CHAPTER -1

GENERAL INTRODUCTION

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Entomology is a branch of science which deals with the study of insects. Insects are a group of highly adaptable invertebrates coming under the largest animal Phylum Arthropoda (Arthro-joint or segment, poda-foot or appendage). The body of an insect is divided in to head, thorax and abdomen in which, thorax has three pairs of legs and one or two pairs of wings. Phylum Arthropoda divided into classes and Insecta is one of the biggest Class of Phylum Arthropoda. Class Insecta is divided into two subclass (Apterygota and Pterygota) based on the presence or absence of wings. Class Insecta again divided into thirty orders on the basis of the structure of wings, mouthparts and metamorphosis etc.

Previously Thysanura, Diplura, Protura and Collembola were included in Subclass Apterygota and the remaining 26 orders are again classified as exopterygotes and endopterygotes under Subclass Pterygota. Exopterygotes are insects with incomplete metamorphosis, wings develop externally and the immature stages resemble the adults. Exopterygotes includes Order Ephemeroptera, Odonata, Plecoptera, Grylloblattodea, Orthoptera, Phasmida, Dermaptera, Embioptera, Dictyoptera, Isoptera, Zoraptera, Psocoptera, Mallophaga, Siphungulata, Hemiptera and Thysanoptera. Endopterygotes are insects with a complete metamorphosis and the wings develop internally and the larvae differ from adults in structure and habitats. Endopterygotes includes Order Neuroptera, Coleoptera, Strepsiptera, Mecoptera, Siphonaptera, Diptera, Lepidoptera, Trichoptera and Hymenoptera (Imms *et al*., 1977). But in a recent classification Protura, Collembola and Diplura are upgraded from the status of Order to Class. The remaining 27 orders are classified under Class Insecta (Parsons, 2015).

Order Neuroptera is one of the Order of Class Insecta, known by about 5000 species from the world; most of them are represented in the temperate and subtropical regions. The members of this order includes a varied, though interrelated assemblage of holometabolous, carnivorous insects most commonly known as Antlions, Lacewings, Snake flies, Alder flies and Dobson flies (Nayar *et al.*, 1976). In earlier, Megaloptera, Raphidiodea, and Neuroptera were considered as Suborders of Order

Neuroptera (Borror and Delong, 1975), but now, these three are considered as three separate Orders. Order Megaloptera includes alder flies and dobson flies, Order Raphidiodea includes snakeflies and Order Neuroptera includes lacewings, mantispids and antlions (Gillot, 2005). The research work mainly focussed on Family Myrmeleontidae, one of the families of Order Neuroptera.

The term Neuroptera derived from two Greek words "Neuro" (nerve) and "ptera" (wings), and they are very similar in appearance to damsel flies (Order Odonata) with long, narrow, many veined wings and a slender abdomen (Borror and Delong, 1975). There are approximately 5000 species of Neuropteran recorded worldwide in which 335 species belonging to 125 genera and 13 families are known from India (Chandra *et al.*, 2014).

1.1. GENERAL CHARACTERS OF ORDER NEUROPTERA

As a group, the Neuropteroids are characterized by the nature of their wings which are membranous and almost subequal. The front and hind wings of most Neuroptera are similar in shape and venation, and are held roof like over abdomen when at rest. They are usually weak fliers. They have chewing type of mouth parts and antennae long, many segmented (Borror and Delong, 1975). These insects undergo complete metamorphosis and the eggs are laid singly or in masses in various situations. Generally the larvae are compodeiform type. The larvae of lacewings and antlions with sickle shaped mandibles suck the body fluids of the victim through a narrow channel formed between the mandibles and the maxillae. Pupation usually occurs in a silken cocoon; this silk is not derived from modified salivary glands as in most insects, but is produced by the malpighian tubules and is spun from the anus. The study of malpighian tubules of *Myrmeleon uniformis* larval instars shows the presence of precursors of silk fibres for the secretion of silk fibres for a cocoon (Pacheco *et al*., 2014).

