Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 5, No. 4, p. 511-519, 2014
http://www.innspub.net

RESEARCH PAPER | OPEN ACCESS

Chetae of larva of antlions (Neuroptera: Myrmeleontidae) *Hagenomyia tristis* (Walker, 1853) and *Myrmeleon obscurus* (Rambur, 1842) involve in the construction of pitfall traps

Leonard Simon Tinkeu Ngamo[*], **Jean Maoge**

Department of Biological Sciences, University of Ngaoundéré, Faculty of Science, Cameroon

Article published on October 27, 2014

Key words: Antlion, Cameroun, chetotaxy, digging process, excavation, *Hagenomyia tristis*, *Myrmeleon obscurus*, pit fall traps.

Abstract

In tropics, immature antlions (Neuroptera: Myrmeleontidae) dig their pits in many type of soils. Those pits are easily found during dry season and even in rainy season in dry places close to houses. To understand how do antlion larvae construct their funnel-shaped pit, observations had been made on the 2 most present pit digging antlions of the Sudano guinean and the Sudano sahelian regions of Cameroon: *Myrmeleon obscurus* (RAMBUR, 1842) and *Hagenomyia tristis* (WALKER, 1853). Description of the pit digging behavior pointed out two main complementary frequently observed steps, the digging of the soil and the removal of the dust. Moreover, scanning of the body wall of the aged antlion larvae or their exuviae elicits the diversity of body wall structures involved in pit construction. Thick setae occurring mainly on the abdominal segment IX are used in digging the soil. In *M. obscurus*, these digging setae are more efficient because they have setal membrane enhancing their mobility. Long and thin setae group in clusters along each side of abdominal segments have the task to excavate the dust by a spiraling backwards motion. Any of the abdominal segment from I to VIII carries a pair of 4 clusters by its side, and no excavating seta is found on the segment IX.

***Corresponding Author:** Leonard Simon Tinkeu Ngamo ✉ leonard.Ngamo@gmail.com

Introduction

Unique in the Insect world for their extremely sedentary predatory behavior, pit-dwelling larval antlions (Neuroptera: Myrmeleontidae), dig pits, and then sit at the bottom and wait, sometimes for months, for prey to fall inside (Karen *et al.,* 2010). Pit-digging antlions, the larvae of winged adult insects, are thought to be the most sedentary of insect predators (Griffiths, 1986; Mansell, 1990, 1992; 1996). After larvae emerge from their eggs and find a shady location that also offers protection from wind and rain, they construct a funnel-shaped pit in sandy soil by spiraling backwards, excavating the sand with their head and mandibles (Griffiths, 1986; Lucas, 1982). Once their pits are completed, antlions position themselves at the vertex, covered either partially or entirely by the substrate, and wait motionless unless disturbed, for prey to stumble inside. Even when prey is scarce, antlions infrequently relocate their pits (Crowley and Linton, 1999).

Indeed, relocation is constrained by so many factors, notably the high energetic costs of moving, that some species remain in the same location for months at a time, without food, until death by starvation (Scharf and Ovadia, 2006). Because of their intermittent food supply, the length of antlions' larval period is long, relative to many other insects, lasting upwards of three years (Gotelli, 1993, 1997; Mansell and Erasmus, 2002; Scharf and Ovadia, 2006). By comparison, antlions' egg, pupal and adult stages last 30 days or less.

Antlion are mostly known in tropical region by their larvae which for many Myrmeleontidae built pitfall traps in the soils. These pits, funnel-like are particular and smart and efficient trap helping these sit-and-wait predators to capture small ground arthropods as ants (Pianka, 1966). They are not harmful insects but may be beneficial if in farmland while feeding on some pests.

Antlion larvae (Fig. 1) dig their pit in many types of soils in dry areas. Pits are easily found in dry season and even in rainy season closed to houses where the soil is sufficiently dry to allow these larvae to live. They are found in sandy soils, red soils, dust, humus in farm or in the vicinity of houses. The constant characteristic of these places is to remain always dry.

