Immature Insects 1987
ed. Fredericki W. Stehr.
Kendal/Hunt Publishing Company
Dubuque, Iowa

Order Anoplura[1] 23

Ke Chung Kim
Pennsylvania State University

SUCKING LICE

The sucking lice are obligatory, wingless, hemimetabolous permanent ectoparasites of eutherian mammals. They have adapted successfully to the microenvironment of the host body surface, the fur environment, and coevolved with the mammalian hosts. Accordingly, the sucking lice are relatively host specific; often a species of Anoplura is restricted to a single host species. They spend their entire life on the individual host, and they have developed many unique adaptive traits for an ectoparasitic mode of life through a long association with mammals. Their body is dorsoventrally flattened and the head is equipped with a protrusible proboscis and sucking mouthparts. They are exclusively blood suckers. Naturally, sucking lice are closely associated with transmission of certain mammalian diseases. *Pediculus humanus* L. is a well-known vector of epidemic relapsing fever caused by ***Borrelia recurrentis*** and the sole agent in the transmission among people of typhus fever caused by *Rickettsia prowazeki*.

The immature stages of the sucking lice are poorly known. Ferris (1951) illustrated several, but until 1959 there was no serious effort to study them. For the first time, Cook and Beer (1959) made an attempt to systematically study *Hoplopleura* larvae in North America. Following Cook and Beer's pioneering work, the larvae of numerous taxa have been studied by Kim (1965, 1966a, b, c, 1968, 1971, 1975), yet our present knowledge is scanty. A systematic treatment is for the first time presented here. The study of larvae is important in biological and ecological research, useful in recognizing sibling species, and provides additional information on anopluran phylogeny.

The present state of the knowledge of the Anoplura larvae does not warrant a serious attempt to generalize structural patterns of different stages in depth and to describe them for every higher taxon. Furthermore, the third stage larvae are considerably different from the first stages, which makes a general description rather difficult and superfluous at best.

DIAGNOSIS

Body dorsoventrally flattened with a prognathous head and segmented abdomen. Head conical with peculiar piercing-sucking mouthparts in a small snout-like proboscis. Thorax relatively small and completely fused, usually with a pair of mesothoracic spiracles. Legs strongly developed with delicate modifications of tibia and tarsus, and the tarsus one-segmented with a strong claw.

Larvae are generally similar to adults in major morphological characters, but they are usually not heavily sclerotized, and they go through some definite changes in three larval stages. These changes are principally associated with the growth of body dimensions, body proportion, development of the thoracic sternites and paratergites, a progressive change of chaetotaxy, and occasionally antennal segmentation. The three stages are easily recognized when a series of specimens is available. In any long series of specimens at least a few are at the point of moulting. At this time, the succeeding instar is usually visible within the skin of the preceding stage.

BIOLOGY AND ECOLOGY

Information on biology of the sucking lice is limited to a handful of species, such as *Pediculus humanus* L. (Buxton 1946), *Haematopinus suis* (L.) (Florence 1921), and *H. eurysternus* Denny (Matthysse 1944, 1946). Murray and his colleagues worked on population biology of the sucking lice on seals (Murray 1958; Murray and Nicholls 1965; Murray, Smith and Soucek 1965), on mice and sheep (Murray 1960, 1961, 1963a, b). Kim (1971, 1972, 1975) published on population ecology of *Antarctophthirus callorhini* (Osborn) and *Proechinophthirus fluctus* (Ferris) on northern fur seals. Factors influencing the distribution of the sucking lice on the host animal were studied by Murray (1960, 1961, 1963a, b) and by Jensen and Roberts (1966).

DESCRIPTION

Immatures are naturally smaller than adults, with a relatively small abdomen. All are quite similar to adults in head shape, eyes, ocular points, thoracic dorsum, legs, and basic chaetotaxy.

Body dorsoventrally flattened with prognathous head and oval abdomen.

Head generally conical with definite proboscis in which are located peculiar piercing-sucking mouthparts. No tentorium. Antennae short, filiform, usually five-segmented, occasionally reduced to three or fourth segments. Fourth and fifth segments each bearing a tuft organ and often additional pore and peg organs. No ocelli present. Compound eyes usually reduced or absent.

Thorax narrower than abdomen, with a pair of mesothoracic spiracles. Thoracic dorsum mostly composed of subcoxal or pleural components. Venter generally membranous but occasionally with a median sternal plate in second and third stages. Legs strongly developed, with a modification of the tibia and tarsus for effective holdfast. Tarsus one-segmented, with a strong claw.

Abdomen of ten segments, of which only nine are easily identified, with terga and sterna usually not sclerotized. Paratergites often developed in the second and third stages. Abdomen normally bearing six pairs of spiracles on lateral part of segments 3–8. In the first instar abdominal spiracles often indistinct. Sexual determination can often be made in the third and rarely in the second stage.

1. Authorized for publication as paper no. 5713 in the journal series of the Pennsylvania Agricultural Experiment Station.

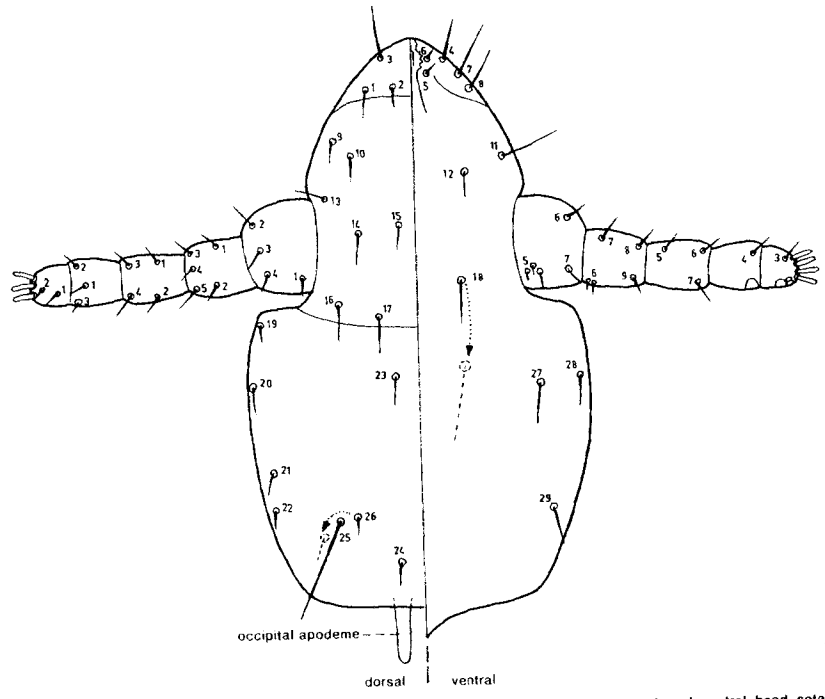


Figure 23.1. Standardized chaetotaxy of Anoplura (generalized), setae on head, thorax, and abdomen are continuously numbered dorsally and ventrally. **HEAD:** Setae on each antennal segment are separately numbered without specific positional designation; 1,2: dorsal anterior head setae (DAnHS); 3,4: apical head setae (ApHS); 5,6: oral setae (OrS); 7,8: anterior marginal head setae (AnMHS); 9,10: dorsal preantennal lateral head setae (DPaLHS); 11,12: ventral preantennal head setae (VPaHS); 13: dorsal preantennal head setae (DPaHS); 14: supraantennal head setae (SpAtHS); 15: supraantennal central head setae (SpAtCHS); 16,17: sutural head setae (SuHS); 18: ventral principal head seta (VPHS); 19, 20, 21, 22: dorsal marginal head setae (DMHS); 23: dorsal anterior central head setae (DAnCHS); 24: dorsal posterior central head setae (DPoCHS); 25: dorsal principal head setae (DPHS); 26: dorsal accessory head setae (DAcHS); 27: ventral lateral head setae (VLHS); 28: ventral anterior marginal head setae (VAnMHS); 29: ventral posterior marginal head setae (VPoMHS) (after Kim and Ludwig 1978).

Morphology and Chaetotaxy

The head is of a generalized type usually found in adults (fig. 23.1) but shows several unique characters in some taxa. Larvae of *Hoplopleura* and *Pterophthirus* have small unpigmented tubercles on the ventral side of the head, antennae, and even on the coxae (figs. 23.18, 23.38, 23.40, 23.41), whereas those of *Proechinophthirus* have numerous heavily sclerotized spiniform setae on the head (figs. 23.10, 23.21 23.23). The number of antennal segments is usually five as in the adults except for *Latagophthirus rauschi* Kim and Emerson, which has three segmented antennae in all stages. In some taxa, however, larvae have fewer segments than the adults. Larvae of *Antarctophthirus callorhini* (Osborn) have four-segmented antennae, whereas the adults have five.

