A MANUAL OF EXTERNAL PARASITES

BY

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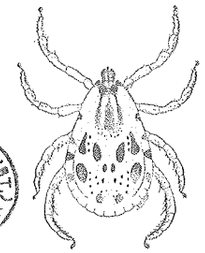

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PREFACE

IN THIS manual of ectoparasites an attempt has been made to give a background for the study of the different groups. Keys in most instances have been given to the known genera of the world; and in addition supplementary taxonomic matter has been added, together with some considerations of the external anatomy, life histories, natural relationships and economy. Treatment has been confined entirely to the five major groups of ectoparasites; the mites, the ticks, the biting lice, the sucking lice and the fleas.

In giving technical descriptions of new genera in the appendix the writer has probably followed a practice that does not meet with the approval of some taxonomists. Yet the inclusion of descriptions of new genera appears logical in a synoptic work which gives keys to the same for the world. It is realized that such descriptions will not be as readily available to foreign workers as they would be if presented in a well established scientific journal; yet this handicap is outweighed, it is believed, by having the technical descriptions accompanying the keys themselves.

The amount of space alloted to the different groups has been determined largely by the number of genera and higher groups included. It is not meant that this work shall be a treatise on the economy of ectoparasites, but rather here is given a sketch of their more evident morphological characters, an enumeration and synopsis of their taxonomic groups and short discussions of their life histories and natural relationships. Thus the economically very important group of ticks is alloted much less space than is devoted to the less economically important biting lice. It is hoped that those who are more particularly interested in the morphology and economy of ectoparasites will be guided to other sources through the references to literature given at the end of each chapter.

In the preparation of this work the writer has been aided directly or indirectly by a number of his coworkers. Particularly has he found the large collection of ectoparasites recently given to the National Museum by Dr. E. A. Chapin of great help in the preparation of the keys. The following workers have aided much through the exchange of material: F. C. Bishopp, H. S. Peters, F. H. Wilson and R. M. Malcomson.

The Washington collections of ectoparasites together probably constitute the most representative and valuable collections of such arthropods assembled at one place. Those of the National Museum which are under the custodial care of the writer include a wealth of type material, there being here represented the types of several well known entomologists. Here are deposited the Baker flea types, the Fox types in the same group,the Ferris Anoplura cotypes and paratypes, the Marx tick types, the Banks tick types, as well as many of the cotypes of Kellogg in the Mallophaga, the types of Banks in the Acarina and some type material by Jordan in the fleas. Besides these types there are many others in smaller numbers by various workers in the different groups of ectoparasites. The writer's very extensive collection of ectoparasites is at present deposited at the National Museum, and his recently established types are a part of the National Museum collections.

Those working in any of the ectoparasitic groups are welcome to come to Washington and take advantage of the facilities of the National Museum in rounding out their papers or in furthering their researches in any way.

H. E. EWING

Washington, D. C., May, 1929.

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CHAPTER I

THE PARASITIC MITES

MITES are minute arthropods and together with the ticks constitute the order Acarina of the class Arachnida. They are distinguished from all the other members of their class by having an unsegmented abdomen broadly united with the cephalothorax. So completely has this union taken place that in many families there is no demarcation between the two, the whole body being aptly described as saclike.

Mites are the smallest of the arthropods, yet lacking in size they are most extravagant in numbers. So numerous are they that in some situations millions of them are to be found in an environment of only a few cubic inches. Besides being the smallest of the arthropods, mites also are the most widely distributed, with the possible exception of the springtails. Both mites and springtails are found from north Greenland southward throughout the temperate and torrid zones into the Antarctic Continent.

The parasitic mites do not constitute one natural group, it is believed, but several such groups each of which has descended from a different type of free living ancestor. The common habit of parasitism, however, has frequently brought about similar adaptations in structure which give certain phylogenetically distinct groups a close superficial resemblance. Parasitic mites attack both land and aquatic hosts, and vertebrates as well as invertebrates. The former are frequently heavily infested, and each of the smaller rodents usually is parasitized by several mite species. Because of this range and intensity of parasitism it is believed that if a thorough survey were made parasitic species would be found to outnumber by far the free living ones. In fact it might be revealed that they outnumber in species even the insects.

In this work, but for a few exceptions, only the groups containing parasitic species will be given consideration. And of these only those that are parasitic on vertebrates are keyed down to the genera. Also the large family of Analgesidae, constituting the feather mites, is keyed only to the subfamilies.

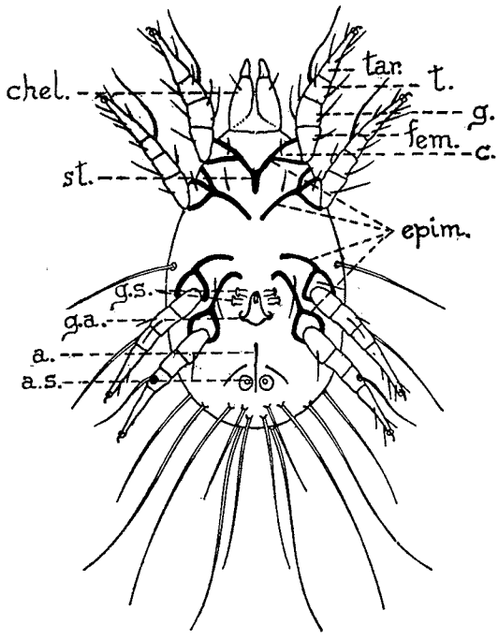

Figure 1. Ventral view of a mite, *Tyroglyphus lintneri*; *a.*, anus; *a.s.*, anal suckers; *c.*, coxa; *chel.*, chelicera; *epim.*, epimera; *fem.*, femur; *g.*, genual; *g.a.*, genital armature; *g.s*, genital suckers; *st.*, sternum; *t.*, tibia., *tar.*, tarsus. (After the writer.)

Origin of Parasitism in the Acarina

Parasitism in the Acarina has undoubtedly arisen several times during the phylogenetic history of the order. In some groups its origin appears to have been very recent and to have affected only a few genera which show but slight morphological changes from the free living types. In other groups the parasitic habit appears to have been one long established, leading back to very ancient times. In such groups many genera or even families are usually affected and the morphological changes that have arisen in consequence of the parasitic life are extensive and profound. They mark off such groups, as for example the itch mites or the ticks, with characters quickly appraised by the taxonomist.

The reasons for the frequent occurrence of parasitism in the Acarina (Ewing, 1911) are to be found largely in the minute size, the great abundance, the wide distribution and the diversity of the habits of the free living members. Parasitism in a nascent state is seen today in certain living species, as for example *Pediculoides ventricosus*. A single individual of this species may be either predaceous, parasitic or act as a scavenger. It may be either one of these or all three of these with equal adaptability depending entirely upon the hazards of its environment.

Classification

Mites have been grouped successfully into suborders depending upon the number and position of their stigmata. Usually other characters are added. In this manner the breaks between the suborders become more evident. Banks (1915) uses a system of superfamilies, largely to supplant the suborders. The writer prefers to use it to supplement them. Not only this but he believes that many of the old families should be broken up into subfamilies, as has been done by various specialists of the group.

Key to the Suborders and Superfamilies Containing Parasitic Mites

1. Tracheae opening through a pair of spiracles situated laterally on the sides of the body...MESOSTIGMATA 5
   Tracheae, when present, not opening on the sides of the body..... 2

2. Tracheae usually present and opening at or near the bases of the chelicerae: adults free living; larvae frequently parasitic.....PROSTIGMATA 6

   Tracheae, when present, never opening at or near the bases of the chelicerae..... 3

3. Tracheae present; abdomen showing evidences of segmentation; females frequently with a pair of clavate sensory organs between the bases of the first and second legs
   HETEROSTIGMATA 8

   Tracheae wanting; abdomen without true segmentation; females never provided with the clavate sensory organs between the first and second legs..... 4

4. Body stout, not vermiform, legs composed of more than three segments.....ASTIGMATA 9

   Body vermiform, legs rudimentary and apparently composed of but three segments; parasitic in the hair follicles of mammals.....BRACHYPODA 10

5. Hypostome small or absent, never with recurved teeth; tracheae usually opening through chitinous tubes or peritremes; sternal plate seldom wanting....PARASITOIDEA

   Hypostome large and provided with recurved teeth; tracheae each opening through a chitinous plate; sternal plate nearly always wanting; skin always leathery.....IXODOIDEA

   (See chapter on ticks)

6. Last palpal segment never forming a thumb to the preceding; legs without swollen tarsi ..... EUPODOIDEA

   Last palpal segment forming a thumb to the preceding, which ends in a claw; tarsi frequently swollen..... 7

7. Legs not adapted for swimming. Land mites
   TROMBIDOIDEA

   Legs adapted for swimming. Water mites
   HYDRACHNOIDEA

8. Contains but a single superfamily..... TARSONEMOIDEA

9. Skin without fine parallel folds; tarsi without stalked suckers; adults never true parasites on vertebrates
   TYROGLYPHOIDEA

   Skin with fine parallel folds; tarsi frequently provided with stalked suckers; parasitic in all stages and chiefly on vertebrates.....SARCOPTOIDEA

10. Contains but a single superfamily and family
    DEMODICOIDEA

The Gamasid Mites, Superfamily Parasitoidea

The gamasid mites, formerly known as the Gamasoidea but now as the Parasitoidea, are of a very generalized type as is clearly indicated by the organization of their mouthparts and by the number and structure of their legs.

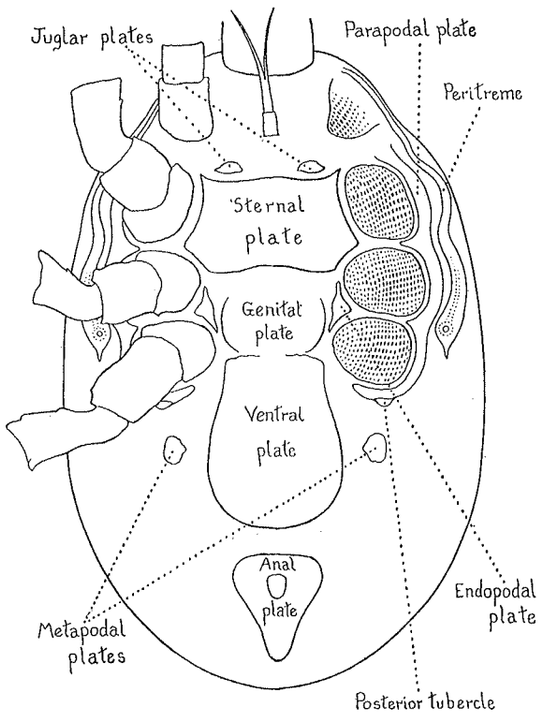

Figure 2. Diagram showing the arrangement and names of ventral plates of a mite of the superfamily Parasitoidea.

External Anatomy: The chelicerae (Fig. 3) are large and powerful in the free-living species, and are composed of three segments. They differ from the chelicerae of the primitive mitelike phalangids only in that they lie entirely in a horizontal position, while those of phalangids are bent

downward at the articulation between the first and second segments. In many of the parasitic gamasids the chelae of the chelicerae are modified into piercing structures (Fig. 3), in which case the movable one may be lost. The pedipalps are conspicuous, free and composed of several cylindrical segments.

The body of a gamasid mite is stout and shows no demarcation between the cephalothorax and abdomen. It is partly or completely covered by well chitinized plates. Above, there is usually one, but sometimes two of these. Below there may be as many as four major plates, as well as a variable number of minor ones, frequently called platelets. The four major plates are: Sternal plate, genital plate, ventral plate and anal plate. The names of the platelets and their relationships are indicated in figure 2. One or more of the plates may be fused together.

The legs are large and powerful and enable these mites to move with great rapidity. Typically they are composed of eight segments—a maximum number for the class Arachnida. The front legs are frequently more slender than the others, being used for feelers. The second legs are greatly enlarged in the males of certain genera and may possess several toothlike tubercles, the shape and position of which are of much importance as specific characters.

Life History: For the most part gamasid mites are oviparous, but a few are ovoviviparous. The oviparous species retain the one large egg that is usually produced at a time until the embryo is well developed. The larvae have only three pairs of legs and are similar in appearance and habits to the adults. Usually two nymphal stages occur, the first being called the protonymph, and the second the deutonymph. Both nymphs are very similar to the adults but may be distinguished from the latter by the absence of the genital opening.

Classification: The gamasid mites were long considered

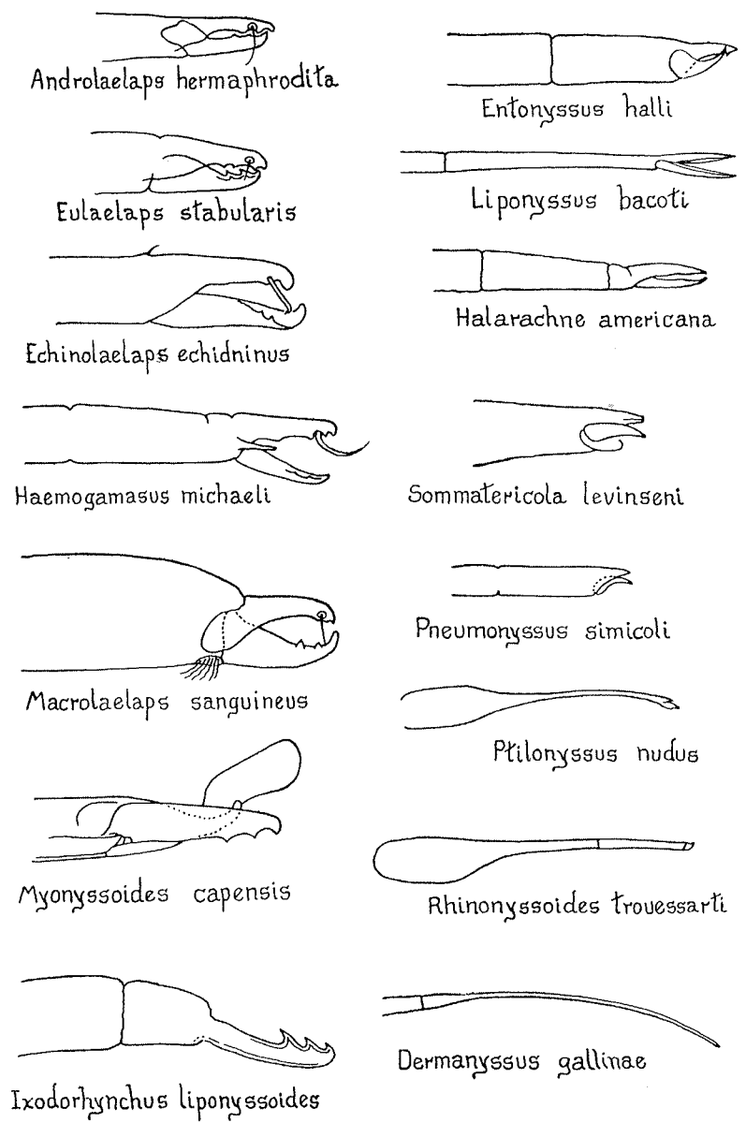

Figure 3. Chelicerae of females of fifteen different genera and species of parasitic Parasitoidea. (Chiefly after various acarologists.)

as constituting only a family, but now are regarded as a superfamily by most authorities. Although there is a great diversity of habits among the various genera, this fact can not well be utilized for separating the families. Most of those that are parasitic on vertebrates have the chelicerae adapted for piercing. These are frequently placed in a family by themselves, the Dermanyssidae.

KEY TO THE FAMILIES OF PARASITOIDEA

1. First pair of legs usually inclosed with the mouth-parts in a body opening; genital apertures of both sexes entirely surrounded by the sternal plate; nymphs frequently attached to arthropods by means of a gluelike pedicel for purposes of transportation ..... UROPODIDAE
   First pair of legs not so inclosed with the mouth-parts; genital opening of female never completely surrounded by the sternal plate; nymphs never attached by means of any such pedicel to arthropods 2
2. Chelicerae of a generalized type having the tips incurved and being provided with teeth, and the fixed arm usually bearing a seta near its tip; body usually well covered with chitinous plates; anal plate, if present, usually united with ventral plate in both sexes. Chiefly free or associated with arthropods ..... PARASITIDAE
   Chelicerae modified, usually without teeth and fixed arm always without seta; body usually only partly covered both above and below with chitinous plates; anal plate nearly always present and distinct from ventral plate in females. Parasitic on vertebrates ..... DERMANYSSIDAE

Family PARASITIDAE

The family Parasitidae, long known as Gamasidae, is by far the largest of the three families of the superfamily Parasitoidea. It includes a vast assemblage of genera, subgenera and species from all parts of the world. The free living members are found chiefly in damp places near the surface of the ground. The parasitic species occur on both invertebrates and vertebrates. Many genera represent species that live in a symbiotic relation with insects and other arthropods.

Other species are parasitic on mammals and resemble very closely those belonging to the family Dermanyssidae. However, their chelicerae possess teeth and are not adapted for piercing as they are in this last named family.

KEY TO THE SUBFAMILIES OF PARASITIDAE

1. Spiracles dorso-lateral in position; legs short, stout and with large caruncles; larval stage passed inside the body of female. Parasitic,—chiefly on bats ..... SPINTURNICINAE
   Spiracles ventro-lateral in position; legs more slender, and with moderate caruncles. Not on bats 2
2. Body circular or nearly so; first legs antennalike, without claws; male genital aperture in sternal plate. Usually associated with ants ..... ANTENNOPHORINAE
   Body usually elongate; first legs with or without claws; male genital aperture frequently in front of sternal plate. For the most part free living mites. Seldom associated with ants..3
3. First pair of legs without claws and caruncle, used as feelers; second legs of male seldom much larger than those of female. Never parasitic on vertebrates ..... MACROCHELINAE
   First pair of legs furnished with either claws or caruncle and usually ambulatory in function; second legs of male frequently enlarged. Free living and parasitic, both on vertebrates and invertebrates ..... PARASITINAE

KEY TO THE GENERA OF THE PARASITINAE THAT ARE PARASITIC ON MAMMALS

1. Body thickly beset with short, fine setae; epistome well developed; genito-ventral plate poorly chitinized and bearing several to many short setae ..... *Haemogamasus* Berlese
   Body sparsely clothed with longer and stouter setae; epistome absent or poorly developed 2
2. Second pair of legs in one or both of the sexes enlarged and calcarate 3
   Second pair of legs not calcarate in either sex 4
3. Second pair of legs of both sexes enlarged and calcarate *Androlaelaps* Berlese
   Second pair of legs of male only, enlarged and calcarate *Raillietia* Trouessart
4. Genito-ventral plate very large and extending to anal plate; anal plate much broader than long and with 3 setae; metapodal plates large and triangular ..... *Eulaelaps* Berlese

Genito-ventral plate not so large; anal plate longer and usually with 3 setae; metapodal plates smaller 5

5. Chelicerae each with a brush of setae attached near the base of the movable arm 6
Chelicerae without such a brush of setae 7

6. Dorsal plate unsculptured; legs and body without stout spines *Geneiadolaelaps*, new genus
Dorsal plate of female sculptured; legs and body provided with spines. Large parasitid mites *Macrolaelaps*, new genus

7. Body oval or eggshape in outline, longer than broad 8
Body subcircular or discoidal 15

8. Genito-ventral plate extending to or almost to the anal plate and with its posterior margin incurved to match the front border of the latter; abdomen frequently more or less studded below with spines . . . . . *Echinolaelaps*, new genus
Genito-ventral plate much reduced, falling short of the anal plate, and without incurved posterior margin 9

9. Anterior margin of genito-ventral plate strong and armed with robust denticles . . . . . *Eugynolaelaps* Berlese
Anterior margin of genito-ventral plate weak, scarcely visible 10

10. Setae on fixed digit of chelicerae very long and filiform. Type species from a marsupial . . . . . *Haemolaelaps* Berlese
Setae on fixed digit of chelicerae of a different nature 11

11. Some of the coxae armed with toothlike spines 12
Coxae and most, or all, of the other leg segments without spines 14

12. Genito-ventral plate with four pairs of setae 13
Genito-ventral plate with only three pairs of setae; body stout; peritreme greatly enlarged . . . . . *Neolaelaps* Hirst

13. Body of usual shape; first and second pairs of legs not greatly enlarged . . . . . *Laelaps* Koch
Body very long; first and second pairs of legs much enlarged and spined . . . . . *Longolaelaps* Vitzthum

14. Genito-ventral plate with four pairs of setae *Tricholaelaps* Vitzthum
Genito-ventral plate with less than four pairs of setae *Atricholaelaps*, new genus

15. Second and third coxae each provided with a prominent spur; shoulders wanting; genito-ventral plate with five pairs of setae *Heterolaelaps* Hirst
Second and third coxae without spurs; shoulders reduced but present 16

16. Abdomen slightly emarginate behind; sternal plate broader than long and with spinelike setae; genito-ventral plate with only a single pair of setae . . . . . *Eubrachylaelaps*, new genus
Abdomen evenly rounded behind; sternal plate longer than broad and with normal setae; genito-ventral plate with three pairs of setae . . . . . *Mesolaelaps* Hirst

Genus Laelaps Koch

In its most restricted sense *Laelaps* includes those species of Parasitinae in which the genito-ventral plate does not extend to the anal plate and bears four pairs of setae, and in which some of the coxae are provided with toothlike spines and the first and second pairs of legs are not greatly enlarged. Many species from small rodents are included, some of them being parasites of rats and mice.

Genus Echinolaelaps, New Genus

Species of *Echinolaelaps* are stout, well chitinized and clothed with either large setae or spines, or both. The genus differs from the other genera of the Parasitinae that are parasitic on vertebrates by having a genito-ventral plate that reaches to the anal plate and matches the same in front with its broadly emarginate posterior border.

The Common Rat Mite, *Echinolaelaps echidninus* Berlese, is found on the domestic species of rats in various parts of the world. It is known to transmit a fatal protozoan disease among white rats. Although a common parasite of house rats this species is not known to attack man.

Genus Haemogamasus Berlese

Species of this genus are distinguished from those of all the other genera of the subfamily Parasitinae by having the body uniformly and thickly beset with short, fine setae and the epistome well developed. *Haemogamasus* shows very strong affinities with the Dermanyssidae, but since the chelicerae possess teeth and a terminal seta on the fixed arm, the genus should be placed in the Parasitinae. The

species are very common in the nests of moles and mice. They are true blood suckers. A synopsis of most of the species has been published (Ewing, 1925).

Family UROPODIDAE

Members of this family differ from those of the other two families of Parasitoidea in having the genital openings of both sexes entirely surrounded by the sternal plate. Usually the first pair of legs is inclosed with the mouth-parts in a common body opening. Members of this family live in association with various arthropods, some of them being parasitic. Dispersal is frequently accomplished by a migratory nymphal instar. Migratory nymphs attach themselves to various insects by means of a gluey pedicel and become quiescent while being transported by the host.

Family DERMANYSSIDAE

In the Dermanyssidae the genital openings are not entirely surrounded by the sternum, and the chelicerae are modified, *i.e.*, the chelae are no longer the stout, simple structures with the incurved tips as they are in most of the free living gamasid mites, and the fixed chela has lost its seta. All of the Dermanyssidae are true parasites. They are found on reptiles, birds and mammals. A synopsis of the North American species has been published by the writer (Ewing, 1922).

Key to the Subfamilies and Genera of Dermanyssidae

1. Stigmata situated laterally 2
   Stigmata situated dorsally. Living in the air passages of birds ..... Rhinonyssinae 19
2. Anal plate present (in males united with ventral plate); abdomen never vermiform. Seldom parasitic in air passages of mammals 3
   Anal plate wanting or very greatly reduced; abdomen frequently drawn out, at times vermiform. Living in air passages of mammals ..... Halarachninae 17

3. Chelicerae either shearlike, needlelike, or with teeth (at least in females) 4
   Chelicerae with fixed arm harpoonlike and movable arm falciform; body plates very poorly chitinized. Living in the air sacs of snakes ..... Entonyssinae 16
4. Chelicerae, at least in females, with teeth ..... Ixodorhynchinae 6
   Chelicerae without teeth 5
5. Chelicerae of females shearlike, with both arms present; anal plate usually eggshape in outline ..... Liponyssinae 8
   Chelicerae of females long and needlelike ..... Dermanyssinae 15
6. Movable arm of chelicerae present; dorsal plate undivided 7
   Movable arm of chelicerae wanting; dorsal plate divided *Ixodorhynchus* Ewing
7. Anal plate very large and provided with many setae *Myonyssoides* Hirst
   Anal plate small, eggshape in outline, with but a few setae *Lophoptes* Mégnin
8. Dorsal plate continued forward over the mouth-parts as a hoodlike projection ..... *Echinonyssus* Hirst
   Dorsal plate without such a hoodlike projection 9
9. Body of both sexes entirely covered above by dorsal plate; sternal plate of female large, reaching the third coxae; anal plate very large, broader than long *Tetragonyssus* Ewing
   Body not entirely covered above by dorsal plate in either sex 10
10. Dorsal plate of female entire 11
    Dorsal plate of female divided 14
11. Legs stout; first and second tibiae less than one and a half times as long as broad; first and second femora spined above *Ichoronyssus* Kolenati
    Legs not so stout; first and second femora not spined above 12
12. Genito-ventral plate of female with a single pair of setae 13
    Genito-ventral plate of female with three pairs of setae *Liponysella* Hirst
13. Sternal plate with but two pairs of setae *Neoliponyssus*, new genus
    Sternal plate with three pairs of setae (posterior pair frequently in poorly chitinized corners) ..... *Liponyssus* Kolenati
14. Posterior dorsal plate large, covering much of the abdomen above; first segment of palpus of female with a hornlike process ..... *Ceratonyssus* Ewing
    Posterior dorsal plate minute; sternal plate with only four setae *Ophionyssus* Mégnin

15. Dorsal plate of female entire; anal plate not eggshape and with anal opening in its posterior part ..... *Dermanyssus* Dugès
    Dorsal plate of female divided; anal plate eggshape and with anal opening situated centrally .... *Allodermanyssus* Ewing
16. Contains but a single genus ..... *Entonyssus* Ewing
17. Palpi filiform, equal in length to coxa and trochanter of leg I Living in bronchial passages of seals ... *Halarachne* Allman
    Palpi reduced to papillalike cones not as long as first coxa. Living in bronchial passages of monkeys 18
18. All tarsi provided with claws .. *Pneumonyssus* Haan & Grijns
    Posterior tarsi without claws, but each provided with a suckerlike empodium ..... *Pneumotuber* Hoepke
19. Two dorsal plates present 20
    Not more than one dorsal plate present 22
20. Posterior dorsal plate about as large as anterior one 21
    Posterior dorsal plate small; body strongly constricted behind the last pair of legs ..... *Ptilonyssus* Berlese & Trouessart
21. Sternal plate present ..... *Neonyssus* Hirst
    Sternal plate absent ..... *Neonyssoides* Hirst
22. With one dorsal plate present 23
    No dorsal plate present ..... *Sommatericola* Trägårdh
23. Chelicerae rodlike and each provided with a single, minute, clawlike chela at the tip ..... *Rhinonyssoides* Hirst
    Chelicerae not so formed 24
24. Sternal plate present but weak ..... *Rhinonyssus* Trouessart
    Sternal plate wanting; genito-ventral plate very long and slender ..... *Sternostomum* Berlese

Synonymy of Genera in the Family Dermanyssidae

Leiognathus Canestrini (1885) = *Liponyssus* Kolenati (1859).
Serpenticola Ewing (1923) = *Ophionyssus* Mégnin (1884).
Liponyssoides Hirst (1913) = *Dermanyssus* Dugès (1834).

The genus *Ophionyssus* Mégnin was for several years considered as a synonym of *Liponyssus* Kolenati. But Hirst (1921) states that he has demonstrated that the type species, *O. natricis* Gervais, possesses a small secondary dorsal shield, and is in fact very similar to *Liponyssus serpentium* Hirst, the type species of *Serpenticola* Ewing. It was largely because of the presence of this second small dorsal shield

in *L. serpentium* that the genus *Serpenticola* was erected for it. Hirst's demonstration not only establishes *Ophionyssus* Mégnin as a good genus but reduces *Serpenticola* to a synonym.

Genus Liponyssus Kolenati

Liponyssus formerly included a large percentage of the species of the family Dermanyssidae. In its restricted sense

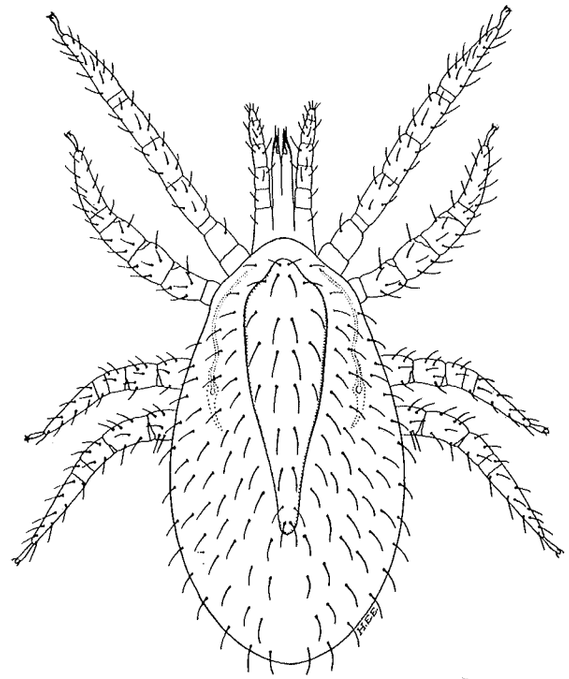

Figure 4. *Liponyssus bacoti*, dorsal view, greatly enlarged. (Original)

it should include only those with the dorsal plate undivided and not entirely covering the upper surface of the body, and in which the sternal plate of the female bears three pairs of setae and the genito-ventral plate a single pair.

The Tropical Rat Mite, *Liponyssus bacoti* (Hirst) (Fig. 4), was originally described from Egypt. It is now

known to occur in many widely separated countries of the world and has been introduced into the United States. In this country the mite frequently attacks man, being most annoying after the rat hosts have been destroyed.

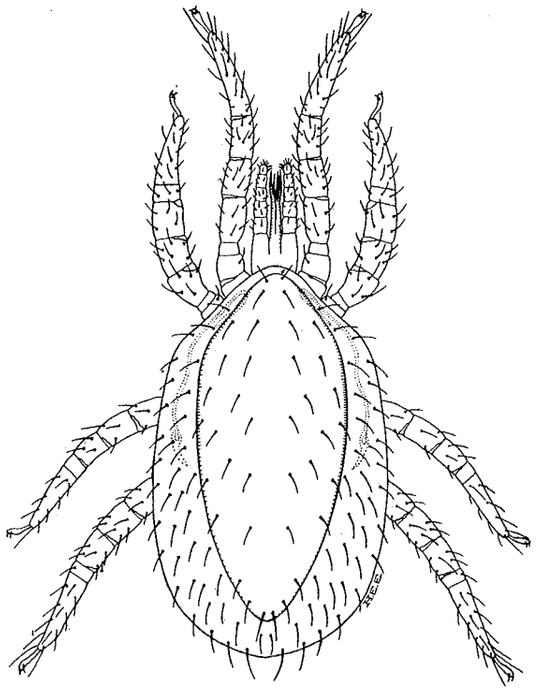

Figure 5. Tropical fowl mite, *Liponyssus bursa*, greatly enlarged. (Original)

The Tropical Fowl Mite, *Liponyssus bursa* (Berlese) (Fig. 5), was described many years ago from South America. In recent years it has become a pest of poultry in the United States, being most injurious in the Southern States. Wood (1920) has made a special study of the life history and control of this mite.

The Northern Fowl Mite, *Liponyssus sylviarum* Canestrini & Fanzago, is very closely related to the tropical fowl mite but has only a single pair of long setae in the posterior end of the dorsal plate, while the latter species has two pairs. This mite has been reported as injurious to poultry in the northern part of the United States.

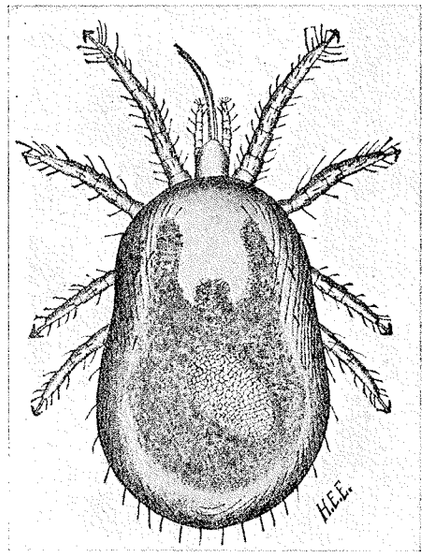

Figure 6. The chicken mite, *Dermanyssus gallinae*. View from above, ×60. (Ewing)

Genus Dermanyssus Dugès

In *Dermanyssus* the chelicerae of the females are long and needle-like, and the dorsal shield is entire. The anal plate is very broad anteriorly.

The Chicken Mite, *Dermanyssus gallinae* (Linnaeus) (Fig. 6), has followed its host wherever the latter has been taken by man. It is a blood sucker, but visits chickens only to feed. The eggs are laid and the transformations take place away from the host, usually in the cracks and crevices

of the coops, crates or hen-houses. Engorged females of this mite may be as much as a millimeter and a half in length, other individuals are much smaller.

Genus Allodermanyssus Ewing

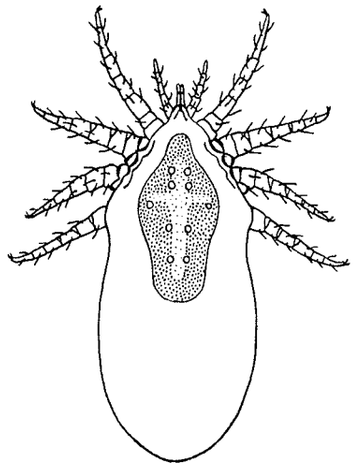

Figure 7. One of the seal lung mites, *Halarachne americana*. (After Banks)

Allodermanyssus differs from *Dermanyssus* in that the female has two dorsal shields instead of one. The sternal plate is squarish and the anal plate is eggshape in outline. One species, *A. sanguineus* Hirst, occurs in Egypt on various rodents.