Fig. 1. General outlook of antlion larva.

In the dry season, antlion larvae built their pit usually in dry, fine soil near houses foundations. Often these pits might be found under the eaves or next to porches, areas that are protected from direct rainfall. The sit-and-wait predatory waits for unsuspecting ants or other small insects to fall into the pit.

Antlions are peculiarly adapted for constructing their pits and for this effective predatory lifestyle. The larva has a flat head with long, sickle-shaped mandibles.

The larvae do not resemble the adult antlions, which look like a small damselfly and have a slender body and delicate outstretched wings.

Out of the pit, larvae of pit building antlion perform backward motion and on dry dust are able to slide through the soil by the posterior of their abdomen. More over the reduce size of its two pairs of anterior legs in opposition with the larger size of the posterior ones suggested that there are the lonely pair of legs involved in the locomotion. They have a broad, flattened body, short front legs and long posterior ones. This morphology is best suited for crawling backward. Other observations added that these long and full of setae legs play an important role in the balance of the organism of the antlion during its movement (Guilette *et al.,* 2009). This oval-shaped abdomen carries many setae that may contribute in the process of construction of the pitfall traps of antlion larvae (Ngamo Tinkeu *et al.,* 2010). It is largely accepted that antlion larva dig its pit using its abdomen as a hoe to excavate dust and its head to send out of the pit the removed sand (Fertin and Casas, 2006). The form of the body and curve of the abdomen facilitated the process and explain the funnel outlook of the pit. When the pit is completely built, the larva remains within the soil, at its bottom, with only its piercing mandibles appearing.

The sit-and-wait predator is in shelter at the bottom of the funnel which wall made of fine sand prevents any arthropod passing there from escaping. The larva of antlion constructs the pit and regularly, after a predation or after and molting, a cleanup of the pit is made.

To our knowledge, less is known about antlion from sub Saharan areas (Prost, 1998; Michel, 1999; Michel and Letourmy, 2007) the description of the construction of the pit is not yet made. The aim of this work is to investigate the use of morphological features of the 2 most present pit digging antlion of the Sudano guinean and the Sudano sahelian regions of Cameroon to better understand the pit digging process of *Hagenomyia tristis* (WALKER, 1853) and *Myrmeleon obscurus* (RAMBUR, 1842).

Material and methods

Construction of pitfall traps

In Sudano guinean and Sudano sahelian regions of Northern Cameroon, two common antlions are frequently founded: *H. tristis* and *M. obscurus*. They were collected from the field and observed in laboratory conditions.

In field conditions, in open and clean pits an extra dust was added and the clean up by the owner of the pit was observed. After all, the larva was captured and taken to the laboratory for further observations.

In laboratory conditions, larvae were released on top of dry soil in cups filled at 3/4 with dry sand. The motion at the surface till the slide within the dust and finally the elaboration of a pit in the cup were observed.

Description of larval body wall processes in relationship with pit construction

Two mains steps are noted in pit elaboration : digging of soil and expulsion or excavation of dust. On the body of the antlion larva, in association with the third pair of legs some setae occurring on the abdomen may act actively in the process. The outer surface of the insect cuticula is seldom smooth, it regularly presents large variety of microscopic or macroscopic roughenings in the form of points, pits, ridges, and sculptured designs, and it is covered with larger outgrowths that takes the shape of spines, hairs, and scales. They are either cellular or non cellular outgrows depending on the contribution of epidermal cell in their constitution or not. The non cellular projections of the outer surface of the body wall are purely cuticular structures (Snodgrass, 1935). They have form of minute points, spicules, small spines, or hairs. The morphological observations were focused on the chetotaxy of the hairy outgrows of the abdomen of both *H. tristis* and *M. obscurus*.

The clearance of the third stage larvae was made by cutting the abdomen, clearing it in a 90% KOH solution for one hour. The preparation was washed in water and dried in 90% ethanolic solution before observation. The chetotaxy was also made on the exuviae or the remaining exoskeleton of aged larvae found within the hatched cocoon from where emerged adult *M obscurus* or *H. tristis*.