Order Neuroptera is divided into three suborders namely, Megaloptera, Raphidiodea and Planipennia. Family Myrmeleontidae is coming under Suborder Planipennia and Superfamily Myrmeleontoidea. The name Myrmeleontidae is rooted in the Greek words 'myrmex' (ant) and 'leon' (lion).

1.2. GENERAL CHARACTERS OF FAMILY MYRMELEONTIDAE

The adult of this group are rather feeble fliers and are often attracted to lights. The wings are clear in some species and irregularly spotted in others. Antlion larvae, or doodle bugs are queer looking creatures with long, sickle like jaws. Some species have an interesting method of capturing their prey, they conceal themselves at the bottom of a small conical pit, made in dry sand or dust, and feed on ants and other insects that fall down into this pits. The pit digging antlions are called 'doodlebugs' in the United States because of the designs they make in the sand. A doodlebug seeks an ideal location to dig its pit, it leaves meandering trails that resemble the random "doodles" of a preoccupied artist. When it finally finds the right place to dig, the doodlebug draws a series of concentric spirals, each deeper than the last, until the pit is excavated.

The adult antlion usually emerges from its cocoon in the evening. It is not yet able to fly, so it climbs at the nearest plant, where it waits for its wings to expand and harden. The adult antlion may eat small flies or water, but its real purpose is reproduction, not feeding. The development is comparatively slow and requires a year or so to become adult (Kapoor, 1985).The sex can be determined by the presence of oviposition setae on females and the pilula axilaris at the base of the hind wing on males. The general morphology of pit building antlion larvae and adult were given in Plate 1, Plate 2 and Plate 3. An idea about doodle marks, larval pits and life cycle are given in Plate 4. Family Myrmeleontidae divided into five subfamilies which include 201 genera and 14 tribes. The Subfamilies are Stilbopterigynae, Palparinae, Myrmeleontinae, Araripeneurinae, and Paleoleontinae (Stange, 2004). Only two subfamilies are seen in India (Subfamily Myrmeleontinae & Subfamily Palparinae) and the classification is described below,

Kingdom : Animalia

Phylum : Arthropoda

Class : Insecta

Order : Neuroptera

Suborder	:	Planipennia
Super family	:	Myrmeleontoidea
Family	:	Myrmeleontidae

1.2.1. Behaviour of larval Myrmeleontids

Larval myrmeleontids possess a number of behavioural patterns like pit building, predation and feeding. For predation, they opt a strategy called conical shape pit making. They make conical pits in sand or soil and wait inside the pit for the arrival of prey. Mostly the ants (Order Hymenoptera) are the victims of antlion predation. Again the pit making is also a beautiful process in which the larvae move backward with the flickering of soil or sand with its mouths part. The mouth parts also have a mechanism which helps in the feeding of larval antlion. Their mouthparts have a hollow mandible which helps to suck the body fluid of prey.

1.2.2. Natural enemies/Predators of antlion larvae

Successful natural ecosystems consist of predators, prey and its specific habitats and the population of each species was controlled and maintained by these preys and predators. Diptera, Hymenoptera, Neuroptera, Arachnida and Lizards are the main natural enemies of larval antlions (Stange, 2004). For increasing the survival rate, the larval antlions relocate its pits in the presence of natural enemies and make steeper pits, but it is different in different species. *Myrmeleon hyalinus* larvae reduce its pit building activity in the presence of its predator wolf spider (Loria *et al*., 2008).

1.2.3. Habitat

The habitat of antlion larvae was different in different places and countries, and the habitat preference is species specific too. The common pit building antlion is coming under Genus *Myrmeleon*, but the species of this genus has different habitats. *Myrmeleon carolinus* found in hot open areas but *Myrmeleon crudelis* found in cooler shaded areas (Lucas, 1985). *Myrmeleon immaculatus* found along the beach close to the vegetation, and under bank or log overhangs (Heinrich and Heinrich, 1984). *Myrmeleon obscures* found in shaded areas, but *Cueta pallens* present in open areas (Fisher, 1989).