Genus Halarachne Allman

This genus includes the lung mites of seals, which are elongate more or less vermiform mites (Fig. 7) that infest the bronchial tubes of their hosts. Two species have been described from America, *H. americana* Banks (Fig. 7) and *H. attenuata* Banks. In the latter named species the body may be vermiform.

Genus Pneumonyssus Haan and Grijns

Pneumonyssus species infest the lungs of certain Old World monkeys. They are somewhat different from the lung mites of seals, and have no dorsal shield on the body. They occur in small cavities in the lungs. Their habits have been but little studied.

Superfamily EUPODOIDEA

In this superfamily are included those mites which have the stigmata situated on or near the mouth-parts and which lack the thumb to the palpus. For the most part the mites of this group are free living and predaceous. Many species are quite agile, and only a small percentage either attack vegetation or parasitize invertebrates. The best known are the snouted mites (family Bdellidae) (Fig. 8) which are rather large and are frequently brightly colored.

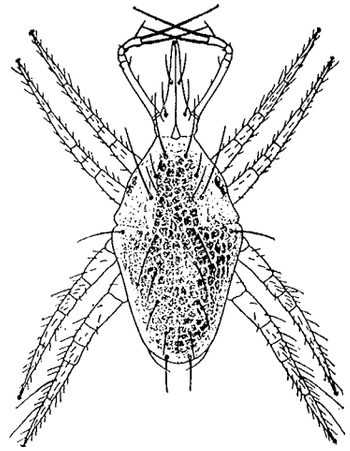

Figure 8. A snouted mite, *Bdella tessellata*. (Ewing)

The Harvest Mites and Others

Superfamily TROMBIDOIDEA

The members of this superfamily have the openings of the tracheae situated anteriorly on or near the bases of the chelicerae (Fig. 9), and the last segment of the palpus is formed into a thumb for apposing the clawlike extension of the next to the last segment.

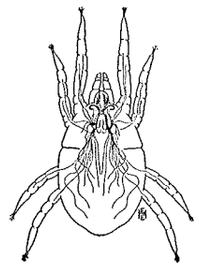

Figure 9. The tracheal system of *Tetranychus telarius*. (Ewing)

External Anatomy: Mites of this suborder never have the integument heavily chitinized, and seldom possess chitinous plates. Usually they are well clothed with setae. The mouth-parts are either large and raptorial or reduced and modified for piercing and sucking liquid food.

Life History: Species of Trombidoidea are oviparous, usually a large number of eggs being laid. These more commonly are spherical, smooth and shiny. In some species,

however, the eggs may be flattened, ribbed or even spined. The larvae are hexapod and either free or parasitic. If parasitic, they attach to the host by means of the chelicerae and hang on and engorge in the manner of a tick. Like ticks also the engorged larvae drop to the ground and transform into nymphs. At this point the analogy with the life history of ticks ceases, for from now on, in nearly all genera of the superfamily, the individuals are free living. They are in fact so similar in habits and structure to the adults that it is hard to distinguish the nymphs from the latter.

In plant feeding species all instars including eggs may be found on a single leaf. With them there are usually two nymphs; with predaceous forms usually only one. The plant feeders are known for the most part as spinning mites or red spiders.

Classification: Variations in the structure and functions of the mouth-parts are used particularly in classifying the Trombidoidea. Also the characters of the tarsi are important.

KEY TO THE FAMILIES OF TROMBIDOIDEA

1. Chelicerae falcate, not needlelike 2
   Chelicerae not falcate but usually either styletiform or needlelike 4
2. First and second legs provided with processes bearing large spines; integument with large chitinous shields. . CAECULIDAE
   First and second legs without processes bearing spines; integument without any large chitinous shield 3
3. Cephalothorax without any rodlike structure and median dorsal groove; legs more slender and tarsi never swollen ANYSTIDAE
   Cephalothorax with a rodlike structure at the bottom of a median dorsal groove; legs stouter and usually with swollen tarsi . . . . . TROMBIDIIDAE
4. Cephalothorax with rodlike structure in a dorsal median groove; tarsi usually somewhat swollen, never attenuated; body well clothed with short setae . . . . . ERYTHRAEIDAE
   Cephalothorax without rodlike structure and dorsal groove; tarsi attenuated; body sparsely clothed with setae of varying lengths 5

5. Each tarsus provided with either a pectinate distal appendage or tenent hairs, or both of these; palpi moderate or small. Plant feeding mites. . . . . TETRANYCHIDAE
   Tarsi usually without pectinate appendages and always without tenent hairs; palpi usually large; predaceous or parasitic in habits . . . . . CHEYLETIDAE

Family CAECULIDAE

But a single genus, *Caeculus*, is included in this family of free living mites. Although structurally most nearly related to the Trombidiidae they also show affinities with the Oribatoidea, or beetle mites. Each leg of the first pair is enlarged and possesses a row of prominent spines on the inner side. The somewhat squarish body is provided with a dorsal shield, and the coxae are arranged close together in a radiate manner. These mites are found in moist decaying organic matter of various kinds.

Family ANYSTIDAE

Members of the family Anystidae are either predaceous or parasitic. Those that are most frequently seen and that have been most studied are the predaceous species. These may be observed on the foliage of plants in the summer time, usually running about very rapidly. The parasitic species are found on reptiles in the warmer parts of the world. Having very small flattened bodies they frequently conceal themselves entirely under the scales of the host.

The family is recognized by the absence of the crista and dorsal groove, the radiate arrangement of the coxae, the tapering tarsi and the absence of chitinous body plates.

HARVEST MITES AND CHIGGER MITES

Family TROMBIDIIDAE

The harvest mites are brilliantly colored, many of them being red or scarlet, others spotted with yellow or orange or black. They are the largest of all the mites, some being almost half an inch in length. The adults and nymphs are

free living and predaceous, but the larvae are invariably parasitic. They parasitize insects and other arthropods and various vertebrates. The vertebrate infesting species are known as chiggers or red bugs in the United States.

Chiggers are very annoying pests to man and domestic animals in warm and damp countries. Because of their small size they easily penetrate ordinary clothing, and then attach to the skin by means of their hooked chelicerae and armed palpi. They feed upon the lymph that collects beneath the epidermis. When chiggers first attach they give little evidence of their presence, but in a few hours an intense itching sets in which may continue for days. Oudemans (1912) has given a taxonomic summary of the larval species of Trombidiidae and Erythraeidae.

Formerly all the larvae known to parasitize man and domestic animals were placed in the genus *Trombicula*. However, they really should be placed in several genera. These may be separated by means of the following key:

KEY TO THE GENERA OF TROMBICULINAE

1. Dorsal plate with six setae in addition to pseudostigmatic organs 2
   Dorsal plate with only five setae in addition to pseudostigmatic organs 3
2. Dorsal plate without any median anterior process but with a poorly developed crista ..... *Hannemania* Oudemans
   Dorsal plate with a median, anterior knoblike process, but without crista ..... *Leeuwenhoekia* Oudemans
3. Pseudostigmatic organs strongly clavate or capitate 4
   Pseudostigmatic organs flagelliform and barbed, not clavate 5
4. Chelicerae armed with a row of teeth above; palpal claw usually bifurcate ..... *Schöngastia* Oudemans
   Chelicerae each with not more than a single dorsal tooth; palpal claw trifurcate ..... *Neoschöngastia*, new genus
5. Each chelicera with a row of teeth on the upper margin of chela *Odontacarus*, new genus
   Each chelicera without more than a single tooth on upper margin ..... *Trombicula* Berlese

SYNONYMY OF GENERA IN THE TROMBICULINAE

Leptotrombidium Nagayo et al. (1916) = *Trombicula* Berlese (1905).

Neotrombicula Hirst (1925) = *Trombicula* Berlese (1905).

Genus TROMBICULA Berlese

Adult individuals of *Trombicula*, as the genus is known in a broad sense, differ from all other harvest mites by having the body greatly constricted somewhat in front of the middle. Larvae of *Trombicula*, as the genus is here

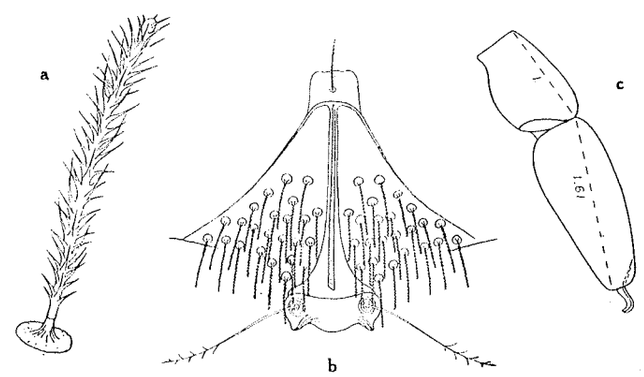

Figure 10. Details of adult of *Trombicula akamushi; a*, seta from dorsum of abdomen; *b*, dorsal view of cephalothorax; *c*, last two segments of right front leg, side view. (Ewing)

characterized, have but five setae on the dorsal plate in addition to the pseudostigmatic organs which are flagelliform and pectinate and each chelicera bears but a single dorsal tooth.

The Japanese Chigger, *Trombicula akamushi* (Brumpt) (Fig. 10), is the transmitter of river fever, a disease fatal to man which is similar in certain respects to our Rocky Mountain spotted fever. In certain parts of Japan about one-third of all those who contract this disease die of it. The transmitting chigger occurs in nature on various small

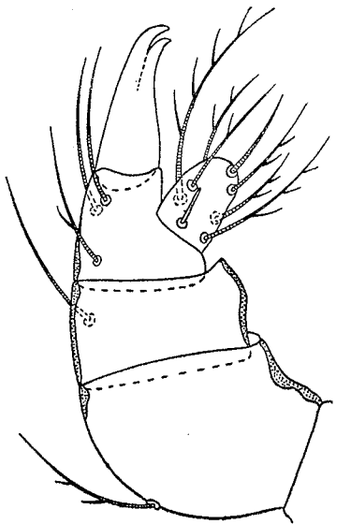

Figure 11. *Trombicula iritans;* ventral view of palpus of larva. (Ewing)

rodents, particularly field mice, which furnish the natural reservoir for the virus. Only those people who go into the low marshy sections become infected. In Sumatra and adjacent regions a much milder disease, now commonly regarded as only a form of river fever, occurs. This disease is known as pseudotyphus.

The Autumnal Chigger of Europe, *Trombicula autumnalis* (Shaw), is active during the months of September, October and November. It has been reported as attacking man, horses, cattle, sheep, dogs, cats and rabbits.

The North American Chigger, *Trombicula irritans* (Riley) (Fig. 12), occurs generally in all the southern states and locally as far west as Kansas and as far north as Minnesota and New York. In the northern part of its range the larvae appear in June and disappear late in September or early in October. Among the wild hosts of this species are rabbits, rats, mice, quails, prairie chickens, various snakes, young toads and the common box turtle. Adults (Fig. 13) or nymphs have been reared from snakes, box turtles and young toads. Besides being very annoying to man this

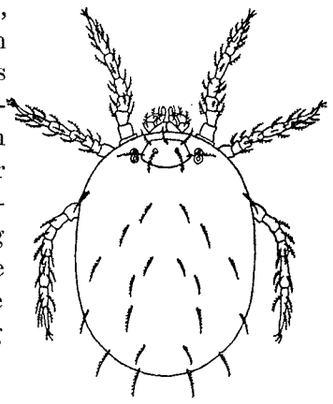

Figure 12. North American Chigger, *Trombicula irritans* (larva, ×100). (After Oudemans)

chigger attacks his domestic animals. Young chickens are frequently killed by it.

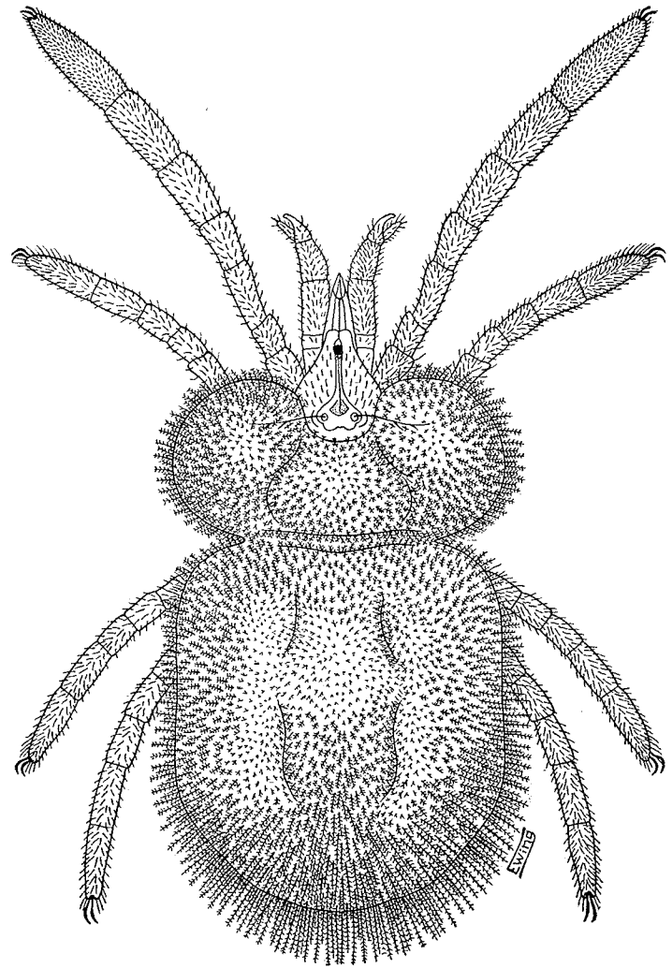

Figure 13. Adult of North American chigger, *Trombicula irritans.* (Ewing)

Genus HANNEMANIA Oudemans

In this genus there are six setae on the dorsal plate in addition to the pseudostigmatic organs which are flagelli-

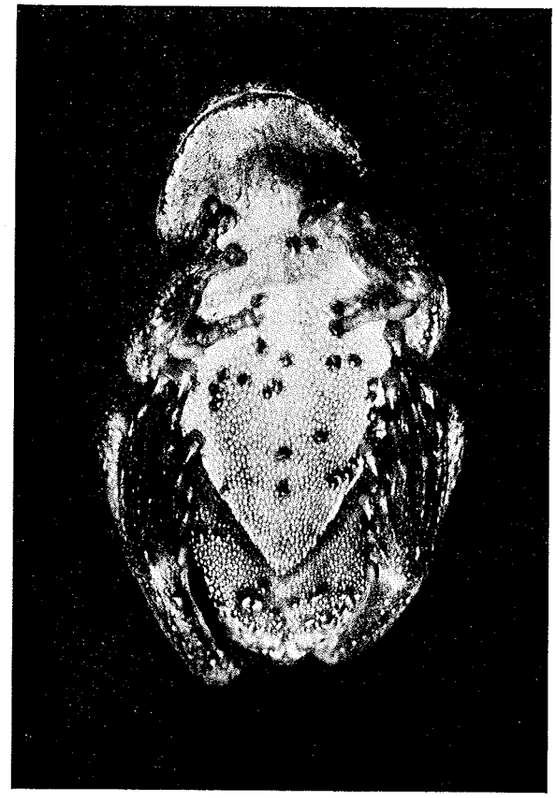

Figure 14. Tree-toad infested with *Hannemania hylae*. (Ewing)

form and pectinate. The dorsal plate itself is without any anterior median process, but may have a poorly developed crista. The species parasitize amphibians exclusively, as far as known.

The Tree-toad Chigger, *Hannemania hylae* (Ewing) (Fig. 15), occurs in southern California. It parasitizes tihe tree-toad, *Hyla arenicolor* (Fig. 14) frequently penetrating the skin and engorging under the same as an endoparaste. Adults and nymphs have been reared. In general ap-

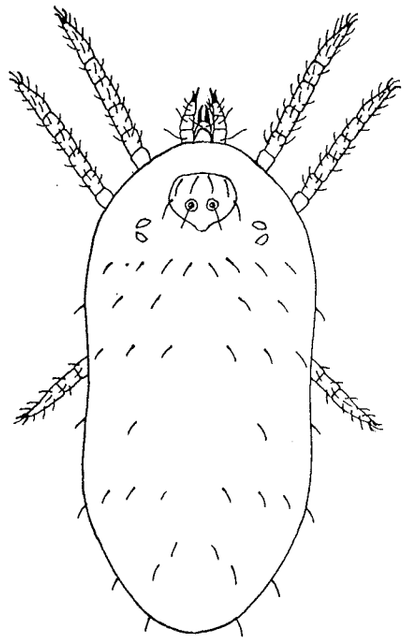

Figure 15. Engorged larva of *Hannemania hylae*. (Ewing)

pearances these are very similar to those of *Trombicula irritans*.

Genus SCHÖNGASTIA Oudemans

In *Schöngastia* the larvae have clavate or capitate pseudostigmatic organs and the chelicerae are armed with a row of teeth along the upper border. The palpal claw is usually bifurcate.

Genus NEOSCHÖNGASTIA, New Genus

Neoschöngastia is similar to *Schöngastia* but the chelicerae are unarmed except for a single dorsal tooth near the apex. The palpal claws are trifurcate.

One species, *Neoschöngastia americana* (Hirst), occurs on chickens in the Southern States and is very injurious to them.

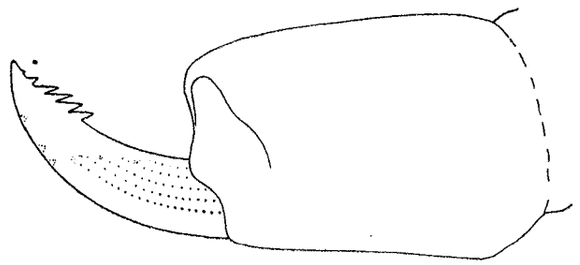

Figure 16. Side view of chelicera of *Odontacarus dentata.* (Ewing)

Family ERYTHRAEIDAE

The family Erythraeidae, formerly known as the Rhyncholophidae, is very closely related to the Trombidiidae, so close in fact that the two families can not be separated from each other except on the structure of the chelicerae. The chelicerae in Erythraeidae are needlelike while in the Trombidiidae they are falcate. In general, members of the family Erythraeidae are more slender than those of Trombidiidae, have longer legs and show less demarcation between the cephalothorax and the abdomen. The larvae (Oudemans 1912) parasitize only invertebrates. They have much more slender legs than the larvae of Trombidiidae, and a somewhat differently shaped capitulum.

Family TETRANYCHIDAE

In this family are included the spinning mites, some of the members of which are called red spiders. They agree with the Trombidoidea in possessing the palpal thumb. The distinguishing family characteristics are: Chelicerae needlelike and arising from a flattened base known as the mandibular plate; setae sparsely covering the body; claws with accessory structures, tenent hairs or bushy pulvillus, for manipulating silk.

The Common Red Spider, or Spider Mite, *Tetranychus telarius* (Linnaeus), frequently gets onto man, but is not in the least parasitic and does not attack him. Overwintering females of this species may collect in great numbers about the stems of plants or trunks of trees where they spin sheets of fine silk.

Family CHEYLETIDAE

In the Cheyletidae the palpi are powerful, and move in a horizontal direction so as to appose each other (Fig. 17). Most of the species are predaceous, and have the palpi variously armed with comblike structures or powerful curved setae. A free living predaceous species is shown in figure 17. Four of the parasitic genera are here considered. Banks (1915) treats of both free living and parasitic genera.

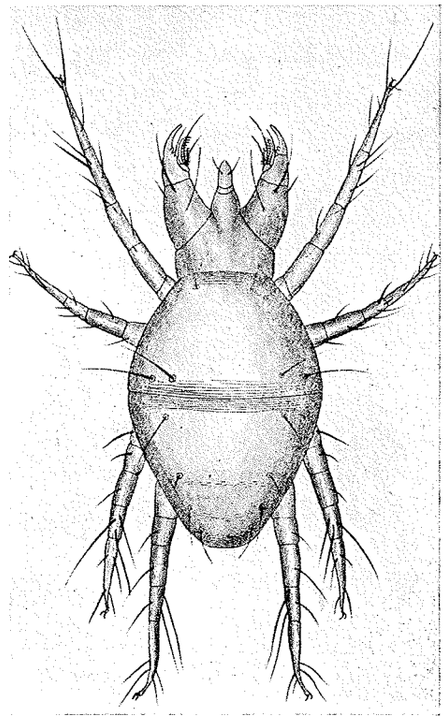

Figure 17. A predaceous cheyletid mite. (Ewing)

Genus Myobia Heyden

In *Myobia* the anterior pair of legs has become modified into hair-clasping apparatus. They are very short and stout and each terminates in a large clawlike structure. The other legs are similar, subequal and one clawed. Although the adults are pilicolous the nymphs infest the hair-follicles. Here they feed on the oily secretions and here they transform into adults. Eggs are laid attached to the hairs of the host. *Myobia* species are found on many small mammals, but particularly on mice and bats.

Genus Syringophilus Heller

In *Syringophilus* (Fig. 18) is illustrated a striking example of a profound modification in the shape of an animal to suit it to a peculiar habitat. In this genus the body is greatly elongated and by being so enables the mites to live inside the quills of birds. The front legs are not specially modified but are similar to the other legs, all of which possess a pair of brushlike, or comblike, pulvilli at their tips. The palpi are filiform, somewhat reduced and without palpal thumb.

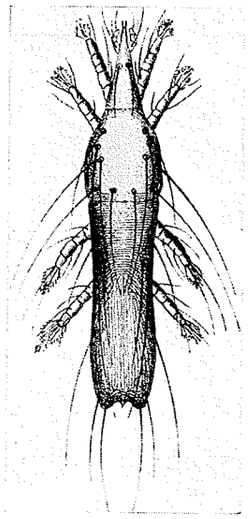

Figure 18. *Syringophilus elongatus*. (Ewing)

One species, *S. bipectinatus* Heller, is sometimes found in great numbers in the quills of the domestic fowl. It has been reported from Europe and the United States. Another species, *S. columbae* Hirst, is found inside of the quills of the domestic pigeon (Hirst, 1922).

Genus Psorergates Tyrrell

Species of this genus are small, soft and about as broad as long. They resemble greatly the true itch mites, or Sarcoptidae, and have the short, stumpy, coneshaped legs found in that group; however, these legs lack the pedicellate suckers of the true itch mites. A peculiarity of this genus is that the penis of the male is situated dorsally on top of the cephalothorax, like it is in the hair-follicle mites. *Psorergates* species are skin parasites. One of them, *P. musculi*, occurs on the house mouse.

Genus Harpyrynchus Mégnin

In *Harpyrynchus* (Fig. 19) the body is short and broad and the legs, particularly the last two pairs, suggest those of the itch mites. The palpi are very large, however, and are provided with heavy curved spines above. The two front pairs of legs are much less reduced than the others and each is terminated with a pair of claws. Species of this genus infest the skins of birds, occurring about the bases of the feathers where they may form tumors. Although largely endoparasitic they have a well developed tracheal system.

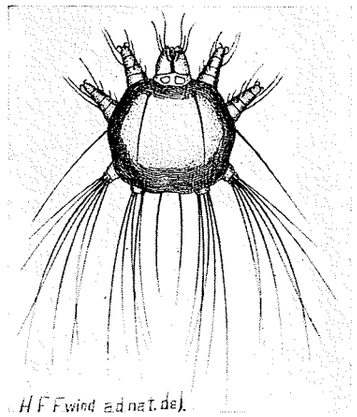

Figure 19. *Harpyrynchus brevis*. (Ewing)

The Water Mites

Superfamily HYDRACHNOIDEA

Water mites are believed to constitute a single phylogenetic unit, or in other words to have descended from a

common ancestor. This ancestor was probably a harvest mite, or a species that would be placed, if it were living today, in the family Trombidiidae. Not only does there exist a series of intergrades between the adults of water mites and harvest mites, but the larvae of some of the

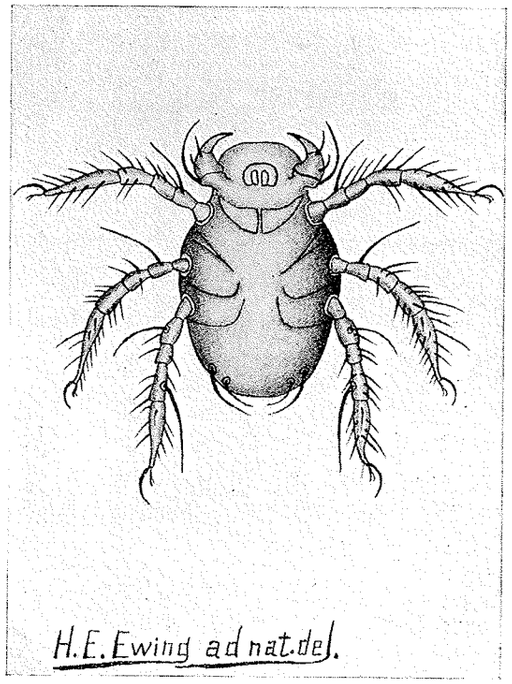

Figure 20. Larva of a water mite, ventral view. (Ewing)

species of the former (Fig. 20) are almost identical with those of the latter.

Water mites, like the harvest mites, are highly colored, but water mites are provided with long, hairlike setae on the legs to aid them in swimming, and are flatter and shorter than harvest mites and have fewer setae on the body. The

larvae of water mites are invariably parasitic but upon aquatic invertebrates. They attach and engorge in the same manner as do the larvae of harvest mites.

The Tarsonemid Mites

Superfamily TARSONEMOIDEA

The tarsonemid mites are of particular biological interest because in this superfamily many species show a body segmentation, a primitive character for the mites, while others show the greatest degeneration known in the order.

External Anatomy: All tarsonemid mites have the modified and degenerate mouth-parts situated in a headlike structure known as the capitulum. In some genera there are four pairs of legs present in both sexes, more commonly, however, one or two pairs are reduced or absent. In the females of most genera there is a pair of clavate structures, known as the pseudostigmatic organs, situated on the sides of the cephalothorax. The spiracles, which are not always present, vary in number and position but open ventrally.

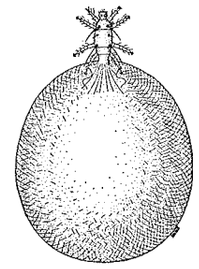

Figure 21. *Pediculoides ventricosus*, gravid female. (Original)

Life History: A rather remarkable peculiarity in the life history of certain species of Tarsonemidae is the suppression of the normal larval or nymphal stage through the development of a deutovum or tritovum stage. Thus in *Pediculoides ventricosus* the larval instar is represented by an octopod deutovum and the nymphal instar by an apodous, intrauterine, pupalike tritovum. The females of some species swell up to many times their normal size (Fig. 21) when becoming gravid with eggs.

Classification: Formerly all of the tarsonemid mites were placed in a single family. In this work, however, three are

recognized. The presence or absence of the second and third legs, and the form and tarsal armature of all the legs are characters of much importance in classification. The family Disparipedidae, which contains only species entirely parasitic on arthropods is not treated in this work. Paoli (1911) has monographed it.

KEY TO THE FAMILIES OF TARSONEMOIDEA, AND TO THE GENERA EXCEPT FOR THOSE OF DISPARIPEDIDAE

1. Females with elongate bodies; capitulum and first two pairs of legs not hidden by any projecting cephalothoracic shield 2
   Females usually with subdiscoidal bodies; capitulum and first two pairs of legs hidden by the projecting cephalothoracic shield ..... DISPARIPEDIDAE
2. Females with four pairs of legs and the last pair ending in two claws and caruncle. Species usually ovoviviparous PEDICULOIDIDAE 3
   Fourth pair of legs of female, if present, devoid of claws and usually of caruncles. Species usually oviparous TARSONEMIDAE 5
3. Female with a large capitulum, showing a rostrum and rudimentary palpi; segments of abdomen distinct 4
   Female with capitulum reduced to a papilla *Pigmephorus* Kramer
4. Larval instar represented by an octopod deutovum; gravid female with only the tip of the abdominal wall swollen *Pediculoides* Targioni-Tozzetti
   Larval instar normal; most of the dorsal wall of abdomen distended in gravid females ..... *Pediculopsis* Reuter
5. Posterior legs of female present and well developed. Phytophagous or parasitic mites ..... TARSONEMINAE 7
   Posterior legs of female reduced (sometimes only slightly so) or wanting. Parasitic mites 6
6. Both sexes with at least three pairs of segmented and functional legs ..... TARSOPOLIPINAE 8
   Females never with more than two pairs of legs; males hexapod PODAPOLIPINAE 12
7. Pseudostigmatic organs present; posterior legs of female ending in two long setae ..... *Tarsonemus* Canestrini & Fanzago
   Pseudostigmatic organs wanting; posterior legs of female each ending in a caruncle ..... *Acarophenax* Newstead & Duvall

8. Females with pseudostigmatic organs but with only six legs; males with eight legs, the last pair being dorsal *Tarsopolipus* Berlese
   Females without pseudostigmatic organs and with three or four pairs of legs 9
9. Females octopod, last pair of legs somewhat reduced 10
   Females with six legs; males with only six legs that show segmentation 11
10. Females without caruncles on first pair of legs, and with one large and one minute terminal seta on each posterior leg *Tarsonemella* Hirst
    Females with caruncles on first pair of legs and with two large subequal terminal setae on each posterior leg *Acarapis* Hirst
11. Female with at least one dorsal plate to abdomen; male without stout forceplike posterior appendages. Parasitic in the tracheae of grasshoppers ..... *Locustacarus* Ewing
    Female without dorsal plate on abdomen; male with a stout forceplike posterior appendage. Parasitic at bases of wings of beetle ..... *Eutarsopolipus* Berlese
12. Second pair of legs in female short but segmented and terminating in claws ..... *Tetrapolipus* Berlese
    Second pair of legs of female degenerate, consisting of a pair of unsegmented papillae ..... *Podapolipus* Grassi & Rovelli

Genus PEDICULOIDES Targioni-Tozzetti

In *Pediculoides* (Fig. 22) the capitulum is large, and contains the needlelike chelicerae while below it bears a pair of minute papillae, the rudimentary palpi. The segmentation of the body is distinct. The larval instar is represented by an octopod deutovum. During pregnancy only the tip of the abdomen of the female becomes distended.

The Grain Itch Mite, *Pediculoides ventricosus* Newport, is commonly observed attacking various insects. This mite has a remarkable symbiotic versatility. The same individual may be either predaceous, parasitic or a scavenger during its own life period, and apparently turns with the greatest facility from the one form of life to the other depending upon the expediencies of its environment. Grain insects, par-

ticularly in the immature stages, may be infested with thousands or millions of these mites. People handling such infested grain, or its straw, or coming in contact with the same are frequently attacked by the mites. The rash they produce is known as grain itch (Webster, 1910).

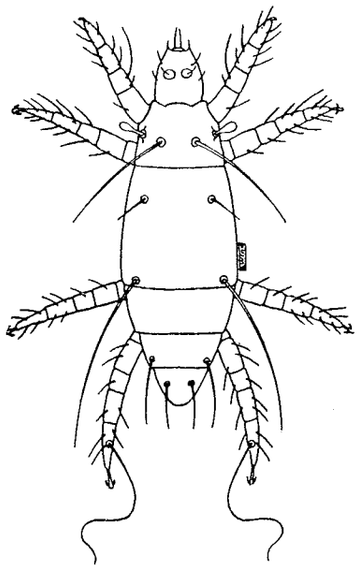

Figure 22. Nongravid female of *Pediculoides ventricosus*. (Ewing)

Genus Tarsonemus Canestrini and Fanzago

Tarsonemus species have all the legs present and well developed, also the pseudostigmatic organs are present in the female. In the female each posterior leg ends in two long setae, while in the male they are modified into claspers and each usually terminates in a large claw. Members of this genus are plant feeders, being found on the leaves or blossoms of many herbaceous plants. Several injurious species are included.

Genus Acarapis Hirst

Acarapis includes but a single species, *A. woodi*, the mite which causes Isle of Wight disease among adult honey bees. This mite was originally described by Rennie as a species of *Tarsonemus*, and is remarkably similar to the plant feeding species of that genus in many respects. However, the loss of the pseudostigmatic organs and the shortening

of the posterior legs indicate degenerative changes sufficient for a generic distinction.

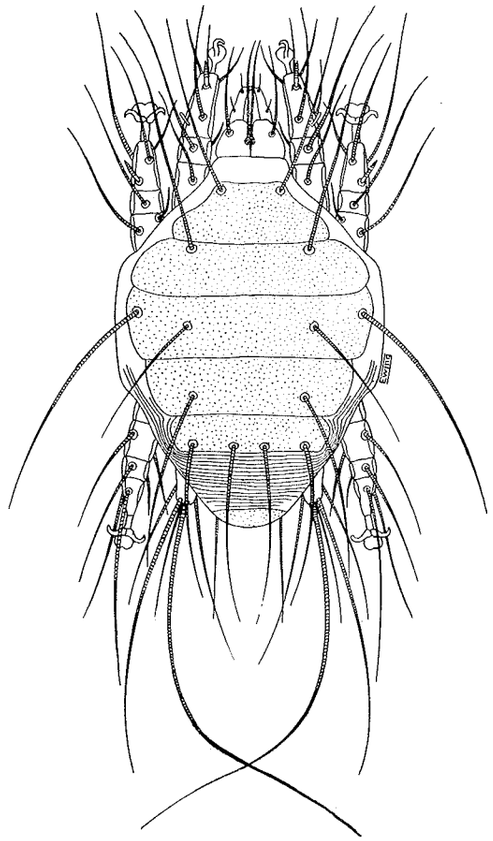

Figure 23. *Acarapis woodi*, dorsal view of female. (Original)

The Tracheal Mite of the Honey Bee, *Acarapis woodi* (Rennie) (Fig. 23), was demonstrated by Rennie, White and Miss Harvey (1921) to be the cause of a serious disease of adult bees known as "Isle of Wight disease." The mites enter

the thoracic spiracles and live and reproduce in the thoracic tracheae. Here their activities bring out a partial or complete paralysis of the flight muscles, causing the bees to crawl about the environs of the hive because they can not fly. Such diseased bees are known as "crawlers." This mite is known only from Europe up to the present.

