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Fine Structure of Anoplura Lice (*Linognathus)* Infected Goats by Scanning Electron Microscope

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Abstract: ***The study present the sucking lice (Anoplura) that affects local farm animals (goats) in the Eastern Province of the Kingdom of Saudi Arabia (Al-Ahsa). The study recorded the classification of the lice, and its description using optical microscope and scanning electron microscope. The study clarified the exact composition of the species (Linognathusafricanus, Kellogg and Paine, 1911), the shape of the head sack, and the distribution of body bristles. Italso showed the shape of the sensory antennae, shape of the leg claws and the structure of the reproductive system (genitalia).***

Keywords: Linognathusafricanus lice, Anoplura, goats, Saudi Arabia, SEM

1. Introduction

Liceisone of the harmful pests in humans and animals, it transmits viral and bacterial diseases and roams the bodies of animals, where it bites the hair and wool of animals that tend to scratch their bodies and rub them against walls, leading to skin ulcers that reduce the skin's commercial value. The infected animal remains in an abnormal state, where it cannot sleep or feed, leading to loss of weight and general weakness, and thus lower milk production rate. Lice live as external parasite on humans and mammals, sucking their blood and causing them skin inflammation, rash and severe irritation. It is sometimes a medium for the transmission of pathogens for some malignant diseases (Durden and Lloyd, 2009).).

Some species of Linognathus have significant veterinarian importance, such as the external parasites of pets or livestock animals, which under certain circumstances can lead to itching, irritation, and especially anemia, allergic reaction and weight loss, in addition, some species may transfer pathogens (Durden and Lloyd, 2009). This species intrudes on local mammals, such as canine sucking lice, Linognathussetosus (von Olfers), sheep lice, Linowathusovillus (Neumann), Linognathuspedalis (Osborn), goat lice, Linognathusstenopsis (Burmeister), cattle lice, Linognathusvituli (Linnaeous) and goats and sheep lice Linognathusafricanus(Kellogg (Rice and Graham، 1997؛ Durden and Lloyd، 2009)). The adverse effects of lice on wild mammals have been poorly recorded by (Durden ، 2001), but, assumably, some species may negatively affect their hosts under certain circumstances or they can transmit pathogens. Most of the described Linognathus species are found in antelopes, deer, giraffes, wilder beast and buffalo ((Weisser, 1975; Durden and Musser, 1994; Pajot, 2000; Durden and Horak, 2004)).

Due to the importance of lice, a group of scientists studied its species, description, and classification. Where (Lyal, 1980) mentioned the most important of the sucking lice species and their hosts found in the Kingdom of Saudi Arabia until March 1980. Eight species were mentioned, six of which were not previously known in the Kingdom. Two species of lice were isolated on sheep in a study conducted by(Kumar, et. al., 1994) in India, which are Bovicolacaprae and Linognathusafricanus, which he collected from 1048 heads (sheep), where the general health condition of the hosts was weak, leading to the fall of the sheep wool. In North Sinai, during a study on 204 sheep, (Mazyad and Helmy, 2001) found lice infection, the majority was with Bivicolacaprae, followed by Linognathusafricanus, then L. stenopsis. They also recorded mixed infection in a single host. (El-Baky,2001) conducted a study in Egypt (Eastern Desert), where he found two species of sucking lice in sheep and goats, Bovicolacaprae and Bovicolaovis and two species of biting lice in sheep, Linognathusafricanus and Linognathusstenopsis. In South Africa, (Sebei, et. al., 2004) studied them with the Scanning Electron Microscope, which contributed to defining parasitic lice in goats. Of the species that were defined in that are: Linognathusafricanus, Bovicolacaprae and Bovicolalimbatus. (Durden and Horak, 2004) described the lice species Linognathusweisseri n. sp. which was collected from South Africa. It is important to record the types of external parasites, in order to increase knowledge of the parasite biodiversity, and because external parasites can have a harmful effect on their hosts through the blood feeding behaviors that can sometimes lead to the transmission of diseases. In this research, we describe a species of Linognathus found in the Eastern Province of the Kingdom of Saudi Arabia, which was collected from the goats living in Al Ahsa region. The aim of the research is to conduct a descriptive study of the Linognathus species of lice that affects farm animals (goats) using the Scanning Electron Microscope, in order to add information about this parasite to the list on the morphologic description of this species in the Kingdom of Saudi Arabia.