A binocular lens, a microscope Nikon SMZ800, a microscope Nikon eclipse E200 both supplied with the numeric camera Nikon coolpix 5400 were used to observed the processes of the body wall and to snap any significant features. From the pictures obtained, some drawing was made to understand their intervention in the process of digging pit by the two antlions studied.

Results and discussion

Construction and cleaning of pit fall traps

In laboratory conditions, as soon as the antlion larva is released on top of the soil in the cup, while moving backwards, it slides in the dust. The most active part of the body during the locomotion is the abdomen. The delay to start the construction of the pit depends of the physiology of the larva. Larvae who are in hunger, will build the pit in less than an hour ; those who feed no long ago or those who are entering ecdysis will start the construction of their pit after a long period, from some hours to 2 or 3 days.

The first step of the construction of the pit is the creation of a cone in the soil which is progressively enlarged and excavated. Finally the larva found himself at the bottom of the funnel built. During the process, strong movements of the anterior setae on abdominal segment are associated with the turning movement of the third legs pushing sands outside the funnel. The huge particles and humus dust which are great to be send away by setal movement are frequently seize by mandibles and a strong movement of the head spear it far away from the funnel. The abdomen therefore throughout its setae contributes in the process of digging the soil ant he process of pushing out the dust produces by this excavation.

After the construction of the pit, the most frequent activity of the larva out of feeding is the cleaning of the pit (Fig. 2). Anytime a dust or anything which is not a suitable prey enters the pit, in the sudden movement of all the part the body involved, it is speared out. The movement performed is a strong torsion, a spring of the body, a spiraling motion backwards.

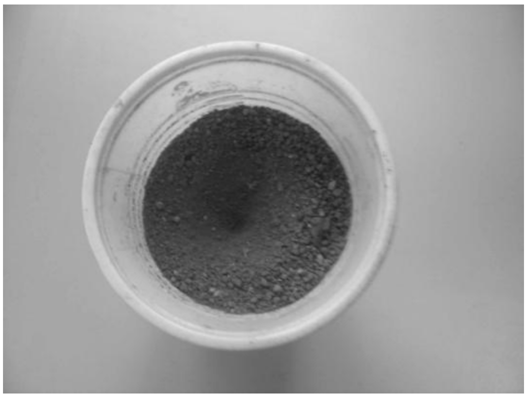
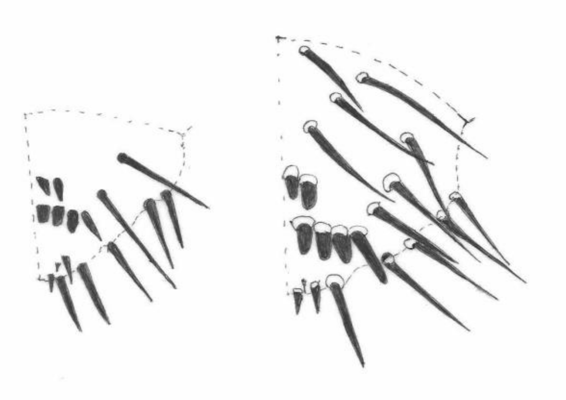


Fig. 2. Pit fall trap of antlion larva.