Plate 1

General Morphology -Adult

Antenna-Clubbed

Wing -Apical portion

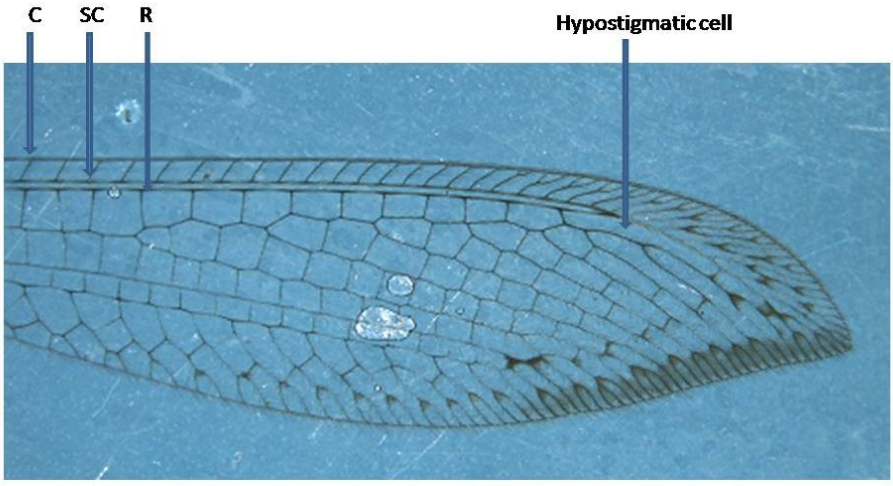
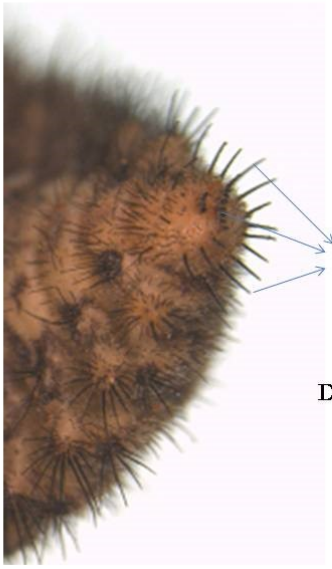


