleon. Sp* is the only species which is present every month. While *M. quinquemaculatus; M. obscurus* and *Hagenomya tristis* were present in March and April.

This result could be explained by the fact that *Myrmeleon sp*. has a capacity to adapt to different climatic and environmental conditions. The works of [1] showed that, this specie is intermediate between two different agro-ecological zones including the high Guinean savannas and the Sudano-Sahelian zones. Other species need a higher temperature to complete their cycles. This was demonstrated by [16] on *M. formicarius* and *M. bore*. These results are in agreement with those in [12] and [13] who showed that some species appear have a period specific property.

4. Diversity of ant lion preys occurring in the sampling sites

Table 4 shows that 2574 arthropods constituting the potential prey of larvae ant lions were trapped on the study site. These organisms are distributed within five Insect Orders and one Arachnid Order. The dominant arthropods caught included ants, particularly the *M. opaciventris* species while solitary wasps were the least represented. These results show that ants constitute the main prey of ant lions. Furthermore, the Family Formicidae remains the main source of food for larvae of ant lions with 81.2% of potential prey.

Table 4: Diversity of prey of ant lion larvae trapped in the sampling site

Order	Family	Species	Amount	Rate (%)
Hymenoptera	Formicidae	*Camponotus* sp. 2	98	3.8
		Camponotus sp.1	79	3
		Camponotus maculatus	102	3.9
		Pachycondyla tarsata FABRICIUS, 1798	345	13.4
		Myrmicaria opaciventris	1028	39.9
		Formica rufa	219	8.5
		Lasius neoniger	225	8.7
	Pompilidae	*Anoplius bifasciatus* TULLGREN, 1904	04	0.01
Diptera	Drosophilidae	*Drosophila* sp.	47	1.8
	Muscidae	*Musca* sp.	31	1.2
Orthoptera	Gryllidae	*Gryllus campestris*	264	10.25
Isoptera	Termitidae	*Heterotermes* sp.	89	3.45
Coleoptera	Carabidae	*Panagaeus sallei* CHAUDOIR, 1862	06	0.02
Araneae	Araneidae		37	1.4
Total			2574	100

The predominance of ants compared to other arthropods captured could be explained by the strong presence of their nests under the trees in the study site which offer not only adequate shelter, but also abundant food resources consist of Plant pollen and nectar [1].

These results are also consistent with those of Wilson [17] according to whom the name "ant lion" of Myrmeleontidae is derived from two characteristics: larval mandibles strongly serrated and prey consisting predominantly of small arthropods and ants. Furthermore traps used to capture only effectively permit the capture of small arthropods crawling on the ground. Only 88 winged insects have ever been trapped. The probability of their interception by the ant lion larvae, hunting using "sit-and-wait" look out technique results in low yield [18]. It therefore appears that on the study site, potential preys of ant lion larvae consist of a variety of arthropods dominated by Class Insecta. Within this class, Family Formicidae (Insecta: Hymenoptera) was the most abundant.

5. Conclusion

In Ngaoundere, within the sudano Guinean highlands, 4 pit builder ant lions species occurred*: M. quinquemaculatus, M. obscurus, H. tristis* and *Myrmeleon* sp. The most abundant specie being *H. tristis* representing 60.34% of the adults emerging from larvae collected and reared. Capture of the terrestrial fauna on the study site pointed out that ants and mostly *M. opaciventris* is the main potential prey of ant lion larvae representing 40% of the overall preys trapped.

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