2. Materials and Methods

This study was conducted to classify and describe a species of lice affecting farm animals in the Eastern Province of the Kingdom of Saudi Arabiain 2018. A sample of 20 lice were collected from local animals (goats, Capra hircus) from various farms in the Eastern Province (Al Ahsa) using a random sample, of which 4 females and 2 males were used in imaging using the Electron Microscope. The lice was collected from 12 goats, where lice can easily be seen with the naked eye when the hair is separated (Zumpt 1970) through cutting it in the infected animals, checking the areas of the neck, behind the ears, tail, back and thighs. This lice was collected using a forceps, it was exposed to 70% concentration alcohol and then kept in 70% concentration alcohol. Samples fixed on permanent slides were examined un-

der the dissecting microscope. They were manually collected using the force p sand then kept in a tube containing a preservative (Ethyl alcohol 70%). To prepare the samples for study under the microscope and prepare the permanent slides, eight samples of lice (8 males and 6 females) were selected and collected from the host, kept in 70% ethanol. These samples were passed through 10% potassium hydroxide, washed in distilled water and then dried in a series of increasing concentrations of ethanol. They were then purified in Xylol and affixed by Canada balsam successively. ***(Kim et al., 1986; Pritchard &Kruce, 1982)*** After preparing the permanent slides, they were examined under a dissection microscope with a camera to photograph the various parts of the sample. It was also sketched using the Camera-lucida program. After that, adult male and female lice were selected for processing with the Scanning Electron Microscope. (JEOL-JSM-5600LV-SEM) according to the method ***(TURNERet al., 2002).*** To identify the taxonomic status of the lice collected during the study, reference was made to taxonomic books, some taxonomic references and the species identification key: (Smith,1973 Blandand Jaques,1980; Borroret. al., 1989;Green & Baker 1996)

3. Results

The study clarified the goats of the genus *Capra hircus* infected by genus *Linognathusafricanus* (Kellogg and Paine, 1911) in the Eastern Province of the Kingdom of Saudi Arabia. The study recorded the species of lice and it was classified and described using optical and scanning electron microscope.

Linognathusafricanus (Kellogg and Paine, 1911).
edrOr: Anoplura (leach, 1815)
:ylimaF Linognathidae (Web, 1946)
:suneG*suhtangoniL* (Enderlein, 1905)
:seicepS*africanus* (Kellogg and Paine, 1911)

3.1 Classification Key *Linognathus* (Furman and Catts 1982) (DURDEN and MUSSER. 1994)

1) Equal head dimensions, sensory antennae approximately equal to the length of the head 2
2) Length of the head is roughly equal to double its width, sensory antennae may be equal in length to the head or slightlyshorter..... 3
3) The dorsal side of the thorax has four long filaments, equal in length to the head or slightly longer. About the width...L. setosus
4) The dorsal side of the thorax has two long filaments, also the length of the head is equal to its width...L. pedalis
5) The front of the head is slightly pointed, the female genital opening contains coetaneous hooks.....L. vituli
6) The front of the head is round, the female genital opening contains a slight edge (protrusiveon sheep and goats)..... 4
7) 4- The head widens behind the sensory antennae, also, the female genital opening is round.....L. africanus

The study recorded their presence in goats, hanging on the hair, especially on the sides of the body and the back, where their eggs are clearly in larger quantities close to the skin and the base of the hair. The body is pressed from top to bottom, and is divided into three areas, head, thorax and abdomen. The head is conical in shape and is smaller than the thorax, merging with it without clear separation between them. Themaleis1.39 mm in average with an average width of 0.64 mm, while the female is 19.9 mm long and 6.5 mm wide. As per the illustrative Figure. 8-9, optical microscope Figure 1 and Scanner Electron Microscope as in Figure 4.