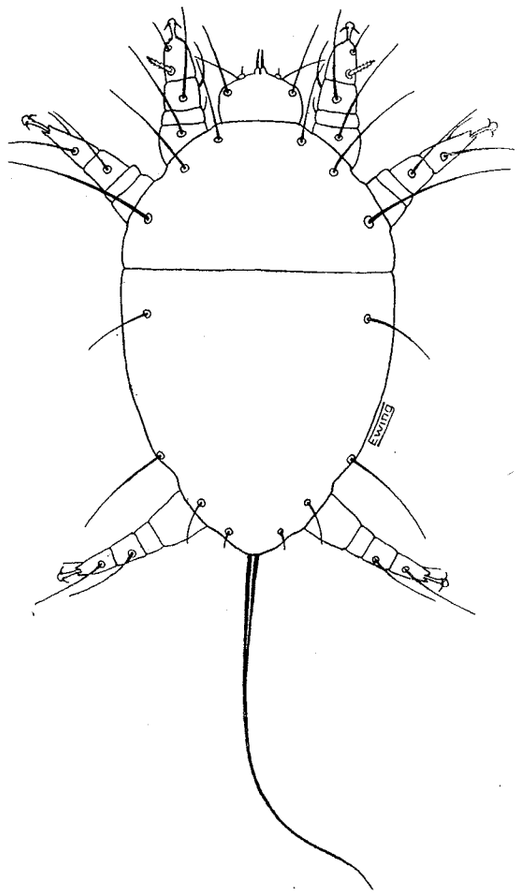

Figure 24. *Locustacarus trachealis*, female from above. (Original)

Genus Locustacarus Ewing

Locustacarus is based upon a single species, *L. trachealis*, found in the tracheae of grasshoppers. The nearest affinity of this genus is not with *Acarapis*, however, but with *Eutarsopolipus* Berlese, which is not a genus of tracheae infesting species. In *Locustacarus* (Fig. 24) both sexes have six legs; the female is provided with at least one dorsal plate on the abdomen; and the male is without stout, forceplike, posterior appendages.

The Tracheal Mite of Grasshoppers, *Locustacarus trachealis* Ewing (Fig. 24), was first found in Kansas in 1914, several years before the discovery of *Acarapis woodi*, but the publication of the observations on this type of parasitism was not made until eleven years later (Wehrle & Welch, 1925). Eggs and different instars occur in the principal tracheae and air sacs of the head, thorax and first six abdominal segments. The two grasshopper species infested are, *Hippiscus apiculatus* and *Arphia carinata*.

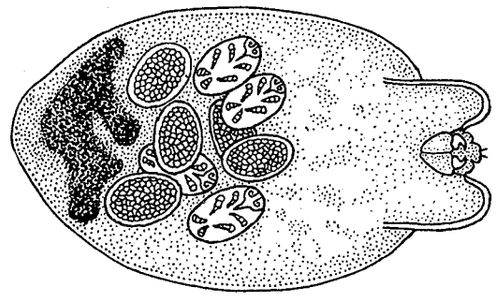

Figure 25. Ventral view of female of *Podapolipus reconditus*. (After Rovelli & Grassi)

Genus Podapolipus Grassi and Rovelli

The limit of degeneration in the Acarina is reached in the genus *Podapolipus*. The adult female, as is noted in the accompanying figure (Fig. 25) of *P. reconditus*, is but little more than a minute lump of putty-like tissue about the size

of the head of a pin. In the immature stage the female is hexapod, as the male is throughout life. This species is found under the elytra of certain Old World beetles.

The Cheese Mites

Superfamily TYROGLYPHOIDEA

Members of the superfamily Tyroglyphoidea, are sometimes called cheese mites, because of the frequency with

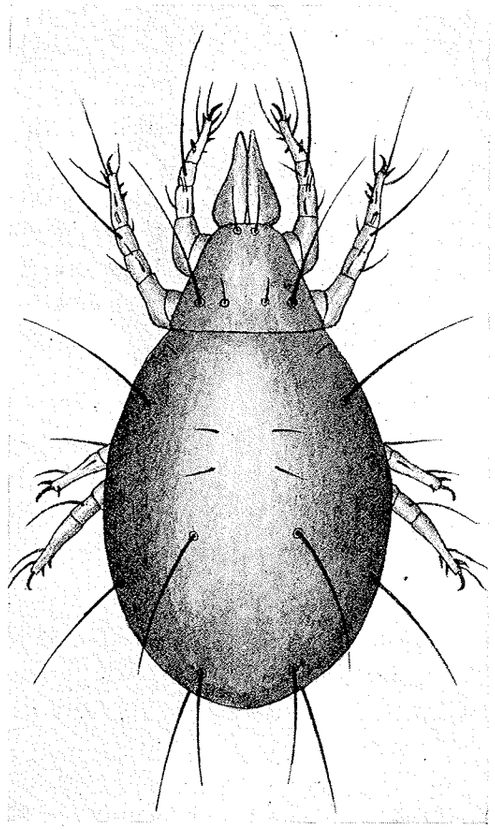

Figure 26. A cheese mite, *Rhizoglyphus phylloxerae*. (Ewing)

which a few of the best known species are found infesting cheese. Their attacks are not confined in the least to cheese, however, and these same species are found on a variety of other food products. Most species feed upon decaying organic matter, and a few are parasitic. The Tyroglyphoidea are the most generalized of the atracheate mites. In most species the chelicerae are chelate; the legs, four in number, are five segmented and terminated with a claw and small caruncle; the skin is without fine parallel folds, and there are few setae. These may be either simple or again wonderfully modified into featherlike structures.

Many cheese mites pass through a migratory nymphal instar, during which time they remain attached to some arthropod by means of several caudal suckers and take no food. Such nymphs are frequently found in large numbers on beetles and flies. The eggs of cheese mites are whitish, slightly oblong and broadly rounded at the ends.

Superfamily SARCOPTOIDEA

In this superfamily are placed most of the parasitic atracheate mites. The group includes a few families that are well defined among themselves and have in common, besides their parasitic habits, the characters here given.

External Morphology: The mouth-parts are degenerate, the palpi being reduced in number of segments and more or less fused with the rostrum; the chelicerae are greatly reduced. The skin has very fine paralleled folds and but few and simple setae. The legs are short, frequently modified for clasping, and usually each is terminated with a stalked sucker.

Life History: Members of the superfamily are parasitic throughout life and on the same host individual. They infest the skin or the hairs or feathers of the host. The eggs are laid either attached to the hairs or feathers of the host or in the host's skin. These are oblong in shape with rounded

ends. Usually sexual dimorphism is pronounced, the males frequently showing modifications of the legs for clasping or holding the female. Females are frequently fertilized before the last skin is shed.

Classification: The families here given are placed in the superfamily because of certain morphological characters they hold in common. A justification for this is found in following Canestrini and Kramer (1899) who have reviewed the group for the world. It is not believed that the group is one of phylogenetic unity.

KEY TO THE FAMILIES OF SARCOPTOIDEA

1. Either maxillae or some of the legs modified into hair clasping organs. Parasitic on mammals.....LISTROPHORIDAE
   Without any specialized apparatus for clasping the hairs of mammals. Parasitic on insects, birds or mammals..... 2
2. Body strongly depressed; sexual dimorphism sometimes very pronounced. Living among the feathers of birds ANALGESIDAE
   Body seldom strongly depressed. Not found in or on the feathers of birds. Soft-bodied mites..... 3
3. Inhabiting the living tissues of vertebrates..... 4
   Parasitic exclusively on insects..... CANESTRINIIDAE
4. Vulva longitudinal. Parasitic in the tissues of birds CYTOLEICHIDAE
   Vulva transverse; mouth-parts free. Parasitic on or in the skins of birds and mammals.....SARCOPTIDAE

Family LISTROPHORIDAE

In this family are placed certain genera of atracheate parasitic mites that infest mammals and cling to the hairs of the same by means of a hair clasping apparatus. This apparatus represents either a modification of the maxillae, or of the first two pairs of legs or again of the last two pairs. In addition to having the legs modified for clasping a hair, the males of some of the genera have either the third or fourth pair of legs modified for clasping the female. The family is a small one and has been studied particularly by

Trouessart, 1918. No species of economic importance is known.

KEY TO THE GENERA OF LISTROPHORIDAE

1. Body depressed, or flattened dorso-ventrally..... 2
   Body compressed, or flattened laterally; first two pairs of legs flattened, curved and adapted for hair clasping..... 9
2. Each leg of the first two pairs provided with a caruncle distally..... 3
   Legs of the first two pairs without caruncles..... 8
3. Maxillae modified for hair clasping, but none of the legs modified for this purpose..... 4
   Maxillae without hair clasper, but some of the legs modified into claspers..... 5
4. Coxae of third pair of legs not united *Listrophorus* Pagenstecher
   Coxae of third pair of legs dilated and fused together to form a large disc, equal in width to that of the abdomen *Euryzonus* Trouessart
5. Legs of the first two pairs modified into hair claspers.... 6
   Legs of the first two pairs not modified into claspers, but those of the last two pairs so modified..... 7
6. Body much broader than high. Type species from Africa *Listrophoroides* Hirst
   Body but slightly broader than high. Type species from Tasmania.....*Campylochirus* Trouessart
7. Last two pairs of legs of males and females the same; and in both sexes each ending in a hard, transverse disc *Trichoecus* Canestrini
   Last two pairs of legs not alike in the two sexes, and not terminating in transverse discs..... *Myocoptes* Claparède
8. Hair clasping legs greatly broadened distally into a truncated shovel.....*Schizocarpus* Trouessart
   Hair clasping legs of about the same width for most of their length, being flattened, curved and pointed distally *Chirodiscus* Trouessart & Neumann
9. Legs of first two pairs about as broad as long and without caruncles; sternal region between legs II and III normal; legs IV of male not enormous..... 10
   Legs of first two pairs much longer than broad and each provided with a caruncle; sternal region between legs II and III provided with a pair of clam-shell-shaped structures for encompassing a hair; legs IV of male enormous *Atopomelus* Trouessart

10. Third pair of legs ending in one long and two short clawlike structures. . . . . *Alabidocarpus*, new genus
Third pair of legs ending in two spines
Labidocarpus Trouessart

SYNONYMY OF GENERA OF LISTROPHORIDAE

Haptosoma P. Kramer, 1896 = *Schizocarpus* Trouessart, 1896.
Chirodiscoides Hirst, 1917 = *Campylochirus* Trouessart, 1893.
Trichobius Canestrini, 1897 (name preoc.) = *Trichoecus* Canestrini (1899).

Genus LISTROPHORUS Pagenstecher

In *Listrophorus* the body is compressed; while the maxillae are modified into a large pair of clam-shell-like structures for clasping a hair. Each of the legs terminates in a sucker distally, none being modified for hair clasping. The abdomen of the male is flattened toward the tip and is somewhat bilobed and is provided with a pair of ventral suckers. Although many species probably exist in nature only a few have been described.

Listrophorus gibbus Pagenstecher is found on rabbits. In this species the male has a long, flat, bilobed abdominal appendage behind, that is equal in length to half the width of the body.

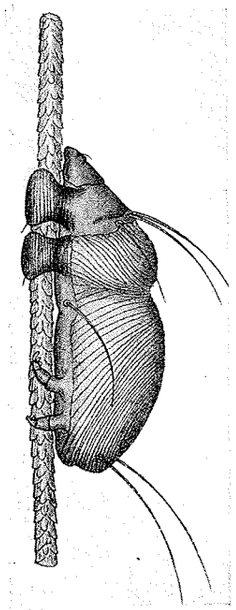

Figure 27. *Alabidocarpus compressus.* (Ewing)

Genus LABIDOCARPUS Trouessart

Species of this genus have the body compressed and the first and second pairs of legs flattened distally and incurved so as to function as hair claspers. Each leg of the third pair ends in two spines. Species of this genus superficially resemble gall mites, being somewhat vermiform and having the skin thrown into annular folds.

Genus MYOCOPTES Claprède

In *Myocoptes* it is the last two pairs of legs that are modified for hair clasping. They are much enlarged and do not have the terminal stalked sucker. The two posterior pairs of legs in the two sexes are different. In the female they are equally enlarged and provided with a few clavate spines; in the male the third and fourth pairs of legs are unequal and are without the clavate spines.

Myocoptes musculinus Koch is frequently found on mice, each mite tightly clutching a single hair at its base. After the mouse host is dead the mites will leave the body and crawl to the tips of the hairs where they are observed as tiny white specks.

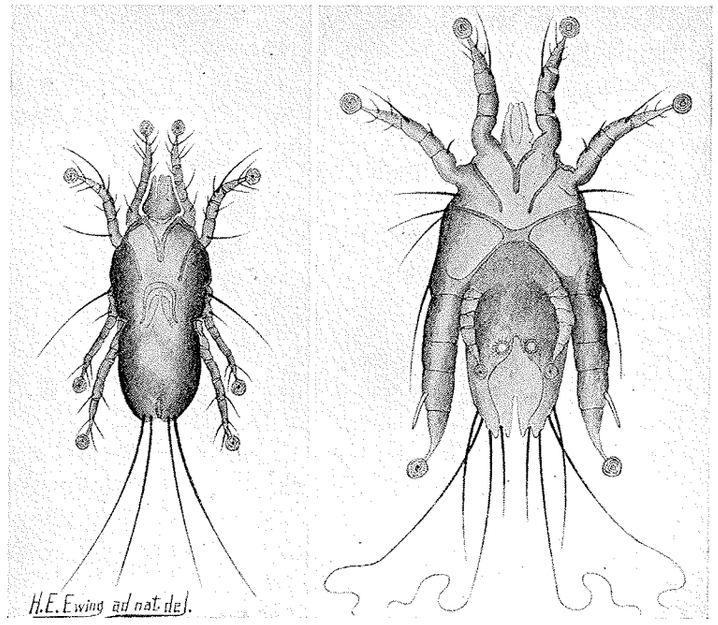

Figure 28. *Megninia magna;* female (to the left) and male. (Ewing)

The Feather Mites

Family ANALGESIDAE

Feather mites are found upon or among the feathers of birds. Members of some of the genera frequent the feathers of the body, others those of the head or neck, and some the long flight feathers of the wings. They are small, greatly flattened (dorso-ventrally) mites, with the legs laterally placed and usually each ending in a sucker. Sexual dimorphism is pronounced (Fig. 28), the male being the larger and in some genera having one pair of legs enormously enlarged for holding the female.

The eggs of feather mites are oblong, and as a rule very much longer than broad. They are usually laid attached to the barbs of the feathers, where a whole row of them may be found lying end to end between two adjacent barbs. A migratory nymph may occur in the life history of some species, and in most species a copulating nymphal stage precedes that of the adult female. Feather mites are clearly related to the itch mites or the Sarcoptidae as is shown by the parallel striations on their skin and the presence of suckers on their tarsi. The division of the family into four sections by Trouessart (1916) is here followed, the sections being regarded as subfamilies.

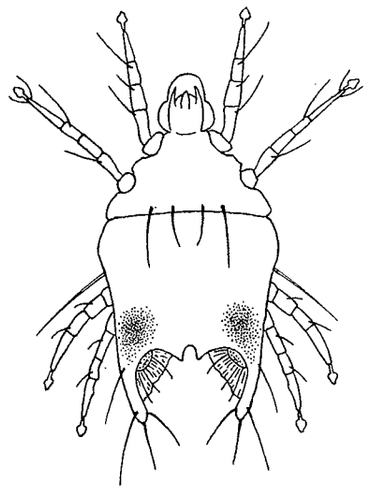

Figure 29. *Pterolichus* sp. (After Banks)

Subfamily Pterolichinae

The Pterolichinae are rather robust feather mites. The adult females are provided with two or more dorsal plates. In the larvae, nymphs and the adult females the abdomen is entire, not lobed. Males usually have either or both of the first two pairs of legs enlarged, but seldom the third or fourth pair.

Members of this subfamily live among the flight feathers of parakeets, birds of prey, pigeons, gallinaceous birds, crows and certain of the passerines. In all, thirty-five genera, or a little over half of all the genera of the Analgesidae, are included in the family. Some of the better known are: *Bdellorhynchus* Trouessart, *Dermoglyphus* Mégnin, *Falculifer* Railliet, *Freyana* Haller, *Pterolichus* Robin (Fig. 29) and *Syringobia* Trouessart and Neumann.

Subfamily Analgesinae

In this group the tarsi of the first two pairs of legs usually have a triangular tubercle on the ventro-external aspect, and there is usually a pair of vertical setae on the cephalothorax. Males may be much larger than the females and with an enormous development of the third or fourth pair of legs. Adult females are similar to the copulating nymphs.

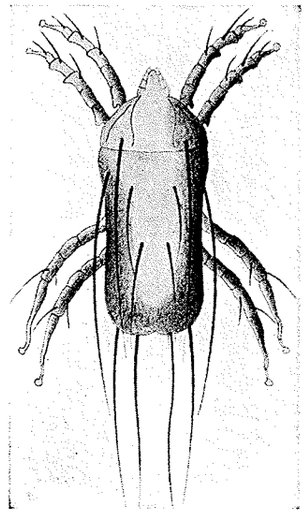

Figure 30. *Analges passerinus*, female. (Ewing)

Members of this subfamily are not found among the flight feathers of the wings, but in a variety of other situations among the feathers of the hosts. They are not confined to any special groups of birds. Seventeen genera are contained, some of the best known being: *Analges* Nitzsch (Figs. 30 and 31), *Hemialges* Trouessart, *Megninia* Berlese, *Pteralloptes* Trouessart and Mégnin and *Xolalges* Trouessart.

Subfamily Proctophyllodinae

In this group the abdomen of the females is bilobed posteriorly, and neither of the last two pairs of legs in the males is usually enlarged. Vertical setae of the cephalothorax are usually wanting. These feather mites occur on certain groups of land birds. They infest by preference the wing feathers, but also feathers of the back and flank.

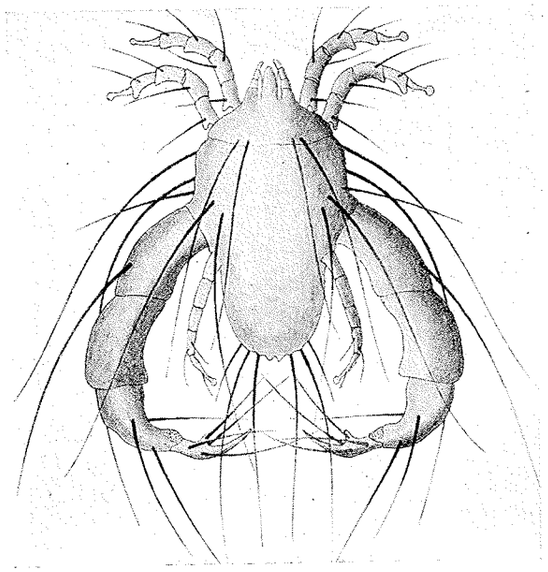

Figure 31. *Analges passerinus*, male. (Ewing)

Nine genera are included in the subfamily. They are *Allanalges* Trouessart, *Alloptes* Canestrini, *Fayettea* Trouessart, *Joubertia* Oudemans, *Montesauria* Oudemans, *Proctophyllodes* Robin, *Pterodectes* Robin, *Pterophagus* Mégnin and *Trouessartia* Canestrini.

Subfamily Epidermoptinae

In this subfamily are placed a few genera that include species that live next to the skin of the hosts among the

down. They are very small acarids and are not easily separated from members of the other subfamilies on morphological characters. Only six genera and a small number of species are included. These genera are: *Dermatium* Trouessart and Neumann, *Epidermoptes* Rivolta, *Heteropsorus* Trouessart and Neumann, *Microlichus* Trouessart and Neumann, *Pachylichus* Canestrini and *Rivoltasia* Canestrini.

Family CYTOLEICHIDAE

In the family Cytoleichidae are placed two genera of mites that are very closely related to the itch mites. They are found in various situations in their hosts, but especially in the air passages and air cells. Both the tarsal claws and the tarsal suckers are much reduced or wanting. The vulva of the female is longitudinal.

Key to the Genera of Cytoleichidae

1. Body stout and without any demarcation between the cephalothorax and abdomen; each leg terminated with a very, small sucker..... *Cytoleichus* Mégnin

   Body elongate and with a line between cephalothorax and abdomen; each leg of the first two pairs ending in a claw those of the last two pairs ending in a claw and suckerless, pedicel..... *Laminosioptes* Mégnin

Generic Synonym in Cytoleichidae

Symplectoptes Railliet, 1885 = *Laminosioptes* Mégnin, 1880.

Genus Cytoleichus Mégnin

In *Cytoleichus* the stout body shows no demarcation between cephalothorax and abdomen; and the legs, which are of moderate length, end in small, knoblike, pedicellate suckers. The body is practically nude. One species is of some economic importance.

Cytoleichus nudus (Vizioli) (Fig. 32) occurs in chickens, turkeys and pheasants, and is reported from both the Old and

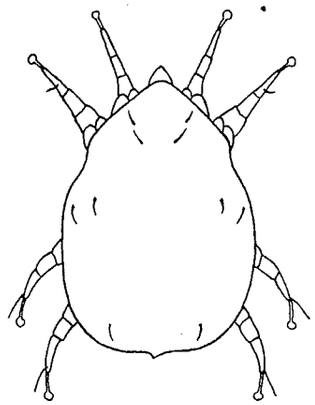

Figure 32. *Cytolichus nudus.* (After Banks)

New Worlds. Some authorities have suspected it as causing disease. The use of certain insecticides about poultry yards is said to restrict the mites.

Genus Laminosioptes Mégnin

The very long body of *Laminosioptes* shows a line of demarcation between the cephalothorax and abdomen. The legs are short, and the first two pairs end in a stumpy claw and a few very short spines. Each leg of the last two pairs has a long, suckerless pedicel.

Laminosioptes cysticola (Vizioli) (Fig. 33) occurs in chickens. The living mites are found in the tissues of the hosts, while the dead ones are surrounded by cysts.

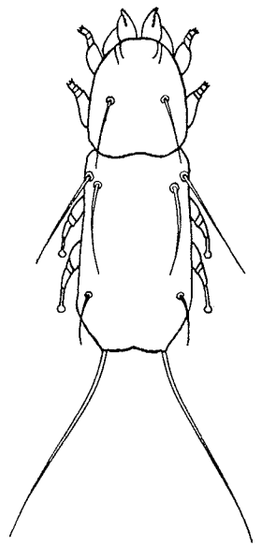

Figure 33. *Laminosioptes cysticola.* (Banks)

The Itch Mites

Family SARCOPTIDAE

Itch mites are so-called because of the intense prurience or itching produced by many of the species. They are skin infesting Acarina, and for the most part are to be found on the surface of the skin underneath the scabby formation which their activities induce. In a few instances itch mites burrow into the skin in the manner of a gopher burrowing into the ground.

Itch mites apparently were derived from the skin-infesting feather mites of the subfamily Epidermoptinae, from which they can scarcely be separated on morphological grounds. In them we observe either the modification or the degeneration and loss of the tarsal suckers. The mouth-parts have become further reduced and consolidated, the chelicerae being adapted for cutting and tearing; the body setae are reduced in number, or substituted by scales or minute, stubby spines; the legs have become greatly shortened.

Fürstenberg (1861) gave us an excellent account of the more common species on man and domestic animals; while Canestrini and Kramer (1899) have reviewed the species of the world. More careful research is yet needed on the minute details of the external anatomy of our most common species before the synonymy can be satisfactorily cleared up.

Key to the Genera of Sarcoptidae

1. Tarsal suckers with unsegmented pedicels 2
   Tarsal suckers with segmented pedicels; males with rudimentary posterior legs and with anal suckers. *Psoroptes* Gervais
2. Both sexes provided with tarsal suckers on all legs *Psoralges* Trouessart
   One or both of the sexes with at least one pair of legs without tarsal suckers 3
3. Males with all the legs provided with a tarsal sucker 4
   Some of the legs of the males without tarsal suckers 9
4. Females with some of the legs provided with tarsal suckers 5
   Females with tarsal suckers wanting on all the legs 8
5. Females with tarsal suckers on the first, second and fourth pairs of legs . . . . . *Chorioptes* Gervais
   Females with tarsal suckers only on the first and second pairs of legs 6
6. Male with abdomen two lobed behind and provided with anal suckers . . . . . *Caparina* Canestrini
   Male with abdomen not bilobed, or very slightly so 7
7. In the female each leg of the last two pairs ending in a single long seta . . . . . *Prosopodectes* Canestrini
   In the female each leg of the last two pairs ending in two long setae . . . . . *Otodectes* Canestrini

8. Females with a pair of dorsal, longitudinal chitinous bars and with long terminal setae; anal opening terminal
Cnemidocoptes Fürstenberg
Females without such bars and terminal setae; anal opening dorsal. . . . . *Nycteridocoptes* Oudemans
9. Some of the legs of females provided with tarsal suckers. . 10
All of the legs of females without tarsal suckers
Teinocoptes Rodhain
10. Anal opening dorsal; dorsal surface of body with only short, sharp setae. . . . . *Notoedres* Railliet
Anal opening not dorsal, but terminal; dorsal surface of body studded with sharp, pointed scales and small, stubby spines
Sarcoptes Latreille

SYNONYMY OF THE GENERA OF SARCOPTIDAE

Dermatodectes Gerlach, 1857 = *Psoroptes* Gervais, 1841.
Dermatokoptes Fürstenberg, 1861 = *Psoroptes* Gervais, 1841.
Symbiotes Gerlach, 1857 (name preoc.) = *Chorioptes* Gervais, 1859.
Dermatophagus Fürstenberg, 1861 = *Chorioptes* Gervais, 1859.
Dermatoryctes Ehlers, 1873 = *Cnemidocoptes* Fürstenberg, 1870.
Eusarcoptes Railliet, 1893 = *Sarcoptes* Latreille, 1802.

Genus CHORIOPTES Gervais

In *Chorioptes* the tarsal suckers have unsegmented pedicels and occur on all the legs of the male and on the first, second and fourth pairs of legs of the female. In the male the last pair of legs is greatly reduced, and the tip of the abdomen is bilobed and provided with very long setae.

Chorioptes equi (Gerlach) lives in colonies on the feet of horses producing a disease known as foot-mange. It has been reported from various European countries.

Chorioptes bovis (Gerlach) infests cattle, first appearing about the base of the tail from which situation the mites spread to other parts of the body.

Genus OTODECTES Canestrini

Otodectes species have suckers, with unsegmented pedicels, on the first two pairs of legs of the female and on all the legs of the male. The hind legs of the male are smaller

than the third pair, and the male abdomen is not bilobed. Members of the genus infest mammals and are held to be oviparous.

Otodectes cynotus (Hering) infests the ears of dogs and cats and occurs in America as well as the Old World. When the inner ear becomes involved deafness may be produced. Hunting dogs infested with this mite have been known to go into convulsions.

Genus CNEMIDOCOPTES Fürstenberg

Males have the tarsus of each leg terminated with an unsegmented, sucker bearing pedicel; females have all the tarsi without such pedicellate suckers. In the females there is a pair of dorsal, longitudinal, chitinous bars that pass backward from the anterior margin. The anal opening is terminal.

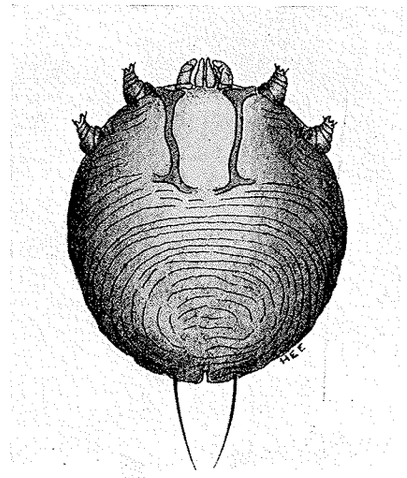

Figure 34. *Cnemidocoptes mutans.* (Ewing)

Chicken Scab Mites, *C. mutans* (Fig. 34) and *C. gallinae* Railliet, produce a disease of chickens known as scaly-leg. The mites pass beneath the scales of the leg and lacerate the skin. Serum and blood oozing out clot about the scales and sloughed skin so as to form matted layers of great thickness. Scaly leg occurs in America as well as in Europe.

Genus NOTOEDRES Railliet

Unsegmented sucker bearing pedicels occur on the first, second and fourth pairs of legs of the male and on the first

and second pairs of the legs of the female in *Notoedres* species. The anus is dorsal; anal suckers are wanting in the male. Only mammal infesting species are included.

The Head Mange Mite of the Cat, *N. cati* (Hering), first attacks cats about the ears, eyes and mouth. The type of scabies produced is severe, and should be cleared up as soon as detected.

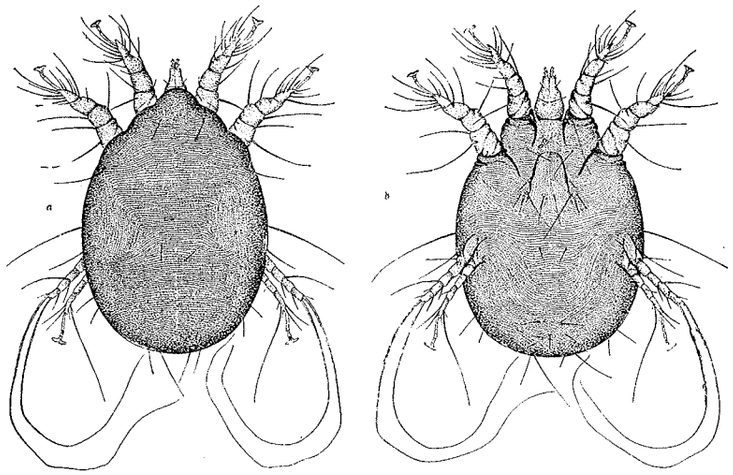

Figure 35. *Psoroptes ovis*, female,—*a*, dorsal view; *b*, ventral view. (After Salmon and Stiles)

Notoedres notoedres (Mégnin) infests rats, occurring chiefly about the ears. It is common in parts of the United States and infests several rat species.

Genus Psoralges Trouessart

Only in *Psoralges*, of all the genera of Sarcoptidae, are all the tarsi of both sexes provided with suckers. These have unsegmented pedicels. The anal opening is terminal. Males are provided with anal suckers and have the abdomen two lobed. The genus is based upon *P. libertus* Trouessart, a Brazilian species.

Genus Psoroptes Gervais

Species of *Psoroptes* differ from all other itch mites in possessing tarsal suckers that have segmented pedicels. They are large mites for their kind and infest the skin of various ungulates. A disease known as scab is produced which is serious to sheep and cattle. The males in this genus have rudimentary posterior legs but are provided with anal suckers.

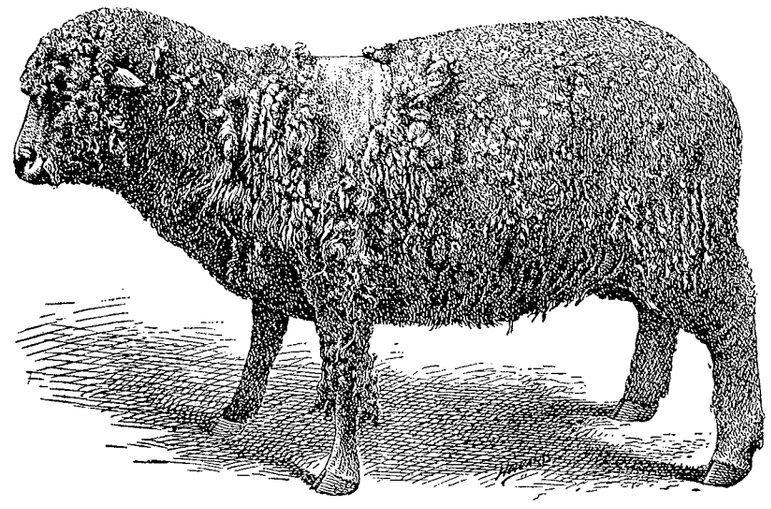

Figure 36. Sheep with advanced case of scabies. (After Salmon & Stiles)

The Sheep Scab Mite, *Psoroptes ovis* (Hering) (Fig. 35), is the most important pest of the genus *Psoroptes*. Years ago in the United States and Australia before effective measures were taken against it this mite caused one of the most serious and widespread diseases of sheep. In the early stages of the disease the wool of the infested host becomes roughened, then scabs appear. As the mites spread "tags" of wool hang from the skin (Fig. 36), and in advanced excessive cases large areas of the skin become bare. The mites

can pass directly from one animal to another when the two are in actual contact, but are carried in various other ways particularly by large tags of wool from infested animals.

