COURSE CODE: *ZOO 361*

COURSE TITLE: *BASIC ENTOMOLOGY*

NUMBER OF UNITS: *3 Units*

COURSE DURATION: *2 Hours per week*

COURSE DETAILS:

Course Coordinator: Dr O.A. Oke. B.Sc., M.Sc., Ph.D.

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COURSE CONTENT:

Insect evolution, Classification and Distribution. Organisation of External Structure, Ingestion, digestion and excretion. Blood circulation water system. Behavior and ecology of social insects. Aspects of applied entomology with particular reference insects, mites and ticks of medical and veterinary importance.

COURSE REQUIREMENTS:

This is a compulsory course for all zoology students in the University. Students are expected to participate in all course activities and have a minimum of 75% attendance to be able to write the final examination.

READING LIST:

1. **Imms. A text-book of Entomology. Vol 1 and 2**
2. **Ross. A text-book of Entomology**
3. **Fros. A textbook of Entomology**

4. Anthony Youdeowei. *A Laboratory Manual of Entomology.* Ibadan, Oxford University Press. 1977.

LECTURE NOTES

INSECT EVOLUTION

Insects are supposed to have originated from Annelid Stock which is segmented worm consisting of a pre-oral segment called Prostomium. From the Prostomium, arises the paropodia on the segments of the body and on the last segment we have pygium.

The first trunk segment fused with the prostomium, this fusion portion is evident in a living specie of *Peripatus (Onychophora).*

From the margin of first segment arose a pair of antennae and a pair of simple eye. There is the enlargement of the eye into a compound eye and the fusion of one more trunk segment to the head.

From this stage, the segments have their appendages shifted forward thus assisting in feeding. This stage is well illustrated in the Trilobites which are all extinct arthropods.

From this stage, a further evolution occurred which is the further segmentation of the appendages.

From this basic structure came a divergence into:

1. Chelicerata group
2. Mandibulata group

From here, we have the development of the different mouth parts.

From the mandibulata group came again a divergence:

1. Insecta
2. Diplopoda
3. Pauropoda
4. Symphyla
5. Collembola

From here, we have the development of the thoracic region and their enlargement.

From here, we have loss of abdominal appendages leaving only the thoracic appendages e.g. Insecta. However in the collembola, there is the abdominal appendages which is used for springing. In the abdominal segments (no. 8 & 9) of the female are modified into ovipositors while those of the males are truncated into genital scales.

This is the evolutionary trend of the Insecta although there is no uniform opinion.

GENERAL CHARACTERISTICS OF INSECTS

Insects represent ¾ or seventy five percent of the species of animals known to science. They are consequently diversed in shape and structures and they have been grouped into about twenty six groups. They are characterized as follows:

1. **Division of the body into head thorax and abdomen.**

   The head consists essentially of six segments of which none is visible individually. One of these segments is lost in the embryo. Three of them bear appendages, these are the mandible, the first

maxilla and the second maxilla which is fused to form the labium. These are usually associated with feeding.

The head capsule also bear a pair of compound eyes which is unique with the insects and a pair of antennae. Ocilli might be present. They are usually three in number but might be reduced to two. The compound eyes are used for sight and they are made up of structures known as OMMATIDIA. The antennae are sensory in function.

The thorax comprises of three segments; i.e. the pro, meso and meta-thorax. They each essentially bear a pair of walking legs. The meso and meta-thorax bear a pair of wings. In some insects, however, wings are primitively absent; these are referred to as the Apterygotes. In some insects, they are secondarily wingless. This is usually associated with parasitism. Examples are the head-lice and the fleas. In the diptera, only a pair of wing is functional. The meta-thorax wing has been modified into halterers (balancing organs). In other insects, where the two pair of wings are not functional, they are cuticunized and are not used for flight. The meta-thoracic pair is membraneous usually folded when in repose (resting) and it is usually the organ of flight.