3.2 Description

3.2.1 Head

The length of the head is more than its width, of a slightly elongated crest, with moniliform type sensory antennae, consisting of five segments, each containing three filaments distributed peripherally. The top of the last segment of the sensors ends with a group of fine bristles, reaching a total of five sensory bristles found in a cavity at the end of the segment. The last two segments also include sensory on the sides of the sensors as shown in illustrative diagram 10 and the optical and scanning electron microscopes Figure 5. The front of the head has five fine bristles on each side of the head before the sensory antennae. The mouth follicles protrude in the front of the head as per Figure 10, in the form of needles inside a retractable bag in the head. The head has two rows of bristles; each row has two bristles on the ventral side of the head. It also contains a group of bristles (5-7) surrounding the mouth opening, Figures 1, 5 and 6. This species is characterized with the presence of a protrusion on the sides of the head, which is considered as one of the most important features of this species, as in figure 1 when imaged under the optical and electron microscopes in Figure 5.

3.2.2 Thorax

The thorax consists of three segments: Prothorax, mesothorax and metathorax. However, these segments appear welded from the dorsal side as shown under the Scanning Electron Microscope Figure 5, as it is not possible to distinguish the segments of the thorax, appearing as a smooth surface on the dorsal side while the ventral side appears covered with square-shaped scales. A pair of spiracles are present on the dorsal side of the middle thorax, figure 3, with a pair of legs coming out of each thorax segment on the ventral side.

3.2.3 Legs

The thorax includes three pairs of legs, each pair coming out from a thorax segment on the ventral side. The first pair is curved to attach to the host and is smaller than the other two pairs of legs. The legs consist of five segments: Coxa, trochanter, femur, tibia, and tarsus, which consists of one part ending with the claws. A set of fine and short bristles are found on the legs, the coxa contains two bristles on the ventral side and two on the side; the trochanter has one bristle on the ventral side, with bristles spread with irregular density on the remaining segments on both the ventral and dorsal sides, as shown in the illustrative Figure 10 and under the optical and scanner electron microscopes, Figures. 2, 5 and 6.

3.2.4 Abdomen

The abdomen is large and wide, consisting of nine segments. It is covered with a set of square-shape scales (hexagonal shape) on both the ventral and dorsal sides that are

more pronounced on the ventral side. Each of the abdomen segments contain twolines of bristles on the ventral side, each line has eight fine and short bristles. The upper bristles are shorter than the lower bristles. The dorsal side also contains two lines of bristles, each with close to 16 bristles. The eighth segment contains only two bristles, with the abdomen containing to long pointy bristles on the sides of the abdomen segments (5-6-7-8). Also pairs of ventral spiracles appear on the abdomen, that are present on the segments from (3-8) on the ventral side. The spiracles are round in shape and slightly protrude from the body level, as in figure 7. The end of the male is round and the male organ is evident under the optical and electron microscopes, as in figure 7. The end of the female is split and contains two genital protrusions in the eighth ring surrounding the genital opening and covered by thick hair. The end of the body is covered by a set of fine bristles, arranged in two side lines covered by thick and short hair. While some long bristles extend as we move towards the front of the body, with the genitals appearing at the end of the body as per Figures 2, 7 and 8.