The Scab Mite of Cattle, *Psoroptes bovis* (Gerlach), is morphologically almost, if not entirely, identical with the scab mite of sheep, *P. ovis*. It is frequently encountered in certain sections of the western part of the country, and

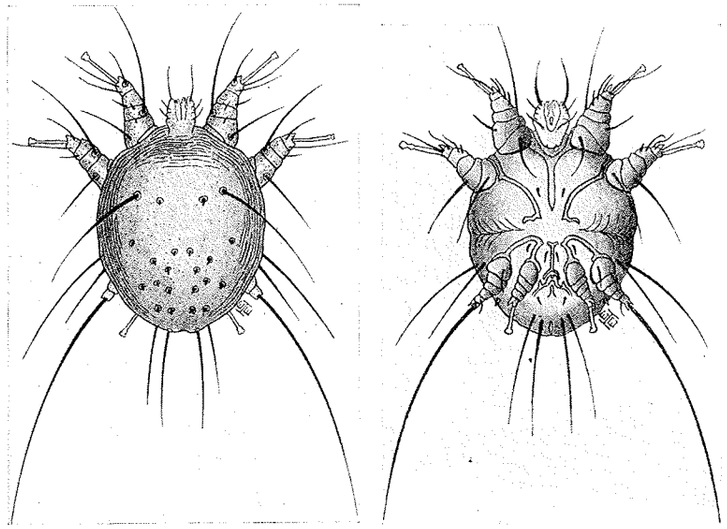

Figure 37. *Sarcoptes scabiei;* male from above (left) and from below (right), greatly enlarged. (Ewing)

causes psoroptic scabies. Imes (1918) gives effective measures for its control.

The Psoroptes of Horses, *Psoroptes equi* (Hering), is rather rarely met with, and in this country is confined largely to the western plains.

The Psoroptes of Rabbits, *Psoroptes cuniculi* (Delafond), attacks the ears of rabbits and may produce an incrustation of scabby material so thick as to fill entirely the outer ear.

Genus Sarcoptes Latreille

Sarcoptes species are almost circular in shape and are almost nude except for sharp-pointed scales and short, sharp, stubby spines. The tarsal suckers have unsegmented pedicels and are present on the first and second pairs of legs in the female and on the first, second and fourth pairs in the male. Males are without anal suckers, and the anus is terminal.

The Itch Mite of Man, *Sarcoptes scabiei* De Geer (Fig. 37), formerly a common source of acarine itch, has become a rarity in the United States and some other civilized countries. The mites usually begin their attacks between the fingers or toes, and spread from these sources. In this species the female mite burrows into the skin and lays her eggs in the burrows she makes.

Sarcoptes equi Gerlach produces scabies of horses. This mite has been reported from the United States but is of rare occurrence here.

Sarcoptes ovis Mégnin attacks the more exposed parts of sheep, such as the ears and lips. It is not of very common occurrence.

Sarcoptes caprae Fürstenberg attacks goats in the Old World, but is not known in this country.

Sarcoptes suis Gerlach occurs on swine, and infests by preference the back of the host.

Family CANESTRINIIDAE

Included in this family are sarcoptoids that infest exclusively insects. Some of them possess tarsal pedicels which indicate the the relation of the group to the Sarcoptidae. Members of this family lack the hair clasping apparatus, do not have the body either depressed or compressed, are soft bodied and usually lack well developed tarsal suckers. Up to the present thirteen valid genera have been described.

Hemisarcoptes malus Shimer (Fig. 38) is an important enemy of scale insects, preying particularly upon the oyster-shell scale in the north central states.

The Hair-Follicle Mites

DEMODICOIDEA

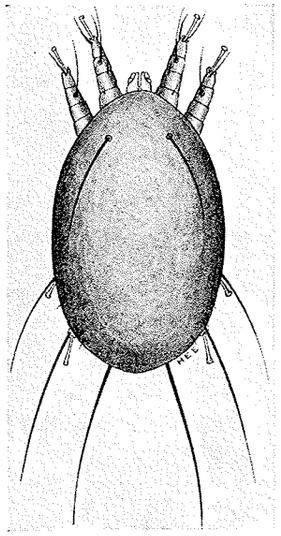

Figure 38. *Hemisarcoptes malus;* dorsal view. Ewing)

The hair-follicle mites constitute a highly aberrant group of mites that infest the hair follicles of mammals. In them the eight legs have been reduced to mere stumps, and the abdomen is drawn out and vermiform. The mouth-parts are degenerate and consolidated, the palpi being three segmented and the chelicerae minute, curved and adapted for piercing. The anus is wanting.

So minute are the hair-follicle mites that scores of them may be found in a single follicle. Heavily infested follicles become distended and may contain pus. Most species are of no serious consequence to their hosts. A single family and genus are included.

Genus Demodex Owen

The genus *Demodex* (Fig. 39) has the characters of the family Demodicidae and the superfamily Demodicoidea. For many years there was much confusion as to the species and varieties included in it. Hirst (1919) has reworked the group, applying the most up to date technique, with the result that most of the species have been put on a good morphological basis.

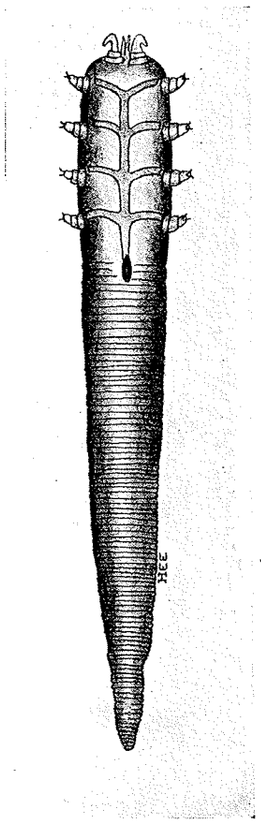

Figure 39. *Demodex phylloides.* (Ewing)

The Follicle Mite of Man, *Demodex follicularum* Simon, is very abundant in some countries, being harbored by most of the population. In the United States most individuals appear to be free from it. Although suspected by some in the past of causing certain types of dermatitis it is believed today to be harmless.

The Dog Follicle Mite, *Demodex canis* Leydig, however, is far from being harmless; on the contrary it causes the worst type of acariasis of the dog, that known as red mange. The mites appear to work in company with the bacterium that is the chief cause of the dermatitis.

The Control of Dermanyssid Mites

The tropical rat mite, *Liponyssus bacoti*, according to Bishopp (1923) may be controlled by destroying its hosts. Rats may be eliminated from many buildings by means of fumigation with hydrocyanic-acid gas, 10 ounces of sodium cyanid being employed for each 1,000 cubic feet of space to be fumigated. As this gas is very fatal to all animal life it should be used only by an expert.

The tropical fowl mite, *Liponyssus bursa*, and the northern fowl mite, *Liponyssus sylviarum*, breed upon their

hosts; hence direct action should be taken against them in the application of powders or dips. Wood (1920) recommends the use of a mixture of sulphur and soap in water, the proportions being 2 ounces of sulphur and 1 of soap for every gallon of water. Chickens should be dipped with considerable care and only on warm, sunny days.

The common chicken mite, *Dermanyssus gallinae*, lays its eggs and undergoes its transformations away from its host, its favorite breeding places being in the cracks and crevices of coops, crates and chicken houses. These should be treated with a strong insecticide, which may be applied by means of a common garden spraying outfit using a coarse nozzle. Davidson (1924) recommends a number of insecticides that are effective, among them being kerosene-oil emulsion containing 77 per cent of oil, which is diluted 1 to 3, or 25 per cent, before applying. Heavy oils from coal tar and wood tar are effective.

Protection from and Control of Chiggers

Protection from chiggers may be had by dusting sulphur next to the skin about the legs. This may be done by means of a small dust gun or by sprinkling a small amount of sulphur under the clothing and shaking the same to scatter the dust about. A better way to apply the sulphur is by means of impregnating some of the garments with a sulphur-soap solution (Ewing, 1925). The lower part of the trousers, the underwear or the stockings, or wrap puttees may be dipped in a strong warm soap solution to which about 2 ounces per gallon of sulphur has been added. After the garments are dry the loosely adhering sulphur should be shaken off before they are worn.

Chigger infested areas are hard to clean up under most conditions. Pasturing with sheep and cattle or the cutting out and burning of the undergrowth reduces their numbers greatly. Dusting trails about camps with sulphur is a very practical method to give protection to those who follow them.

Control of Straw Itch

Straw itch, caused by *Pediculoides ventricosus* (page 35), can be avoided very largely by the thrashing of infested grain in the fields immediately after harvest according to Webster (1910). Since the worst cases arise from the use of straw in bed ticks and pillows, an inspection of all straw to be used for such purposes should lead to the discovery of the mites and its rejection. Coarse grain products may be infested with meal worms which in turn bring with them the mites. They should be destroyed.

Control of Mange and Scabies

Mange and scabies are due to the presence of itch mites (Sarcoptidae) in and on the skin of the afflicted animals. They are effectively destroyed by various acaricides which are used as dips, *i.e.*, the acaricide in a liquid form is placed in a vat large enough for a diseased animal to be entirely submerged (Fig. 40). After the vat is filled to the proper level an animal is either driven or placed in the vat, the acaricide coming over its back but not its head. After a sufficient time has elapsed for the action of the fluid, the head is usually carefully pushed under and the animal removed.

The best acaricides or dips for use against mange and scab are the lime-sulphur and nicotine dips. Imes (1918) describes the preparation of both of these in detail. The lime-sulphur dip is made in the proportion of 12 pounds of unslaked lime and 24 pounds of powdered sulphur to 100 gallons of water. The lime may be slaked in a water-tight box, enough water being added to make a thin paste. The sulphur is sifted and stirred into this paste until the mixture has the consistence of mortar. The mixture is now added slowly to 30 gallons of boiling water. It is boiled about 2

hours, until the sulphur disappears from the surface. Then the pure liquid is drawn off and the sediment discarded. Water is added until 100 gallons of dip is obtained. A dip so made is $3\frac{1}{3}$ times the strength to be used in the vat. It is the concentrate and should be diluted 7 to 3 when placed in the vat.

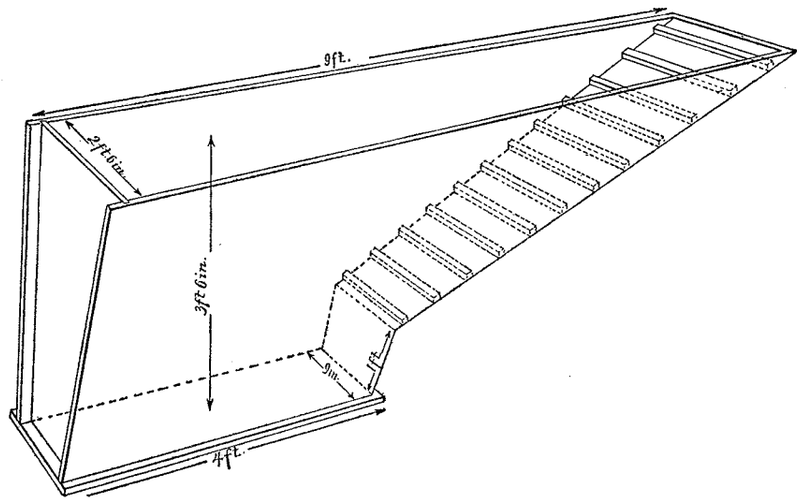

Figure 40. A small portable dipping vat for sheep. (After Salmon and Stiles)

Remedies for Red Mange of Dogs

Red mange, or demodectic mange, of the dog is the worst type of canine acariasis. It is due to the presence in the hair follicles of *Demodex canis* (see page 59). So serious is the disease in its advanced stages and so hard to cure that some have recommended the humane destruction of animals with the advanced acariasis. Hence the initial stage should be watched for and immediately upon detection should receive prompt, thorough and efficient treatment. Hall (1925) recommends the clipping of the animal before treatment, then the application of a proper acaricide. One of

these is castor oil, which should be applied daily to and around the diseased areas. Another is a mixture of the following: Kerosene 8 ounces, raw linseed oil 8 ounces, carbolic acid 1 ounce, oil of tar 1 ounce and sulphur 1/4 pound. This mixture is applied once a week, being mildly rubbed in.

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CHAPTER II

THE IXODIODEA, OR TICKS

THE ticks constitute the superfamily Ixodoidea of the order Acarina. They are distinguished from the remaining members of this order, the mites, particularly in their possession of a pair of stigmal plates situated laterally behind the last pair of legs and also usually by their large size and leathery integument. The group is not a large one in number of species, there being less than three hundred from the whole world; but in number of individuals it is one of the largest and most important of all those of ectoparasites. About a dozen genera are usually recognized as valid, excluding a number of subgenera. Ticks infest four of the five great classes of vertebrates but are more abundant on reptiles and mammals than on amphibians and birds, and in the tropics and subtropics than in temperate regions. Neumann (1911) published a synopsis of the ticks of the world. Since that time some of the genera have been monographed by a group of English workers (Nuttall, Warburton, Cooper & Robinson, 1908, 1911, 1915 & 1926).

External Anatomy

Ticks are known to most of us as they are found in an engorged condition. They are best studied, however, when unengorged, in which state their external structures are seen to advantage. The body of a tick (Fig. 41, C) is divided into a small anterior part carrying the mouth-parts, known as the capitulum (Fig. 41, A) and the body proper which bears all of the four pairs of legs.

The mouth-parts consist of the beak and the palpi. The beak includes the hypostome, the chelicerae (mandibles) and the mandibular sheath. The hypostome surrounds the chelicerae and is dartlike in shape and provided externally

with rows of recurved teeth. The shortened and much modified chelicerae are movable, and each possesses at its tip two or more curved processes known as the apophyses. The palpi are reduced and modified in nearly all of the ticks and usually are grooved next to the beak.

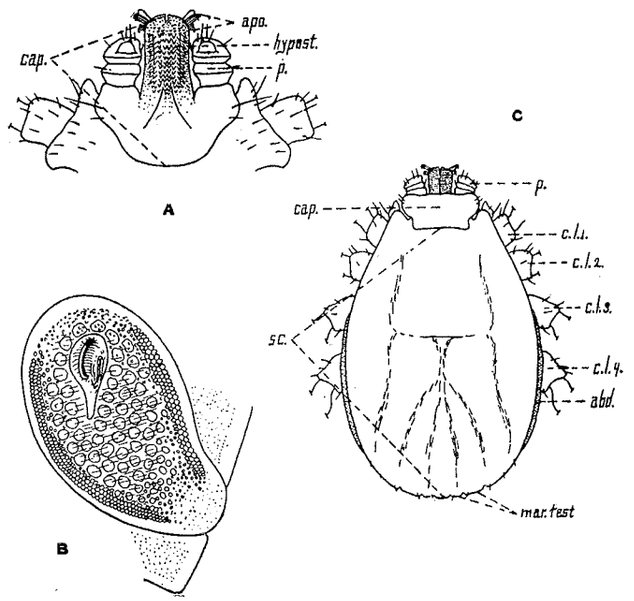

Figure 41. Detail figures of tick anatomy. A, Capitulum of male of *Margaropus annulatus; apo.*, apophyses; *cap.*, capitulum; *hypost.*, hypostome; *p.*, palpus. B, Stigmal plate of male of *Dermacentor occidentalis*. C, Dorsal view of body of *Margaropus annulatus; abd.*, abdomen; *cap.*, capitulum; *c. l. 1*, coxa of leg I; *c. l. 2*, coxa of leg II; *c. l. 3*, coxa of leg III; *c. l. 4*, coxa of leg IV; *mar. fest.*, marginal festoons; *p.*, palpus; *sc.*, scutum. (Ewing)

Above on the body proper is the dorsal shield which in the males usually covers the entire abdomen. Eyes when present are reduced and situated on the sides of the cephalothoracic region. Around the posterior margin of the abdomen there are frequently present several small folds or festoons, called the marginal festoons. Ventrally is found

the genital opening which has a similar position in both sexes, far forward between the coxae of the legs. The anus is ventral and near the posterior margin. The stigmal plates (Fig. 41, B) are found just above and behind the insertion of the last pair of legs. Their shape varies greatly among the different species and is of much taxonomic importance (Stiles, 1910). In some of the genera the males are provided with one or two pairs of plates situated at the sides of the anus. These are known as the anal plates.

The legs have been considered as being composed of six segments as follows beginning with the proximal one: Coxa, trochanter, femur, tibia, protarsus and tarsus. Two of these segments, the femur and the tarsus, have been regarded as possessing pseudoarticulations. According to the musculature, however, there is strong evidence for regarding the tick leg as being eight segmented. Each tarsus terminates, in nearly all species, in a pair of stout claws and a padlike pulvillus.

Life History

Eggs of ticks are laid in one or more masses in the surface soil or under accumulations of leaves, humus etc. Each female lays from two to ten thousand eggs.

The tick larva, known as a "seed" tick, hatches from the egg as a hexapod individual and is very hardy and can endure fasting for many days. The larvae leave the ground where they hatched and scatter about, climbing up on the vegetation to wait for a chance to attach to a host. After engorging on the first host the larva, in nearly all species, falls to the ground and becomes quiescent. From this quiescent stage the nymph emerges.

In the family Ixodidae the nymphs find new hosts, attach to them and engorge, after which they usually drop to the ground and transform to the adult. Nymphs, as well as adults, of the family Argasidae only visit the host to suck blood and do not inhabit the same.

Adults attach to the final host and mating takes place there, the males frequently remaining attached to the ventral side of the females for several days. The pregnant female engorges until she is many times her former size, then falls to the ground to lay her eggs, immediately after which she usually dies. Hooker, Bishopp and Wood (1912) have worked out the life histories of several North American Ticks.

Origin and Relationships

Ticks have undoubtedly originated from mites similar to those that are now placed in the parasitic family Dermanyssidae, which in turn have originated from free living types similar to those going into the family Parasitidae. The origin of the ticks from such parasitic mites was early suggested by the similarity of many of the structures in the two groups, particularly in the lateral position of the spiracles.

The discovery by Neumann (1902) of a species, *Spelaeorhynchus praecursor*, occurring on bats has given us an excellent intergrade between the ticks and mites. Although this species shows degeneration in the loss of the tarsal claws, it is so primitive a tick that some authorities claim it is a mite instead of a tick. This species yet retains the ventral plate, the simple, untoothed hypostome and the maxillae. Reproduction is by means of a single large egg which hatches inside the body, as is the case in certain gamasid mites.

Classification

Although the ticks were only recognized as a family by the early entomologists they have in recent years been regarded as constituting either a suborder or superfamily. Canestrini was the first to propose a suborder for the ticks, that of Metastigmata. This ranking of the ticks and this name has been followed with more or less consistency since

Canestrini proposed it. But Nuttall, Warburton, Cooper and Robinson (1911), as well as others, have followed Banks (1908) in regarding the ticks as constituting the superfamily Ixodoidea. The present writer follows Neumann (1911) in considering the mitelike *Spelaeorhynchus* a tick, but would give family rank to the genus, following Oudemans (1902).

Key to the Families, Genera and Subgenera of Ixodoidea

1. Sternal plate present; adults without tarsal claws; body provided in front with a broad, hoodlike, chitinous projection; chelicerae situated in a large buccal cavity; genital opening posterior, just in front of anus . . . . Spelaeorhynchidae 3
   Sternal plate wanting; tarsal claws present in all stages; body not provided in front with any projecting hoodlike structure; chelicerae not situated in a buccal cavity; genital opening situated far in front of anus, between the coxae 2
2. Mouth-parts hidden from above by the projecting margin of the body and with slender, ungrooved palpi; scutum wanting; stigmal plate usually in front of last pair of coxae Argasidae 4
   Mouth-parts not hidden from above; palpi, except in the males of a few species, grooved on the inside; scutum present; stigmal plates behind and lateral to the last pair of coxae Ixodidae 5
3. Only one genus contained . . . . . *Spelaeorhynchus* Neumann
4. Body flat, with projecting margins and a distinct marginal border; eyes absent . . . . . *Argas* Latreille
   Body depressed but not flat and without marginal border; eyes frequently present . . . . . *Ornithodoros* Koch
5. No posterior marginal festoons and males without any caudal process; eyes absent; stigmal plates almost circular 6
   Either posterior, marginal festoons present (indistinct in engorged females) or males with a caudal process; eyes frequently present; stigmal plates usually not at all circular 8
6. Palpi of males not grooved on their inner surface 7
   Palpi of both sexes grooved on their inner surface; capitulum not angulate on sides . . . . . *Ixodes* (*Ixodes*) Latreille
7. Third segment of male palpus very long, pointed, coneshaped; posterior margin of abdomen of male with brushes of setae. Parasitic on birds . . . . . *Ixodes* (*Ceratixodes*) Neumann
   Third segment of male palpus short, swollen and with broadly

rounded anterior margin; male without brushes of setae; legs very slender. Parasitic on bats
Ixodes (*Eschatocephalus*) Frauenfeld

8. Males with anal plates; palpi short 9
Males without anal plates; palpi either long or short 12

9. Mouth-parts more slender; second palpal segment longer than broad; stigmal plates not oval . . . . . *Hyalomma* Koch
Mouth-parts stouter; second palpal segment broader than long; stigmal plates frequently oval or subcircular 10

10. Anal groove present and conspicuous; stigmal plates variously shaped but not subcircular . . . . . *Rhipicephalus* Koch
Anal groove absent; stigmal plates subcircular
Margaropus Karsch 11

11. Second and third palpal segments normal, not produced into sharp-edged, transverse ridges; adanal plates united in front of anus, accessory plates wanting; last pair of legs of male enormous; males with a median caudal process
Margaropus (*Margaropus*) Karsch
Second and third palpal segments produced so as to form sharp-edged transverse ridges; adanal plates not united in front of anus, accessory anal plates present; last pair of legs of male only very slightly enlarged
Margaropus (*Boophilus*) Curtice

12. Palpi longer, second segment always much longer than broad
Amblyomma Koch 13
Palpi shorter, second segment but little if at all longer than broad 14

13. Eyes present . . . . . *Amblyomma* (*Amblyomma*) Koch
Eyes wanting . . . . . *Amblyomma* (*Aponomma*) Neumann

14. Eyes present; second segment of palpus not sharply angulate laterally 15
Eyes wanting; second segment of palpus produced laterally so as to form an acute angle . . . . . *Haemaphysalis* Koch

15. Capitulum subrectangular; dorsal shield usually ornate; coxae IV of male much enlarged . . . . . *Dermacentor* Koch
Capitulum hexagonal; dorsal shield not ornate
Rhipicentor Nuttall & Warburton

Generic Synonyms in the Ixodoidea

Carios Latreille, 1796 = *Argas* Latreille, 1796.
Rhynchoprion Hermann, 1804 = *Argas* Latreille, 1796.
Alectorobius Pocock, 1907 = *Ornithodoros* Koch, 1844.
Crotonus Duméril, 1822 = *Ixodes* Latreille, 1796.

Euixodes Neumann, 1904 = *Ixodes*, subgenus *Ixodes* Latreille, 1796.
Sarconyssus Kolenati, 1857 = *Ixodes*, subgenus *Eschatocephalus* Frauenfeld, 1853.
Phauloixodes Berlese, 1899 = *Rhipicephalus* Koch, 1844.
Eurhipicephalus Neumann, 1904 = *Rhipicephalus* Koch, 1844.
Adenopleura Macalister, 1872 = *Amblyomma* Koch, 1844.
Xiphiastor Murray, 1877 = *Amblyomma* Koch, 1844.
Rhipistoma Koch, 1844 = *Haemaphysalis* Koch, 1844.
Gonixodes Dugès, 1888 = *Haemaphysalis* Koch, 1844.
Herpetobia Canestrini, 1890 = *Haemaphysalis* Koch, 1844.
Opisthodon Canestrini, 1897 = *Haemaphysalis* Koch, 1844.
Prosopodon Canestrini, 1897 = *Haemaphysalis* Koch, 1844.
Pseudixodes Haller, 1882 = *Dermacentor* Koch, 1844.

Family SPELAEORHYNCHIDAE

Only the single genus, *Spelaeorhynchus* Neumann, is contained in this family which has several characters in common with the gamasid mites. Its characters have been given in the key to the smaller taxonomic groups of the Ixodoidea.

Genus Spelaeorhynchus Neumann

This genus was established for a single species, *S. praecursor* Neumann, taken from a bat, *Carollia brevicauda*, collected at Pernambuco, Brazil. Since its establishment Banks has described a second species, *S. latus*, which may prove to be only a synonym of *praecursor*. The genus is of chief interest because of the mitelike characters exhibited by it.

Family ARGASIDAE

Members of the family Argasidae have the mouth-parts concealed by the protruding flattened body; the palpi are composed of cylindrical segments and are not closely appressed to the beak. In this family the parasitic habit is not a fixed one to the extent that it is in the Ixodidae. The individuals in most instances only visit the host to suck its blood and do not attach. Members of the family are con-

fined almost exclusively to the tropics and subtropics. Only two genera are included.

Genus Argas Latreille

Members of this genus are recognized because of their flat body with its sharp edges and a definite margin, or

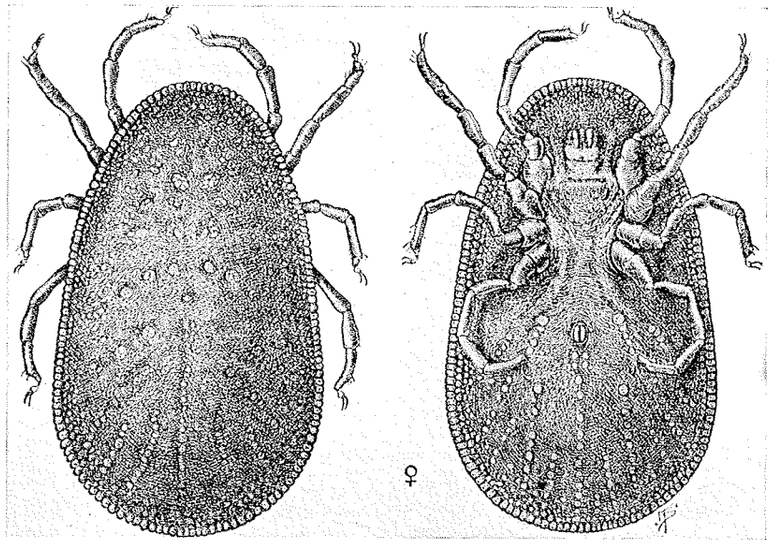

Figure 42. *Argas persicus* (Oken); dorsal and ventral views. (Bishopp)

border. Neumann (1911) in his monograph of the ticks recognized eight good species in the genus.

The Fowl Tick, *Argas persicus* (Oken) (Fig. 42), is a very important pest of chickens that is found in the warmer regions of all six of the continents. In the United States it is only found in the warmer southwestern part of the country (Fig. 43). Not only does this species cause much annoyance by its parasitic habits, but in certain countries it transmits a disease among fowls known as spirochaetosis.

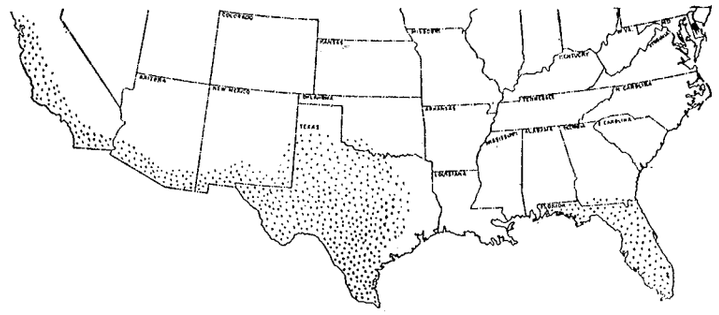

Figure 43. The distribution of *Argas persicus* in the United States.

The Pigeon Tick, *Argus reflexus* (Fabricius) (Fig. 44), is widely distributed in Europe and also occurs in North Africa and locally in North America. In this tick the sides of the body are emarginate in front of the shoulders, and the lateral margins of the body are minutely wrinkled so as to form radial striae.

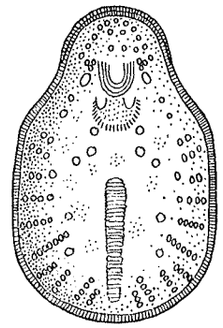

Figure 44. Dorsum of the pigeon tick, *Argas reflexus*, ×10. (After Nuttall and Warburton)

Genus Ornithodoros Koch

Species of *Ornithodoros* may be recognized from those of *Argas*, the only other genus in the family Argasidae, by having the edges of the body rounded instead of being sharp angled and the eyes frequently present. In this genus also there is no distinctly marked marginal border. Neumann (1911) in his synopsis of the Ixodoidea recognized twelve good species in the genus *Ornithodoros*. This genus, like the genus *Argas*, is confined almost exclusively to the tropics and subtropics.

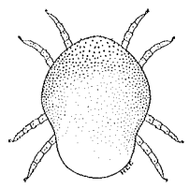

Figure 45. The spinose ear tick, *Ornithodoros megnini* Dugès. Dorsal view of the nymphal instar, the instar which is most commonly observed.

The Relapsing FeverTick of Africa, *Ornithodoros moubata* (Murray), transmits one type of relapsing fever to man. The unengorged adults of this tick are about 8 mm. in length. They feed on many domestic animals including pigs, sheep, goats and dogs and also on man and monkeys. Although confined to the continent of Africa this tick has a very wide distribution there being found from Egypt to Cape Colony. The ticks are often found in large numbers in native huts and are stated to be carried about long distances in bedding and "porter's loads."

The Spinose Ear Tick, *Ornithodoros megnini* (Dugès) (Fig. 45), is found in Mexico and the southwestern part of the United States. This tick is peculiar in a number of ways: In the nymphal instar the body is studded with short spines; by preference it attaches inside the ears of cattle; only one nymphal stage is passed during its development, and the adult tick never engorges.

The East African Ornithodoros, *Ornithodoros savignyi* (Audouin), is very closely related to the relapsing fever tick. Above, this tick is covered with small papillae or mammillae. The species occurs on most of the common domestic animals and on fowls and man. It is found in the eastern part of Africa from Egypt to Cape Colony.

Family IXODIDAE

Members of the family Ixodidae are sometimes referred to as the "true" ticks in contradistinction to the other members of the superfamily Ixodoidea. They differ from the others in one important aspect of their habits, *i.e.*, they are fixed parasites attaching themselves to their hosts for long periods. In this family the palpi are shortened, guttered on the inside and appressed to the beak. The capitulum is well developed and is not covered above by the body. In this work eight genera are recognized in the family, and three of these are divided into subgenera. Not only is this

family much the largest of the tick families, but it is by far the most widely distributed being abundantly represented in the tropics, subtropics and temperate regions, even being found in subarctic localities.

Genus Ixodes Latreille

This genus, which is here regarded as being composed of three subgenera, *Ixodes* Latreille, *Ceratixodes* Neumann and *Eschatocephalus* Frauenfeld, is easily recognized from the others of its family because of the absence in both sexes of the marginal festoons, the absence of eyes and the subcircular shape of the stigmal plates. In it are found several of the most common species attacking man and domestic animals. Nuttall and Warburton (1911) in their monograph of the genus recognize fifty-one valid species. Of these fifty-one, one belongs to the subgenus *Eschatocephalus* of Frauenfeld and one to the subgenus *Ceratixodes* Neumann.

The Castor-bean Tick, *Ixodes ricinus* (Linnaeus) (Fig. 46), receives its common name because of its resemblance to the castor-oil bean. It is common in Europe but according to Banks (1908) is rare in the United States. It occurs on nearly all of the domestic animals, but is especially prevalent on dogs.

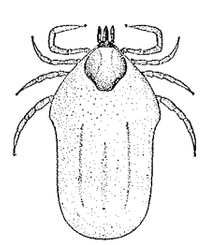

Figure 46. Engorged female of the castor-bean tick, *Ixodes ricinus*. (After Marx)

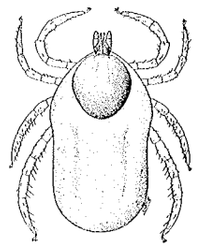

Figure 47. The black-legged tick, *Ixodes scapularis*. Female, much enlarged. (Original)

The Black-legged Tick, *Ixodes scapularis* Say (Fig. 47), is a common North American species frequently confused with the castor-bean tick. It is distinguished from the latter by having smaller porose areas on the capitulum and by having a very dark shield. This species is particularly annoying to dogs.

The Rotund Tick, *Ixodes kingi* Bishopp, occurs in the western part of the United States. The species is found chiefly upon wild animals, but is also found on dogs.

The Bat Tick, *Ixodes vespertilionis* Koch, is a long-legged tick occurring in Europe, Africa and Australia. It has been found only on bat hosts or in their haunts. In unengorged specimens the legs are much longer than the body.

Genus Hyalomma Koch

In *Hyalomma* the marginal festoons are present; the males are provided with anal plates; the palpi are short, with the second segment longer than broad; the stigmal plates are not subcircular. The genus is one of the smallest of those of ticks containing, according to Neumann (1911), four good and three doubtful species. In its distribution *Hyalomma* is restricted to the warmer countries of the Old World.

The four species recognized by Neumann are as follows: *H. aegyptium* (Linnaeus), occurring on many mammals (mostly ungulates) and man in Europe, Asia and Africa; *H. rhipicephaloides* Neumann, in Egypt; *H. syriacum* Koch, occurring on turtles in western Asia, southern Europe and Africa; *H. hippopotamense* (Denny), occurring on the hippopotamus in Africa.

Genus Rhipicephalus Koch

In the genus the posterior marginal festoons are present; the males are provided with anal plates; the second palpal segment is broader than long; the anal groove is present and conspicuous. *Rhipicephalus* is a large, Old World genus, although a few records of its occurrence in the New World have been noted due to recent introductions. Neumann (1911) lists twenty-three good species and eleven doubtful ones in this genus.

The Brown Dog Tick, *Rhipicephalus sanguineus* Latreille, is a very widely distributed species occurring in many countries as the most important tick upon the dog.

In the United States it has been introduced into several localities and has maintained itself only in the southern parts of Texas and Florida. This tick is one of the very few species to be parasitized by an insect. The parasitic species is *Hunterellus hookeri* Howard.

Other species of *Rhipicephalus* are: *R. simus* Koch, an African species, found on many wild and domestic mammals and concerned in the transmission of East Coast fever and *R. appendiculatus* Neumann, the chief transmitter of East Coast fever. The male of the last mentioned species has a prominent anal projection or tube.