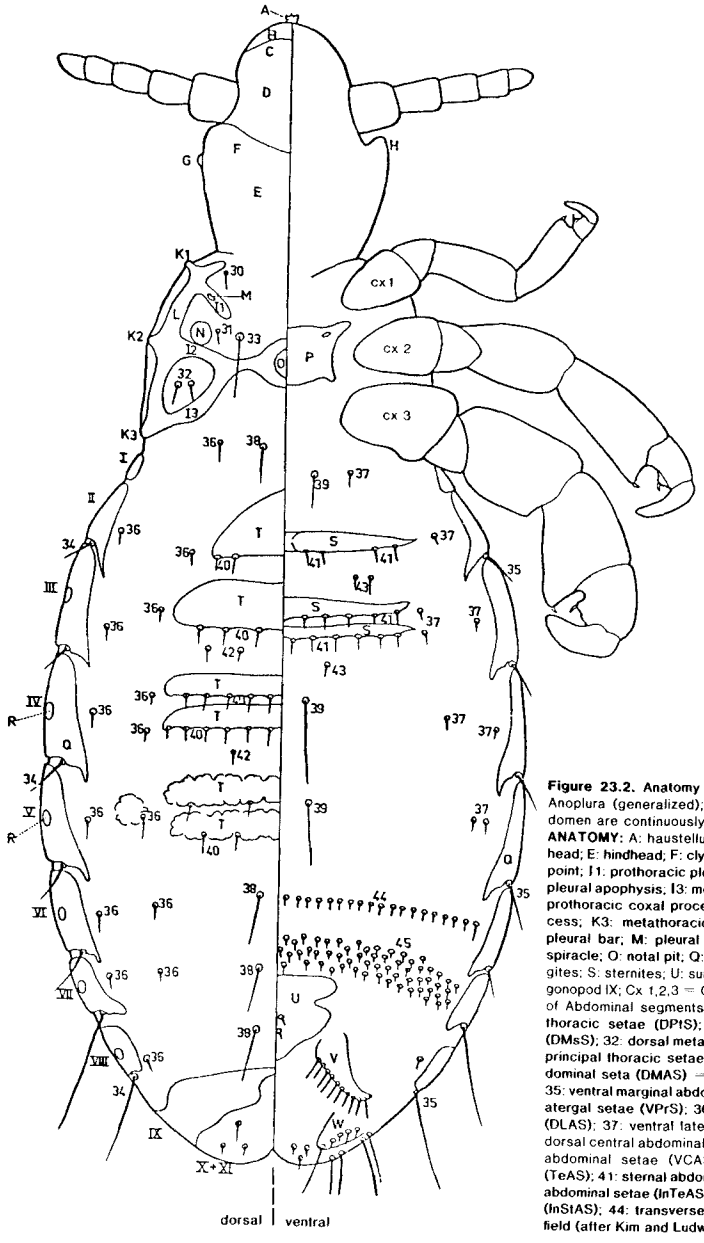


Figure 23.2. Anatomy and standardized chaetotaxy of Anoplura (generalized); setae on head, thorax, and abdomen are continuously numbered dorsally and ventrally. **ANATOMY:** A: haustellum; B: labrum; C: clypeus; D: forehead; E: hindhead; F: clypeofrontal suture; G: eye; H: ocular point; I1: prothoracic pleural apophysis; I2: mesothoracic pleural apophysis; I3: metathoracic pleural apophysis; K1: prothoracic coxal process; K2: mesothoracic coxal process; K3: metathoracic coxal process; L: longitudinal pleural bar; M: pleural apophysial pit; N: mesothoracic spiracle; O: notal pit; Q: paratergites; R: spiracles; T: tergites; S: sternites; U: subgenital plate; V: gonopod VIII; W: gonopod IX; Cx 1,2,3 = Coxae 1,2,3; I – X + XI – Number of Abdominal segments. **CHAETOTAXY:** 30: dorsal prothoracic setae (DPtS); 31: dorsal mesothoracic setae (DMsS); 32: dorsal metathoracic setae (DMtS); 33: dorsal principal thoracic setae (DPTS); 34: dorsal marginal abdominal seta (DMAS) = dorsal paratergal setae (DPrS); 35: ventral marginal abdominal seta (VMAS) = ventral paratergal setae (VPrS); 36: dorsal lateral abdominal setae (DLAS); 37: ventral lateral abdominal setae (VLAS); 38: dorsal central abdominal setae (DCAS); 39: ventral central abdominal setae (VCAS); 40: tergal abdominal setae (TeAS); 41: sternal abdominal setae (StAS); 42: intertergal abdominal setae (InTeAS); 43: intersternal abdominal setae (InStAS); 44: transverse setae row; 45: transverse setal field (after Kim and Ludwig 1978).

Thoracic sternal plate usually undeveloped in the larvae and always lacking in the first stage. In some taxa, the sternal plate is already developed in the second stage; for example, *Enderleinellus* (figs. 23.30, 23.31).

The abdomen is proportionally small and usually composed of ten segments of which the last segment may not be distinct (fig. 23.2). Each segment can be identified by the position of spiracles and setal rows. In *Hoplopleura onycomydis* Cook and Beer and *H. oenomydis* Ferris, the abdominal segmentation is evident in the first stage (figs. 23.39a, b). The spiracles are usually evident in the second and third stages but are occasionally seen in the first stage, as in *Hoplopleura arboricola* Kellogg and Ferris and *H. sciuricola* Ferris. The spiracles are often associated with paratergites, which usually become sclerotized in the second stage, yet are distinctly visible in all stages of some species as in *Haematopinus quadripertusus* Fahrenholz and *H. eurysternus* Denny (figs. 23.34–23.37).

The primary pattern of chaetotaxy on the head, antennae (fig. 23.1), thorax, and legs is already developed in the first stage and does not change throughout postembryonic development. New setae are added to the primary chaetotaxy or each seta becomes longer and larger as it goes through successive stages to the adult. No setae of the primary chaetotaxy are lost during metamorphosis, although some setae in the larval instars are replaced by other types or become greatly reduced in subsequent instars. The most striking difference between larvae and adults is in the abdominal chaetotaxy. In more generalized taxa, such as *Haematopinus* and *Solenopotes*, the adult chaetotaxy is already mostly developed in the second stage (figs. 23.35, 23.49). In specialized taxa, exemplified by *Hoplopleura* and *Polyplax*, larvae lack the extensive chaetotaxy of the adult (figs. 23.38–23.43, 23.57–23.59). In many species larvae I and II simply have one or two rows of central abdominal setae (CAS) for each side (dorsal and ventral) and one to three marginal abdominal setae (MAS) on abdominal segments 7 and 8, and sometimes on segment 9 (fig. 23.2).

EXPLANATION OF CHAETOTAXAL TERMS

Position	*Structure*
Ac—accessory	A—abdominal
An—anterior	At—antennal
Ap—apical	G—genital
C—central	H—head
D—dorsal	Ms—mesothoracic
I—inner	Mt—metathoracic
If—infra	Oc—occipital
Im—intermedian	Or—oral
In—inter	Pa—preantennal
M—marginal	Pr—paratergal
Md—median	Pt—prothoracic
L—lateral	S—setae
O—outer	St—sternal
P—principal	Su—sutural
Po—posterior	T—thoracic
Sp—supra	Te—tergal
V—ventral	

Examples:

DAnHS = dorsal anterior head setae
VLAS = ventral lateral abdominal setae
SpAtHS = supraantennal head setae

COMMENTS

Sucking lice are widely distributed throughout the world (Hopkins 1949; Ludwig 1968) wherever host animals exist. The anopluran fauna is especially rich in the Ethiopean region. Ludwig (1968) recorded 34.4 percent of the total, or 135 species, from the Ethiopean region, 18.3 percent from the Palaearctic, 13.3 percent from the Oriental, 10.2 percent from the Nearctic, and 11.0 percent from the Neotropical. Currently, 76 species of sucking lice (9 families, 19 genera) are known from North America (Kim et al. 1986).

The diversity of the Anoplura is not fully known as yet. At present there are 486 species known from approximately 840 species (241 genera) of mammals (Kim and Ludwig 1978). They are parasitic on diverse groups of mammals but are apparently absent in several major mammalian taxa; Monotremata, Marsupialia, Edentata, Pholidota, Chiroptera, Cetacea, Proboscida, Sirenia, and most terrestrial Carnivora (Kim 1985).

The suprageneric classification of Anoplura by Kim and Ludwig (1978), which is adopted here, contains 15 families and 42 genera.

COLLECTION AND PRESERVATION TECHNIQUES

Sucking lice are small and often difficult to find on the host animals. Most immature lice are very small and usually escape visual examination of the host skin, unless special care is taken. When sucking lice are found on freshly killed animals, all specimens should be preserved in 75–80 percent ethyl alcohol. They can be collected from museum skins by combing; these specimens should be relaxed in Barber's before preservation in alcohol (but the benzene in Barber's is a known carcinogen, so use proper precautions or another relaxing technique).

To collect all stages, the host animal may be trapped in the field and skinned. Each skin or hide is placed in a separate plastic bag in order to prevent contamination and kept frozen for future study. To extract lice, the entire skin or a small piece of a large hide is placed in a beaker with 1 percent trypsin (certified 1:250) buffered to pH 8.3 ± with sodium diphosphate and kept at ambient temperature for 10 to 24 hours. After the initial digestion period, an equal amount of 10 percent KOH solution is added to the beaker containing the digested skin. This mixture is then boiled for several minutes or until hairs and tissues are completely dissolved. The cleared specimens are then strained out of the resulting solution through an 80-mesh screen. This process recovers the entire louse population including eggs (Cook and Beer 1959; Kim 1972). The concentration of KOH and the length of the digestion period may vary with the size and thickness of skin and the amount of blubber or fat material.