3.2.5 Eggs

Eggs are oblongtoelliptical in shape, and are found hanging on the bristles by one of their pointy ends far from the cover. Their outer shape is the same as the scales on the body of the adult insect, otherwise, the surface is smooth and does not include and spikes or protrusions. As in Figure 4

4. Discussion

Using the optical and Scanner Electron Microscopes, the study showed the shape of the head sack of the lice and the distribution of the head, thorax and abdomen bristles. It also showed the extent of differences in the shape of the sensory antennae and the hooks in the lice, showed their location and the shape of the ventral spiracles in lice and some of the scales that cover the surface of the lice's body, which conform with (Zakir and Iqbal, 2002), (Kim et. al., 1986), (Furman and Catts1982). The study also showed the shape of the thorax and abdomen spiracles, with more explanation of the features of the male and female genital openings for the species Linognathusafricanus. They conform with what was mentioned by each of (Sebei, et. al. 2004; Zakir and Iqbal,2002) .

The main aim of this research was to study the morphological characteristics by the Scanner Electron Microscope SEM, which can help identify or distinguish the types of lice present which infect goats in the Kingdom of Saudi Arabia. Microscopic images clarified the morphological characteristics of L. africanus and the details that are unclear under the optical microscope. This could help with the differences between the morphological characteristics shown in the microscopic images received from SEM and the illustrative diagrams in previous research, showing the difference in the descriptive power of the optical and electron microscopes (Green et al. 2001؛ Turner et al 2002). Accordingly, the Scanning Electron Microscope SEM gave a more accurate definition of the species. This method contributes to field epidemiological studies of the various species that cannot be accurately identified under the optical microscope. It also contributes to updating and identifying the morphological characteristics in case of a confusion using the optical microscope during the study of the various species of lice.

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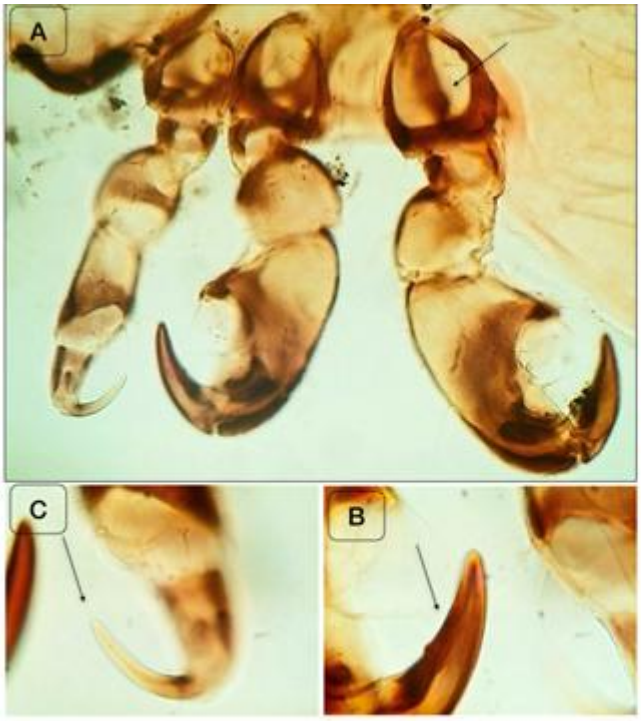

Figure 2: Genus *Linognathus africanus* by light microscope A-Fore-legs are smaller than the mid- and hind-legs. (coxa arrow) B-Claw of second and third legs. C-Claw First leg Enlarge and very thin than other legs.