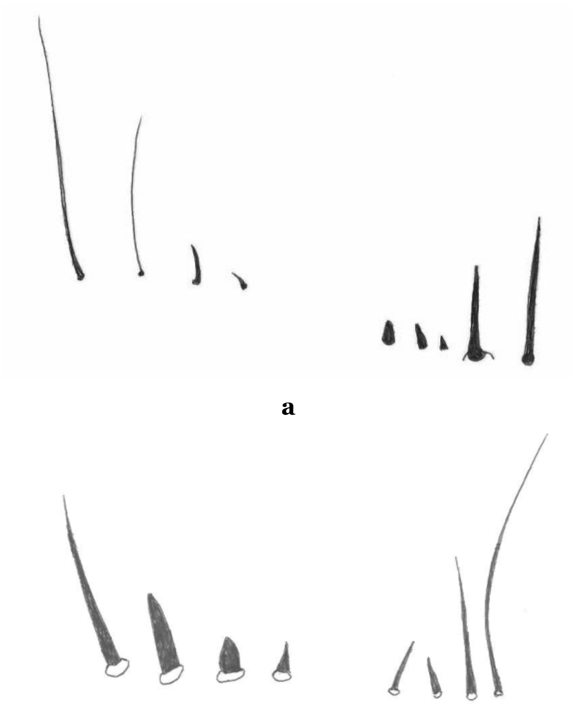
a **b**

Fig. 3. Variation in the consistency of thick setae on the antlion abdominal segment IX.

a: Thick setae on *Hagenomyia tristis* b: *Thick setae on Myrmeleon obscurus.*

Diversity of the abdominal hairy outgrows of the larvae of the antlion species studied

Abdomen of the antlion larva is made of 9 segments that taper backwards. All segments of abdomen as well as those of the head and the thorax are coated with setae of different shape and location (Fig. 4). The setae observed a typical, they are slender hair like process of the cuticula. On top of thorax and on the 2 or 3 first segments of the abdomen, in the central part of the sternite or the tergite, these hairs are short slight and thin ones. Without any important specific specialization. While moving by the side, long and thin setae appear in 4 clusters at each side of the segment.



a

b

Fig 4. Variation in the consistency of setae on the antlion abdominal segments.
a: Setae on *Hagenomyia tristis*; b: Setae on *Myrmeleon obscurus*.

Microscopical observations made clear the presence of diverse type of setae on the body of larvae of antlion (Fig. 4). Considering their aspect, they are in 4 categories : long and thin, short and thick, slightly thick and slightly thin. According to their distribution they all appear alone bur the long and thin one always come together to form a cluster made of more than 10 long an thin setae (Fig. 5). Considering their distribution setae in cluster appear only on the size of the 8 first segments of the abdomen, short and thick setae are present only on the sternite IX and finally the slightly long and thin are present anywhere on the abdomen. Long and thin setae associated in clusters are mostly involved in the process of propulsion of sand or dust from the excavation process. The short and thick setae concentrated on the last segment are mainly excavating structure important in digging the soil. Their organizations are in relationship with the specie of antlion.

How do immature antlions move through the soil and construct their funnel-shaped pit? The shape of the larva's abdomen, with its relatively blunt anterior end gradually tapering toward the posterior enables the antlion to slide backward easily through the sand. The hairs on the antlion's body curve forward, and the long third pair of legs help it move backward.

An antlion excavates its pit by using its oval-shaped abdomen as a plow and its flat head as a shovel for flicking huge sand particles upward. It circles backward through the sand and repeatedly flicks sand upward, raising its head above the soil surface.

If an antlion larva encounters a small pebble or other object when it is constructing its pit, it will attempt to flick the object out of its pit. If the object is too large to flick but large enough to move, it may literally be "pushed" up and out of the pit by the larva. When the pit is completed, the larva lies motionless on the bottom, concealed beneath the sand, with only its long, piercing mandibles exposed.

When an ant or other small insect accidentally steps inside the rim of the pit, it will slip on the soft sand particles on the side of the pit and fall to the bottom. The unfortunate victim usually becomes impaled by the antlion's piercing mandibles. But if it tries to escape, the antlion will flick sand and shower the prey. As this storm of loose sand falls on the slope of the pit, it speeds up the treadmill effect. After the prey has been captured, the antlion drags the victim deeper into the sand where it sucks out its body fluids. The antlion then disposes of the carcass by flicking it out of the pit.