To study lice, specimens must be slide mounted. Clear specimens by placing them in a small dish containing 10% KOH for about 10 hours. To speed up this process warm the beaker on a hot plate for a few minutes (if specimens are collected by the digestion process, they need not be cleared this way). After clearing, wash specimens thoroughly in distilled water and dehydrate them by going through a 30–50–75–95% to absolute ethyl alcohol series. Leave specimens in each solution 5 minutes or more before transferring to creosote, where they can remain until mounted. Center the specimen on a microscope slide, ventral side up, one specimen per slide. Place a small drop of Canada balsam on the specimen, add the cover glass, and press gently to spread the legs and antennae properly. Slides should be completely dry before permanent labels are attached, with collection label on the right and identification label on the left.

CLASSIFICATION OF NORTH AMERICAN FAMILIES

Order **ANOPLURA**
- Echinophthiriidae, the echinophthiriids
- Haematopinidae, wrinkled sucking lice
- Enderleinellidae, the enderleinellids
- Hoplopleuridae, the hoplopleurids
- Linognathidae, smooth sucking lice
- Pecaroecidae, the pecaroecids
- Pediculidae, human lice
- Polyplacidae, the polyplacids
- Pthiridae, crab lice

HOST LIST OF NORTH AMERICAN ANOPLURA

Order **Insectivora,** insectivores
- Family Talpidae, moles ..... *Haematopinoides*

Order **Lagomorpha,** lagomorphs
- Family Leporidae, hares and rabbits ..... *Haemodipsus*

Order **Rodentia,** rodents
- Family Sciuridae, squirrels ..... *Enderleinellus*, *Microphthirus*, *Linognathoides*, *Neohaematopinus*, *Hoplopleura*
- Family Heteromyidae, heteromyids ..... *Fahrenholzia*
- Family Cricetidae, New World rats and mice ..... *Hoplopleura*, *Neohaematopinus*, *Polyplax*
- Family Muridae, Old World rats and mice ..... *Hoplopleura*, *Polyplax*

Order **Carnivora,** carnivores
- Family Canidae, canids ..... *Linognathus*
- Family Mustelidae, mustelids ..... *Latagophthirus*

Order **Pinnipedia,** pinnipeds
- Family Otariidae, eared seals ..... *Antarctophthirus*, *Proechinophthirus*
- Family Odobenidae, walrus ..... *Antarctophthirus*
- Family Phocidae, haired seals ..... *Antarctophthirus*, *Echinophthirus*

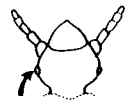
Order **Artiodactyla,** even-toed ungulates
- Family Tayassuidae, peccaries ..... *Pecaroecus*
- Family Cervidae, cervids ..... *Solenopotes*
- Family Bovidae, bovids ..... *Linognathus*, *Haematopinus*
- Family Suidae, pigs ..... *Haematopinus*

Order **Perissodactyla,** odd-toed ungulates
- Family Equidae, horses ..... *Haematopinus*

Order **Primates,** primates
- Family Hominidae, humans ..... *Pediculus*, *Pthirus*

KEY TO THE FAMILIES OF NORTH AMERICAN IMMATURE ANOPLURA

1. Head with distinct eyes (fig. 23.3) or subacute ocular points (fig. 23.4) on lateral margins posterior to antennae 2
1′. Head without external eyes or prominent ocular points (fig. 23.5) 5
2(1). Head with prominent ocular points but without eyes (fig. 23.4); on bovids, pigs and horses ..... ***Haematopinidae*** (p. 233)
2′. Head with eyes having a distinct lens but without ocular points (fig. 23.3); on other hosts 3
3(2′). Head long and slender, much longer than thorax (fig. 23.6); large louse with narrowly elliptical abdomen; on peccaries ..... ***Pecaroecidae*** (p. 238)
3′. Head about as long as thorax (figs. 23.7, 23.8); small lice with oval or elliptical abdomen; on humans 4
4(3′). Compact, with body less than 2× as long as wide (fig. 23.7); thorax very wide; fore legs slender, mid and hind legs very stout, each with stout claw; on humans ..... ***Pthiridae*** (p. 241)
4′. Slender, with body more than 2× as long as wide (fig. 23.8); abdomen long, wider than thorax; all legs slender, each with an acuminate claw; on humans ..... ***Pediculidae*** (p. 239)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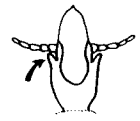
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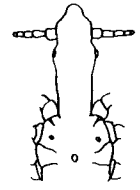
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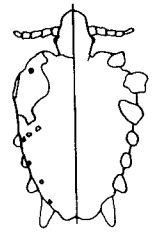
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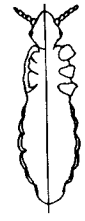
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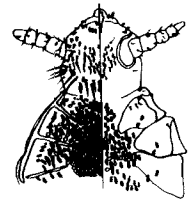
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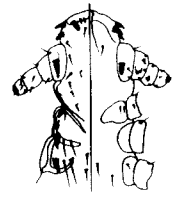
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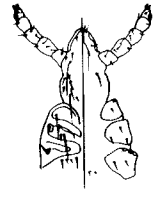
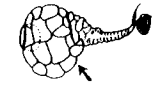


Figure 23.11


Figure 23.11a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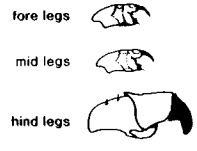

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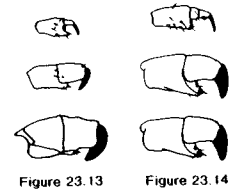
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Figure 23.14


Figure 23.15

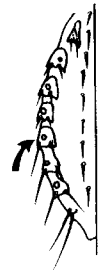
Figure 23.16


Figure 23.17

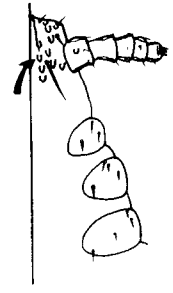
Figure 23.18


Figure 23.19

5(1'). Head and thorax thickly covered with various setae (fig. 23.9) or with strong spiniform setae (fig. 23.10); spiracular atrium tubular (fig. 23.11a); on seals, sea lions, walrus, and river otter ..... ***Echinophthiriidae*** (p. 230)

5'. Head and thorax with only a few setae (fig. 23.11); spiracular atrium bulbous (fig. 23.11b); on terrestrial mammals 6

6(5'). Fore legs subequal to mid legs in size and shape, both more slender and smaller than hind legs, each with acuminate claw (fig. 23.12); on squirrels ..... ***Enderleinellidae*** (p. 233)

6'. Fore legs smallest of the 3 pairs (fig. 23.13, 23.14); mid legs usually subequal to hind legs in size and shape or at least somewhat larger than fore legs, each with larger and stouter claws 7

7(6'). Abdomen without any evidence of paratergites in all stages (fig. 23.15); first instar with 4 rows[2] of VCAS (ventral central abdominal setae) (figs. 23.44, 23.48); on even-toed ungulates and canids ..... ***Linognathidae*** (p. 237)

7'. Abdomen usually with paratergites in second or third larval stage (fig. 23.16); first instar with no, or at most, 2 rows[2] of VCAS (fig. 23.17); on small mammals 8

8(7'). Hind legs largest of three pairs, stout, each with a stout, blunt claw (fig. 23.13); small unpigmented tubercles densely distributed on ventral surface of head, first antennal segment and coxae (fig. 23.18); parasitic on rodents (**Hoplopleurinae**), or if absent, abdomen with 4 rows[2] of CAS (central abdominal setae) in third stage (fig. 23.43), parasitic on moles (**Haematopinoidinae**) ..... ***Hoplopleuridae*** (p. 233)

8'. Hind legs usually subequal to mid legs in shape and size (fig. 23.14); head, basal antennal segment and coxae usually without such tubercles (fig. 23.19); all instars usually with more than 4 rows of CAS; on rodents ..... ***Polyplacidae*** (p. 241)

2. The figures show only half the rows since the left half of each figure is a dorsal and the right half is a ventral view.

ECHINOPHTHIRIIDAE

The Echinophthiriids

Figures 23.20–23.27

Relationships and Diagnosis: The echinophthiriids are rather unique lice, exclusively parasitic upon aquatic carnivores, namely Pinnipedia and aquatic Mustelidae. They are somewhat related to the Haematopinidae. All the echinophthiriids are easily recognized by the presence of unique spiracles with a tubular atrium (Key fig. 23.11a) and variously shaped setae on the head and thorax; tuberculiform and setaceous setae of various sizes (*Antarctophthirus, Echinophthirus,* and *Latagophthirus,*) or strong spiniform setae (*Proechinophthirus*).

Biology and Ecology: All instars inhabit the fur and skin of the host and feed on blood. All larvae tend to aggregate on particular areas. *Antarctophthirus* seems to prefer the areas of the body surface devoid of dense fur, such as the base of the flipper, eyelids, and the area surrounding the genital opening, but *Proechinophthirus* inhabits the area of dense fur (Kim 1972, 1975).

Eggs are usually oblong with a number of small knoblike tubercules (5–15) on the operculum (figs. 23.20, 23.24). The first instar does not have scales on the abdomen and ventral surface of the thorax.