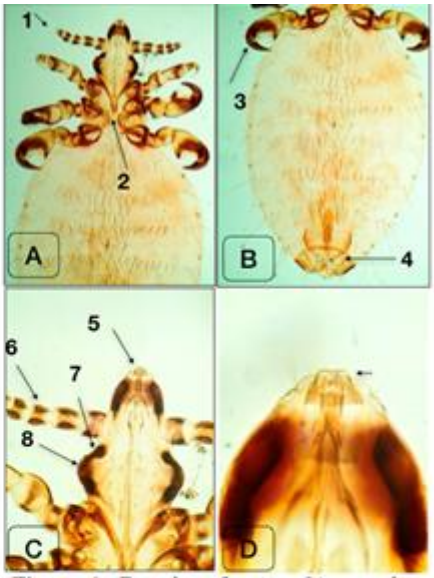

Figure 1: Female, of genus *Linognathus africanuca by light microscope* . A-general view of lice ventral view . B-Abdomen Ventral view C- Elongated head.D-mouth parts in enlarged .1-antenna .2-Sternal plate on ventral surface of thorax is narrow.3- claws 4-genitalia 5-head elongated .6- antenna 7-ocular point posterior to the antenna.8-Extend behind antenna

Figure 3: Famel, Genus *Linognathus africanus* by light microscope. A- Terminal abdomen enlarge and clarified genitalia B- Ventral view of the abdomen. C-D- spiracle of the abdomen.

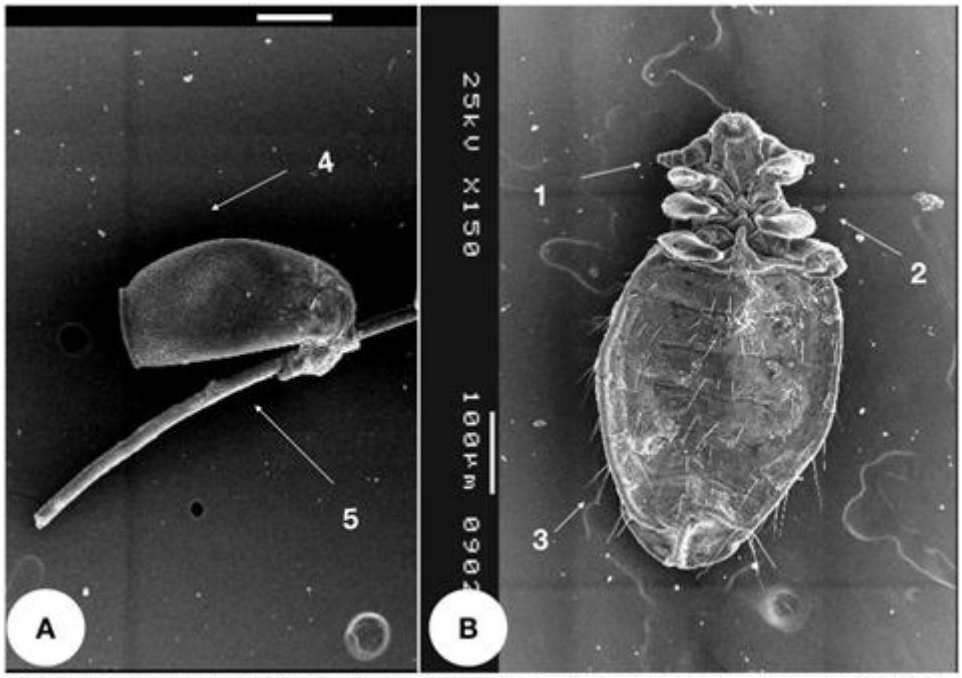

Figure 4: Genus *Linognathus africanuca*. By scanning electron microscope A- General view of the egg adhesion to the hair . B-General view of the lice 1-antenna 2- head 3- abdomen 4- egg 5-hair .