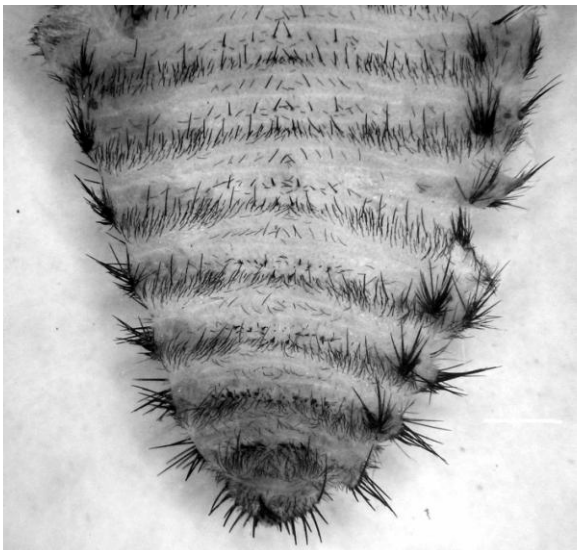
Chetotaxy of the abdomen of Myrmeleon obscurus and Hagenomyia tristis

The tools involve in the process of the construction of the pits in both *H. tristis* and *M. obscurus* are in the same two groups: digging structures made of short or long thick setae and secondly excavating structures made of elongated thin setae. In both species, excavating setae are associated in clusters and excavating setae appear each alone, separated each from other. Their location on the antlion larva is almost the same. Excavating setae occur only on the lateral border of the abdominal segment I to VIII and the digging setae are observed only on the segment IX (Fig. 3). In the dorsal view of the segment VIII, some short and thick setae occurred.

The most specific design in the organization of the digging setae is observed in its ventral view. The main difference between the two species studied comes from their size. *M. obscurus* is larger than *H. tristis*. *M. obscurus* has larvae bigger than that of *H. tristis* at the same instar. Obviously, the abdomen of *M. obscurus* is larger than that of *H. tristis*. It is also observed that excavating setae of *M. obscurus* are more numerous in the cluster (more than ten each time) and more longer than what appeared with larvae of *H. tristis*. At the level of the sternite IX, on the ventral view, the amount of digging setae is greater in *M. obscurus* than it is with *H. tristis*.

The digging setal system in antlion (Fig. 3) is composed with short thick setae at the middle of the sternite. They are oriented straight and backwards. They are in three rows of 2 –3 – 2 setae from the anal marging to the inner body on *M. obscurus* and three rows of 1 –3 – 2 setae from the anal marging to the inner body on *H. tristicis*. The long and thick setae are oriented laterally to the side of the body. In *M. obscurus*, they are from the marging to the inner body 4 rows of 5 – 4 – 3 – 1 setae. On *H. tristis*, only 2 rows are present a first row of 5 at the marging and a second of 3 on the sternite. Another similarity in the two antlion larvae is that the second row of long and thick setae is associated with that of the sort and thick setae that move straight backwards. The two short and thick setae on the second row are very close each to another. The inner long and thick seta of the second row is associated to that pair of short setae. It is obvious to notice the presence of setal membrane at the base of all setae of the sternite IX of the antlion *M. obscurus*. The setal membrane which is a small membranous ring of the body wall surrounding the seta, when it exists allows its movement in different directions (Snodgrass, 1935).