Description: Body size variable. The third-stage larvae 1.5–2.7 mm in length. Body usually covered with setae of various shapes and sizes. Primary setae distinct in the first stage. *Head* usually about as wide as long or much longer than wide (*Proechinophthirus*); anterior margin rounded; postantennal angles usually developed; antennae usually four-segmented, five-segmented (many *Antarctophthirus*) or rarely three-segmented (*Latagophthirus*). *Thorax* with phragmata well developed; mesothoracic spiracles small, with specialized closing apparatus; no sternal plate. *Abdomen* oval, with six small spiracles, each with specialized closing apparatus; no tergal, sternal, or paratergal sclerites developed; with numerous spiniform setae, scales and regular setae in *Antarctophthirus* (figs. 23.25, 23.26) and *Latagophthirus;* or with numerous spiniform and regular setae in *Echinophthirus* and *Proechinophthirus* (figs. 23.21–23.23) and in the first instars of *Antarctophthirus* (fig. 23.25).

Comments: Five genera are presently recognized; *Proechinophthirus, Echinophthirius, Lepidophthirus,* and *Antarctophthirus* on Pinnipedia, and *Latagophthirus* on river otter (Mustelidae, Carnivora). All genera except *Lepidophthirus* occur in North America.

Selected Bibliography

Ferris 1951.
Kim 1971, 1972, 1975.
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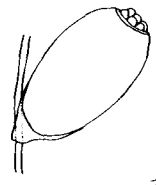

Figure 23.20

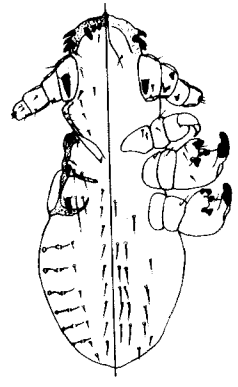

Figure 23.21

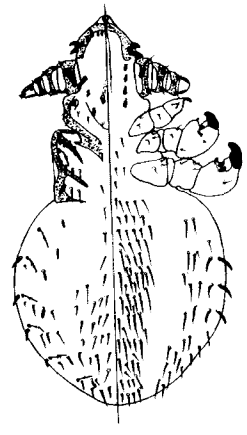

Figure 23.22

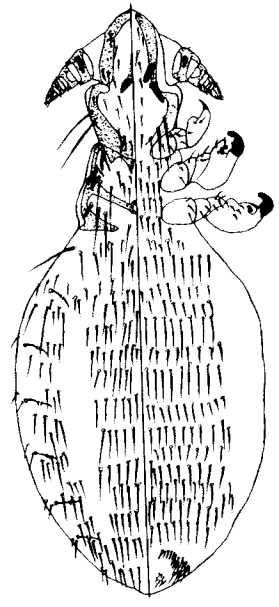

Figure 23.23

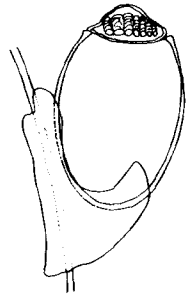

Figure 23.24

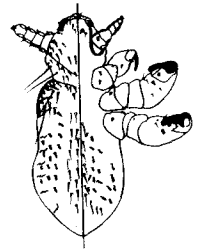

Figure 23.25

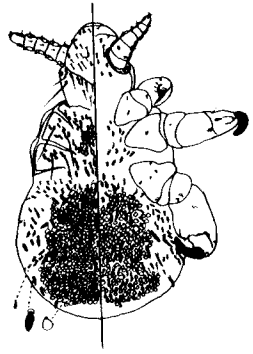

Figure 23.26

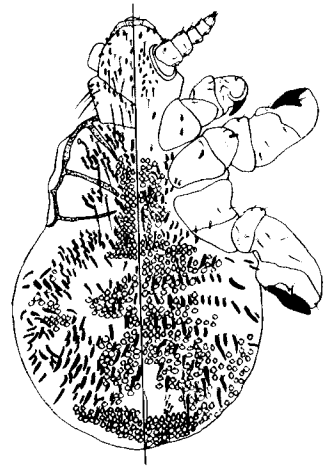

Figure 23.27

Figures 23.20–23.23. Echinophthiriidae. *Proechinophthirus fluctus* (Ferris); **(23.20)** egg; **(23.21)** larva I; **(23.22)** larva II; **(23.23)** larva III.

Figures 23.24–23.27. Echinophthiriidae. *Antarctophthirus microchir* (Trouessart and Neumann); **(23.24)** egg; **(23.25)** larva I; **(23.26)** larva II; **(23.27)** larva III.

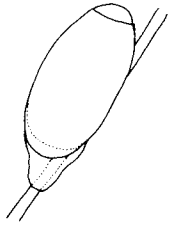

Figure 23.28

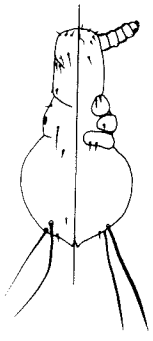

Figure 23.29

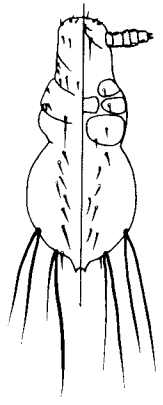

Figure 23.30

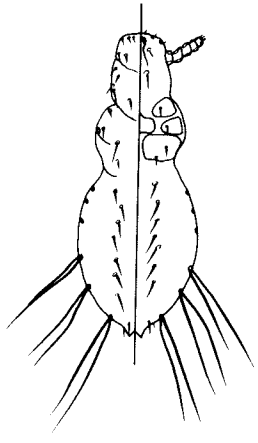

Figure 23.31

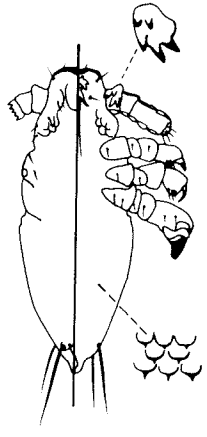

Figure 23.32

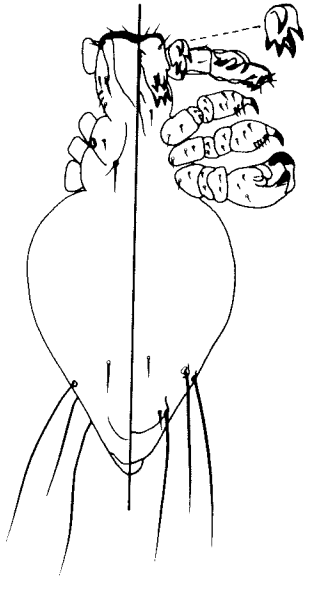

Figure 23.33

Figures 23.28–23.31. Enderleinellidae. *Enderleinellus*; **(23.28)** egg of *E. osborni* Kellogg and Ferris; **(23.29–23.31)** *E. longiceps* Kellogg and Ferris, legs removed; **(23.29)** larva I; **(23.30)** larva II; **(23.31)** larva III.

Figures 23.32–23.33. Enderleinellidae. *Microphthirus uncinatus* (Ferris); **(23.32)** larva I; **(23.33)** larva III.

ENDERLEINELLIDAE

The Enderleinellids

Figures 23.28–23.33

Relationships and Diagnosis: Very small lice, related to the hoplopleurids, but easily distinguished from other lice by having the fore legs subequal to the mid legs in size and shape, both small and slender. DPHS are very small but VPHS are distinct and large in all larval stages.

Biology and Ecology: The enderleinellids are exclusively parasitic on squirrels (Sciuridae).

Description: Third stage larvae about 0.5 mm in length. *Head* with anterior margin rounded or truncated; antennae five-segmented; clypeofrontal suture distinct; DPHS very small but VPHS distinct and long. *Thorax* with comparatively large DPTS; thoracic sternal plate generally absent. *Abdomen* with two central rows of DCAS and VCAS and three visible pairs of spiracles in larva III.

Differences between species and between the early stages are striking in abdominal morphology (figs. 23.29–23.31). The first stage has only two pairs of MAS. The second stage has four pairs of MAS and five to seven or more pairs of DCAS and VCAS, and usually three or more paratergites on each side. The third stage has six pairs of MAS and numerous LAS in addition to CAS. On the anterior half of the abdomen there are four or more paratergal plates on each side. In *E. longiceps* Kellogg and Ferris there is no evidence of paratergites but the thoracic sternal plate is developed in the second and third stages (figs. 23.30, 23.31).

Comments: Five genera are presently recognized: *Enderleinellus* (43 species), *Werneckia* (3 species), *Microphthirus* (1 species), *Phthirunculus* (1 species), and *Atopophthirus* (1 species) (Kim and Ludwig 1978). *Enderleinellus* (figs. 23.28–23.31) and *Microphthirus* (figs. 23.32, 23.33) occur in North America.

Selected Bibliography

Ferris 1951.
Kim 1966a, 1966b, 1977.
Kuhn and Ludwig 1965.

HAEMATOPINIDAE

Haematopinids, Wrinkled Sucking Lice

Figures 23.34–23.37

Relationships and Diagnosis: The haematopinids are among the most devastating ectoparasites of domesticated animals. They are easily distinguished from other lice by their large size, the presence of prominent ocular points posterior to the antennae, all legs subequal in size and shape, and abdominal cuticula leathery and minutely wrinkled.