Plate 2

General Morphology- Larvae



Digging setae

Dorsal picture of larvae

Leg

Trochanter

coxa

femur

tibia

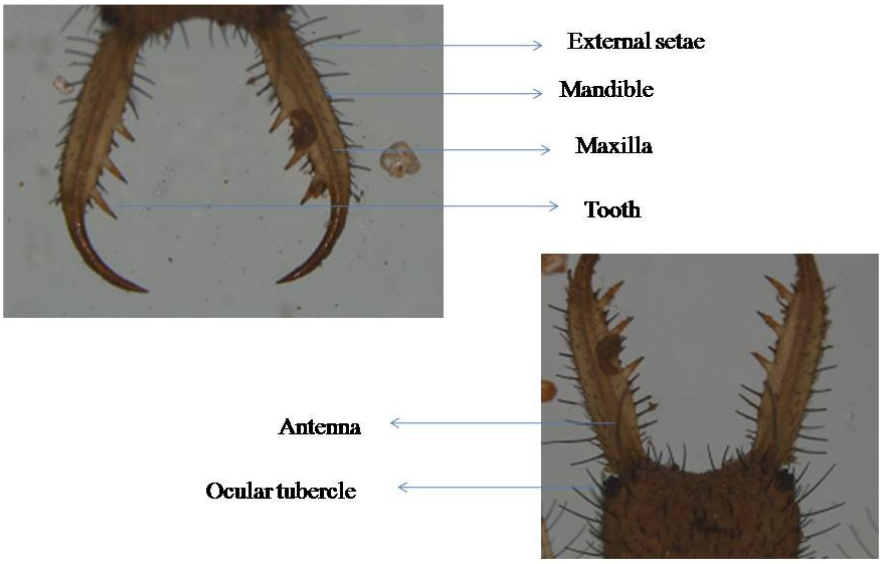
Tibial spurs

Tarsus

claw
s

Plate 3

Head portion

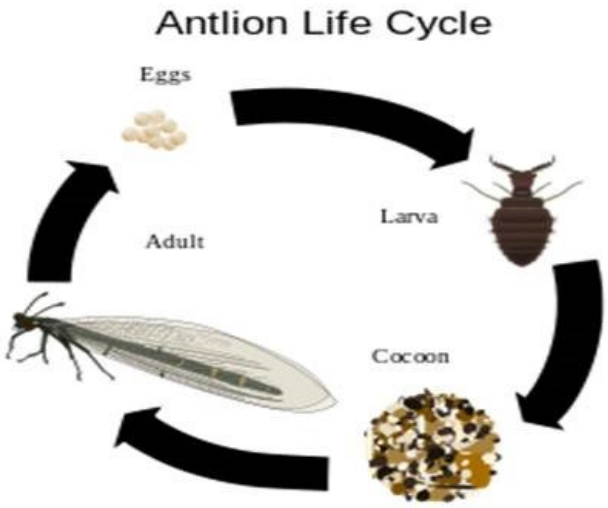


Ventral side of larvae

Plate 4

Doodle marks

Antlion larval pits



1.2.4. Parasites of antlion

The main parasites of antlions are coming under Order Hymenoptera, Diptera and Protozoa. Chalcididae, Eulophidae and Ichneumonidae are the parasites coming under Order Hymenoptera (Stange, 2004). *Itamuton stangei* is an Ichneumonidae which parasitize Central Chilean antlion *Elicura litigator* (Porter, 1989*)*. The species *Hockeria eriensis* and *Paravilla sp* parasitize larvae of *Myrmeleon brasiliensis* from Brazil (Uchoa and Missirian, 2014).

1.3. SIGNIFICANCE OF THE PRESENT STUDY

Neuroptera being a predator devouring over other insects which may include serious pests of crops and forest vegetations, it is of immense importance economically as well as ecologically. But, no serious attempts have been made to study the diversity, ecology and behaviour of this group in Southern parts of Kerala. Antlions are often included in lists of beneficial insects, no doubt because they prey upon ants, a common pest to humans.

The significance of the study relies on the pit building strategy of antlion larvae and its predation. It has an inherent architectural ability to make its steep conical pits like the honey comb made by honey bee. The exceptional behaviour as a predator, make this group a very interesting, but the studies were in initial stage in Kerala. The number and species of Myrmeleontids were decreasing gradually because of different anthropological activity, so if the study hasnt done now, after some years we cant get this much data.

It took up to two years to emerge an adult from larvae, so that the life stages studies were very difficult. Though there is an absence of enough taxonomic keys regarding Family Myrmeleontidae, the identification purpose is too hard; it makes to relay on molecular taxonomy than classical taxonomy. Sometimes antlions are categorized under bio indicators of hot condition (xerophilous) because they are living in dry places which indicates the global warming (Ngamo *et al.*, 2015)

The reasons for the selection of the group as study organisms and its significance are as follows,

- Considered as Bio indicators of global warming, because they are xerophilous insects, its presence is an indication of hot condition
- It is a model organism for studying the soil vibration and soil stability
- The architectural strategy was something different and new to science
- The ecology of antlion larvae and how they adapted to different types of habitat in Kerala was not studied yet
- Least studied group in India
- No studies in kerala till date

Lots of plants and animal species are disappearing from the earth due to anthropogenic activity and encroachment of lands for human life styles. So the natural habitats of several species are destroyed. According to the ZSI reports different species of antlions were reported from different states of India. Although the study of Southern species of antlions are still in upbringing stage.

The study was somewhat challenging because it is a preliminary study of antlions in the southern parts of India. Even though the collection of larvae was easy, but the identification of the species was difficult in Indian scenario due to the scarcity of experts in the same field. In order to increase the authenticity of species level identification both morphology and molecular sequencing was used as tools. There are lots of sequence deposits in NCBI and BOLD, but most of them are under the tag of Genus *Myrmeleon*. The numbers of species reported from India in 1984 were not caught now because of the habitat destruction due to human interaction.

1.4. OBJECTIVES OF THE PROPOSED WORK

The main objectives of the study include

- To study the different habitat of antlion larvae
- To analyze the physical and chemical structure of antlion inhabited soil
- To investigate the antlion larval behaviour patterns
- To examine the intraspecific and interspecific interactions

The first two objectives were studied under ecology and the remaining two coming under behaviour studies.