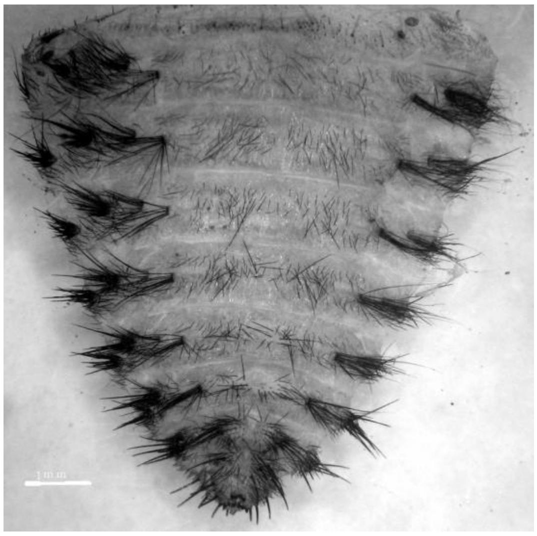
a



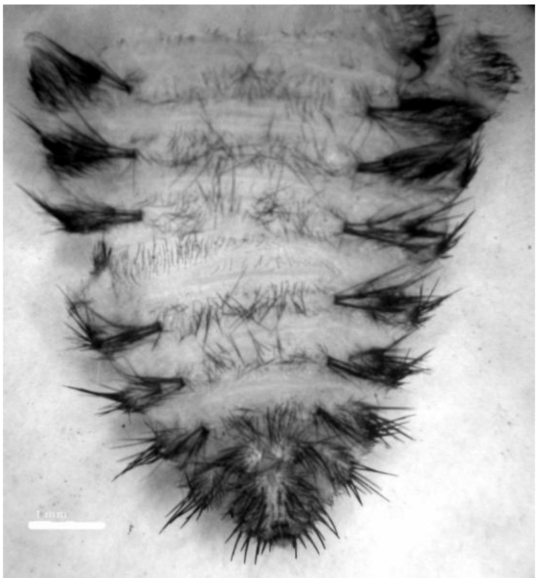
b

c

d



e



f

Fig. 5. Presentation of setae on the abdominal segments: a : *Hagenomyia tristis*, dorsal view; b : *Myrmeleon obscurus*, dorsal view; c : *Hagenomyia tristis*, lateral view; d : *Myrmeleon obscurus*, lateral view; e : *Hagenomyia tristis*, ventral view; f : *Myrmeleon obscurus*, ventral view.

Discussion

The classification of the Myrmeleontidae based on larvae (Stange and Miller, 1990) pointed out the presence of the presence of blade-like digging setae on sternite IX as an important character that separate Tribes. The development of a pair of digging setae on the posterior marging of the sternite IX is a character particular to the larvae that construct pit-fall traps and that can move backward (Lucas and Stange, 1981). Larvae of Neuroptera which did not contruct pit-fall traps have on their lateral marging very long setae. No particular distinction appears from the shape and the consistence of the setae in relationship with their location on the body (Henry, 1976). This specialization of the abdominal setae evolved in relationship with the capacity of these species to construct efficiently pits into sandy soils. This evolution is also in accordance with their size (Stange and Miller, 1988). The larvae of the Family of Stibopteryginae with large size instead of having a blade-like setae have on their posterior marging a pair of large processes carrying several digging setae. This structure also observed on Dimarini and some Palparini may be precursor of blade-like setae. The sternite IX of Myrmeleontini is without blade-like digging setae, it carries numerous large and well developed digging setae organized in precised disposition. These large digging setae while surrounded by basal papilla (*M. obscurus*) perform more efficiently than when they are absent (*H. tristis*). This specialization may be the main explanation of the success of Myrmeleontid to proliferate and disperse widely in dry season in tropical areas building pits even on hostile conditions.

Conclusion

Antlion larvae are sit-and-wait predators usually found in shelter at the bottom of the funnel-like pit fall traps. The trap is constructed and regularly cleaned up by its owner. Till these observations, it was widely accepted that the antlion larva constructs the pit by using its mandible to seize dust and with a strong movement of the head send it away, in addition to this, the ovoid shape of the abdomen of this larva explain the funnel shape of the pit. The present investigation by observing the 2 most present pit digging antlion of the Sudano guinean and the Sudano sahelian regions of Cameroon makes clear that two types of body process are present: they are complementary one digging the soil and the other excavating the dust.

Acknowledgements

Authors are grateful to the Belgian Cooperation for Development (CUD) for providing the material used in this work. We also extend our thanks to Dr Michel Bruno (CIRAD, Montpellier) who identified our insects.

References

Crowley PH, Linton MC. 1999. Antlion foraging: Tracking prey across space and time. Ecology, **80**,2271–2282.

Fertin A, Casas J. 2006. Efficiency of antlion trap construction. Journal of Experimental Biology; **209**, 3510–3515.

Gotelli NJ. 1997. Competition and coexistence of larval ant lions. Ecology; **78**,1761–1773.

Gotelli NJ. 1993. Ant lion zones: Causes of high-density predator aggregations. Ecology; **74**, 226–237.