Biology and Ecology: The life cycle takes three to five weeks from eggs to eggs. The incubation period for eggs takes 10–17 days and each stage requires three to seven days before moulting (Matthysse 1946). However, the total period for the life cycle varies by season and host species.

Each species prefers specific parts of the host body by season. During August and September *Haematopinus eurysternus* Denny is found in the ears near the tips but the main area of infestation is the top of the neck in the winter in New York state (Matthysse 1946). *H. suis* L. frequents the folds of skin on the neck and the jowl, the inside and the base of the ears, the inside of the legs, flanks, and, in smaller numbers, the back (Florence 1921). This distribution pattern may be altered by seasonal temperature changes.

H. suis feeds readily on humans and other hosts and thus is well adapted for experimental work. Hosts of *Haematopinus* are Suidae, some Bovidae, Cervidae (Artiodactyla), and Equidae (Perissodactyla).

Description: Third instars 2–2.8 mm long. *Head* with distinct ocular points; antennae five-segmented; primary chaetotaxy distinct. *Thorax* much wider than head, heavily pigmented, with distinct notal pit and large mesothoracic spiracles; no evidence of sternal plate. All legs subequal in size and shape, each leg with strong acuminate claw. *Abdomen* membranous, leathery and wrinkled, with distinct paratergites and spiracles on segments 3–8; with numerous sclerotic plates; with 9 DCAS, 2–6 DInAS, 3–7 VMdAS on segments 1–7, 1–3 VLAS on each side (fig. 23.37).

Larva II (fig. 23.35) is very similar to larva III in general appearance, but smaller. Larva I (fig. 23.34) is naturally smaller, with a reduction in chaetotaxy and fusion of sclerotic plates, and with no mesothoracic seta.

Comments: This monotypic family, with 22 known species, is widely distributed throughout the world. *Haematopinus eurysternus* Denny, *H. quadripetusus* Fahrenholz, and *H. tuberculatus* (Burmeister) are important cattle lice (Meleney and Kim 1974). *H. suis* and *H. apri* Goureau are lice of swine; *H. asini* (L.) is an important parasite of horses.

Selected Bibliography

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Florence 1921.
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HOPLOPLEURIDAE

The Hoplopleurids

Figures 23.38–23.43

Relationships and Diagnosis: The hoplopleurids are specialized lice somewhat similar to Linognathidae and Polyplacidae. Larvae of Hoplopleuridae can be distinguished from the linognathids and the polyplacids by having the hind legs stout and usually larger than the mid and fore legs, and each leg with a stout and blunt claw. Larvae of the subfamily Hoplopleurinae have numerous tubercles on the ventral side of the head and antennae, whereas the Haematopinoidinae larvae lack ventral tubercles on the head and usually have distinct paratergites.

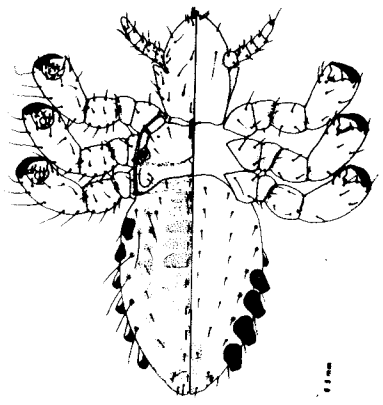

Figure 23.34

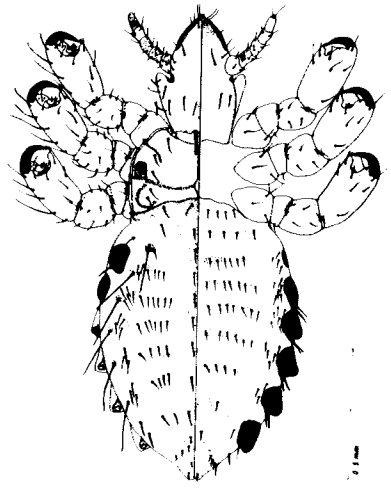

Figure 23.35

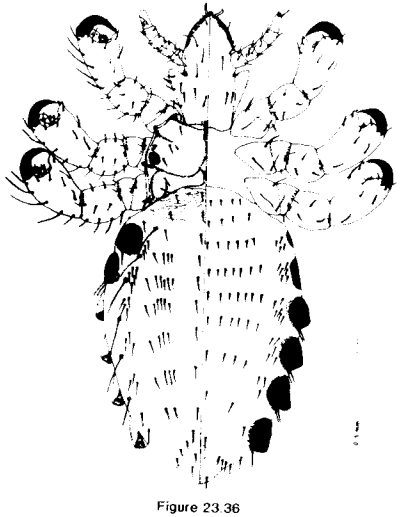

Figure 23.36

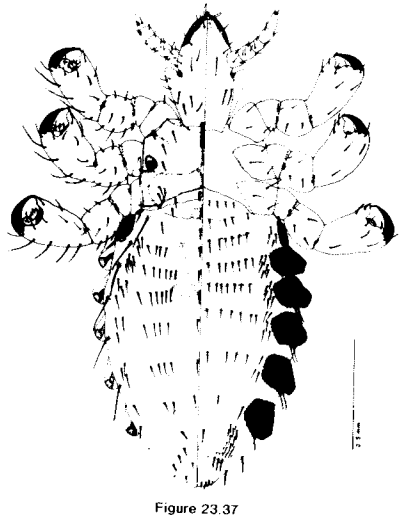

Figure 23.37

Figures 23.34–23.37. Haematopinidae. *Haematopinus eurysternus* Denny; **(23.34)** larva I; **(23.35)** larva II male; **(23.36)** larva III male; **(23.37)** larva III female.

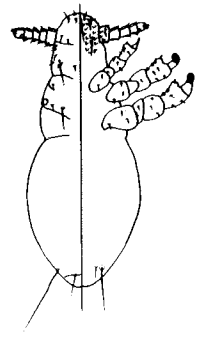

Figure 23.38

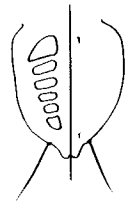

Figure 23.39a

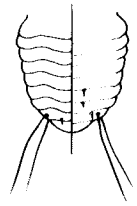

Figure 23.39b

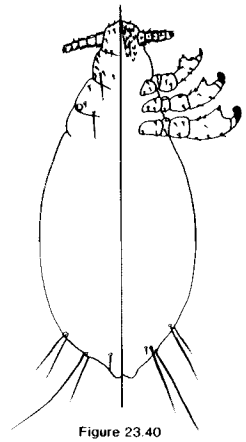

Figure 23.40

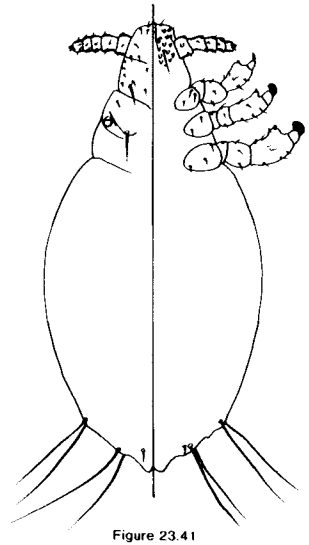

Figure 23.41

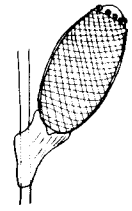

Figure 23.42

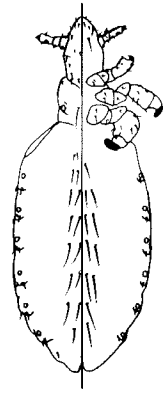

Figure 23.43

Figures 23.38–23.43. Hoplopleuridae. **(23.38)** *Hoplopleura acanthopus* (Burmeister), larva I; **(23.39a)** abdomen of *H. pacifica* Ewing, larva I; **(23.39b)** abdomen of *H. onychomydis* Cook & Beer, larva I; **(23.40)** *H. acanthopus* (Burmeister), larva II; **(23.41)** *H. acanthopus* (Burmeister), larva III; **(23.42)** egg of *H. pacifica* Ewing; **(23.43)** *Haematopinoides squamosus* Osborn, larva III.

Biology and Ecology: Hoplopleurinae are parasitic on rodents and pikas (Ochotonidae, Lagomorpha), and Haematopinoidinae are parasites of moles and shrews (Talpidae and Soricidae; Insectivora) and myomorph rodents (Gliridae and Zapodidae).

Description: Small lice; larva I 0.30–0.50 mm long, larva II 0.35–0.70 mm, and larva III 0.60–0.90 mm. *Head* with anterior margin irregularly rounded or truncated and without external eyes or ocular points; antennae usually five-segmented or rarely four-segmented (*Ancistroplax* and *Haematopinoides*, both on Insectivora); numerous tubercles usually present on the ventral head (*Hoplopleura* and *Pterophthirus*). *Thorax* gradually larger than head; thoracic sternal plate usually lacking except *Schizophthirus;* mesothoracic spiracles small; no notal pit. Fore legs always small, each with an acuminate claw; mid legs usually larger than fore legs, although similar in shape; hind legs usually largest, each with a stout claw and highly developed tibial thumbs. *Abdomen* usually with one or more pairs of MAS and two central rows of DCAS and VCAS.