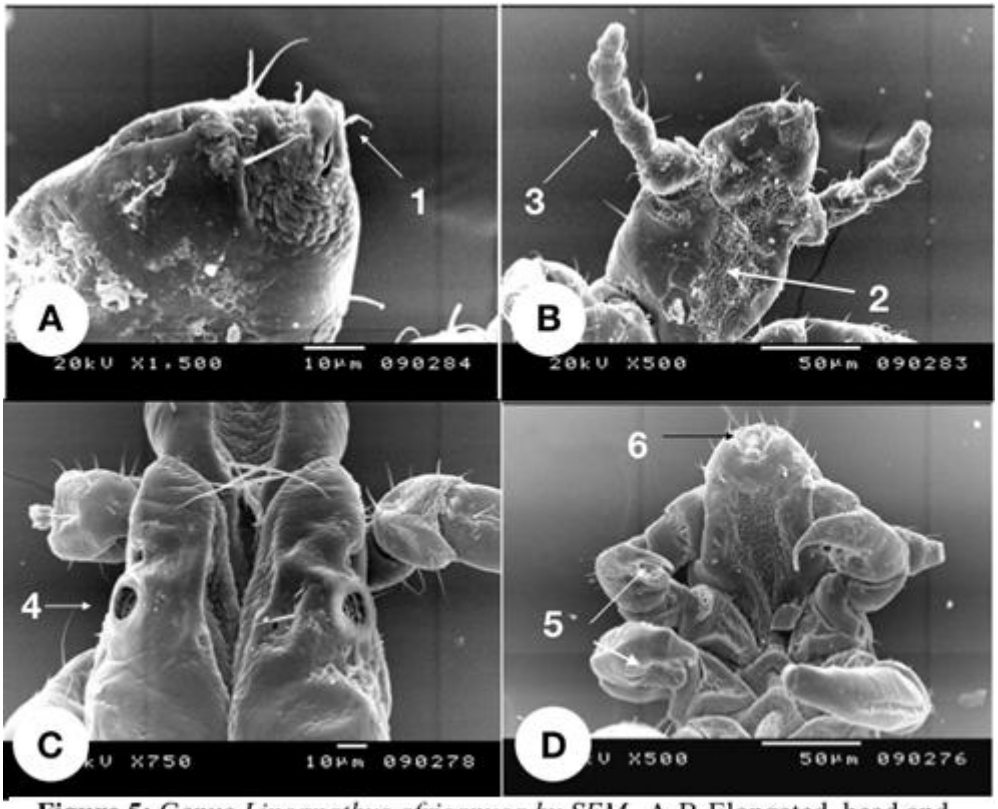

Figure 5: Genus *Linognathus africanuca by SEM* . A-B-Elongated head and mouthparts C-thoracic ventral view D- Ventral view of Head 1-6 mouth parts 2-head 3-antenna 4-spiracle. 5-Fore-legs are smaller than the mid- and hind-legs.