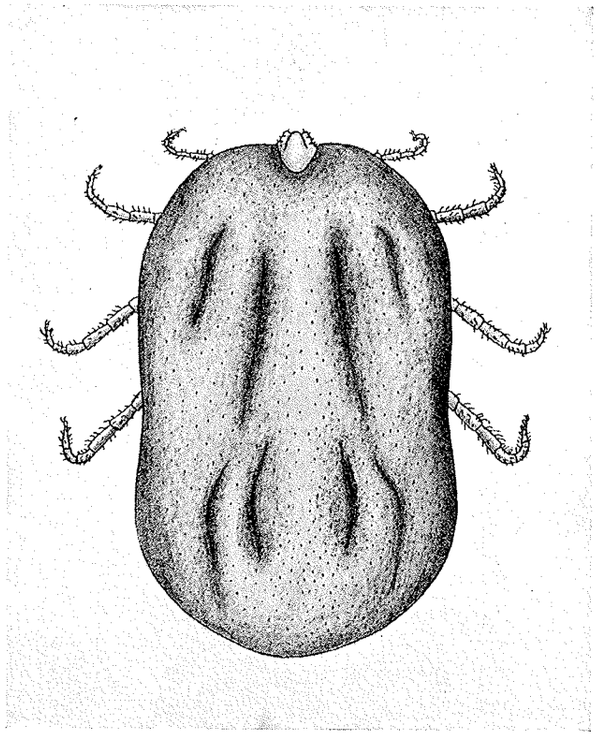

Figure 48. *Margaropus annulatus*. Engorged female, much enlarged. (Ewing)

Genus Margaropus Karsch

Margaropus is similar to *Rhipicephalus* but lacks the anal groove, and the stigmal plates are subcircular. This genus is represented by two very distinct subgenera, *Margaropus* Karsch and *Boophilus* Curtice. Some authorities consider *Boophilus* a synonym of *Margaropus*, but Nuttall and Warburton (1911) regard it as a distinct genus. The genus is a small one which is found almost exclusively on ungulates. Less than half a dozen good species are included.

The North American Cattle Tick, *Margaropus annulatus* (Say) (Fig. 48), is the transmitter of Texas fever among cattle, hence is one of the most serious tick pests of all the Ixodoidea. The males of this tick are about 2 mm. long, the unengorged females are a little longer. Both are of a brownish color and when examined with a microscope may be distinguished from any other species occurring in the United States by the prominent transverse ridges on the palpi.

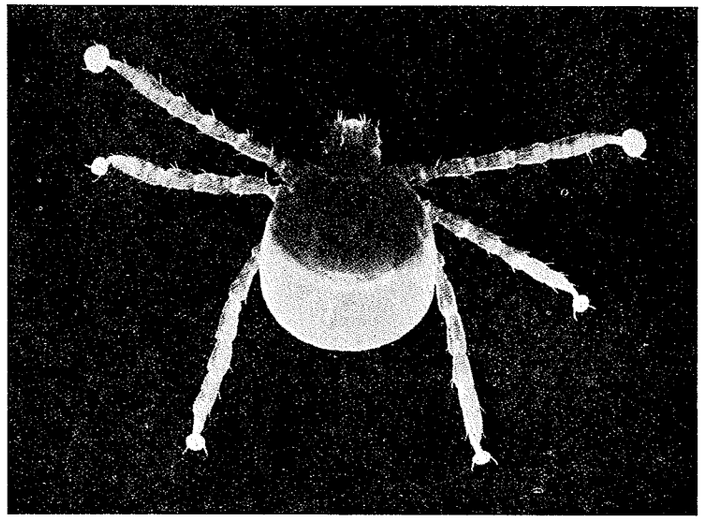

Figure 49. *Margaropus annulatus*. Larva, or "seed tick." (After Cotton)

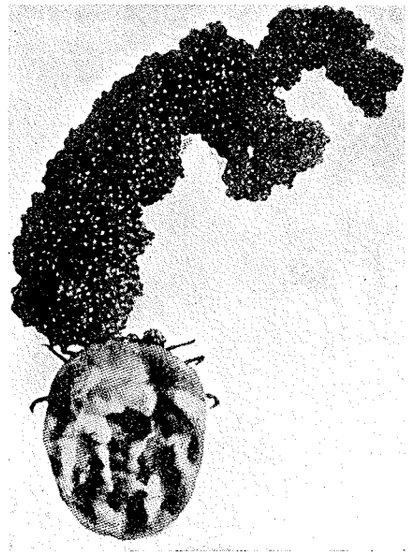

Figure 50. *Margaropus annulatus* Nearly spent female with her egg mass. (After Cotton)

This tick was first reported from the white-tailed deer, and probably is a species native to North America. It occurs on a variety of hosts but chiefly on the ungulates. Records have been made from dog and man, but it is doubtful if the tick could complete its life cycle on either of these. *M. annulatus* differs from most of the ticks in its life history for it does not leave its host to molt. Eggs are deposited (Fig. 50), several days after the female drops from the host, near the surface of the ground and usually under a cover of rubbish of some sort. As many as 4,000 may be deposited.

The tick formerly was distributed over most of that portion of the United States as is represented by the cotton growing area and northern Mexico. In 1891 a national quarantine line was established about the northern limits of its range, and inside of this line eradication was begun and continued to the present date. So successfully has the eradication campaign progressed that today the tick has been destroyed in over half of its former territory. The fever is fatal chiefly to cattle that have been shipped into infested regions. Animals reared in the south usually contract the disease while young, when they are least susceptible to injury, and after that are immune. Artificial immunity may be produced either by inoculating a young

animal with virulent blood from an infested one or by placing on the young animal a number of infested seed ticks.

The Australian Cattle Tick, *Margaropus annulatus* var. *australis* Fuller, differs from the typical form in a number of ways: The anal plates of the male are more chitinous

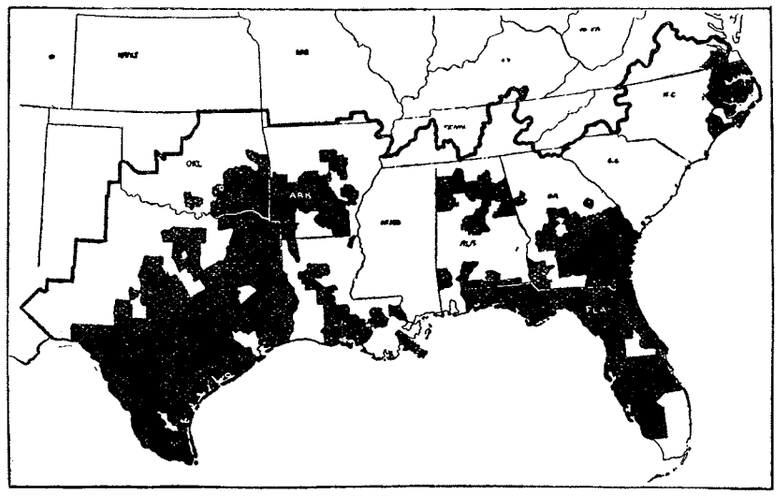

Figure. 51. Map showing the original area quarantined on account of tick fever, below the heavy line (line through California not shown); and the area freed from tick infestation and released from quarantine, white area below heavy line. (Map from Bureau of Animal Industry)

than in *annulatus*, and the postero-lateral spines of the base of the capitulum are more marked in the male of *australis*.

Genus Amblyomma Koch

Members of the genus *Amblyomma* are usually recognized very easily on account of the width of their body, the presence of the marginal festoons and the long, smooth palpi. This genus is the largest of all the tick genera.

Robinson (1926) in his monograph of it lists eighty-six valid species. Members of the genus favor reptiles as hosts and are by far more abundant in the tropics than elsewhere. Two subgenera may be recognized, *Amblyomma* Koch and *Aponomma* Neumann, the former with eyes and the latter without.

Figure 52. Cow dying from gross infestation with the North American cattle tick. (After Hunter and Bishopp)

The Gulf Coast Tick, *Amblyomma maculatum* Koch, is a very large species that occurs along the Gulf Coast in the United States. It parasitizes domestic animals, wild birds and wild mammals. Over ten thousand eggs have been reported as being laid by a single female tick.

The Lone Star Tick, *Amblyomma americanum* (Linnaeus), is an important pest of cattle in the United States. It is restricted to the eastern part of North America, occurring as far north as Labrador. It is stated that in this

species unfertilized females fail to engorge and die after about a month following attachment.

The Cayenne Tick, *Amblyomma cajennense* (Fabricious), is a tropical American species occurring as far north as southern Texas and Florida. It is broad, well marked and ornamented. Horses appear to be the favorite host of this tick although a large number of animals are attacked, including cattle, sheep, goats, pigs and dogs.

Genus DERMACENTOR Koch

The chief characters of *Dermacentor* are as follows: Marginal festoons present; palpi short, the second segment not angulate laterally; eyes present; capitulum subrectangular; dorsal shield ornate; coxae IV of male much enlarged. It is a small genus containing about a dozen good species, the most of which infest the larger mammals of the temperate regions of both the Old and New Worlds. Although several of the tick genera have been monographed, this one has been left much in need of revision. The biology of some of the North American species has been studied by Bishopp and Wood (1913).

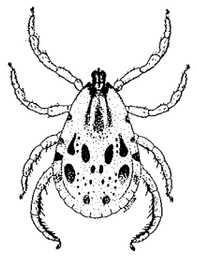

Figure 53. *Dermacentor andersoni*. Male, ×7. (Original)

The Rocky Mountain Spotted Fever Tick, *Dermacentor andersoni* Stiles (Fig. 53), also known as *Dermacentor venustus* Banks, is the transmitter of a very fatal disease of man, Rocky Mountain spotted fever. This tick is distributed throughout the intermountainous regions between the Cascades and the Rockies from the northern boundary of the United States to as far south as southern Nevada and Utah. It is never found west of the Cascade Mountains but extends east of the Rockies through most of Montana and Wyoming.

Immature stages of the tick attach to practically all of the smaller mammals living in the infested area. Adult ticks seldom attach to small mammals, but to such large ones as the mountain goat, bears, coyotes, wild cats and badgers. However, the most important of all the hosts for adults are horses and cattle.

The virus of the disease is transmitted by the bite of the tick. The seed ticks or the nymphs acquire the infection by feeding on diseased animals and transmit it to the adult tick. Ricketts demonstrated that the engorged female tick could transmit the disease to her offspring through the eggs. The tick itself is similar to the wood tick of eastern United States, *Dermacentor variabilis*, except that the silvery patches are larger and more extensive. It is even more similar to *Dermacentor occidentalis* but has stigmal plates (Fig. 54) with much narrower processes than in that species.

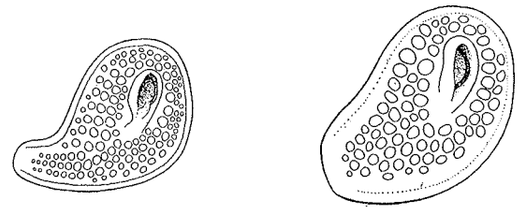

Figure 54. Stigmal plate of male of *Dermacentor andersoni* (to left) and stigmal plate of male of *D. occidentalis* (to the right). Both drawn to the same scale. (Original)

Adult males vary from about three to six millimeters in length; unengorged females may be over twelve millimeters.

The life history of *D. andersoni* is similar to that of most of the members of the Ixodidae, which drop from their host to molt. The ticks may be largely avoided by wearing of tight fitting clothing and by carefully examining the same for ticks when going into infested regions. According to Cooley the ticks can be greatly reduced in numbers by the dipping of domestic animals.

The American Dog Tick, *Dermacentor variabilis* (Say) (Fig. 55), is probably, the best known tick species in the United States. It is one that usually is encountered by picnic parties in the populous northern and eastern sections of the country. This tick is also known from the Pacific Coast, from Alaska and from Nova Scotia and Labrador. Males and unengorged females are about five millimeters in length. The dorsal shield is a reddish brown with white spots.

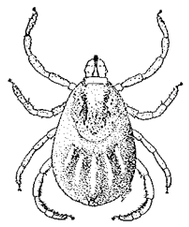

Figure 55. *Dermacentor variabilis.* Unengorged female, ×5. (Original)

The Pacific Coast Tick, *Dermacentor occidentalis* Neumann, is found along the Pacific Slope in the United States. In many localities within its range it is the most common tick encountered in the woods. Deers are especially favored hosts for this species.

The Tropical Horse Tick, *Dermacentor nitens* Neumann, is a rather small tick that is found in the American tropics. It is particularly prevalent on horses. The only locality in the United States where this tick is found is in the southernmost part of Texas. The stigmal plates (Fig. 36) in this tick are almost circular.

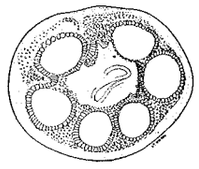

Figure 56. Stigmal plate of female of the tropical horse tick, *Dermacentor nitens.* (After Stiles)

Genus Rhipicentor Nuttall and Warburton

In this genus are placed a few species which are rather closely related to *Dermacentor* but are inornate and have a hexagonal capitulum as in the genus *Rhipicephalus*. The type species is *R. bicornis* Nuttall and Warburton.

Genus Haemaphysalis Koch

Haemaphysalis species have the marginal festoons, are blind, and have the second segment of the short palpus produced laterally so as to form an acute angle. The genus has been monographed by Nuttall and Warburton (1915) who list forty-two valid species. Of this number all but three belong to the Old World. The genus is found almost entirely upon mammals but is sparingly reported from birds and reptiles.

The Rabbit Tick, *Haemaphysalis leporis-palustris* Packard, is found throughout most of North America south of Canada as well as in at least three South American countries. Rabbits are the favored hosts. In many localities in the northern part of the United States this tick is the most common species. It is parasitized by a chalcid fly, *Ixodiphagus texanus.*

The Bird Tick, *Haemaphysalis cinnabarina* Koch, is similar in appearance and habits to the rabbit tick. For many years this species was known under the name of *H. chordeilis* Packard. Although originally described from Brazil it is known to science almost entirely from North America where it is widely distributed east of the Rockies. Occasionally this tick attacks poultry and has been known to kill turkeys.

Other species of *Haemaphysalis* may be mentioned: *H. bispinosa* Neumann occurs on many kinds of mammals in Asia, Africa and Australia; *H. concinna* Koch, a species restricted to Europe, occurs chiefly on wild mammals; *H. leachi* (Audouin) occurs on a great variety of hosts in Africa, Asia and Australia; *H. hoodi* Warburton and Nuttall is stated (Nuttall & Warburton, 1915) to be the only species of *Haemaphysalis* that is restricted to bird hosts. It is known only from Africa.

Methods of Avoiding Tick Attacks

Ticks are wingless, sluggish arthropods with a more or less restricted habitat and a definite seasonal life cycle. For these reasons much may be done by the way of avoiding their attacks. Picnickers should investigate situations to be used in their outing before they stop for the day and should be particularly careful to avoid a heavily infested spot in spreading their dinner. A low grassy place down near the creek in a cow pasture—one that may be very inviting—is liable to be heavily infested, particularly with seed ticks. When it is necessary to go into regions heavily infested or where disease carrying ticks occur, special precaution should be taken. The bed should never be made on the ground. A suspended hammock gives excellent protection. The legs should be tightly clothed, laced boots or wrap puttees are preferred. And before entering a dwelling the clothing should be changed and all adhering ticks destroyed.

To Destroy Ticks Attached to their Hosts

When ticks are attached to their hosts they may be destroyed either by individually removing them or by dipping the host in an acaricide. When they are attached to man, or to a pet animal in small numbers, the first method may be employed. First a tick irritant should be applied to the attachment point. For this purpose vaseline or very salty lard may be used. These substances have the double value of irritating the tick and of softening the skin about the attached part of the beak. If the tick does not let go itself it should be pulled off by a backward motion in the reverse direction from that indicated by the position of the tick itself. This should prevent the breaking off of the mouth-parts.

For dipping tick-infested cattle the following formula is recommended by the United States Department of Agriculture:

Sodium carbonate (sal soda)	24 pounds
Arsenic trioxide (white arsenic)	8 pounds
Pine tar	1 gallon
Water	500 gallons

Where only a few domestic animals are to be treated they may be sprayed with oil emulsion. The spray material

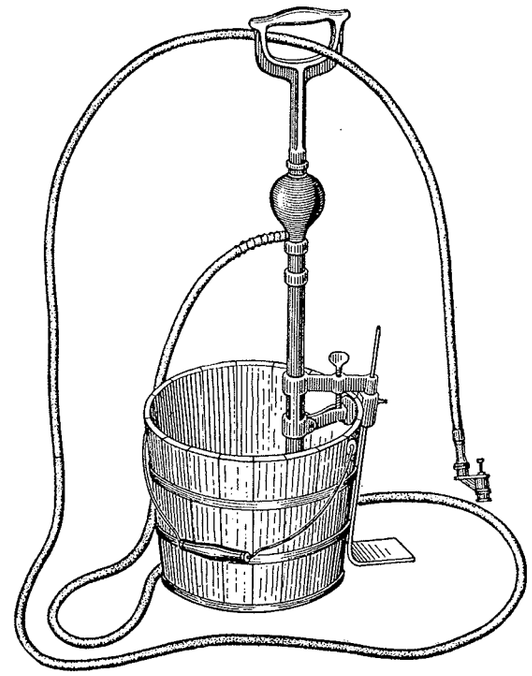

Figure 57. Outfit for spraying cattle infested with ticks. (After Graybill)

may be applied by means of a bucket spraying outfit with a coarse nozzle (Fig. 57). The following formula has been recommended for spraying purposes:

Hard soap	1 pound
Soft water	1 gallon
Crude petroleum	4 gallons

The emulsion is made in the usual way for a stock solution and should be diluted with about three times its volume of water before using.

To Destroy Unattached Ticks

When the ticks are unattached they may be destroyed by removing their hosts from the infested fields in which they occur. This is a very effective way to starve out species that are dependent largely or entirely upon domestic animals. Another way to destroy the ticks is by burning the vegetation or by plowing early in the spring or late in the fall. These methods are only applicable under favorable local conditions.

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CHAPTER III

THE MALLOPHAGA, OR BITING LICE

THE biting lice constitute the order Mallophaga, a group usually considered as one of the smaller orders of insects. It may be, however, that when a majority of the species have been described that this order will be found to contain more species than are placed in some of the larger orders. The described species were catalogued by Harrison, 1916. He listed 1520 as valid. Since then this number has been greatly increased. Biting lice were made the object of special study by the entomologists of the early part of the nineteenth century. Denny's monograph of the British "Anoplurorum" appeared in 1842, abundantly illustrated with colored plates. The most extended work ever published on them appeared in 1880 by Piaget. Osborn (1896) was a pioneer in the study of American species.

External Anatomy and Terminology

Biting lice are very small insects yet are easily discernable with the unaided eye. The smallest of them are about one millimeter in length, while the largest species are at least ten millimeters. The whole body is greatly depressed, *i.e.*, dorso-ventrally flattened. This is an adaptation to aid them in slipping easily about among the feathers or hairs of their hosts.

The head (Fig. 58) is large for the size of the body and in the suborder Amblycera has lateral longitudinal excavations for the repose of the antennae. These are called the antennal fossae. That part of the head in front of the antennae is frequently referred to as the forehead; while the swollen posterior regions are known as the temples. The clypeus forms the anterior margin of the forehead and may be separated from the rest of the head by distinct clypeal sutures which traverse the lateral marginal bands.

In some species a distinct central chitinous plate, known as the signatural plate, is developed in connection with the clypeus. Immediately in front of the bases of the antennae often may be found short chitinous processes known as the trabeculae. When well developed they frequently are movable, though are not known to perform any definite function. The mandibles are strong and heavily chitinized and may be simple, notched or toothed.

The antennal fossae may be open, or partially or completely covered, either above or below. The covering above is due to a lateral expansion of the head, and this expansion may be entire or divided by a transverse suture. Eyes (Fig. 58) are present in nearly all species and may be provided with double corneas. They are situated on or in front of the temples and frequently are marginal. The region between the temples is known as the occiput. In certain species there is a heavy chitinization of a part of the pharynx which is termed the pharyngeal sclerite (Fig. 58), and in a few genera there is a ventral plate in the gular region. This is known as the gular plate.

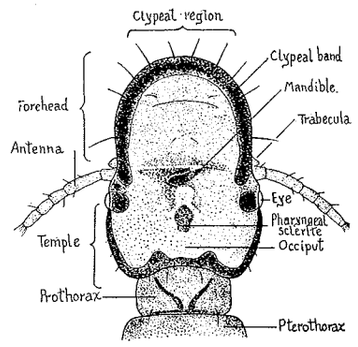

Figure 58. *Lipeurus variabilis;* head and prothorax, with parts labeled.

The thorax of the more generalized Mallophaga retains its primitive segmentation being divided into the three distinct parts as in most insects. In a majority of the genera, however, the meso–, and metathorax have become completely fused so as to form a single segment, the pterothorax. The mesothorax is greatly reduced in certain Amblyceran mammal-infesting genera; and in one of these, *Trimenopon*,

is fused with the prothorax, a condition not found elsewhere in the order.

The abdomen usually shows distinct tergal and sternal plates, and in a few genera pleural plates also, through which the abdominal spiracles frequently open. These number six pairs in most of the genera but in others only five.

The genital armature of the male, in its simplified form consists of a basal plate, at the posterior end of which is borne a larger pair of clasperlike structures, the parameres, and inside of these a smaller pair, the endomeres. When the endomeres unite distally they may give rise to a structure known as the pseudopenis. The real penis, frequently absent, is a tubular structure in front of the position occupied by the pseudopenis.

The legs are short and generally of similar structure and ambulatory in function. In some genera one or more of the legs may be modified into claspers for holding onto hairs of mammals or in a few males for clasping the legs of the female. Snodgrass (1899) has made a special study of the anatomy of the Mallophaga.

Life History and Habits

A biting louse spends its entire life upon its host. Upon the feathers of the bird or the hairs of the mammal the eggs are laid. The young nymphs when hatched are remarkably similar to the adults except for size and a lighter chitinization. The larger nymphs may be recognized from the adults by the absence of the genitalia in the male and of the gonapods, or setae which perform the function of gonapods, in the female.

Biting lice feed most extensively upon the barbules of the feathers when infesting birds, and when infesting mammals are known to feed upon cast epidermal scales and oily secretions of the skin. Blood has occasionally been found

in the stomach of certain species, but it is not known that it constitutes a part of the normal diet.

Origin and Relationships

The Mallophaga are most nearly related, according to most authorities, to the book lice or Corrodentia among the free-living insects and to the Anoplura, or sucking lice, of the parasitic ones. Of the two Mallophagan suborders, the Amblycera and Ischnocera, the first mentioned is considered as being the more generalized, hence the more primitive. In this suborder the palpi are retained, and the claws in most of the genera are two and equal.

Harrison (1916) considers the Mallophaga of the Australian marsupials (family Boopidae Mjöberg) as being the most primitive. Undoubtedly there are many facts which tend to justify such a conclusion, the two most important probably being their admittedly very generalized structure and the very primitive condition of their hosts. Yet this conclusion is based upon a highly debatable assumption, *i.e.*, that the biting lice originated as mammal parasites. This assumption is hardly the rational one according to the writer's opinion. It is to be remembered that the biting lice are practically universally present on all birds, while they are conspicuously absent from several large and important mammal groups. Then since the evidence is so strong indicating the origin of the biting lice from the Corrodentia would one not look for the most generalized types on the more ancient of the land birds. Here we are met by the fact that the lice upon the large flightless birds, the Palaeognathae, belong to the more specialized order, or the Ischnocera. Evidently these lice, some of which are peculiarly specialized in being asymmetrical, are of a relatively recent acquisition by the hosts. Of the land groups of birds of flight it is precisely upon the commonly accepted most ancient group, the Galliformes, that we find the most

generalized forms of lice, those of the genera *Menopon* and *Menacanthus* and other nearly related genera. These lice are distinguished from those occurring on Australian marsupials by only trivial characters hardly of sufficient importance to be accorded generic significance.

Could not the Australian marsupials have obtained their lice from birds just as the domestic dog in North America has obtained one of its louse species, *Heterodoxus longitarsus*, from an Australian marsupial? Certainly American marsupials did not get their biting lice from Australian marsupials, but rather from rodents with which they were associated.

Taxonomy

For very many years the order Mallophaga was divided into two suborders, the Amblycera and the Ischnocera, each of which was divided into two families. The division of the order into these two suborders, which was made by Kellogg (1896) is accepted today; while the number of families has been increased to over twice the former number. A summary of the suborders and families is given in this chapter, there being several changes in their number and arrangement as given by Harrison, 1916. Aside from the reduction of the family Boopidae Mjöberg to a subfamily because of the very close relationship of its genera to *Menopon* a number of other modifications have been made. The Ancistroninae as a subfamily is dropped. Mjöberg has been followed in placing *Trichophilopterus* Stobbe in a family by itself. Harrison's family Nesiotinidae is not retained because its only genus *Nesiotinus* Kellogg, based on a species from a penguin, is apparently related to Harrison's penguin-infesting genus, *Austrogoniodes*. So much remains to be worked out in regard to the genera of Philopteridae that it has been decided best for the present to abandon all suggested subfamily divisions.

Key to the Suborders and Families of Mallophaga

1. Maxillary palpi present; antennae swollen toward the free ends and when in repose largely concealed in fossae ..... Suborder AMBLYCERA 2
   Maxillary palpi wanting; antennae usually filiform and always exposed ..... Suborder ISCHNOCERA 6
2. Tarsi of all legs two clawed; labial palpi 1-, or 2-segmented 3
   Tarsi of the last two pairs of legs either single clawed or clawless; labial palpi 1-segmented. Infesting mammals ..... Gyropidae
3. Antennae lying in grooves at the sides of the head; abdomen usually broad and always with lateral notches at the junctions of the different segments 4
   Antennae situated in capsules which open ventrally; pterothorax joined with the abdomen in such a way that the lateral contours of the latter are continuous with those of the former, the two together forming practically a single body region 5
4. Six pairs of abdominal spiracles present; labial palpi 1-segmented; pro-, and mesothorax never fused. On birds and Australian marsupials ..... Menoponidae
   Only five pairs of abdominal spiracles present; labial palpi 2-segmented; mesothorax either greatly reduced or fused with the prothorax. On rodents and American marsupials ..... Trimenoponidae
5. Antennal capsules not bulbous and not producing lateral swellings on the head; labrum frequently provided with protrusible sucker cups; abdomen sometimes showing slight lateral notches at junctions of segments; oral opening moderate ..... Ricinidae
   Antennal capsules bulbous and constituting conspicuous lateral swellings on the head; abdomen without any lateral intersegmental notching; oral opening very large, extending backward beyond bases of antennae .... Laemobothriidae
6. Tarsi two clawed; antennae five segmented in both sexes. 7
   Tarsi one clawed; antennae always three segmented in the male and usually in the female. On mammals .. Trichodectidae
7. Last segment of antenna somewhat swollen or clubbed; sides of forehead provided with stout recurved hooks. On mammals ..... Trichophilopteridae
   Last segment of antenna not clubbed; forehead without recurved hooks. On birds ..... Philopteridae

Family MENOPONIDAE

Members of the family Menoponidae, as the group is here recognized, may be arranged into two subfamilies. One subfamily, the Menoponinae, occurs on birds and the other, the Boopinae, on Australian marsupials. The Menoponinae (=Menoponidae of some authors) are given special consideration by Ferris, 1916 & 1924 and the Boopinae (or Boopidae) were reviewed by Harrison and Johnston, 1916. These two subfamilies and their contained genera may be separated as follows:

Key to Subfamilies and Genera of Menoponidae

1. Antennae either 4-, or 5-segmented, but usually 4-segmented; setae of thorax seldom spinelike; genitalia of male without accessory sac. On birds.....Menoponinae 2
   Antennae 5-segmented; some of the setae, particularly on the thorax, spinelike; genitalia of male with a large accessory sac. On Australian marsupials..... Boopinae 24
2. Thorax normal; meso-, and metathorax usually united, when separate both somewhat similar in shape to abdominal segments..... 3
   Thorax very strongly developed and heavily chitinized, and with the meso-, and metathorax divided by a distinct suture and neither of them similar in shape to abdominal segments; abdomen composed of nine segments, the first two without spiracles; legs stout, short and heavy.....*Trinoton* Nitzsch
3. Ocular emarginations when present not deep; occipital bands poorly developed or wanting; last segment of antenna slightly clavate, clavate or capitate; antennal fossae covered above by lateral expansions from top of head; temporal lobes usually rounded; eyes sometimes vestigial or absent 4
   Ocular emarginations usually deep; occipital bands usually pronounced; posterior femora and certain of the abdominal sternites frequently with combs of small setae; last segment of antennae clavate or capitate; antennal fossae usually open above; temporal lobes large and usually somewhat subrectangular; eyes present, with double corneas..... 17
4. Posterior femora usually without a ventral patch of setae; abdominal sterna without more than a single pair of definite ventral patches or brushes of setae..... 5

   Posterior femora and two or more abdominal sterna with definite ventral patches or brushes of setae; thoax three segmented..... 14
5. Temples rounded..... 6
   Temples angulate; ocular emarginations wanting; prothorax as large as head. On a fulmar and petrel
   Ancistrona Westwood
6. Prothorax as large as head; abdomen very large
   Eureum Nitzsch
   Prothorax smaller than the head..... 7
7. Ocular emarginations wanting. Slender lice on hosts of genus *Numida*.....*Somaphantus* Paine
   Ocular emarginations present; head with variously formed lateral margins..... 8
8. Body somewhat slender; last abdominal segment frequently as long as broad or even longer; males with a spur on end of each tibia. Parasitic on pelicans....*Tetrophthalmus* Grosse
   Body stout, last two abdominal segments much broader than long..... 9
9. Gular region of head without gular plate..... 10
   Gular region of head provided with trilobed plate..... 13
10. Forehead provided with large, ventral, spinelike, or hornlike, processes..... 11
    Forehead without such processes.....*Menopon* Nitzsch
11. Forehead provided with a single pair of spinelike processes which arise from a position behind the palpi..... 12
    Forehead provided with a ventral pair of hook or hornlike processes which arise from a position in front of the palpi. On lorikeets.....*Eomenopon* Harrison
12. Esophageal gland present; pleural apodemes conspicuous
    Neumannia Uchida
    Esophageal gland wanting; pleural apodemes wanting, or poorly developed.....*Menacanthus* Neumann
13. Central lobe of gular plate tongueshaped and somewhat similar to lateral ones.....*Pseudomenopon* Mjöberg
    Central lobe of gular plate squarish and much larger than the lateral lobes.....*Machaerilaemus* Harrison
14. Second abdominal sternite sometimes with a pair of asters of heavy spines on posterior margin; esophageal sclerite present..... 15
    Second abdominal sternite never with asters of spines; esophageal sclerite wanting.....*Dennyus* Neumann

15. Temporal region of head of usual shape being much broader than forehead and prothorax; posterior margin of last abdominal segment without row of spinelike setae; prothoracic sternum present; last antennal segment capitate
Myrsidea Waterston

Temporal region reduced, but little broader than forehead or prothorax; posterior margin of last abdominal segment frequently with a row of spinelike setae; thoracic sternum wanting; first coxae expanded into body sclerites; last antennal segment filiform to slightly clavate 16

16. Expansion of head covering top of antennal fossa, divided by a transverse suture; female with a row of stout spines on the posterior margin of last abdominal segment
Amyrsidea Ewing

Expansion covering top of antennal fossa entire; female without spines on posterior margin of last abdominal segment
Numidicola Ewing

17. Posterior femora and abdominal sterna without any definite ventral patches of setae, although combs of spines may be present 18

Posterior femora and certain abdominal sterna with definite ventral patches or brushes of setae 22

18. Mesothorax greatly enlarged, equal to pro-, and metathorax taken together; basal segment of each tarsus produced distad and overlapping over one-half of the distal segment; tarsal claws minute. Small stout lice on rifle birds
Acolpocephalum Ewing

Mesothorax normal, less than pro-, and metathorax combined; basal segment of each tarsus but slightly produced along base of distal segment. Not such stout lice 19

19. The sexes different, or dimorphic 20
The sexes alike 21

20. Third abdominal sternite with combs. Occurring chiefly on Falconiformes ..... *Ferrisia* Uchida

Several of abdominal sternites with combs. Occurring on Cuculiformes, Coraciiformes and Strigiformes
Cuculiphilus Uchida

21. Gastric teeth present. Occurring on various orders of birds
Colpocephalum Nitzsch

Gastric teeth wanting; posterior femora and third abdominal sternites with combs. On Falconiformes .. *Kurodaia* Uchida

22. Setae of femoral and sternal patches smaller than those clothing the body ..... *Heleonomus* Ferris

Setae of femoral and sternal patches as large as those which clothe the body 23

23. Forehead broad and rounded with large mandibles in normal position; genital armature of male weak with long rodlike basal plate ..... *Actornithophilus* Ferris

Forehead reduced, triangular, with small mandibles situated approximate to the front margin of clypeus; genital armature of male large with broad basal plate
Chapinia Ewing

24. Temporal lobes not produced laterally at the posterior boundary of antennal fossae into an acute angle; palpi four segmented 25

Temporal lobes produced laterally into an acute angle behind the antennal fossae and tipped with a short spine; palpi two segmented ..... *Latumcephalum* LeSouëf

25. Antennal fossae largely open above; temporal lobes more or less quadrangular 26

Antennal fossae completely covered above by lateral expansions of head 28

26. Head without spinelike processes below ..... *Boopia* Piaget
Head with a pair of strong spinelike processes below 27

27. Cephalic spinelike processes arising immediately behind the bases of palpi ..... *Dendrolagia* Mjöberg

Cephalic spinelike processes arising from a point much behind bases of palpi ..... *Phacogalia* Mjöberg

28. Head without true spinelike processes below but with a pair of short, peglike setae on throat beneath the occiput; abdominal spiracles situated in pleurites
Paraheterodoxus Harrison & Johnston

Head with ventral spinelike processes rising from the base of palpi 29

29. Ventral cephalic spines much smaller; metathorax triangular in shape; abdomen with a transverse row of flattened setae and six longitudinal rows of much longer hairs
Macropophila Mjöberg

Ventral cephalic spines much longer; metathorax not triangular; abdominal spiracles situated in tergites
Heterodoxus LeSouëf & Bullen

Synonymy of Genera of Menoponidae

Piagetia Picaglia, 1884 (name preoc.) = *Tetrophthalmus* Grosse, 1885.