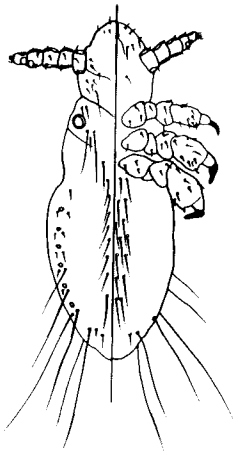

Figure 23.44

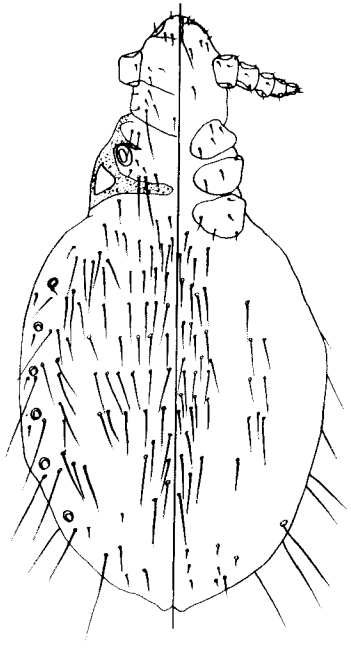

Figure 23.46

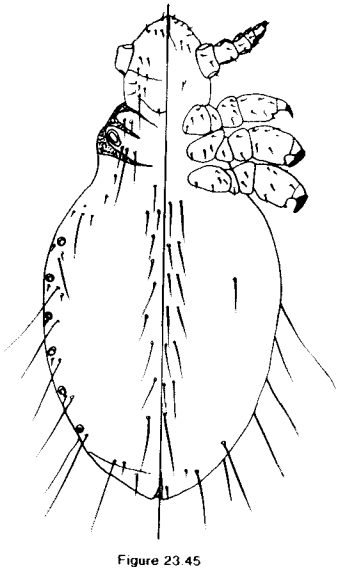

Figure 23.45

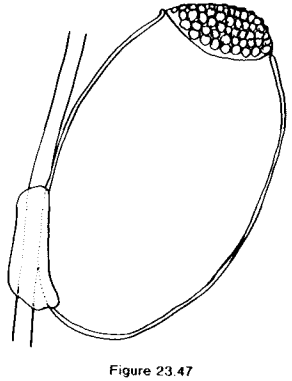

Figure 23.47

Figures 23.44–23.47. Linognathidae. *Linognathus*; **(23.44–46)** *L. setosus* (von Olfers): **(23.44)** larva I; **(23.45)** larva II; **(23.46)** larva III, legs removed; **(23.47)** egg of *L. pedalis* (Osborn).

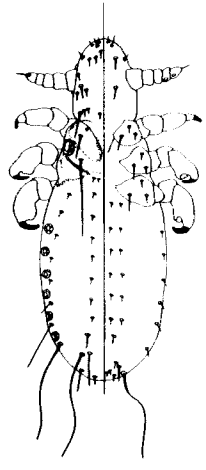

Figure 23.48

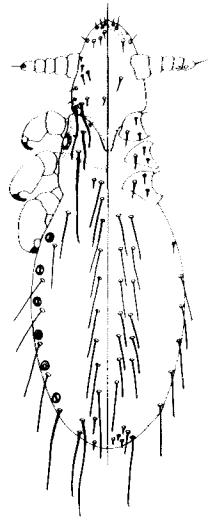

Figure 23.49

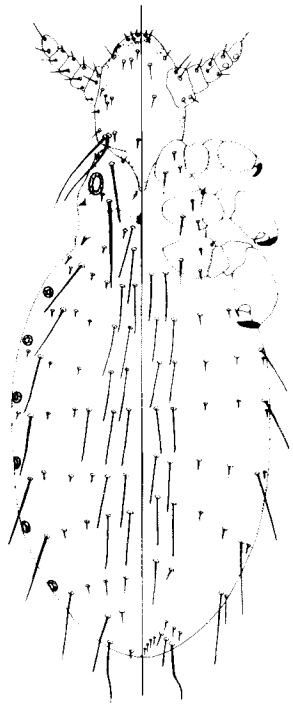

Figure 23.50

Figures 23.48–23.50. Linognathidae. *Solenopotes tarandi* (Mjöberg): **(23.48)** larva I; **(23.49)** larva II; **(23.50)** larva III.

Comments: Two subfamilies and five genera are recognized: Hoplopleurinae—*Hoplopleura* (117 species) (figs. 23.38–23.42) and *Pterophthirus* (5 species), and Haematopinoidinae—*Haematopinoides* (1 species) (fig. 23.43), *Ancistroplax* (2 species), and *Schizophthirus* (7 species). Of these, *Hoplopleura* and *Haematopinoides* occur in North America.

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Ferris 1951.
Johnson 1972.
Kim 1965.
Pratt and Karp 1953.

LINOGNATHIDAE

Linognathids, Smooth Sucking Lice

Figures 23.44–23.50

Relationships and Diagnosis: The linognathids are a rather homogeneous group, closely related to the Ratemiidae (Old World zebra and ass lice) and the Polyplacidae. Linognathids can be distinguished by having four rows of VCAS and DLAS in larva I, the mid legs and hind legs subequal and larger than the fore legs, and no paratergites in larvae II and III.

Biology and Ecology: The life cycle usually takes 21–30 days from eggs to eggs. Each species infests particular parts of the host animal. *Linognathus vituli* (L.) is abundant on the dewlap and shoulders, although it is also found on the sides of the neck, the rump, sides of the body, topline, udder,

perineum, and belly. *Solenopotes capillatus* Enderlein is usually found on the neck and head of infested animals (Matthysee 1946). Seasonal fluctuations in the *Solenopotes capillatus* population are caused by air temperature changes in the louse habitat and hair shedding (Jensen and Roberts 1966). As the temperature moves above or below the optimum (31–33°C), less favorable environmental conditions are available for reproduction and population maintenance.

Linognathus is primarily parasitic on Bovidae and Giraffidae (Artiodactyla) and has expanded its distribution to Canidae (Carnivora). *Solenopotes* is parasitic on Bovidae and Cervidae (Artiodactyla), and *Prolinognathus* is found exclusively on Procaviidae (Hyracoidea).

Description: Medium lice; larva I 0.80–1.25 mm, larva II 1.10–1.80 mm, larva III 1.70–2.10 mm. The abdominal chaetotaxy develops gradually in size and number from the first to the third stage. *Head* usually cone-shaped, without external eyes or ocular points; antennae usually five-segmented or rarely four-segmented (*Prolinognathus*); DPoMHS and DPHS distinct. *Thorax* without sternal plate; DPtS and DPTS distinct; mesothoracic spiracles usually large (or small in *Prolinognathus*). Legs relatively short; fore legs smallest, mid legs much larger, and hind legs largest; fore coxae separated widely from each other. *Abdomen* elliptical, without any indication of paratergites, sternites or tergites; spiracles usually visible; abdominal chaetotaxy with mostly minute DMdAS and VMdAS between larger LAS and CAS.

Comments: Three genera are recognized: *Linognathus* (51 species), *Solenopotes* (10 species), and *Prolinognathus* (8 species). Some species of *Linognathus* (figs. 23.44–23.47) and *Solenopotes* (figs. 23.48–23.50) are found in North America. *Linognathus vituli* and *Solenopotes capillatus* are important cattle lice.

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Jensen and Roberts 1966.
Kim and Weisser 1974.
Matthysse 1946.
Weisser and Kim 1973.

PECAROECIDAE

The Pecaroecids

Figures 23.51, 23.52

Relationships and Diagnosis: Pecaroecids are superficially similar to *Haematopinus* and are distinguished from other lice by the long slender head and distinct eyes.

Biology and Ecology: Pecaroecids are parasites of the peccary (Tayassuidae).

Description: Large lice with long, slender body. *Head* long and slender, with clearly evident eyes represented by a lens; antennae five-segmented. *Thorax* relatively short and heavily sclerotized, with distinct notal pit; no sternal plate; mesothoracic spiracles distinct. All legs subequal in size and shape but fore legs with enlarged tibial thumb. *Abdomen* long and narrowly elliptical; derm finely wrinkled; segmental setae short and arranged in transverse rows.

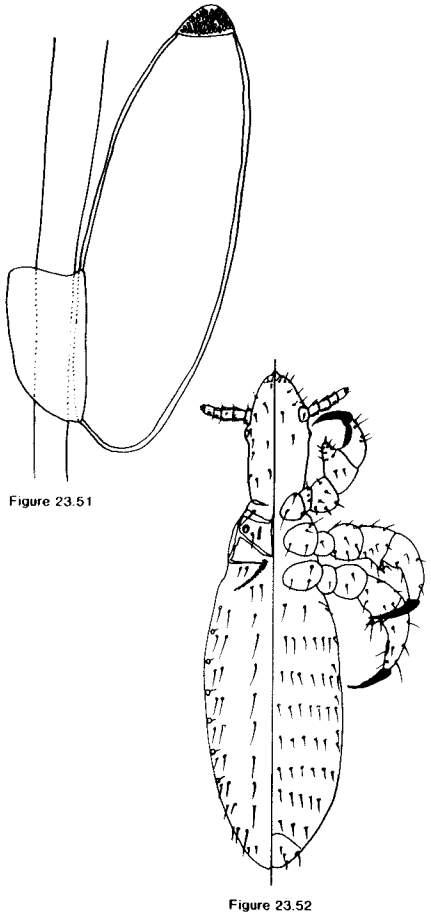

Figure 23.51

Figure 23.52

Figures 23.51–23.52. Pecaroecidae. *Pecaroecus javalli* Babcock & Ewing; **(23.51)** egg; **(23.52)** larva II.