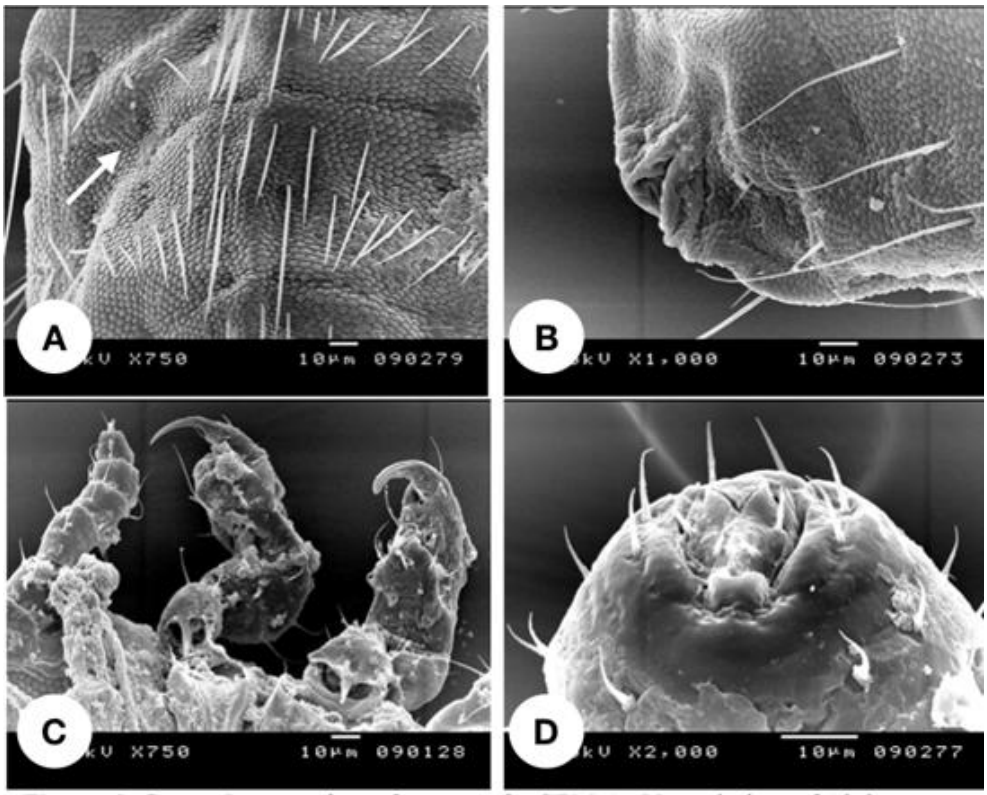

Figure 6: Genus *Linognathus africanuca by SEM*. A- Ventral view of Abdomen shows row of seta in segments B-enlarged genitalia C-claw on the fore-leg , mid and hind legs, D- terminal of head shows mouthparts.

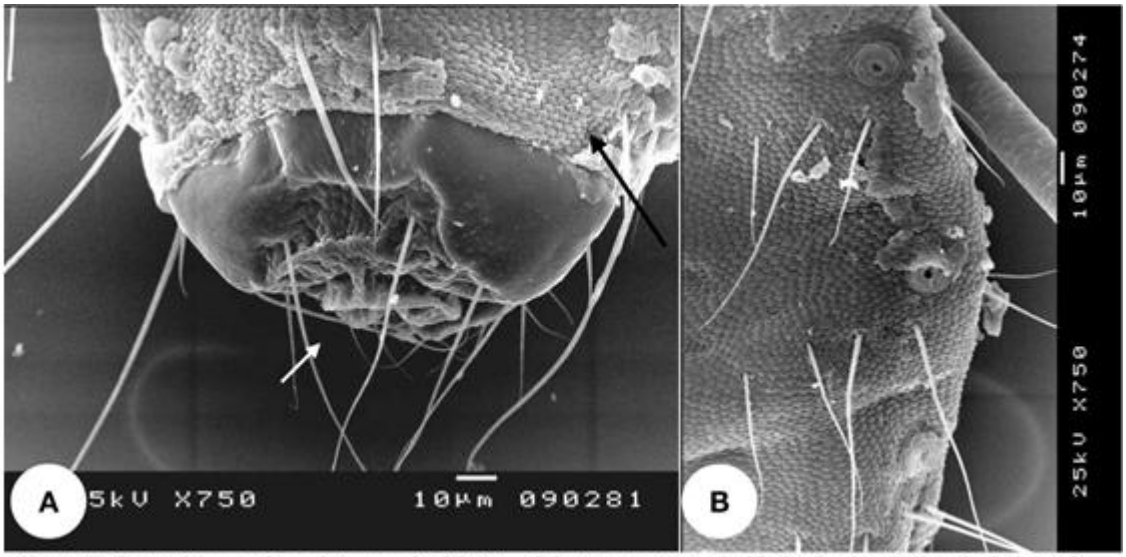

Figure 7: Genus *Linognathus africanuca by SEM*. A- abdomen segments clarified spiracles .B-Terminal view of abdomen in Male. clarified genitalia.