Piagetiella Neumann, 1906 = *Tetrophthalmus* Grosse, 1885.

Eomenacanthus Uchida, 1926 = *Menacanthus* Neumann, 1912.

Nitzschia Denny, 1842 (name preoc.) = *Dennyus* Neumann, 1906.

Takamatsuia Uchida, 1926 = *Dennyus* Neumann, 1906.

Genus Trinoton Nitzsch

In *Trinoton* the thorax is very strongly developed and heavily chitinized, the three segments being distinct, and none of them similar in shape to the abdominal segments. The legs are stout, short and heavy. The genus is not a large one, but contains three poultry lice.

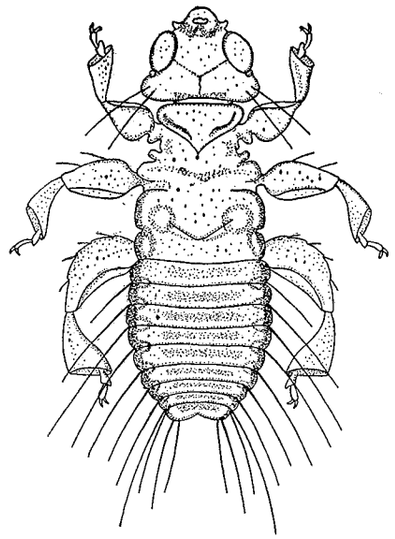

Figure 59. Trinoton of the goose, *Trinoton lituratum*. (After Osborn)

The Trinoton of the Goose, *Trinoton lituratum* Nitzsch (Fig. 59), is a peculiar appearing louse, the large expansions of the head simulating enormous eyes. It is not a serious pest to its host.

The Goose and Swan Louse, *Trinoton anserinum* Fabricius, is a very large species being about six millimeters long.

The Duck Louse, *Trinoton quequedulae* (Linnaeus), is one of the commonest of the whole genus, being found on both wild and domestic ducks.

Genus Menopon Nitzsch

The genus *Menopon* is based on the common *Menopon gallinae* (Linnaeus) as a type. In its restricted sense it includes those species of Menoponidae in which

the antennal fossae are covered dorsally by a lateral expansion of the head; the posterior femora and abdominal sterna are without definite ventral patches or brushes of setae; the temples are rounded; prothorax smaller than head; gular plate absent and forehead without ventral spine-like processes. This is a large genus and is well represented on birds of the order Galliformes.

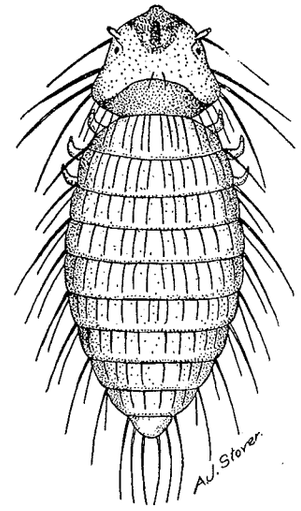

Figure 60. The common chicken louse, *Menopon gallinae*. (Ewing)

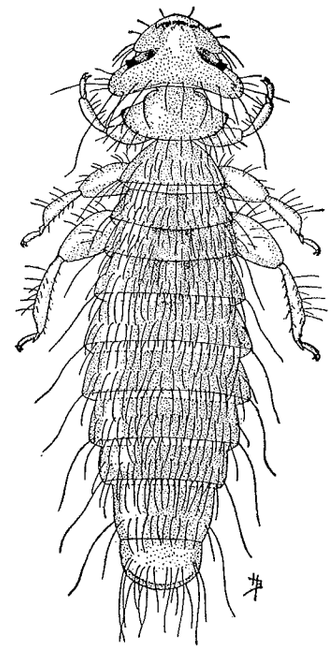

Figure 61. The common large louse of the hen, *Menopon stramineum*. (After Bishopp and Wood)

The Common Chicken Louse, *Menopon gallinae* (Linnaeus) (Fig. 60) is a small pale species, about one and a half millimeters long. It infests all parts of the host, and is at times a serious pest, particularly to young chickens.

The Common Large Louse of the Hen, *Menopon stramineum* Nitzsch (Fig. 61), is, according to Herrick (1915),

next to *M. gallinae* in abundance. This species was long known under the name of *M. biseriatum* Piaget.

Menopon numidiae Giebel is found on the guinea fowl. It is of about the same size as the common chicken louse and of very similar structure.

Genus Menacanthus Neumann

Menacanthus is like *Menopon* except that in this genus the forehead is provided with a pair of large, spinelike processes which are directed downward and backward. The species are larger and not so fragile as those in *Menopon*.

Genus Colpocephalum Nitzsch

This very large genus may be defined as follows: Sexes alike; ocular emarginations pronounced; occipital bands well developed and usually heavily stained with brown or black; antennal fossae open above; temporal lobes large and somewhat subrectangular; posterior femora and certain abdominal sterna without any definite ventral patches of setae, although combs of spines may be present; mesothorax less than the pro,–and metathorax combined; basal segment of each tarsus but slightly produced along base of distal segment. Gastric teeth present.

Members of this genus infest many of the major groups of birds. They are usually of moderate size and seldom exceed more than three millimeters in length.

Genus Heterodoxus Le Souëf and Bullen

The characters of *Heterodoxus* are as follows: Palpi four segmented; antennal fossae completely covered above by lateral expansions of the head; temporal lobes subangulate postero-laterally; head bearing a pair of ventral spinelike processes which arise from the base of palpi; metathorax not triangular; abdominal spiracles situated in tergites.

Heterodoxus longitarsus Piaget, is normally parastic on kangaroos, but has succeeded in establishing itself on the domestic dog in several localities in North America. This fact is very remarkable since there is no close phylogenetic relationship between these two hosts.

Family TRIMENOPONIDAE

This family may be diagnosed as follows: Tarsi two clawed on all of the legs; antennae lying in grooves (not capsules) at the sides of the head; five pairs of abdominal spiracles; body clothed with heavy setae some of which are spinelike; mesothorax greatly reduced or even completely fused with the large prothorax.

Members of this family are found on rodents and on marsupials in Central and South America. Ferris, 1922, has given a good review of the group. He recognizes four genera and five species. These four genera may be separated as follows:

Key to the Genera of Trimenoponidae

1. Head without recurved hornlike, or spinelike processes . . . 2
   Head provided with large hornlike, or spinelike processes 3
2. Dorsal expansion of head over antennal fossa deeply emarginate; temporal lobes broad and rounded
   Philandesia Kellogg & Nakayama
   Dorsal expansion covering antennal fossa but slightly if at all emarginate; temporal lobes subangulate; mesothorax greatly reduced dorsally; body setae distinctly spinelike
   Trimenopon Cummings
3. Forehead produced laterally into a large pair of recurved hornlike processes; temporal lobes also produced laterally but each ending in a heavily chitinized, toothed tubercle; head without ventral spinelike processes
   Harrisonia Ferris
   Neither forehead or temporal lobes produced laterally into any hornlike processes or tubercles; head provided with two pairs of large, recurved, ventral, spinelike processes
   Cummingsia Ferris

GENERIC SYNONYMS IN TRIMENOPONIDAE

Philandria Kellogg, 1914 = *Philandesia* Kellogg and Nakayama, 1914.

Acanthomenopon Harrison, 1922 = *Cummingsia* Ferris, 1922.

Family RICINIDAE

Members of this family may be recognized from those of the other families of the suborder Amblycera by the following characters: Tarsi of all the legs two clawed; antennae situated in capsules which open ventrally, such capsules not bulbous and not producing lateral swellings on the head; abdomen with lateral contours but slightly broken by lateral notching at the junctions of the segments. This family is a very small one including only two genera which may be separated by the following characters:

1. Head of normal shape, not constricted in the middle; abdomen slender, and with six pairs of functional spiracles. Occurring chiefly on passerines..... *Ricinus* Degeer
   Head deeply emarginate laterally; abdomen stout. On humming birds..... *Trochiloectes* Paine & Mann

GENERIC SYNONYMS IN RICINIDAE

Physostomum Nitzsch, 1818 = *Ricinus* Degeer, 1778.
Liotheum Nitzsch, 1806 = *Ricinus* Degeer, 1778.
Nirmus Hermann, 1804 = *Ricinus* Degeer, 1778.

Family LAEMOBOTHRIIDAE

Laemobothriidae is rather closely allied to the family Ricinidae. Members of this family are like those of the Ricinidae in having all the legs two clawed and the antennae enclosed in capsules which open ventrally. But in the Laemobothriidae the capsules are bulbous and constitute conspicuous lateral swellings on the head. In this family the lateral contours of the abdomen are unbroken by any notching at the junction of segments.

Formerly but a single genus, *Laemobothrion* Nitzsch, was included in this family. This genus, however, should be

divided, those species occurring on birds of prey being left in *Leamobothrion* and those occurring on water birds being placed in a new genus. These are separated as follows:

KEY TO THE GENERA OF LAEMOBOTHRIIDAE

1. Clypeus incurved, or emarginate, in front and bearing several porrect, peglike spines on or near front margin. On water birds..... *Eulaemobothrion*, new genus
   Clypeus not emarginate in front and without peglike spines. On birds of prey..... *Laemobothrion* Nitzsch

GENERIC SYNONYM IN LEAMOBOTHRIIDAE

Laemobothrium Burmeister, 1838 = *Laemobothrion* Nitzsch, 1818.

Family GYROPIDAE

The Mallophagan family Gyropidae includes those genera of the suborder Amblycera in which the tarsi of the last two pairs of legs are either single clawed or clawless (Fig. 62). In most of the species the front tarsi are also single clawed or clawless and in many of them some of the legs are adapted for hair clasping.

Biting lice of this family are confined entirely to Central and South America and are for the most part found on rodents. According to the writer (Ewing, 1924) nine genera and twenty six valid species are known to science. The three subfamilies and nine genera may be separated as follows:

KEY TO SUBFAMILIES AND GENERA OF GYROPIDAE

1. Each tarsus provided with at least one claw; 6 pairs of abdominal spiracles present; maxillary palpi composed of more than 2 segments..... 2
   Tarsal claws wanting; abdominal spiracles reduced to five pairs; maxillary palpi 2-segmented..... GLIRICOLINAE 9
2. Maxillary palpi composed of 3 segments; none of the tarsi modified so as to form a hair-clasping apparatus PROTOGYROPINAE 3
   Maxillary palpi composed of 4 segments; at least one of the two posterior pairs of legs modified so that each leg of a pair forms a hair-clasping apparatus..... GYROPINAE 4

3. But a single genus in subfamily..... *Protogyropus* Ewing
4. Tarsus I provided with a single claw..... 5
   Tarsus I provided with 2 claws..... 8

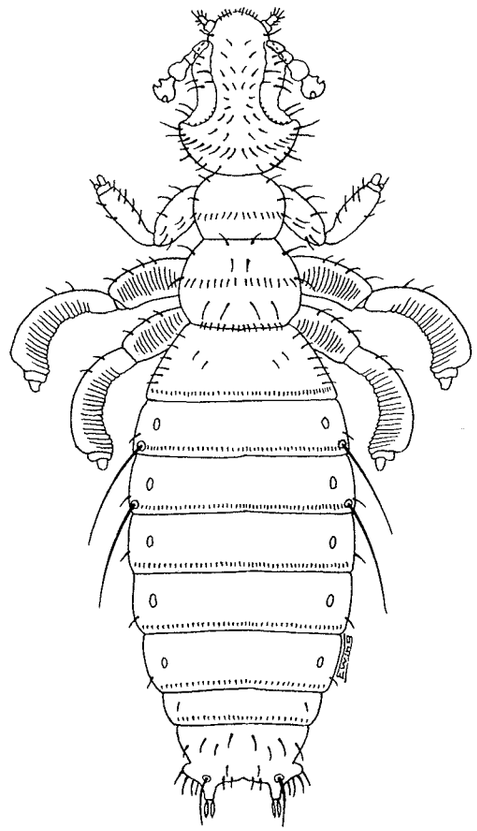

Figure 62. *Paragliricola quadrisetosa*. Dorsal view of female, ×100. (Ewing)

5. Femur of leg III without forked and striated tenaculum for holding tarsus; second segment of tarsus III not transversely striate..... *Monogyropus* Ewing
   Femur of leg III with tenaculum and tarsus III transversely striate..... 6

6. Most of abdominal segments provided dorsally with one or two transverse rows of subequal setae..... 7
   Abdomen with but few setae above, some of which are large and in longitudinal rows, four such rows are always present *Tetragyropus* Ewing
7. Typically each abdominal segment with two transverse rows of dorsal setae..... *Gyropus* Nitzsch
   Typically each abdominal segment with a single transverse row of dorsal setae..... *Allogyropus* Ewing
8. Tibia I swollen on the inside near its tip into a more or less thumblike tubercle; tarsus I with first and second segments about equal..... *Macrogyropus* Ewing
   Tibia I not swollen into any thumblike tubercle near its tip; tarsus I with segment I twice as broad as long and about half as long as segment II..... *Heterogyropus* Ewing
9. Anterior horns of hypopharyngeal chitinization unarmed *Paragliricola* Ewing
   Anterior horns of hypopharyngeal chitinization each armed with a row of teeth at its tip..... *Gliricola* Mjöberg

Generic Synonyms in Gyropidae

Diplocerus Nitzsch, 1874 = *Gyropus* Nitzsch, 1818.
Haemabarus Nitzsch, 1874 = *Gyropus* Nitzsch, 1818.
Micropus Denny, 1842 (name preoc.) = *Gliricola* Mjöberg, 1910.

Genus Protogyropus Ewing

This genus established in 1924 (Ewing, 1924) for *P. normalis* Ewing is of particular interest because in it none of the legs is modified for hair clasping. Each of the tarsi is composed of two small, simple segments, the terminal one bearing a moderate simple spine. The type species is the only one known. It was taken from skins of *Cavia* species and *Oryzomys* species.

Genus Gyropus Nitzsch

This, the type genus of the family, was established by Nitzsch in 1818 for the common *G. ovalis* Nitzsch of the guinea pig. There are two species of Gyropidae on the guinea pig. This species is the larger and much the broader of the two. Besides being found on the domestic guinea pig, *G. ovalis* is also found on several wild *Cavia* species.

Besides the *G. ovalis* this genus includes the following species: *G. forficulatus* Neumann, *G. pollicaris* Ewing, *G. gracilipes* Ewing and *G. wetmorei* Ewing.

Genus Gliricola Mjöberg

Gliricola was established (Mjöberg, 1910) for the common slender louse of the guinea pig, *G. porcelli* Linnaeus. Only one other species has been added to the genus, *G. distincta*

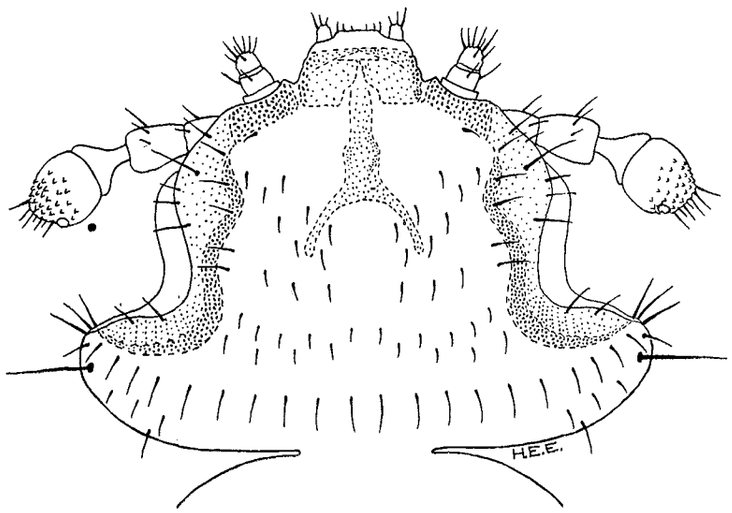

Figure 63. *Gyropus ovalis*. Dorsal view of head. (Ewing)

Ewing, which was described from specimens taken from a fresh skin of *Cavia anolaimae* collected in Colombia. The slender species of *Gliricola* and *Paragliricola* clasp a single hair with all four legs of the last two pairs, the body being held parallel to the hair thus clasped.

Family PHILOPTERIDAE

The family Philopteridae is the largest of all the families of biting lice and includes most of the genera as well as the

species of the suborder Ischnocera. Harrison, 1916, has divided the group into six subfamilies. So much work remains in separating the vast number of species in this family into recognizable, natural generic units that it is doubtful if a logical subfamily grouping can be given at present. Much remains to be learned about the fundamental morphological characters of many of the species and some genera. For example it is not known definitely whether there are six pairs of abdominal stigmata in all genera. Then it is not known for sure in certain species whether or not the meso,–and metathorax are distinct.

In the key to genera which follows it has not been possible in all instances to get a definite, clearcut division between paired categories, but after some practise the divisions should be followed more easily. This difficulty is overcome in part by naming the host group or groups to which a given genus is confined.

Key to the Genera of Philopteridae

1. Mesothorax distinct from metathorax, the latter being overlapped laterally by the enlarged first segment of abdomen 2
   Mesothorax united to metathorx, forming the unified pterothorax 3
2. Head triangular in shape, lateral margins of temporal lobes usually exceeding the posterior ones; trabeculae reduced or absent . . . . . *Kelloggia* Carriker
   Head not triangular in shape, lateral margins of temporal lobes not exceeding the posterior ones; trabeculae very prominent . . . . . *Ornicholax* Carriker
3. Forehead (at least in male) produced laterally into a pair of large, recurved hooklike processes 4
   Forehead not produced into any such lateral appendages . 5
4. Temporal lobes rounded; clypeus without ventral spinelike processes . . . . . *Physconella* Paine
   Temporal lobes angulate; clypeus provided with a pair of large, spinelike processes on ventral side *Physconelloides* Ewing
5. Forehead more or less rectangular or trapezoidal in shape, sides seldom convex; trabeculae present and usually pronounced; temporal lobes rounded 6

Forehead not rectangular or trapezoidal, sides convex; trabeculae usually small or wanting; temporal lobes frequently angulate 27

6. Pterothorax broader than long, sides strongly divergent and with posterior margin angulate or outwardly rounded. Stouter species 7
Pterothorax usually but slightly, if at all, broader than long, sides frequently subparallel and posterior margin not convex. Slender species 23

7. Forehead with a membranous flap which projects beyond the lateral margins of the head and is very conspicuous in the male 8
Forehead without laterally projecting membranous flap .. 9

8. Antennae alike in the two sexes. On petrels. *Giebelia* Kellogg
Antennae different in the two sexes. On giant fulmars and shearwaters ..... *Trabeculus* Rudow
Cacalymensus Enderlein

9. Antennae alike in the two sexes; trabeculae very large, usually somewhat swollen and movable 10
Antennae different in the two sexes 18

10. Clypeal region expanded, with free margin hyaline throughout, in front incurved, and bearing above on each lateral chitinization (clypeal band) a tuft of three or more setae. Parasitic chiefly on cuckoos ..... *Cuculoecus* Ewing.
Clypeal regions without such characters 11

11. Clypeal region expanded and with hyaline free margin throughout but rounded and not emarginate in front; antennae short. On geese, ducks and swans ... *Anatoecus* Cummings.
Clypeal region without an evenly rounded and expanded hyaline margin 12

12. Forehead irregularly rounded; trabeculae reduced, immovable, not reaching the distal end of first antennal segment. On owls ..... *Eustrigiphilus* Ewing.
Forehead more or less rectangular with sides somewhat incurved; trabeculae larger and usually movable; eyes with rounded hyaline corneas 13

13. Signatural plate divided; second segment of antennae distinctly longer than any of the others. On ibises and spoonbills ..... *Ibidoecus* Cummings
Without such characters 14

14. Clypeal margin deeply notched in front, and notch flanked with hyaline flaps 15
Clypeal margin never more than broadly emarginate in front and without the pair of hyaline flaps 16

15. Abdomen bearing many short spines on its anterior ventral aspect. On parrots ..... *Echinophilopterus* Ewing
Abdomen without short spines below; clypeal flaps usually touching each other at tips. Chiefly on water birds
Incidifrons, new genus

16. Clypeal region bounded posteriorly by a broadly and backwardly curving suture, and bearing dorsally just in front of this clypeal suture two pairs of short, stout, erect spines. On toucans ..... *Austrophilopterus*, new genus
Clypeal region without such characters 17

17. Tergites of female interrupted. On storks
Neophilopterus Cummings
Tergites of females sometimes interrupted and sometimes not. Not on storks ..... *Philopterus* Nitzsch
Dollabella Cummings

18. Inner margins of pleura of eighth abdominal segment of female each with a process bearing two or more spines ... 19
Inner margin of each pleuron of eighth abdominal segment without spine-bearing processes 21

19. Premandibular hyaline area doubly concave in front. On *Apteryx* species ..... *Aptericola* Harrison
Premandibular hyaline area not doubly concave in front .. 20

20. Slender, deeply colored species. On shore birds
Parricola Harrison
Stouter, lighter species ..... *Rallicola* Johnston & Harrison

21. Antennae of male with first segment elongated and curved. On a diving petrel ..... *Pelmatocerandra* Enderlein
Without such characters 22

22. First three antennal segments of male very much lengthened, last two very short; abdomen with 7 pairs of spiracles. On albatrosses ..... *Docophoroides* Giglioli
Only the first segment of male antennae lengthened; second segment normal, third appendiculate. On owls
Strigiphilus Mjöberg

23. Forehead with large membranous flap which extends beyond the lateral margins of the head. On petrels and related birds
Philoceanus Kellogg
Forehead without such membranous flap 24

24. Head almost twice as broad through the temples as in front of antennae, therefore heartshaped. Parasitic on gannets
Pectinopygus Mjöberg
Head never over one and a half times as broad through the temples as in front of the antennae, and not heartshaped 25

25. Head symmetrical. Not on Struthious birds..... 26
Head asymmetrical; incrassations of anterior margin of head different on the two sides; left mandible with enormous basal process. On Struthious birds *Struthiolipeurus* Cummings

26. Clypeus unarmed dorsally..... *Esthiopterum* Harrison
Clypeus armed with two pairs of spines dorsally, one being flattened and porrect and the other recurved
Columbicola, new genus

27. Clypeus deeply and angularly notched..... 28
Clypeus not so notched..... 30

28. Antennae the same in the two sexes. Parasitic on Anatidae
Acidoproctus Piaget
Antennae different in the two sexes..... 29

29. First segment of antennae of male with appendage. On screamers..... *Bothriometops* Taschenberg
First segment of antennae of male without appendage. On semi-palmated goose..... *Heteroproctus* Harrison

30* Head longer than broad, with projecting forehead and rounded temples. Slender species..... 31
Head usually about as broad as, or even broader than, long; clypeus reduced and broadly rounded; antennae usually different in the two sexes..... 35

31. Antennae the same in the two sexes..... 32
Antennae different in the two sexes..... 33

32. Forehead continuously circumfaciate; occiput shallowly concave; upper surface uniformly chitinized except for two sutures. On grouse..... *Lagopoecus* Waterston
Without such a combination of characters *Degeeriella* Neumann

33. Third segment of antennae of male without conspicuous appendage..... 34
Third segment of antennae of male with appendage. On parrots..... *Psittaconirmus* Harrison

34. Pterothorax with sides subparallel or outwardly rounded. Parasitic on Anatidae..... *Ornithobius* Denny
Pterothorax with sides strongly divergent, hence this segment is much the broadest behind. On hornbills
Paroncophorus Harrison

35. Temples rounded..... 36
Temples angulate (except in *Strongylocotes*)..... 37

36. Forehead as long as, or longer than, broad. Not on parrots
Lipeurus Nitzsch
Forehead much broader than long. On parrots
Paragoniocotes Cummings

* The division here is poor and will not hold for all species.

37. Forehead so reduced as to be almost obliterated. On penguins
Nesiotinus Kellogg
Forehead equal to at least one-third of the postantennal region of head..... 38

38. Temples produced backward into spine-tipped, angular processes which overlap somewhat the prothorax. On penguins
Austrogoniodes Harrison
Temples not produced into such overlapping structures... 39

39. Several of the body sclerites bearing combs of toothlike tubercles; sides of temple region almost straight
Pectenosoma, new genus
Body and body sclerites without such combs of tubercles 40

40. Third segment of male antenna without appendage, first also without the same..... 41
Third segment of male antenna with appendage, first sometimes with the same..... 42

41. Metathorax about one-half as broad as mesothorax with which it is incompletely fused and completely overlapped by the fused first two segments of abdomen; temples rounded. On tinamous..... *Strongylocotes* Taschenberg
Metathorax fused with mesothorax; temples angulate or produced into tubercular processes..... *Goniocotes* Burmeister

42. Temporal lobes produced laterally and backward far beyond the front margin of prothorax; segment III of male antenna formed into a clawlike hook; parameres of male styliform
Pterocotes, new genus
Temporal lobes less produced; male without such characters
Goniodes Nitzsch

Generic Synonyms in Philopteridae

Lepidophorus Taschenberg, 1882 (name preoc.) = *Ornicholax* Carriker, 1903.

Ancistrocephalus Paine, 1913 (name preoc.) = *Physconella* Paine, 1914.

Mackayia Waterston, 1912 = *Trabeculus* Rudow, 1866.

Oncophorus Rudow, 1870 = *Trabeculus* Rudow, 1866.

Docophorus Nitzsch, 1818 = *Philopterus* Nitzsch, 1818.

Eurymetopus Taschenberg, 1882 (name preoc.) = *Docophoroides* Giglioli, 1864.

Taschenbergius Neumann, 1906 (name preoc.) = *Docophoroides* Giglioli, 1864.

Taschenbergiella Neumann, 1913 (name preoc.) = *Docophoroides* Giglioli, 1864.

Nirmus Nitzsch, 1818 (name preoc.) = *Degeeriella* Neumann, 1906.

Ricinus Enderlein, 1909 (name preoc.) = *Degeeriella* Neumann, 1906.
Metapleuron Rudow, 1870 = *Ornithobius* Denny, 1842
Ornithonomus Neumann, 1909 = *Ornithobius* Denny, 1842.
Oxylipeurus Mjöberg, 1910 = *Lipeurus* Nitzsch, 1818.
Nesiotes Kellogg, 1903 (name preoc.) = *Nesiotinus* Kellogg, 1903.

Genus Anatoecus Cummings

Cummings, 1916, established the genus *Anatoecus* for those species of *Philopterus* which infest geese, ducks and swans. This genus not only appears to be a natural one but infests exclusively a particular group of birds. Its species may be recognized by the peculiar characters of the clypeal region. This region of the head is expanded and has a hyaline free margin throughout, but this margin is outwardly rounded, not emarginate.

Anatoecus dentatus (Scopoli) is found on many ducks including the domestic species. It is a short, stout species, about one and a half millimeters long. The abdomen has prominent lateral bands.

Genus Philopterus Nitzsch

This, the type genus of the family Philopteridae, at one time included over two hundred and fifty valid species, and even now after several genera have been derived from it, includes probably more species than any other genus in the family except *Degeeriella*. The species of the genus are, almost without exception, very stout, with the chitinized parts dark brown, the temporal lobes large and rounded, the trabeculae well developed, the antennae short and the forehead of a peculiar shape. Since there have been so many subtractions from the genus recently it is hard to give the characters of the genus in its restricted sense in a few words. For the purpose of a more accurate delimitation the key to the genera of the Philopteridae may be used.

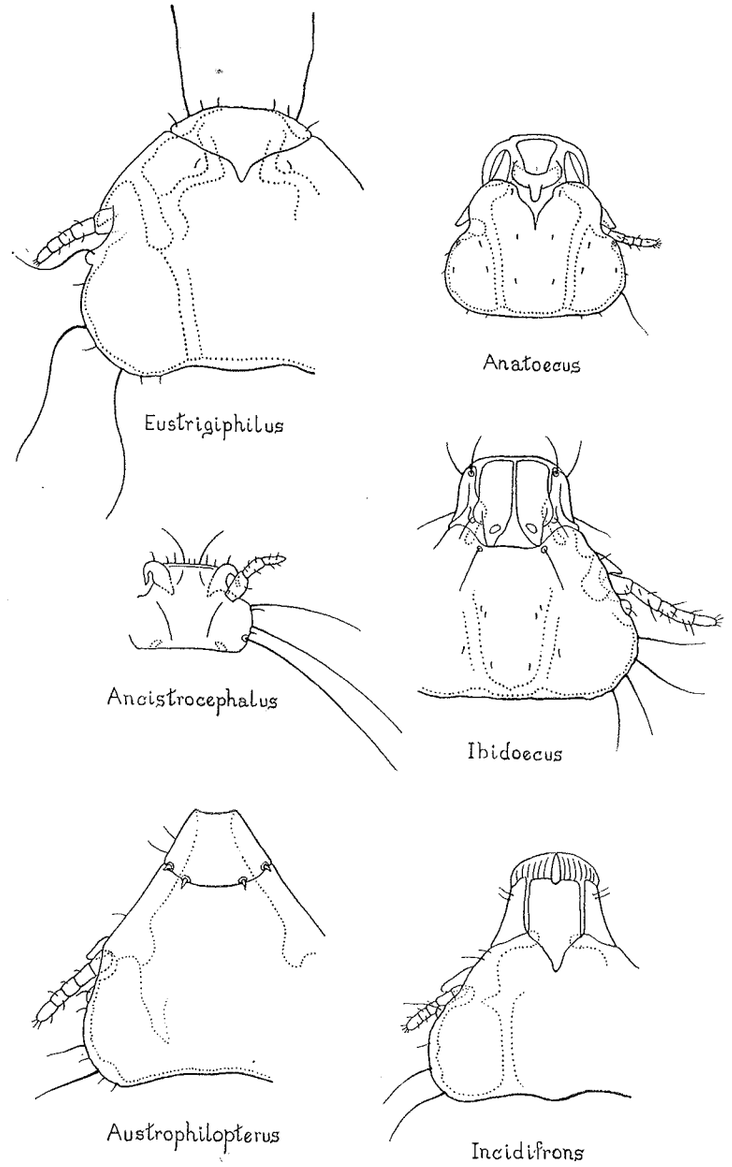

Figure 64. Dorsal views of heads of biting lice of several genera of Philopteridae: *Eustrigiphilus ceblebrachys, Anatoecus obtusus, Ancistrocephalus kelloggi, Ibidoecus flavus, Austrophilopterus cancellosus & Incidifrons pertusus.* (In part after other authors)

Genus Esthiopterum Harrison

Species of *Esthiopterum* are the most slender of all the biting lice, except possibly for those of the genus *Columbicola*, which were formerly placed in *Esthiopterum*. The forehead is long with the sides almost straight; the pterothorax is quadrangular; the antennae of the male are appendiculate. Formerly all of the species in this genus were placed in *Lipeurus* Nitzsch. Only those species with the broadly rounded forehead are now left in *Lipeurus*. Even after the subtraction of the species in *Lipeurus* and *Columbicola* the genus *Esthiopterum* yet includes over one hundred and fifty species.

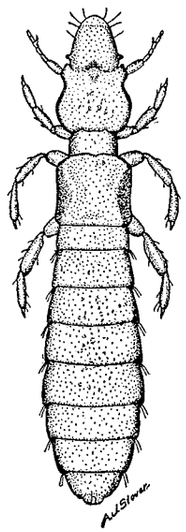

Figure 65. The slender duck louse, *Esthiopterum crassicorne*. (Ewing)

The Common Louse of the Goose, *Esthiopterum anseris* (Linnaeus) infests the flight feathers of its host. This long species measures fully three millimeters in length. In addition to having the lateral process on the third segment the male antenna has the first segment swollen.

The Slender Duck Louse, *Esthiopterum crassicorne* (Scopoli) (Fig. 65), has similar habits to those of the louse of the goose.

Genus Columbicola, New Genus

This genus is established for those species of *Esthiopterum* in which the clypeus is armed with two pairs of spines dorsally, one being flattened and porrect while the other pair is strongly recurved. These lice which prefer the long, flight feathers of their hosts are themselves the most slender of all the biting lice.

The Pigeon Louse, *Columbicola columbae* (Linnaeus) (Fig. 66), formerly called *Lipeurus baculus* Nitzsch, is very abundant on pigeons. There are many records for the species in North America. It is probably an introduced species here.

Genus Degeeriella Neumann

This enormous and long neglected genus only awaits the attention of some taxonomist to break it up into its

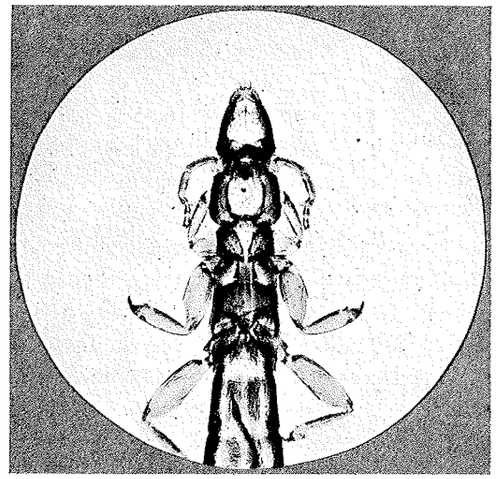

Figure 66. The pigeon louse, *Columbicola columbae;* head and thorax of male. (Original)

really natural generic units. Many of the species are hardly distinguishable from those of *Philopterus* and others are near *Lipeurus*. The species are for the most part slender and in all of them the antennae are the same in the two sexes. Harrison listed no less than two hundred and sixty-six valid species for this genus in 1916.