THE ABDOMEN- there are usually ten to eleven segments in the abdomen. Although, variation occurs in various groups of insects. Usually, they do not bear appendages except in collembola. The abdomen house all the essential organs. The exterior of the reproductive structure in the female are associated with a pair of cuticunized structure called ovipositor. In some, they are well developed i.e. the ovipositor are well developed e.g. grasshoppers while in others, they are poorly developed e.g. housefly

2. **The presence of cuticle**

   This is essentially an arthropod characteristic. But those of the insects differ in that the endocuticle lack calcium as in millipede and possess a wax layer on top of the epicuticle. This makes the insect capable of withstanding desiccation. It is also significantly related to the success of the insects

3. **The presence of trachea and spiracles as breathing organs.**

   The trachea is essentially an insect structure although it occurs in other arthropods. The trachea system enables each cell of the muscular tissue of the insect to receive direct oxygen for metabolism. This is of great importance during flight. The spiracle is responsible for entry and exit of air. There are usually ten pairs of spiracles in the typical insect e.g. grasshopper while the number reduces in the advanced insects as we found in the hemiptera and dipterans.

4. **The presence of tubular heart and free flowing haemolymph**

5. **Metamorphosis during development**

   There are two types of metamorphosis; i.e. complete (holometamorphosis) and incomplete (hermimetamorphosis) and the third one non metamorphosis or Ametamorphosis

Complete metamorphosis is egg – larva – pupa – adult

Embryo feeding resting reproductive

Incomplete metamorphosis is egg- 'nymph'- adult or

Egg- larva- adult

Embryo feeding reproductive stage.

However, some insects can give birth directly to their young ones, this is viviparous e.g. aphids in the order Hemiptera.

6. The ecdysis process

The process of growth in insects is through the shedding of the cuticle.

THE INSECT HEAD

Although it looks like a segment, the insect head have six segments. It is not the number of segments in the Prostotomium. However, there are four post-oral segments.

The first segment is the larva and adult form

The second segment is the mandible

The third segment is the maxilla

The fourth segment is the labium (second pair of maxilla)

Insect head have some structures associated with it:

1. Compound eyes and ocelli
2. Antennae
3. The mouth-parts

An insect has pair of compound eyes which comprise of many facets. These facets range from a few hundreds in the lower pterygotes to over fifty thousands facets in the advanced dipterans and coleopterans. Each facet is associated with an ommatidium.

Light rays pass through a number of facets at a time. Consequently, it is possible for the insect to observe a moving object since the rays will fall at different facets at the same time.

The insect eye can also see colour and it is superior to the human eyes in that it can also perceive with ultra violet rays. However, some are blind to the red colour.

The ocelli are simple eyes and their position is important in insect classification. They may be absent in some insects.

ANTENNAE

The antennae is an appendage of the head and it is usually segmented. Segmentation ranges from three to a large number which may approach a hundred. It is usually a sensory organ although it occasionally perform the function of smell and sometimes hearing as the case in the mosquito.

Various types of antennae are found in the insect world and this is usually classified according to its shape:

1. Filiform (thread-like) e.g. *Zonocerus variegatus*
2. Setaceous (tapering) e.g. *Periplaneta americanus*
3. Moniliform (bead-like) e.g. *Macrotermes bellicosus*
4. Clavate (clubbed) e.g. *Danaus alcippus (butterfly)*

5. Capitate (head-like) e.g. *Dermestes maculatus*
6. Lamellate (leaf-like) e.g. *Anomela tibialis*
7. Pectinate (comb-like) e.g. silkworm moth
8. Aristate e.g. *Glossina palpalis*
9. Plumose (hairy) e.g. male Culex spp. (diptera)
10. Geniculate (knee-like) e.g. honey bee

THE MOUTH-PARTS OF THE INSECT

The typical mouth-parts of insect consists mainly of

1. Labrum
2. One pair of mandible
3. One pair of maxillae
4. One labium
5. Hypopharynx

This type of insect mouth part is known as Mandibulate mouth part.

Zonocerus variegatus are phytophagus insects (plant eaters).

There is another type of mouth-part associated with **chewing and lapping.** This type is found in the bees.