Griffiths D. 1986. Pit construction by ant-lion larvae: A cost-benefit analysis. Journal of Animal Ecology; **55**, 39–57.

Guillette LM, Karen LH, Markarian A. 2009. Learning in a sedentary insect predator: Antlions (Neuroptera: Myrmeleontidae) anticipate a long wait. Behavioural Processes; **80,** 224–232.

Henry CS. 1976. Some aspects of the external morphology of larval owlflies (Neuroptera: Ascalaphidae), with particular reerence to Ululodes and Ascaloptynx. Psyche, **83(1),** 1-31.

Lucas JR, Stange LA. 1981. Key and description to the Myrmeleon larvae of Florida (Neuroptera: Myrmeleontidae). Florida Entomologist, **64(2)**, 207-216.

Lucas JR. 1982. The biophysics of pit construction by antlion larvae (Myrmeleon, Neuroptera). Animal Behaviour. **30**, 651–664.

Mansell MW. 1992. Specialized diversity: the success story of the antlions. The Phoenix. **5**, 20–24.

Mansell MW. 1996. Predation strategies and evolution in antlions (Insecta: Neuroptera: Myrmeleontidae). pp 161–169. In Pure and applied research in neuropterology. Proceedings of the fifth international symposium on neuropterology. 1996, Toulouse, Canard M, Aspöck H and Mansell MW, Editors.:

Mansell MW. 1990. Biogeography and relationships of southern African Myrmeleontidae (Insecta: Neuroptera). pp 181-190. In *Advances in Neuropterology*. Proceedings of the. 3rd Symposiumof Neuropterology. Berg en Dal, Kuger National Park, RSA 1988, Pretoria. Mansell MW and Aspock H (Eds).

Mansell MW. 1999. Evolution and success of antlions (Neuropterida: Neuroptera, Myrmeleontidae). Stapfia; **60**, 49-58.

Mansell MW, and Erasmus BFN. 2002. Southern African biomes and the evolution of palparini (Insecta: Neuroptera: Myrmeleontidae). Acta Zoologica Academiae Scientiarum Hungaricae **48 (Suppl. 2),** 175-184.

Michel B. 1999. Biodiversité et écologie des Palparinae du sud du Mali (Neuroptera, Myrmeleontidae). Bulletin de la Société Entomologique de France; **104**, 45-51.

Michel B, Letourmy P. 2007. Characterisation of a West African Myrmeleontinae assemblage (Neuroptera Myrmeleontidae): first evidence of a relationship between adult occurrences and climatic conditions. Tropical Zoology, **20**, 197-209.

Ngamo Tinkeu LS, Maoge J, Aminatou Boubakari AB. 2010. Predation of Myrmeleon obscurus (NAVAS, 1912) (Neuroptera: Myrmeleontidae) on the ground ant Myrmicaria opaciventris EMERY (Formicidae: myrmicinae). International Journal of biological and Chemical Sciences. **4(2)**, 509 – 514.

Pianka ER. 1966. Convexity, desert lizards and spatial heterogeneity, Ecology, **47,** 1055-1059.

Prost A. 1998. Les Acanthaclisinae d'Afrique occidentale et centrale (Neuroptera, Myrmeleontidae). Revue Française d'Entomologie, **10**, 157-173.

Scharf I, Ovadia O. 2006. Factors influencing site abandonment and site selection in a sit-and-wait predator: A review of pit-building antlion larvae. Journal of Insect Behaviour; **19 (2)**, 197-218.

Snodgrass RE. 1935. Principles of Insect Morphology. Chap III. The body wall and its derivatives. Mc Graw-Hill Book Co, New York and London. Pp 48 – 69.

Stange LA, Miller RB. 1990. Classification of Myrmeliontidae based on larvae (Insecta: Neuroptera). Pp 151-169 In Advances in Neuropterology. Proceedings of the. 3rd Symposiumof Neuropterology. Berg en Dal, Kuger National Park, RSA 1988, Pretoria. Mansell MW and Aspock H Eds.