Comments: The single known species, *Pecaroecus javalii* Babcock and Ewing (1938), is distributed in the southwestern United States.

Selected Bibliography

Babcock and Ewing 1938.
Ferris 1951.

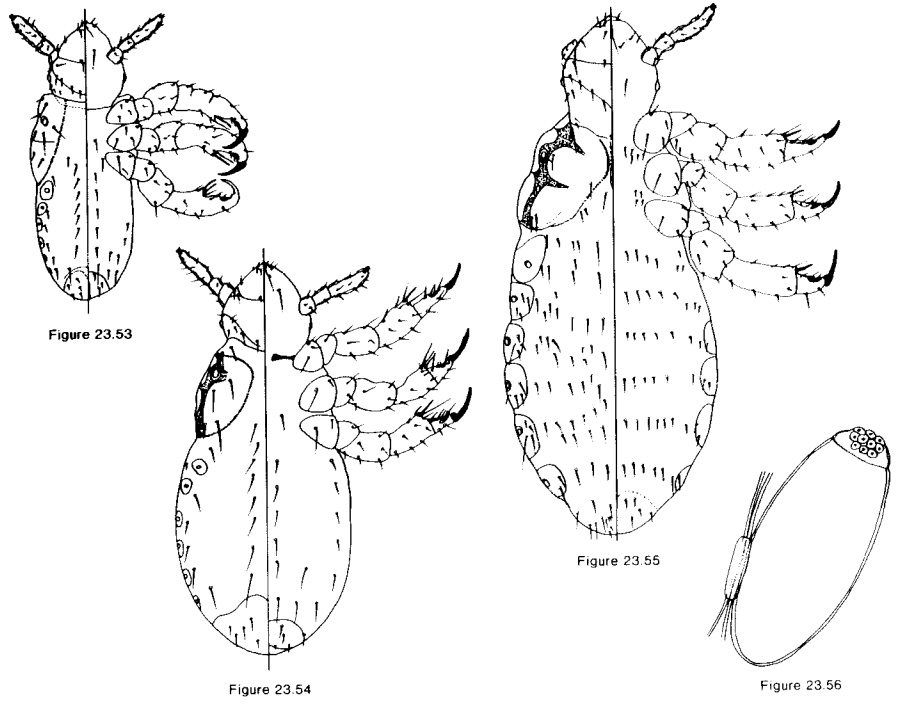

Figure 23.53

Figure 23.54

Figure 23.55

Figure 23.56

Figures 23.53–23.56. Pediculidae. *Pediculus humanus humanus* L. **(23.53)** larva I; **(23.54)** larva II; **(23.55)** larva III; **(23.56)** egg.

PEDICULIDAE

Pediculids, Human Lice

Figures 23.53–23.56

Relationships and Diagnosis: The pediculids, although highly specialized as are the Pecaroecidae and the Haematopinidae, retain many primitive characters. Larvae of the pediculids can be distinguished from other lice by the presence of external eyes, distinct notal pit and all legs subequal in size and shape.

Biology and Ecology: *Pediculus* is parasitic upon New World monkeys (Cebidae), gibbons and great apes (Pongidae), and humans (Hominidae). The human louse, *Pediculus humanus* L., has two subspecies, *P. h. humanus* L. and *P. h. capitis* De Geer. The life cycle takes 18–20 days from eggs to eggs. The eggs (fig. 23.56) take 8–9 days at 30° C. to hatch, and larval stages last 12–21 days. *Pediculus h. capitis* (head louse) is able to feed at any time, but *P. h. humanus* (body louse) can only feed undisturbed when the host is at rest (Buxton 1946). The eggs of head lice are cemented to hairs whereas body louse eggs are glued to fibers of the clothing.

Description: Medium lice, often translucent; larva I 0.90–1.30 mm long (fig. 23.53); larva II 1.35–1.58 mm long (fig. 23.54); larva III 2.00–2.70 mm long (fig. 23.55). *Head* relatively short, abruptly constricted posteriorly into a short neck, with eyes externally represented by pair of distinct lenses and pigmentation on the lateral lobes; antennae five-segmented (terminal segments often fused). *Thorax* with well-developed phragmata and notal pit; no sternal plate; mesothoracic spiracles distinct. All legs subequal in shape and size and each with a long acuminate claw; tibial thumbs developed. *Abdomen* membranous, with lateral margins more or less lobed and six pairs of spiracles; segmental setae distinct, arranged in transverse fields.

Comments: Many species had formerly been recognized for *Pediculus*. Currently only two species are accepted as distinct and others as subspecies or infraspecific variants: *Pediculus humanus* on humans and New World monkeys (Cebidae), and *P. schaeffi* Fahrenholz on gibbons and great apes (Pongidae).

Selected Bibliography

Buxton 1946.
Ferris 1951.
Kim and Emerson 1968a.

POLYPLACIDAE

The Polyplacids

Figures 23.57–23.73

Relationships and Diagnosis: The polyplacids are a rather heterogeneous group and somewhat related to the Linognathidae and the Hoplopleuridae. They can be distinguished from other lice by having no or two rows of VCAS and no DLAS in larva I, and mid legs usually subequal to the hind legs in size and shape, and paratergites in larvae II and III.

Larvae are superficially similar among *Polyplax* (figs. 23.57–23.60), *Neohaematopinus* (figs. 23.64–23.67), *Proenderleinellus*, *Linognathoides* (figs. 23.61–23.63), *Fahrenholzia* (figs. 23.68–23.70), and *Haemodipsus* (figs. 23.71–23.73), but larvae are quite different among *Lemurphthirus*, *Lemurpediculus*, *Phthirpediculus*, *Eulinognathus*, *Ctenophthirus*, *Scipio*, *Sathrax*, *Johnsonpthirus*, and *Docophthirus*. However, the larvae are very similar to their adults in general morphology and primary chaetotaxy.

Biology and Ecology: Polyplacids are parasitic on Rodentia, Lagomorpha, Insectivora, and Prosimian Primates. *Polyplax* (76 species) and *Neohaematopinus* (30 species) are the two largest genera, primarily parasitic on rodents and occasionally infesting Insectivora. *Sathrax* (1 species) and *Docophthirus* (1 species) are found on Tupaiidae (Primates), and three genera are parasitic on Prosimian Primates: *Lemurphthirus* (2 species) on Lorisidae, *Lemurpediculus* (2 species) on Lemuridae, and *Phthirpediculus* (2 species) on Indridae. *Haemodipsus* (6 species) are parasites of rabbits (Leporidae, Lagomorpha).

Description: Small lice; body size variable. *Head* with antennae five-segmented; head about as long as wide; VPHS long; DPHS, MHS, DAnCHS, DPoCHS distinct; some species with sclerotized ventral tubercles (e.g., *Fahrenholzia microcephala*). *Thorax* wider than head; DPtS and DPTS distinct; sternal plate usually lacking in the first stage but frequently present in the second and third stages. Fore legs always small and slender, each with an acuminate claw; mid legs subequal to hind legs in size and shape, or hind legs larger than mid legs. *Abdomen* oval or elliptical, with six pairs of small spiracles; paratergites often present in larvae II and III; MAS and CAS distinct; usually larva I with two rows of CAS and two pairs of MAS, larva III with two or four rows of CAS and four or more pairs of MAS, and larva III with four or more rows of CAS and usually six pairs of MAS.

Comments: *Polyplax*, *Neohaematopinus*, *Linognathoides*, *Fahrenholzia*, and *Haemodipsus* are commonly found in North America.

Selected Bibliography

Ewing 1927.
Ferris 1951.
Johnson 1969.
Kim and Adler 1982.
Kim and Emerson 1968b, 1973.
Pratt and Karp 1953.

PTHIRIDAE

Pthirids, Crab Lice, Pubic Lice

Figures 23.74–23.77

Relationships and Diagnosis: The pthirids are unique lice with a compact body, wide thorax, and short abdomen. Because of the host relationships, *Pediculus* and *Pthirus* have been considered closely related and have been grouped into the family Pediculidae by many workers (Ferris 1951), but they basically represent two different lineages with numerous morphological differences (Kim and Ludwig 1978).

Larvae are very similar to the adults except for size and setal density.

Biology and Ecology: The entire life cycle of *Pthirus pubis* L. takes 13–17 days from eggs to eggs at skin temperature. Eggs hatch 7–8 days after oviposition (Buxton 1946). *Pthirus pubis* infests the pubic regions particularly, but also the armpits and more rarely the mustache, beard, eyelashes, and eyebrows.