The mandible is well-developed but it is not toothed (endites) for kneading. The labrum is reduced in size and the labium is modified into a flagellum (a tongue-like) structure.

The suctorial insects

There are two types of suctorial mouth parts:

1. Sponging type e.g. housefly
2. Siphoning type e.g. butterfly and moth.

The mandible has become non-existent. We have over development of the labium. In case of house fly, the labium has been extensively developed. The terminal end of the labium has been developed into labella which develop pseudo-trachea.
If it is a solid food e.g. sugar, it first of all pour its own fluid o soften the sugar and the house fly sucks in the sugar.
In the case of butterfly, we have over development of a part of the labium called the proboscis used in sucking the fluid.

Piercing and sucking

The two main important types are

1. Bugs (hemipterans) which are of two orders: homoptera and heteroptera
2. Mosquitoes.

All bugs have well developed mouth parts. Also, all mosquitoes have their mouth parts well developed.
Over simplicity of the mandible, maxilla and hypopharynx in the mosquito which are developed into thin thread-like structures. While the labium in the bug forms the main cone and in the mosquito it is also thread like.

THE THORAX

The insect thorax is a box-like structure which comprises of three segments. From the anterior, the prothorax, the meso and the meta-thorax. In the primitively wingless insects, these three segments look much alike. However, in those with wings, the meso and metathorax have become structurally modified to accomodate the wing muscles. The dorsal part of the thorax is covered by the notum, called the tergum (the dorsal cuticle), the ventral called the sternum and the lateral called pleuron. The soft and thin portion (pleuron) usually accommodate the appendages. The three segments of the thorax each bear a pair of walking legs. While the meso and meta thorax bear a pair of wing. Usually the meso-thorax pair of wing is hardened and is reffered to as elthyra while the meta-thoracic pair is membraneous and it is used for flight. In some cases, as in the house-fly, it has been modified into a balancing wing called the halteres.

THE INSECT LEG

The insect legs consist of five main segment; the coxa, trochanter, femur, tibia and tarsus.

The coxa is associated with a deep-like (cup-like) depression around the pleural segments of each thoracic segment and it is usually made big by muscles. Next to this is the trochanter which is small and triangular and it is more or less a connecting joint between the coxa and the femur. The femur is the biggest segment of the leg where the muscles are usually housed. Next is the long, thin, tibia which articulates with

tarsus. The tarsus is usually segmented between two to five depending on the order. But the tarsus terminates in a battery of claws and pads. There is usually one pair of claw and in all cases a median pad called AROLIUM. In some order e.g. Diptera small pads are associated with the arolium and are referred to as PULVILLI (US).

Modifications of insect legs

Do all insect legs look alike?

Although the insect leg has the same basic structural patterns, they have evolved to perform specific functions. This is usually related to the habits or habitats of such insects. Consequently, we have an array of different structures of such legs. They include those for walking and running which is typical and those for digging, for clasping, for grasping, for jumping as well as for swimming. These functions are either related to the femur, tibia or tarsus.

THE INSECT WING

The evolution of the insect wing is not clear because there were no fossil evidences of how the wings developed. However, it is believed that it might have originated from the development of flaps across the thorax which was then used for gliding. From here, it is presumed that the hinged system occurred and the wings could be flapped.

There is an array of structural differences in the wing system as we know them today. However, it is known that they could be traced to common ancestral. The basic insect wing is an accession of cuticle one up one down which has been held together with a few ridges between them. These are referred to as Veins.

Various opinions are known about the origin of the veins. The most appropriate is the one that believes in the probably extension of the trachea which have now lost contact with the trachea of the insect. The main function of the veins is to provide extra strength and rigidity to the wings.

The pattern of the venation is of utmost importance in the insect classificatiom and various names has been assigned to the various veins of wings: coastal vein, subcoastal, radius, median, cubitus, cubital furrow, anal, jugal furrow and jugal.

The number of veins may be reduced in higher insects. The reduction is usually associated with margin together of veins rather than obtelarata of the veins. Hence the more primitive an insect, the more number of veins and higher the insect, the less veins.