Genus Lipeurus Nitzsch

Lipeurus in its present restricted borders includes those species of the old genus in which the forehead is broadly rounded in front. The antennae of the two sexes are different; the temples rounded; the trabeculae are small; the forehead without lateral expansions or hook-like processes.

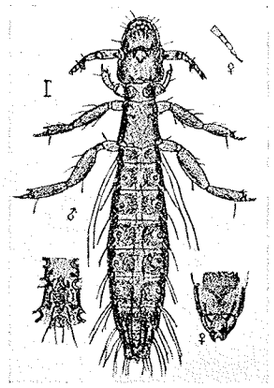

Figure 67. Slender louse of the turkey, *Lipeurus gallipavonis*. (Piaget)

The Variable Hen Louse, *Liperus variabilis* Nitszch, is a long, slender louse with prominent dark marginal bands. This louse is the one commonly found on the large wing feathers of fowls. The eggs are laid attached to the barbules of the feathers.

The Head Louse of Chickens, *Lipeurus heterographus* Nitzsch, is a serious pest of young chickens. The eggs of this species are laid attached to the down or small feathers. They hatch in from four to five days. Maturity is reached in about three weeks. Chief injury is to the head and neck of chickens.

The Slender Louse of the Turkey, *Lipeurus gallipavonis* (Geoffroy) (Fig. 67), is a common parasite on the domestic turkey. In the male the first segment of the antennae is greatly swollen. The louse infests the wing feathers.

Genus Goniocotes Nitzsch

Species of this genus are large and stout and are especially abundant on gallinaceous birds. The antennae of the male are different from those of the female, but the third segment is without appendages; the metathorax is fused with the mesothorax; the temples are angulate or produced into tubercular processes.

The Lesser Chicken Louse, *Goniocotes hologaster* Nitzsch, is occasionally found on the back and rump of chickens. It is a small louse, being about one millimeter long. The abdomen is somewhat circular in outline.

The Large Hen Louse, *Goniocotes gigas* Taschenberg (Fig. 68), is similar in shape to *G. hologaster*, but is about three times as long. Besides occurring on chickens it is found also on guineas.

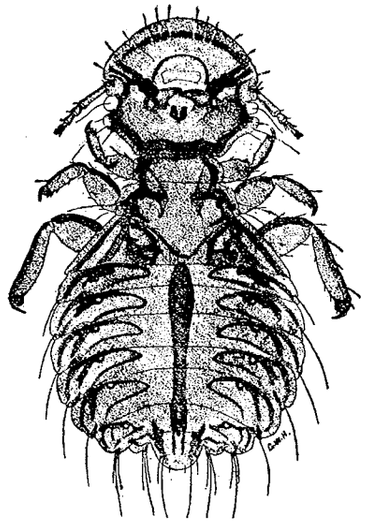

Figure 68. The large hen louse, *Goniocotes gigas*. (After Herrick)

Genus Goniodes Nitzsch

Goniodes Nitzsch is similar to *Goniocotes* Nitzsch, but the third segment of the antennae of the male has a process while the first also may have one. This genus, like *Goniocotes*, is especially abundant on gallinaceous birds. Some of the species are of economic importance.

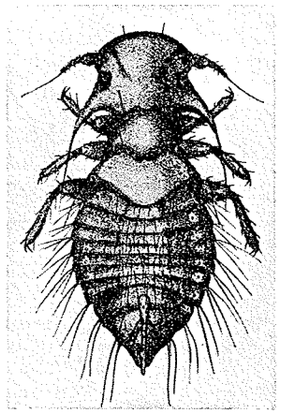

Figure 69. The large turkey louse, *Goniodes meleagridis*. (After Lugger)

The Chicken Goniodes, *Goniodes dissimilis* Nitzsch, is a common fowl pest in Europe, but it is not very common in America. It is a stout species and is about two and a half millimeters long. The temporal lobes in this louse are acutely angulate.

The Large Turkey Louse, *Goniodes meleagridis* (Linnaeus) (Fig. 69), is the most common louse

of the turkey. It is a large and well marked species with the temporal lobes extending far backward and terminating in styletlike processes.

The Peacock Goniodes, *Goniodes pavonis* (Linnaeus), is a stout louse, over three millimeters in length, and with a somewhat squarish head. It is a common parasite of the peacock both in Europe and America.

Family TRICHOPHILOPTERIDAE

This family was established but recently by Mjöberg for the peculiar genus *Trichophilopterus* Stobbe. Stobbe's genus was erected in 1913 for a single species, *T. babakotophilus*, which was taken from *Lichonotus indri*, a lemur of the island of Madagascar. In this species some of the characters of the family Trichodectidae are combined with others of the family Philopteridae.

In *Trichophilopterus* the last segment of the antennae is swollen; the tarsi are two clawed; the sides of the forehead are provided with short recurved hooks. Although occurring on a mammal host *Trichophilopterus* shows a very definite relationship to the bird-infesting genus *Degeeriella* Neumann.

Family TRICHODECTIDAE

With but a single exception, that of *Trichophilopterus babakotophilus* Stobbe, all of the mammal-infesting species of the suborder Ischnocera belong to this family. They constitute the one-clawed representatives of this suborder. The antennae are three segmented instead of being five segmented as in the other two families. Most of the species have in the past been placed in the single genus *Trichodectes* Nitzsch, notwithstanding the fact that they come from such distantly related hosts as rodents, carnivores and ungulates. Happily this large genus can be easily divided into at least five genera on good morphological grounds. The different genera of Trichodectidae are keyed out as follows:

Key to the Genera of Trichodectidae

1. Antennae of both sexes 3-segmented; temporal lobes without posterior triangular processes 2
   Antennae of male 3-segmented, of female 5-segmented (since the last segment is divided into three); temporal lobes each with a large, posterior, daggerlike process *Eurytrichodectes* Stobbe
2. Forehead usually much broader than long and not trapezoidal in shape 3
   Forehead much longer and angulate at sides of clypeus, therefore more or less trapezoidal in shape; antennae of the two sexes markedly different 7
3. All of the abdominal segments provided with pleural plates although they may be poorly chitinized 4
   Some of the abdominal segments without pleural plates; head characters different between the two sexes; parameres usually united distally 6
4. Antennae the same in the two sexes; parameres of male genital armature not united 5
   Antennae of the two sexes different . . . . . *Trichodectes* Nitzsch
5. Forehead triangular, with sides almost straight. On felines *Felicola*, new genus
   Forehead not triangular, but outwardly rounded. On bovines *Bovicola*, new genus
6. First three abdominal segments with pleural plates; second segment of antennae of female with appendage. On gophers and other rodents . . . . . *Geomydoecus*, new genus
   All of abdominal segments without pleural plates; second segment of antennae of female without appendage. Chiefly on carnivores . . . . . *Neotrichodectes*, new genus
7. Clypeus with a deep U-shaped notch, or emargination, which is deeper than wide . . . . . *Damalinia* Mjöberg
   Clypeus without any deep emargination in front *Eutrichophilus* Mjöberg

Genus Trichodectes Nitzsch

The genus *Trichodectes*, as considered in the restricted sense of this manual, includes those members of the family Trichodectidae which have the following characters: Antennae three segmented in both sexes but of different shape; temporal lobes without posterior processes; forehead

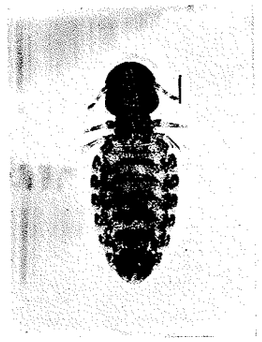

Figure 70. The common biting louse of the horse, *Trichodectes equi*, ×20. (Original)

rounded; all of the abdominal segments with pleural plates. In it are found some of the common lice of domestic animals.

Trichodectes pilosus Giebel is a common parasite of horses in the Old World. It is less than two millimeters long and has a tapering abdomen which is broadest in front of the middle.

Trichodectes equi (Linnaeus) (Fig. 70) appears to be the more common biting louse of the horse in America. It is of similar appearance to *T. pilosus* and infests particularly the regions of the neck and the base of the tail.

The Biting Louse of the Dog, *Trichodectes canis* Degeer, is the type species of the genus. Although described as long ago as 1778 it has not been very commonly reported from the dog. Puppies are troubled the most with this small louse which scarcely exceeds one millimeter in length.

Genus Felicola, New Genus

In this genus the forehead is triangular, the sides converging in a straight line from the bases of the antennae to the borders of the very narrow hair-groove at the apex. The antennae are the same in the two sexes (For further details of description consult the appendix). Only a few species are included in the genus. Felines harbor but few parasites. This is probably largely because of their very short hair and cleanly habits.

The Cat Louse, *Felicola subrostrata* (Nitzsch), is a small species about one millimeter in length. The abdomen is stout and has pronounced banding. Lousy cats are seldom

encountered in America. This louse is easily recognized from the biting louse of the dog on account of its pointed head.

Genus Bovicola New Genus

Lice of this genus are similar to those of *Felicola* but do not have the triangular forehead. They are found on bovines. Several species infest domestic animals.

The Biting Louse of Cattle, *Bovicola bovis* (Linnaeus), is frequently known as the red louse of cattle. It is a common parasite on American cattle, but its injury is not as great as that of the sucking lice of cattle. This species is about one and a half millimeters in length. The head is reddish and the body is of a reddish brown.

The Biting Louse of Sheep, *Bovicola ovis* (Linnaeus), has a characteristic appearance. The head is circular and the abdomen swollen. The transverse banding is conspicuous. It is not a serious pest.

The Biting Lice of Goats, *Bovicola caprae* Gult. and *limbatus* Gervais, are so nearly alike that it has been suggested that they are the same. They are about one and a half millimeters in length, the males being somewhat smaller than the females.

Genus Eutrichophilus Mjöberg

Members of this genus may be recognized from nearly all the species of other genera by the shape of the forehead which is more or less trapezoidal. They are more slender than most members of the family.

The most remarkable thing about this genus is its peculiar host relationships. Its species infest, as far as known, only two mammal groups, the porcupines and the Cervidae, groups almost diametrically apposed in their phylogenetic positions. It may be added that the species from these two host groups have a remarkable similarity in all details, and the writer feels sure that they constitute a natural group.

The Control of Biting Lice on Domestic Animals

Biting lice occur on practically all of the domesticated animals, including both birds and mammals. They are more serious as pests on poultry, where they are probably most often encountered.

On the larger domesticated animals lice may be killed by a local application of an insecticide where there is only a slight infestation. For this purpose the insecticide, which may be a lime-sulphur solution or kerosene emulsion at the strength of one to six, is applied by means of a brush, broom or rag.

Where there is a serious infestation of a single animal, or a number of animals, the dipping process should be resorted to. This may be done in the same way as for ticks or scab mites. The arsenical tick dip should not be used for biting lice.

On poultry, lice may be destroyed in a number of ways. Where poultry houses are well constructed, well ventilated and well lighted lice are not so liable to become serious pests. Chickens should be supplied with a dust bath. Dry road dust, or dust from a fine sandy soil is mixed either with a small quantity of snuff, flowers of sulphur or slaked lime and placed in a box easily accessible to the infested fowls.

Dipping of infested fowls is somewhat dangerous but is recommended by Bishopp and Wood. They have shown that sodium fluorid may be used in making a dipping solution which does not injure the feathers or skin. One ounce of sodium fluorid to a gallon of water is employed, and the fowl is submerged about one-half of a minute. The fowls should be dipped on warm sunny days, and the water should be tepid.

Fowls are more commonly treated for lice by dusting them with a perforated can. For this purpose a mixture of crude carbolic acid (one-fourth pint), of gasoline (three-fourths pint) and plaster paris (two and a half pounds) may

be used. Sodium fluorid may also be applied as a dust by means of the perforated can.

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CHAPTER IV

THE ANOPLURA, OR SUCKING LICE

THE sucking lice constitute the order Anoplura, one of the smallest of the orders of insects, but one that contains many species that are of biological interest or economic importance. In the last catalogue of the group (Ferris, 1916) one hundred and twenty species were listed from the world. The number of species described since then would bring the total nearly to two hundred. Sucking lice are confined entirely to mammals and are particularly abundant on such rodents as rats and mice and on many ungulates and most of the primates. Upon insectivores but few species are found; while marsupials, bats and a few other groups are not known to harbor them.

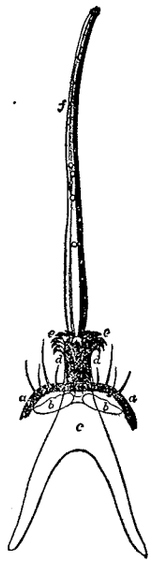

Figure 71. Mouth-parts of a sucking louse; *a, a,* head margin; *b, b,* chitinous band; *c,* hind part of lower lip; *d, d,* protruding part of haustellum; *e, e,* hooks turned outward; *f,* inner suction tube. (Schioedte)

EXTERNAL ANATOMY

Sucking lice are very similar in size and general appearances to the biting lice, but they differ from the biting lice in a number of fundamental ways. Their mouth-parts are entirely of the sucking type, instead of the biting type; the thorax is unsegmented in all genera (unless it be in the highly specialized genus *Haematomyzus*), instead of being two or three segmented, and the first pair of abdominal spiracles is situated on the third instead of the second visible abdominal segment.

The mouth-parts of a sucking louse lie in a long tubular invagination of the floor of the

buccal cavity, called the piercer-sheath, which extends backward for most of the length of the head. They are composed of four elements. The most dorsal of these, the dorsal-piercer, is a slender, flattened, stylet which is attached posteriorly to two muscles arising from the posterior wall of the head capsule. Just beneath the dorsal-piercer and adhering to it at the base is a minute, chitinous tube of unknown function. Below this tube is the ventral piercer which is similar to the dorsal one. It too is attached to two muscles which originate from the head capsule. Finally there is the most ventral structure which consists of a divided chitinous plate embedded in the floor of the piercer-sheath. It has been regarded as the mentum and submentum. The regions of the head have the same names as in the biting lice; while some of the head structures of the latter are wanting.

The thorax (Fig. 72) of a sucking louse is broad and flat and is consolidated into a single segment except possibly in one genus. It bears dorsally a single pair of large spiracles, and ventrally but a single body plate as a rule. This is the sternal plate which is usually entire, but is divided in a few genera.

The abdomen (Fig. 72) is nine segmented in the more primitive genera, but in many of the others the first two abdominal segments have been fused, while in a single genus, *Phthirus*, no less than the first five segments have been fused, although in this instance the first and second pairs of spiracles have been retained. In most of the genera some or all of the pleural plates have been retained, while only a few possess well developed tergal or sternal plates. The genital armature of the male has the same general structure as in the biting lice, and the more important parts are similarly named.

The legs are short and stout, and some of them usually modified so as to clasp hairs. The clasping apparatus is

formed by the enlarging and flattening of the tarsal claw and the developing of a distal, spined thumb on the tibia which is placed in apposition to the tarsal claw. In many

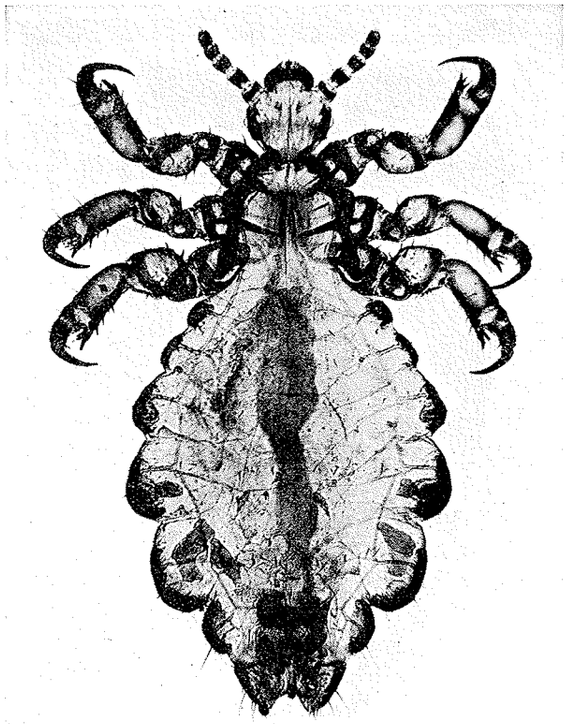

Figure 72. A monkey louse, *Pediculus consobrinus;* female from above. (Ewing)

of the genera the first pair of legs is smaller than the rest and in such instances is usually not modified for hair clasping.

LIFE HISTORY AND HABITS

The sucking lice have a development and habits quite parallel to those of the biting lice already described, except

that they suck blood. The eggs, or nits, are laid attached to the hairs of the host, and the young hatching from the eggs begin and lead a life on the same host individual as the later nymphs and adults.

Blood of mammals constitutes practically the exclusive diet of the sucking lice. And it is largely because of this habit that such diseases of man as typhus, relapsing fever and trench fever are transmitted by these parasites. When the louse feeds it breaks the skin and sets up an irritation. This irritation causes scratching, and the scratching crushes the lice, and rubs into the wound the infective contents of the louse's body. The biology of *Pediculus humanus* has been studied by several workers, but particularly by Nuttall (1917).

ORIGIN AND RELATIONSHIPS

The origin of the sucking lice is yet an unsolved mystery. Formerly, and even recently, it has been held that they are very closely related to, and have apparently originated from the biting lice. Yet although genus after genus has been added to both the Anoplura and the Mallophaga from the four corners of the earth and from the most diverse and peculiar and primitive hosts, yet in the nature of the mouth parts and in the composition of the thorax there is a sharp and fundamental break between these two groups.

The mouth-parts would seem to be more easily homoligized with those of the true bugs or Hemiptera as has been claimed by Enderlein (1904), yet there are difficulties in doing so according to Harrison and others.

TAXONOMY

Dalla Torre (1908) in his synopsis of the Anoplura recognized four families. These four have been generally recognized by others. They are; the Pediculidae, for those lice with eyes which infest primates; the Haematomyzidae,

for those with a tubular head and occurring on elephants; the Echinophthiriidae, for the short, spined lice of marine mammals; and the Haematopinidae, for the remaining blind forms that are found chiefly on rodents and ungulates.

In the classification here given the weight accorded to the different characters is intended to be in proportion to the fundamental nature of those characters. Those considered of most importance, hence to be used chiefly for defining the families and subfamilies are: The fusion of abdominal segments; the number and position of the abdominal spiracles; the type of setae clothing the body; the general shape of the head and the type of legs composing each pair. Two new families are suggested, one for the peculiar genus *Haematopinoides* described by Osborn and one for the inguinal, or crab, louse of man.

KEY TO THE FAMILIES OF SUCKING LICE

1. Head not drawn out into any tubular process; tibiae of at least one pair of legs broadened distally and forming a spine-like or thumblike process apposable to tarsal claws 2
   Head produced into a tubular beak which is much longer than the head proper; tibiae of all the legs not broadened distally or formed into any process apposable to tarsal claw. On elephants . . . . . HAEMATOMYZIDAE
2. Body sparsely clothed with setae the most of which are in definite rows, scales usually wanting. Parasitic on land mammals 3
   Body thickly studded with short stout spines and in some cases with setae or scales in addition. Parasitic on marine carnivores . . . . . ECHINOPHTHIRIIDAE
3. Eyes wanting; pleural plates sometimes vestigial or wanting 4
   Eyes or eye tubercles present; pleural plates usually well developed. On primates 5
4. Antennae five segmented . . . . . HAEMATOPINIDAE
   Antennae three segmented . . HAEMATOPINOIDIDAE, new family
5. First pair of legs similar to the others in structure but sometimes smaller; segmentation of the abdomen typical of the order; first and second pairs of abdominal spiracles lateral in position; abdominal tubercles wanting . . . . . PEDICULIDAE

First pair of legs much more slender than the others; abdominal segments III–V fused; first and second pairs of abdominal spiracles dorsal in position; lateral abdominal tubercles present.....PHTHIRIDAE, new family

Family HAEMATOPINIDAE

This family is by far the largest of those in the order Anoplura. In it are included twenty-nine genera and more than half of the species of sucking lice. These lice are confined largely to rodents, insectivores and ungulates. Enderlein (1904) divided the family into three subfamilies; Haematopininae, Trichaulinae and Euhaematopininae. Ferris (1916) accepts these three divisions, but reduces the genus *Trichaulus* to the synonymy of *Linognathus* thus changing the subfamily name Trichaulinae to Linognathinae.

In the classification here given, the genus *Euhaematopinus* Osborn is reduced to the synonymy of *Haematopinoides* Osborn and taken out of the Haematopinidae and placed in a family of its own, the Haematopinoididae. The genus *Acanthophthirus* Perkins, established for an immature specimen from a bat, needs further study as its status is very uncertain. The number of subfamilies recognized is increased to six. The characters used for their differentiation as well as for their genera are made evident in the following key:

KEY TO THE SUBFAMILIES AND GENERA OF HAEMATOPINIDAE

1. First pair of legs smaller than one or both of the other pairs 2
   Legs all subequal, the tarsus and tibia of each forming a hair-clasping apparatus. On ungulates....HAEMATOPININAE 6
2. First pair of legs smaller than either the second or third pair 3
   First two pairs of legs of the same size and much smaller than the last pair. On rodents
   ENDERLEINELLINAE, new subfamily 7
3. Abdomen provided with distinct pleural plates on some of its segments..... 4
   Abdomen without pleural plates, or with only slight rudiments of the same..... 5

4. Tarsus I with 2 claws and apparently 2-segmented; third antennal segment longest
   HYBOPHTHIRINAE, new subfamily 13
   Tarsus I with but 1 claw and unsegmented; second antennal segment usually longest
   HOPLOPLEURINAE, new subfamily 14
5. Six pairs of abdominal spiracles present; abdomen clothed with normal setae.....LINOGNATHINAE 29
   Only one pair of abdominal spiracles present; abdomen studded with short setae and pointed scales
   NEOLINOGNATHINAE, new subfamily 34
6. Only one genus.....*Haematopinus* Leach
7. Antennae bearing several toothlike processes; abdomen elongate.....*Microphthirus* Ferris
   Antennae without toothlike processes; abdomen very broad usually subcircular..... 8
8. Tibiae and tarsi of legs I & II of about the same width throughout; tarsal claws I & II each provided with a conspicuous tooth on its inside near the tip...*Hoplophthirus*, new genus
   Tibiae I & II broadened at their distal ends and tarsi I &II at their proximal ends, and forming with tarsal claws clasping structures; claws of tarsi I & II with or without tooth 9
9. Second abdominal segment without any ventral plates, or discs; 7 distinct pairs of abdominal pleural plates present
   Proenderleinellus Ewing
   Second abdominal segment provided ventrally with a pair of tubercle-bearing plates; less than 7 distinct pairs of abdominal pleural plates present..... 10
10. Tubercle-bearing plates of second abdominal segment subcircular and disclike and each tubercle cylindrical and setigerous..... 11
    Tubercle-bearing plates of second abdominal segment not subcircular and disclike and tubercles themselves not cylindrical; abdomen subcircular; tarsal claws I & II each with a tooth.....*Cyclophthirus*, new genus
11. Pleural plates present either on abdominal segment V or VI or on both these segments.....*Enderleinellus* Fahrenholz
    Pleural plates absent on both abdominal segment V & VI. 12
12. Tarsal claws I & II bifurcate at their tips; forehead longer than broad, coneshaped, with lateral margins about straight
    Rhinophthirus, new genus
    Tarsal claws I & II simple; forehead broader than long, domeshaped, with lateral margins rounded
    Euenderleinellus, new genus

13. Segment of antennae equal to or longer than IV & V taken together; head not expanded into angular lateral lobes immediately behind the antennae . . . . . *Scipio* Cummings
    Third segment of antennae less than IV & V combined; head expanded immediately behind the antennae into lateral angulate lobes . . . . . *Hybophthirus* Enderlein
14. Pleural plates of second abdominal segment divided, one of the parts of each plate being dorsal in position and one ventral. On "kangaroo" rats and mice *Fahrenholzia* Kellogg & Ferris
    Pleural plates of second abdominal segment, when present, not divided in such a manner. Not on "kangaroo" rats and mice 15
15. Typical abdominal segments of female each with but a single transverse row of setae 16
    Typical abdominal segments, at least in the female, with more than one transverse row of setae 17
16. Abdominal segments I to V provided with pleural plates; setae of abdomen truncate . . . . . *Eulinognathus* Cummings
    Abdominal segments I & II without pleural plates *Ratemia* Fahrenholz
17. Not more than two transverse rows of setae above and below on typical abdominal segments 18
    Some of the abdominal segments at least in females with three transverse rows of setae above and below 22
18. Forehead truncate in front; underside of head with several large recurved hooklike processes *Docophthirus* Waterston
    Forehead more or less outwardly rounded; head without ventral hooklike processes 19
19. Both males and females with tergal and sternal plates 20
    Females without tergal and sternal plates *Linognathoides* Cummings
20. First antennal segment with a heavy posterior spine, usually surmounting a tubercle; third antennal segment of male modified and bearing one or more short, stout spines *Neohaematopinus* Mjöberg
    First antennal segment without such a spine or tubercle . . 21
21. Antennae of the two sexes the same; last pair of abdominal spiracles not reduced or vestigial *Ahaematopinus*, new genus
    Antennae of male either with the third segment modified or with one or more stout spines; pseudopenis simple *Polyplax* Enderlein

22. Transverse rows of abdominal setae of two types, the posterior, marginal row being made up of foliaceous setae while the interposed row or rows are of normal setae; abdomen with six pairs of spiracles . . . . . *Ctenophthirus* Ferris
    Transverse rows of abdominal setae not so constituted . . . 23
23. Sternal plate of second abdominal segment greatly enlarged, overlapping most of the third segment and divided at the median line; six pairs of abdominal spiracles present *Schizophthirus* Ferris
    Sternal plate of second abdoinal segment differently constituted; last, or sixth, pair of abdominal spiracles usually reduced in size, rarely vestigial or wanting 24
24. Second pair of pleural plates not lobed, but greatly enlarged and winglike and each bearing the pleural setae near the dorsal margin . . . . . *Pterophthirus* Ewing
    Second pair of pleural plates bilobed posteriorly and each bearing on its posterior margin between the lobes a pair of setae 25
25. Third abdominal sternite without spines; typical pleural plates with two posterior lobes . . . . . *Ferrisella*, new genus
    Third abdominal sternite with at least one pair of spines. 26
26. Third abdominal sternite with only one spine on each side of the median plane; tergites of male very large and touching or overlapping each other; posterior margin of abdomen of female with a comb of seta-bearing tubercles *Ctenura*, new genus
    Third abdominal sternite with more than one spine on each side; tergites of male not touching; posterior margin of abdomen of female without comb of seta-bearing tubercles 27
27. Third abdominal sternite with only 2 divergent spines on each side of the median line . . . . . *Hoplopleura* Enderlein
    Third abdominal sternite with 3 divergent spines on each side of median line 28
28. Typical pleural plates with only 2 posterior lobes; pseudopenis of male genital armature articulating with the ends of parameres. On Petauristid rodents *Euhoplopleura*, new genus
    Typical pleural plates with four posterior lobes; pseudopenis does not articulate with ends of parameres *Ctenopleura*, new genus
29. Typical abdominal segments never with more than a single transverse row of setae 30
    Typical abdominal segments with more than a single transverse row of setae; six pairs of abdominal spiracles present 33

30. Abdominal spiracles situated in tubercles. On cattle
Solenopotes Enderlein
Abdominal spiracles not situated in tubercles 31
31. Last two segments of antennae fused together; dorsal and ventral abdominal setae arranged into two dorsal longitudinal and two ventral longitudinal rows. On Procaviidae
Prolinognathus, new genus
Last two segments of antennae distinct; abdominal setae not so arranged 32
32. Temples not swollen and with postero-lateral angles; no vestiges of pleural plates present. On deers
Cervophthirus Mjöberg
Temples more or less swollen and without postero-lateral angles; vestiges of pleural plates present. On hares and rabbits . . . . . *Haemodipsus* Enderlein
33. Head at least three times as long as thorax, the latter very short and apparently composed of only two segments
Microthoracius Fahrenholz
Head not over twice as long as the thorax, the latter normal
Linognathus Enderlein
34. Only one genus included . . . . . *Neolinognathus* Bedford

GENERIC SYNONYMS IN HAEMATOPINIDAE

Neumannellus Fahrenholz, 1916 = *Scipio* Cummings, 1913
Lutegus Fahrenholz, 1916 = *Linognathoides* Cummings, 1914.
Acanthopinus Mjöberg, 1910 = *Neohaematopinus* Mjöberg, 1910.
Eremophthirius Glinkiewicsz, 1907 = *Polyplax* Enderlein, 1904.
Trichaulus Enderlein, 1904 = *Linognathus* Enderlein, 1905.

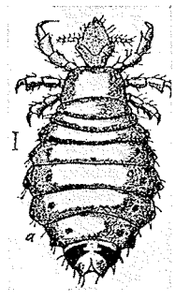

Figure 73. Short-nosed ox louse, *Haematopinus eurysternus*. (Osborn)

Genus HAEMATOPINUS Leach

This, the type genus of the family Haematopinidae, is the only included genus in the subfamily Haematopininae. It is a large genus of large lice occurring exclusively on ungulates. In it are included several species that parasitize domestic animals, some of which are of considerable economic importance.

The Sucking Louse of the Horse, *Haematopinus asini* (Linnaeus), occurs on horses, asses and donkeys. It is seldom found in the United States except on range animals. This is a large louse, but not so large as the sucking louse of swine.

The Short-nosed Ox Louse, *Haematopinus eurysternus* (Nitzsch) (Fig. 73), is similar in appearance to *H. asini*. A very similar species is found on the bison. This louse is not the one most encountered on cattle in America.

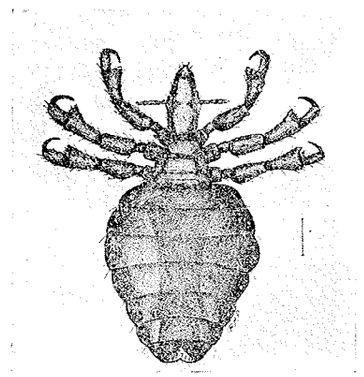

Figure 74. Hog louse, *Haematopinus suis*. (Lugger)

The Hog Louse, *Haematopinus suis* (Linnaeus) (Fig. 74), is one of the largest of all the sucking lice being about six millimeters long. It probably has been studied more than any other louse on domestic animals, being admirably adapted for morphological research on account of its large size (Florence, 1921). In this species there is a strong, black marginal band which passes around the body. This louse is very common in many parts of the world, but in the United States is of more or less local occurrence.

Genus POLYPLAX Enderlein

The genus *Polyplax* belongs to that group of the genera of the subfamily Hoplopleurinae in which there are not more than two transverse rows of setae to a single abdominal segment. There are tergal and sternal plates present in both sexes, but the antennae are different in the two sexes. The third antennal segment of the male is either modified or is provided with one or more, short, stout spines.

The Common Sucking Louse of Rats, *Polyplax spinulosa* (Burmeister), is the type species of the genus. This louse occurs on all of the domestic rats and is of almost worldwide distribution.

The Old World Mouse Louse, *Polyplax serrata* (Burmeister), has been found on the house mouse in the United States only on laboratory animals. It is a common parasite of the house mouse in Europe.

Genus Linognathus Enderlein

Linognathus species may be distinguished from those of the other genera of Linognathinae by the fact that the typical abdominal segments have more than a single transverse row of setae. The genus is restricted to ungulates and the domestic dog. Since only one species occurs on dogs and several species on ungulate hosts it would appear that the latter were the original natural hosts, and that dogs had acquired their species because of the predatory habits of their wolflike ancestors.

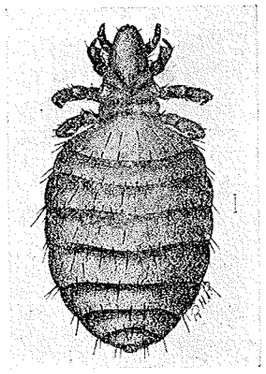

Figure 75. Sucking louse of the dog, *Linognathus piliferus*. (Lugger)

The Long-nosed Ox Louse, *Linognathus vituli* (Linnaeus), is a rather small slender species, being much smaller than *Haematopinus eurysternus*. It is widely distributed in the United States and occurs in many other countries.

The Foot Louse of Sheep, *Linognathus pedalis* (Osborn), occurs almost exclusively on the legs and feet of the host. Such a habit should make it easy to control the pest by driving the infested sheep into a dipping vat with enough insecticide solution to cover the legs.

The Sucking Louse of the Goat, *Linognathus stenopsis* (Burmeister), has a wedge-shaped head, short antennae and a squarish thorax. It is common in the Old World and in America.

The Sucking Louse of the Dog, *Linognathus piliferus* (Burmeister) (Fig. 75), the type species of the genus, is not only a parasite of the dog but also of the fox, the coyote and the ferret. Dogs in the United States are seldom found infested with this louse.

Genus Solenopotes Enderlein

Solenopotes may be distinguished from all other genera in its family by having its six pairs of abdominal spiracles opening through tubular processes on the sides of the body. This genus was established in 1904 for a new species found on cattle.

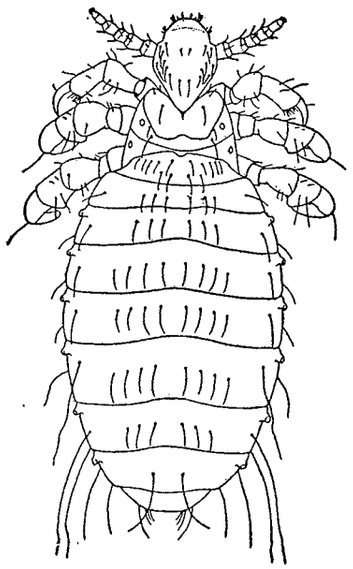

Figure 76. *Solonopotes capillatus;* dorsal view of female, ×40. (Bishopp)

The Tubercle-bearing Louse of Cattle, *Solenopotes capillatus* Enderlein (Fig. 76), known for many years only by a single record from Germany, was reported by Bishopp (1921) to be common in the United States and has since been found by Pillers in England. Female specimens are about one and a half millimeters long. Both sexes have the prominent lateral, spiracle-bearing tubercles.