Description: Medium lice with compact body; larva I 0.63–0.85 mm long, larva II 0.9–1.2 mm, and larva III 1.10–1.50 mm. *Head* short, much narrower than thorax, with distinct eyes; antennae five-segmented. *Thorax* short and wide, without notal pit or sternal plate; mesothoracic spiracles distinct. Fore legs slender, with pointed, acuminate claws; mid legs subequal to hindlegs in size and shape, very large, with stout claws. *Abdomen* relatively small, as broad basally as the posterior part of the thorax, with six pairs of large spiracles, the first three being crowded together and the first two displaced toward the dorsal meson.

Comments: Two species of *Pthirus* are so far known: *Pthirus pubis* (crab louse) on humans and *P. gorillae* Ewing on the gorilla. *Pthirus pubis* is distributed worldwide. Crab lice are usually transmitted from one person to another during sexual activity. They may also be spread on loose hairs transferred by infested persons to such items as towels and bedding.

Selected Bibliography

Buxton 1946.
Ewing 1927.
Kim and Emerson 1968a.
Piotrowski 1961.

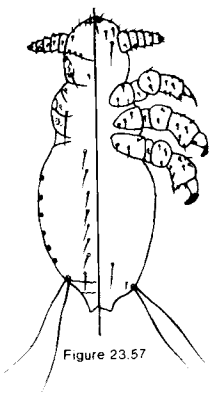

Figure 23.57

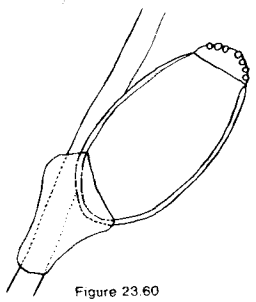

Figure 23.60

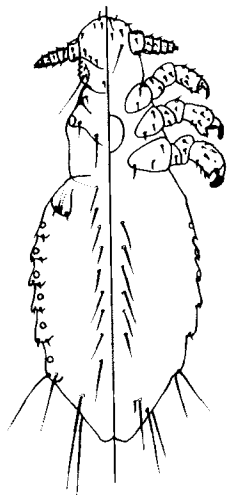

Figure 23.58

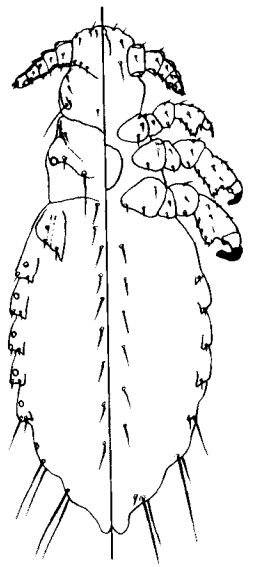

Figure 23.59

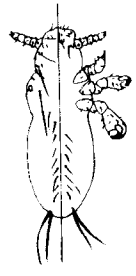

Figure 23.61

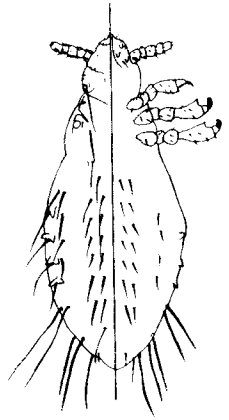

Figure 23.62

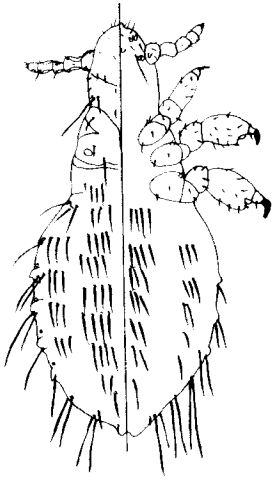

Figure 23.63

Figures 23.57–23.60. Polyplacidae. *Polyplax spinulosa* (Burmeister); **(23.57)** larva I; **(23.58)** larva II; **(23.59)** larva III; **(23.60)** egg.

Figures 23.61–23.63. Polyplacidae. *Linognathoides marmotae* (Ferris); **(23.61)** larva I; **(23.62)** larva II; **(23.63)** larva III.

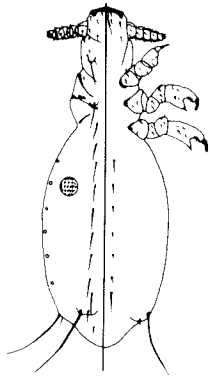

Figure 23.64

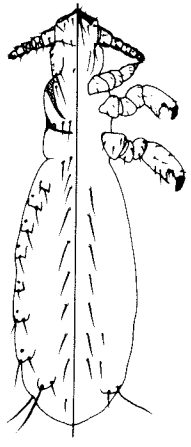

Figure 23.65

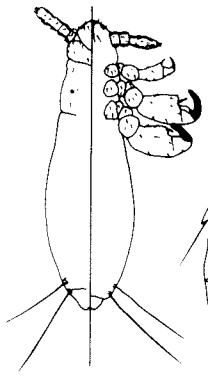

Figure 23.68

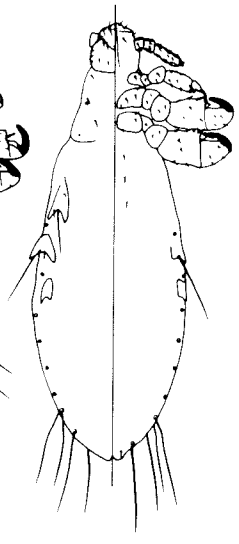

Figure 23.69

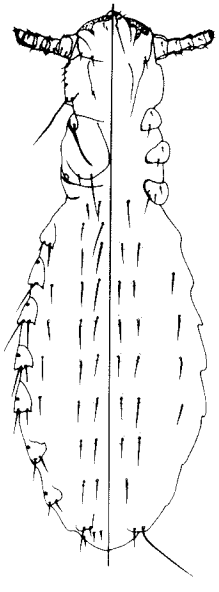

Figure 23.66

Figure 23.67

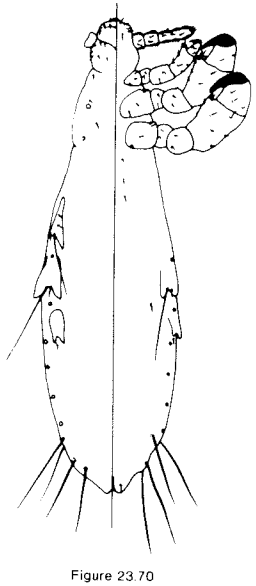

Figure 23.70

Figures 23.64–23.67. Polyplacidae. *Neohaematopinus*; **(23.64–66)** *N. sciuropteri* (Osborn); **(23.64)** larva I; **(23.65)** larva II; **(23.66)** larva III, legs removed; **(23.67)** *N. sciuri* Jancke, egg.

Figures 23.68–23.70. Polyplacidae. *Fahrenholzia fairchildi* Johnson; **(23.68)** larva I; **(23.69)** larva II; **(23.70)** larva III.

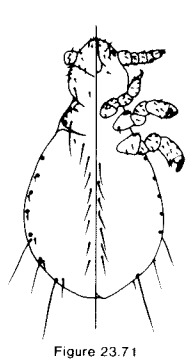

Figure 23.71

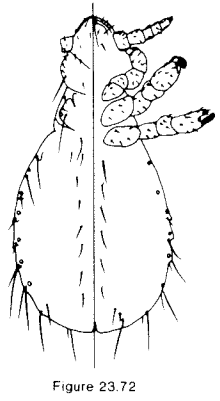

Figure 23.72

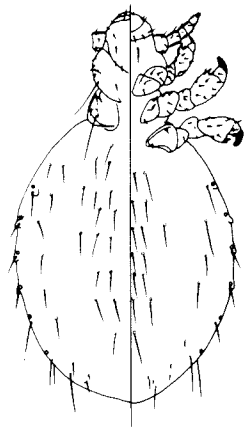

Figure 23.73

Figures 23.71–23.73. Polyplacidae. *Haemodipsus setoni* Ewing; **(23.71)** larva I; **(23.72)** larva II; **(23.73)** larva III.

Figure 23.74

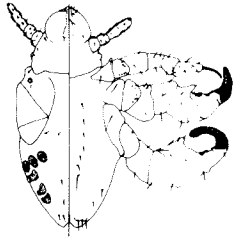

Figure 23.75

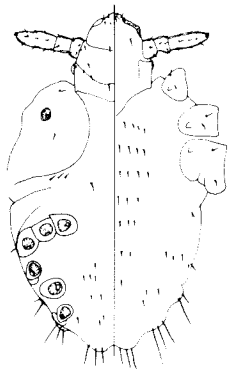

Figure 23.76

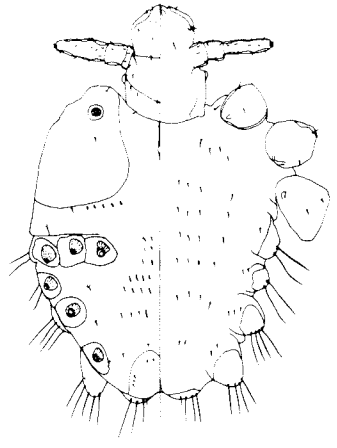

Figure 23.77

Figures 23.74–23.77. Pthiridae. *Pthirus pubis* (L.); **(23.74)** egg; **(23.75)** larva I; **(23.76)** larva II, legs removed; **(23.77)** larva III, legs removed.

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