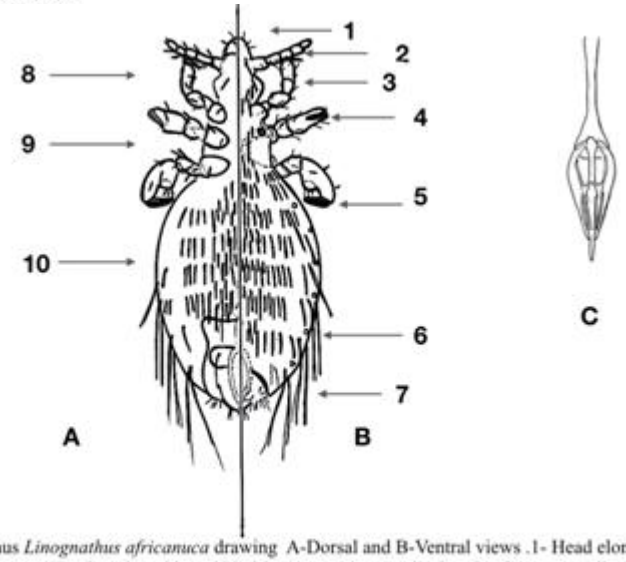

Figure 8: Male, of genus *Linognathus africanuca* drawing A-Dorsal and B-Ventral views .1- Head elongate. 2-antenna. 3- Fore-legs are smaller than the mid- and hind-legs. 4-5-claw on the fore-leg forms a smaller gripping mechanism than on the mid- and hind-legs. 6- Each segment of the abdomen bears two rows of setae.7- Abdomen is without is without paratergal plates. 8-head 9- thorax. 10-abdomen.

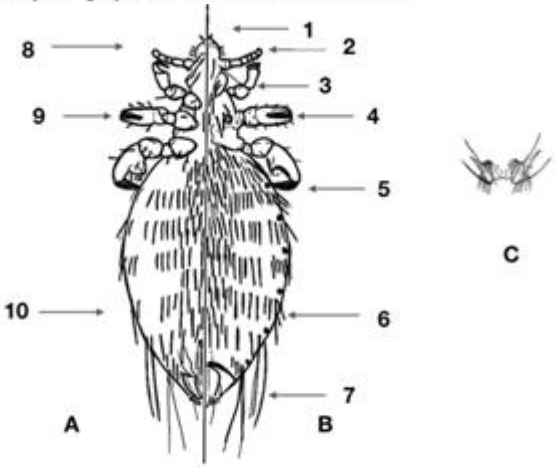

Figure 9: female, of genus *Linognathus africanuca drawing*. A-Ventral and B-Dorsal views c- genitala 1- Head is usually elongate. 2- antenna. 3- Fore-legs are smaller than the mid- and hind-legs; 4-5-claw on the fore-leg forms a smaller gripping mechanism than on the mid- and hind-legs. 6- Each segment of the abdomen bears two rows of setae.7- Abdomen is without paratergal plates. 8-head 9- thorax. 10-abdomen.

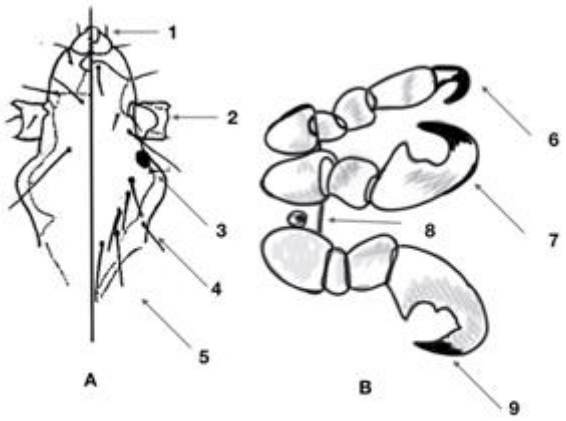

Figure 10: Genus Linognathus africanuca. A-Head and B-Legs . 1- mouth parts 2- antenna.3- simple eye . 4- Setae of head .5- Head elongate. 6-7-9-Fore-legs are smaller than the mid- and hind-legs.claw on the fore-leg forms a smaller gripping mechanism than on the mid- and hind-legs.8- spiracle.