Genus Haemodipsus Enderlein

In *Haemodipsus* there is but a single transverse row of setae to one abdominal segment, the abdominal spiracles

are not situated on tubercles, the last two antennal segments are distinctly separated, the temples are more or less swollen and vestiges of pleural plates are present. The genus is confined entirely to hares and rabbits.

There are but three species in the genus. *H. lyriocephalus* (Burmeister), the type species of the genus, is known only from Europe where it has been reported from two species of *Lepus*. *H. ventricosus* (Denny) is reported from a number of species of Leporidae and is found in Europe and North America. *H. setoni* Ewing was only recently (1924) described from jack rabbits in Western United States.

Family HAEMATOPINOIDIDAE

This family is erected to include two peculiar but not closely related genera in which the antennae are three segmented. One of these genera, *Haematopinoides* Osborn, is North American; the other, *Hamophthirius* Mjöberg, contains but a single species, *H. galeopitheci* Mjöberg, which was taken from a *Galeopithecus* species in Borneo.

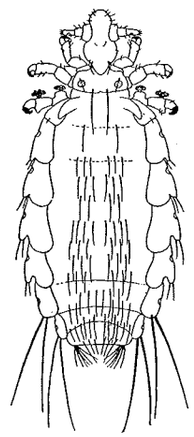

Figure 77. *Haematopinoides squamosus;* female from above, ×25. Drawing made from a type specimen. (Original)

The subfamily Euhaematopininae proposed by Enderlein (1904) included two genera, *Haematopinoides* Osborn and *Euhaematopinus* Osborn. It was suggested some years ago by Kellogg and Ferris that the genus *Euhaematopinus* should possibly be considered as a synomym of *Haematopinoides*. Recently the writer has studied the type specimens of the type species of *Haematopinoides*, *H. squamosus* Osborn (Fig. 77), and has found that these specimens show the peculiar, pedicellate structures on the hind legs so characteristic of *Euhaematopinus*, hence this later established genus should fall into the synonymy of *Haematopinoides*. It has been claimed (Ferris, 1922) that in *H. abnormis* (Osborn) the antennae are four segmented. In this opinion the writer can hardly concur. It is true that the last antennal segment shows double incrassations on the posterior border and sometimes also on the anterior border, but there is no transverse groove or suture present.

Both genera contained in this family are peculiar and rather markedly adapted in certain respects. Further study may show that they have not sufficient in common to be placed in the same family. Although they are both placed in the newly erected family Haematopinoididae, they are placed in different subfamilies.

Key to the Subfamilies and Genera of Haematopinoididae

1. Forehead of usual shape; first antennal segment but slightly larger than the others; posterior femora and tibiae each bearing a lateral pedicellate appendage
   Haematopinoidinae, new subfamily 2
   Forehead strongly constricted and bearing a chitinous hook on each side; first antennal segment enormous and with posterior hook; posterior femora and tibiae without lateral appendages. . . . . Hamophthiriinae, new subfamily 3
2. Contains but a single genus. . . . . *Haematopinoides* Osborn
3. Contains but a single genus. . . . . *Hamophthirius* Mjöberg

Generic Synonym in Haematopinoididae

Euhaematopinus Osborn, 1896 = *Haematopinoides* Osborn 1891

Family PEDICULIDAE

The members of the family Pediculidae (Fig. 78) are provided with eyes except in a single genus, the antennae are five segmented but in some of the genera indistinctly so, the body is clothed with normal setae, and the head is not drawn out into any tubular process. This family apparently is most nearly related to the *Haematopinidae*, the genus

Pediculus differing from *Haematopinus* particularly in having eyes, but also in other respects.

The Pediculidae live exclusively on primates,–lemurs, monkeys, apes and man. Usually the genus *Phthirus* Leach is included in the Pediculidae, but because of its fundamental differences should be placed in a family by itself.

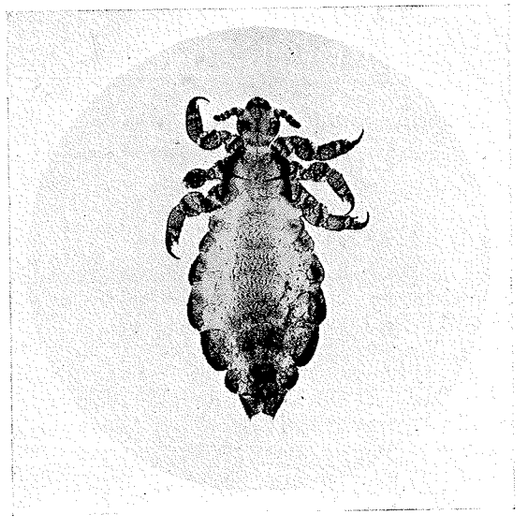

Figure 78. The head louse, *Pediculus humanus humanus;* female from above. (Original)

KEY TO THE SUBFAMILIES AND GENERA OF PEDICULIDAE

1. Antennae long and distinctly five segmented 2
   Antennae shorter, indistinctly five segmented, the last two segments being poorly separated and much reduced; abdomen never with more than three pairs of small pleural plates . . . . . PEDICININAE 5
2. First pair of legs very small, the other two pairs much en larged; eyes vestigial or wanting. Parasitic on lemurs PHTHIRPEDICULINAE, new subfamily 3
   Legs subequal, except that in the male the anterior ones are somewhat stouter than the others and usually provided with larger tibial processes; eyes well developed PEDICULINAE 4

3. Eyes present though much reduced; thorax broad and with conspicuous spiracles; six pairs of pleural plates present *Phthirpediculus* Ewing
   Eyes wanting; thorax slender and without spiracles; with but a single pair of pleural plates which are situated on the second abdominal segment . . . . . *Lemurphthirus* Bedford
4. Subfamily includes but a single genus . . . . *Pediculus* Linnaeus
5. All legs provided with subequal, slender and sharp claws *Pedicinus* Gervais
   Second and third pairs of legs with broader and stouter claws than those of the first pair 6
6. Abdomen with three pairs of pleural plates *Neopedicinus* Fahrenholz
   Abdomen with only two pairs of pleural plates *Phthirpedicinus* Fahrenholz

Genus PEDICULUS Linnaeus

This, the type genus of the family Pediculidae, is the oldest of all of the genera of Anoplura and is the only one contained in the subfamily Pediculinae. It is distinguished from all of the other genera in its family by having the legs subequal and the antennae distinctly five segmented. The species of the genus are found on man, apes and monkeys. Those occurring in the New World have recently been revised (Ewing, 1926). Those occurring on New World monkeys have the typical pleural plates with lateral lobes and are placed in the subgenus *Parapediculus* Ewing.

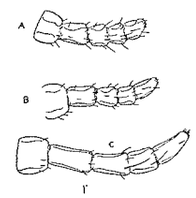

Figure 79. Antennae of female of; *A, Pediculus humanus humanus;* B, *P. h. americanus;* C, *P. h. nigritarum;* all drawn to the same scale. (Ewing)

Much controversy has raged over the question as to whether or not each of the primary races of mankind has harbored a distinct race or subspecies of *Pediculus*. The writer has already stated (Ewing, 1926) that it is his belief that each primary race did originally harbor a distinctive variety of *Pediculus*. This opinion was only arrived at after

a study of the lice infesting mummies. Undoubtedly much mixing of louse types has taken place following the intermingling of the primitive races during the civilized period of human history.

The Head Louse of the White Race of Man, *Pediculus humanus humanus* Linnaeus (Fig. 78), is to be considered the typical form of the species. The head louse of Europeans and others of the white race originally differed from those found on American Indian mummies, and on African negroes and on the yellow race by having the body setae more peglike, and in having scarcely half of them in distinct rows, and in having larger spiracular bulbs, these being over one-tenth of a millimeter in diameter.

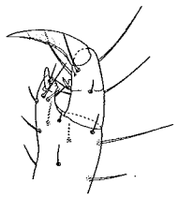

Figure 80. Ventral view of end of left anterior leg of male of *Pediculus humanus humanus*. (Ewing)

The so called head louse of man in Europe and to a lesser degree in the United States is usually what appears to be a hybrid of this variety. In central European and north European countries it is more nearly typical of those specimens collected half a century ago.

The Head Louse of African Negroes, *Pediculus humanus nigritarum* Fabricius, may have been the only form originally found in Ethiopia, but this point will be hard to settle now. Undoubtedly a number of types of lice are found today on African Negroes. One of the types which probably represents the *nigritarum* of Fabricius is a large louse with long antennae, every segment of which, except for the first, is longer than broad. This variety of *humanus* is very near and undoubtedly in some instances identical with some of the types of body lice found in United States and in certain other countries.

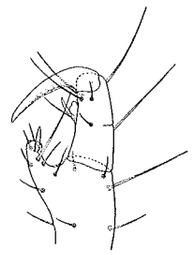

Figure 81. Ventral view of end of left anterior leg of male of *Pediculus humanus nigritarum*. (Ewing)

The Head Louse of American Indians, *Pediculus humanus americanus* Ewing, was described (1926) from lice taken on the scalps of Indian mummies. All of these specimens were larger than the European head louse, the segments of the antennae were longer in proportion to their width, the body setae were less peglike, and there were a number of other differences. The same type of louse as was taken from Indian mummies has been taken also from heads of living Indians. Living Indians, however, have been found harboring also the European head louse.

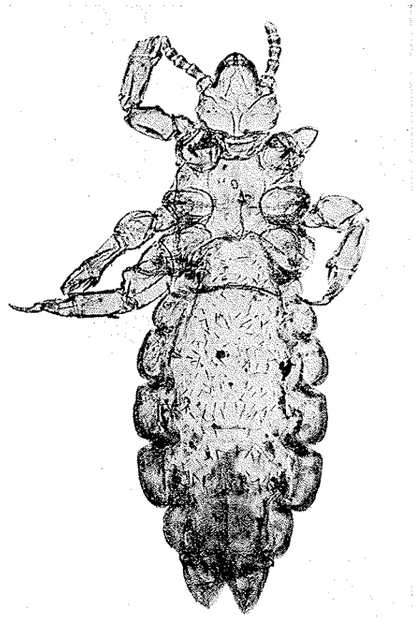

Figure 82. *Pediculus humanus americanus*, from scalp of prehistoric American Indian mummy. (Ewing)

The Head Louse of the Yellow Race of Man, *Pediculus humanus angustus* Fahrenholz, is very near that of the American Indian. Attempts to divide the head lice of the yellow race into more than one variety hardly appears to be justified.

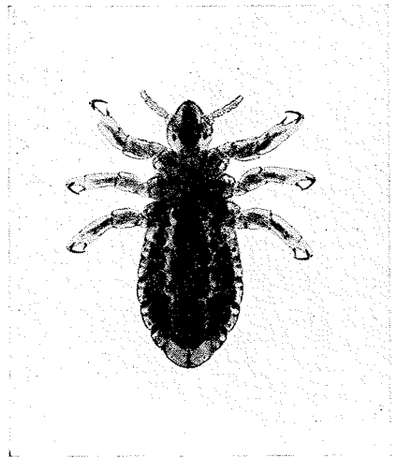

Figure 83. The body louse, *Pediculus humanus corporis;* nymph greatly enlarged. (Original)

The Body Louse, *Pediculus humanus corporis* Deeger, is a term applied to forms of *Pediculus* occurring on man which infest by preference the body and which lay most of their eggs on the clothing. Such forms are exceedingly variable in their morphological characters, as they are in their egg-laying habits. It may be that a clothes-infesting variety of the European head louse developed as the habit of wearing clothes became established among Caucasians, or it may be that the clothes louse was originally only the African head louse which found the animal skins and woolen garments worn by man somewhat similar in their fibrous structure to the woolly hair of the negro race. Body lice of today appear to be chiefly hybrids.

The body louse, or clothes louse, is an important disease transmitter being responsible for the transmission of typhus and relapsing fevers and also trench fever. In civilized countries during peace times this louse is usually prevalent only among the shiftless and the very poor, but during times of stress where large numbers of the population are denied

the common practices of laundrying it may become very abundant. As a wartime pest the clothes louse is probably of greatest importance. Methods for its control are considered at the end of the chapter on the Anoplura.

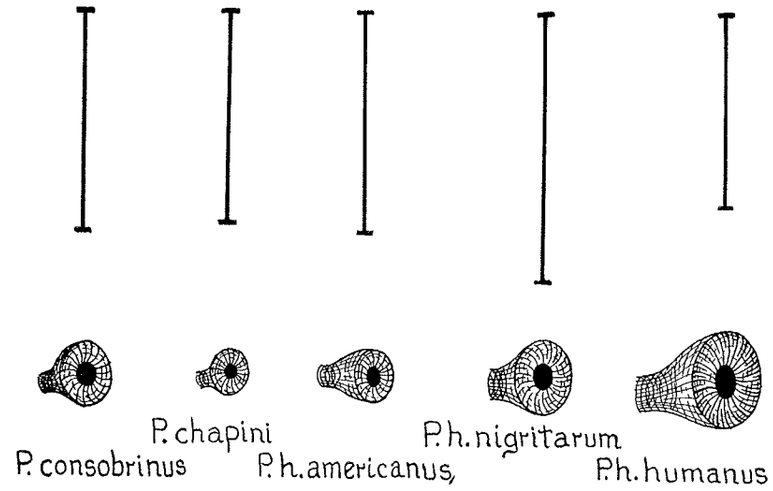

Figure 84. Drawings of the right thoracic spiracle of a female louse of five different kinds of Pediculi, all enlarged, ×100. The line above drawing of each spiracle represents the length of the louse, ×10.

Family PHTHIRIDAE

Although the crab louse, *Phthirus pubis* (Linnaeus), has been recognized as being generically distinct from the other lice infesting man for over a century, evidently the importance of the generic characters of the genus *Phthirus* have not been fully recognized in the past. This has doubtless been due in part to the fact that the lice of primates in general have been only recently studied to any extent. The genus *Phthirus* differs from all other genera of sucking lice in having the first five segments of the abdomen fused and reduced to one, also in this genus only are the abdominal segments produced laterally into large tuberclelike lobes.

The Crab Louse, *Phthirus pubis* (Linnaeus), has the legs attached to the sides of the body like those of a crab, hence its common name. The front legs are very slender and provided with sharp claws; each of the other legs is much enlarged and formed into a hairclasper. Crab lice infest chiefly the pubic region where their eggs are laid attached to the pubic hairs. These lice are scattered about chiefly by means of the detached, nit-bearing hairs which are left on towels or dropped about the floors.

Family ECHINOPHTHIRIIDAE

The large, leathery, spine-studded lice that constitute this family have the remarkable habit of infesting marine carnivores. In the case of water birds which are infested by lice it is observed that the lice being under the oily feathers next to the skin are not only protected from the water but are provided with an abundance of air to breathe. Perhaps the lice of the family Echinophthiriidae get their air at the same intervals with their hosts when the latter come to the surface of the water to breathe.

This family is not a large one and contains only four genera; which, however, are arranged into three subfamilies.

Key to the Subfamilies and Genera of Echinophthiriidae

1. Body bearing minute scales; except for a single species, antennae five segmented..... 2
   Body without scales, antennae four segmented
   Echinophthiriinae 5
2. Antennae five segmented; head and thorax very distinctly separated; tibia I with thumb greatly reduced or wanting; body usually with some long setae above in addition to short, stout thorns.....Antarctophthiriinae 3
   Antennae four segmented; head almost coalescing with thorax; tibia I though smaller than the other tibiae yet provided with a large, toothed thumb; body with only short, stout thorns above.....Lepidophthiriinae 4
3. Contains but a single genus.....*Antarctophthirus* Enderlein
4. Contains but a single genus.....*Lepidophthirus* Enderlein

5. Body long; abdomen much longer than broad and clothed with both short spines and long setae; anterior legs greatly reduced in size and with tibial thumb obsolete; sternum wanting.....*Proechinophthirus* Ewing
   Body short, stout; abdomen subcircular, clothed with spines only; anterior legs similar to the others and almost as large; sternum present.....*Echinophthirius* Enderlein

Generic Synonym in Echinophthiriidae

Arctophthirus Mjöberg, 1910 = *Antarctophthirus* Enderlein, 1906.

Family HAEMATOMYZIDAE

There is included in this family but a single genus and species. This species is quite remarkable in its structure, from which the following family characters are enumerated: Head produced anteriorly into a beaklike, proboscis; antennae five segmented. Legs of nearly the same size, slender and without tibial, thumblike process apposible to the tarsal claw. In the only species of this family the prothorax is separated off from the rest of the thorax, a condition not found elsewhere in the order.

The single genus, *Haematomyzus* Piaget, was established for the sucking louse of the African elephant, *Haematomyzus elephantis* Piaget. A variety of this species *H. e. sumatranus* was described from an Asiatic elephant by Fahrenholz. Two generic names come under the synonymy of *Haematomyzus*, *Idolocoris* Walker & Richter and *Phantasmocoris* White, both established in 1871.

The Control of Sucking Lice on Man

In this work only a few suggestions are given in regard to the control of lice. Those who are particularly interested in the control of human lice are referred to a large article by Nuttall (1918) and another by Moore and Hirschfelder (1919), which are listed in the bibliography at the end of this chapter.

Head lice may be effectively destroyed by first clipping

the hair close to the head and then applying an insecticide to the scalp. A hot solution of two percent lysol or a two percent solution of carbolic acid may be used. A moist towel should be wrapped about the head making a turban and the solution allowed to act for some time.

Body lice may be suppressed at times by applying proper laundrying methods to the clothing. Louse powders may be used against them, the following formula being one fre-

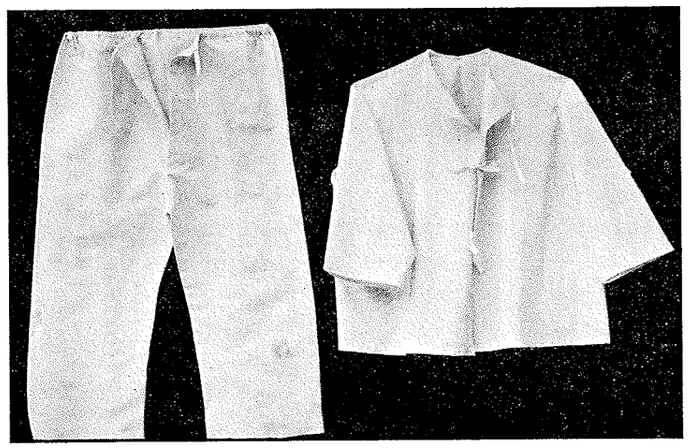

Figure 85. "Cootie clothing." A large unit of the American Expeditionary Force was supplied with these "cootie" suits.

quently employed: Naphthaline, 96 per cent; creosote, 2 per cent; iodoform, 2 per cent. Powders have been applied by means of sachets worn on the legs. The impregnation of underwear was tried during the World War with varying success. One American division was supplied with specially made underwear (Fig. 85) impregnated with a solution of naphthaline and sulphur dissolved in gasoline.

Crab lice at times become abundant in gymnasiums or in lodging houses. They are scattered about on towels or laundry and by means of the eggs on hairs detached because

of scratching. Not only is it frequently necessary to destroy the eggs and lice on the bodies of the infested persons, but extra precautions must be taken in regard to the use of towels and the cleaning of the floors. Crab lice will frequently spread to the hairs of the armpits, or on some persons to the hairy patches on the chest or even on the back. Such patches of hair should not be overlooked during the employment of clean up measures.

The Control of Sucking Lice on Animals

Sucking lice are confined entirely to mammals hence are not found on poultry. On domesticated mammals they may be destroyed in the same manner as the biting lice, *i.e.*, by the local application of an insecticide where there is a mild infestation, or by dipping the whole animal where the infestation is serious. Insecticides, particularly oil emulsions may be applied by a spray pump to advantage on warm days.

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CHAPTER V

THE SIPHONAPTERA, OR FLEAS

FLEAS are ectoparasites that infest their hosts only temporarily. They are small, degenerate, wingless insects that are so flattened that they pass readily between either the hairs or feathers, of their hosts. Lice are flattened dorso-ventrally, or depressed; while fleas are flattened laterally, or compressed. Fleas resemble the biting lice in being found on both birds and mammals. They are especially abundant on rodents or on mammals that construct nests in which to rear their young or to hibernate. Marine mammals are without them, but winged mammals are infested. The fleas of the world have recently been catalogued by Dalla Torre, 1924. The American Siphonaptera were revised by Baker (1904) and those of Brazil by Cunha (1914).

External Anatomy

The head of a flea is much compressed, is usually longer than high, and has an outwardly rounded front. Practically all evidence of sutures between sclerites has been obliterated. The head proper is divided more or less into two parts by the oblique antennal fossae. The region in front of the antennal fossae is represented by the frons, the most anterior part; and the gena, the postero-ventral areas below the antennal grooves. The area behind the antennal fossae represents the occiput. The eyes, which are frequently wanting, are situated near or contiguous with the ventral margin of the antennal fossae between the genae and the frons. Each gena frequently bears along its ventral margin a comb of toothlike spines known as the genal comb, or ctenidium, also a large seta is frequently present near the ventral margin over the mouth opening, the oral seta. Along the front margin of the frons in some genera is found a small notch

in which is usually situated a minute, pointed tubercle, this notch and its usually contained tubercle is known as the frontal notch, or frontal tubercle. Near the posterior border of the frons, in front of the eye, may be found a large seta, the ocular seta. Much of the distal part of the antenna is partly, or completely, broken up into several small segments. This region is known as the club, or antennal club, and is usually club-shaped.

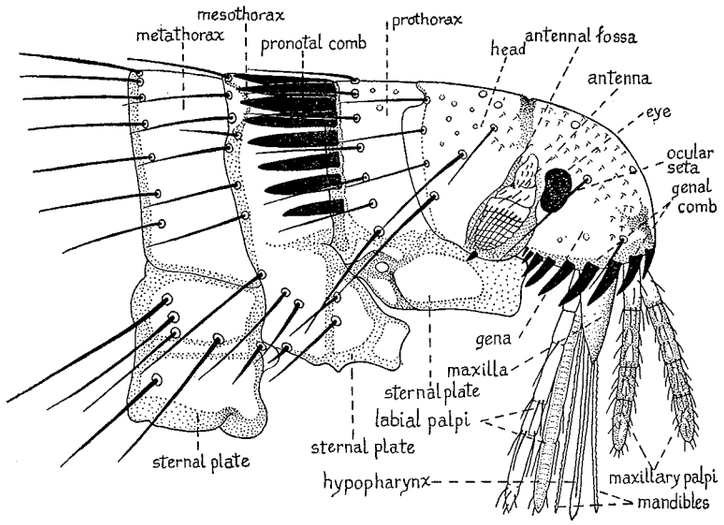

Figure 86. Head and thorax of a flea, *Ctenocephalus canis*, with different parts labeled. (Original)

The internal skeleton of the head is of importance in taxonomy. A large apodeme, or incrassation, may be present between the bases of the antennae and the vertex. Along this incrassation a suture is frequently developed. Oudemans (1909) divides all the fleas into two groups depending upon the presence or absence of this suture. From the anterior, ventral angle of the frons an inner tubercle, the frontal

incrassation, may develop. In some genera this frontal incrassation may extend half way across the frons. From about the middle of the dorsal margin of the occiput an apodeme may extend downward. This is sometimes known as the posterior tubercle, probably the term occipital apodeme would be more appropriate.

The mouth-parts (Fig. 86) are of the sucking type. In front there extends downward the filiform, segmented maxillary palpi. The most posterior of the mouth structures are the segmental labial palpi which extend downward from the head. The piercing structures lie between the two pairs of palpi and are composed of the unpaired needlelike hypo-, or epipharynx, and the paired needlelike mandibles. The maxillae proper are triangular lobes and are lateral in position.

The thorax (Fig. 86) is much reduced, in a few genera greatly so. The pronotum frequently bears a row of toothlike

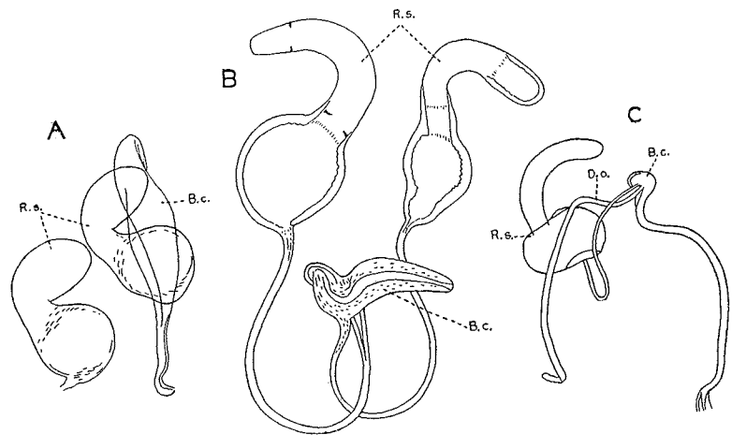

Figure 87. The three different types of receptacula seminis found in a female flea. A, equal paired type, as found in *Atyphloceras echis;* B, unequally paired type as found in *Macropsylla hercules;* C, single or unpaired type as found in *Mesopsylla hebes*. *B.c.*, bursa copulatrix; *D.o.*, duct of obsolete bursa copulatrix; *R.s.*, receptaculum seminis (Jordan & Rothschild)

spines, the pronotal comb, along the posterior margin. The powerful legs are each composed of the following segments: A large, flat, platelike coxa; a small trochanter; a large, flattened femur; a tibia that is broadened distally; and a five-segmented tarsus.

The abdomen is greatly flattened and is composed of ten segments—a rather remarkable circumstance considering how degenerate the fleas are in a number of ways. In females the abdomen may become much distended with eggs. The receptaculum seminis, a chitinous structure, varies much in shape among the different species (Fig. 87), and thus affords an excellent character in distinguishing closely related species. The complicated male genital armature is shown in figure 88, with the parts labeled. Its structure is a matter of much concern in describing species.

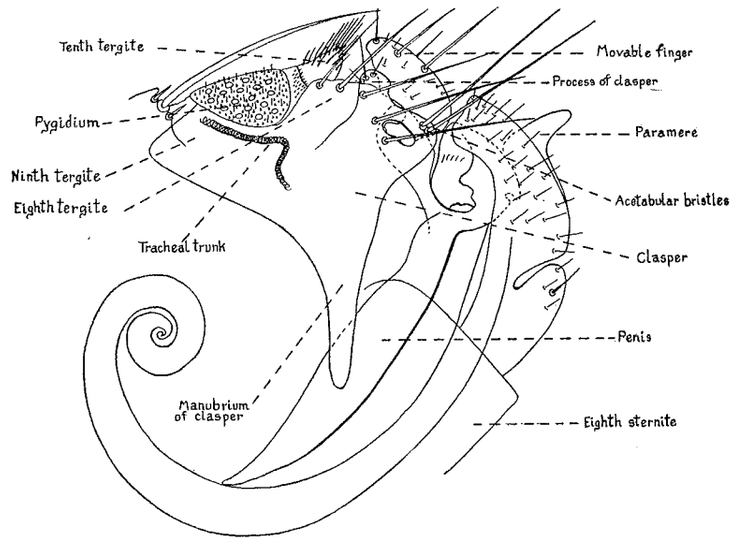

Figure 88. Modified terminal abdominal segments and genitalia of male of *Ceratophyllus fasciatus*.

Life History and Habits

Fleas lay their eggs only when feeding upon or when closely associated with their favorite host or hosts. They are not attached in any way, so soon fall into the litter of the nest or retreat. These eggs are minute, whitish, oblong objects. From them there hatches out a legless larva, similar in certain respects to some dipterous larvae. These larvae feed upon the organic matter of the dust and debris in which they are found, and especially upon the bloody excrement of adult fleas. Upon reaching larval maturity the larva spins a thin, oval cocoon and pupates inside of it. The pupal stage lasts from one to four weeks. From the pupal skin the adult emerges.

Origin and Relationships

Fleas have become so highly specialized in adaptation to their particular type of parasitic life that attempts to trace back their origin from free living forebears have been rewarded only with speculative theories. More commonly fleas have been either regarded as degenerate dipterons or to have originated from the Diptera. Packard and others have held the view that the fleas originated from the Nematocerous Diptera. According to another hypothesis the fleas are to be regarded as originating from Phorid-like ancestors. Martini (1922) has advanced a very interesting theory in regard to the origin of the Siphonaptera. He would consider the group as a derivative of the coleopterous superfamily Staphylinoidea.

Classification

The fleas constitute an order of remarkable unity and attempts to divide it into suborders and numerous families have only met with partial success. If the group is to be divided into two suborders probably those of Oudemans (1909), the Fracticipita and Integricipita, are as acceptable

as any that could be given. But not only is it hard to determine in certain genera whether the head is to be regarded as divided by a dorsal suture (Fracticipita) or not (Integri-

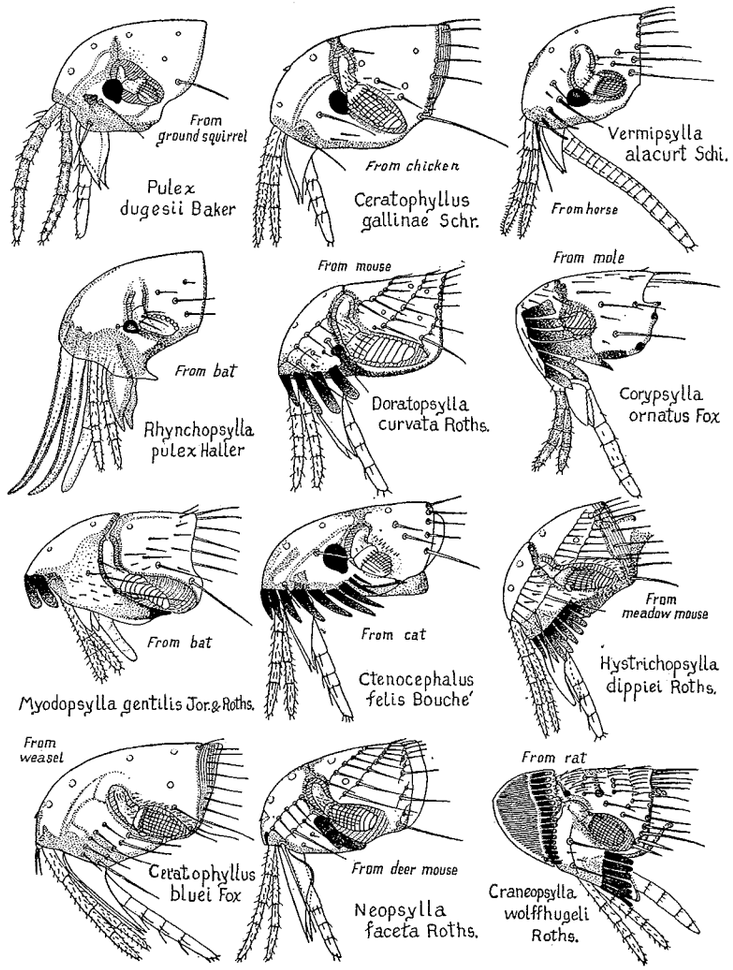

Figure 89. Heads of fleas belonging to eleven different genera; not equally enlarged. (Original)

cipita), but there are not enough other correlating characters to justify such a division according to the writer.

As to families no less than eighteen have been suggested. Most of these have but little justification for their retention. Big breaks among the genera, *i.e.*, ones involving two or more characters of more than generic importance are few, hence the families recognized should be few. The classification of American fleas for many years has been based largely on the work of Baker (1905).

Key to the Families of Siphonaptera

1. Thorax not reduced, the three thoracic tergites together being longer than the first abdominal tergite; gravid females only slightly, if at all, enlarged 2
   Thorax greatly reduced, the three thoracic tergites together being shorter than the first abdominal tergite; frontal region fused with occiput; females with a single receptaculum seminis, sometimes with a reduced number of abdominal spiracles, and when gravid with the abdomen greatly distended ..... Hectopsyllidae
2. Frontal region continuous with the occiput, there being no vertical suture from dorsal margin of head to bases of antennae; front almost evenly rounded along margin 3
   Frontal region separated from occiput by a suture which passes upward from the bases of antennae to the dorsal margin of head; front with margin usually most strongly curved at vertex 4
3. Typical abdominal tergites with but a single row of setae; frontal tubercle usually wanting; eyes usually present Pulicidae
   Typical abdominal tergites with at least two rows of setae; frontal tubercle present or absent; eyes frequently wanting Dolichopsyllidae
4. Head without a pair of antero-ventral flaps on each side. Not on bats 5
   Head with a pair of antero-ventral flaps on each side which hang down opposite the mouth cavity. On bats Ischnopsyllidae
5. Occipital region without dorsal incrassation; frontal region entire; females frequently with two, equal receptacula seminis ..... Hystrichopsyllidae

Occipital region with a dorsal incrassation about the middle; frontal region usually divided, the anterior part bearing a border of spines and having the appearance of a crown
MACROPSYLLIDAE

Family PULICIDAE

Much discussion might be indulged in concerning which family of fleas should be considered the most generalized or primitive. All families show certain characters that are evidently the result of degeneration or adaptation incident to the parasitic life followed by their contained species. In the Pulicidae the thorax has not become reduced; the eyes are nearly always present; there is no reduction of the spiracles in either sex; abdominal combs are wanting; and in one genus at least the receptaculum seminis of the female has a double head.

The family Pulicidae is a large one including representatives from all the chief zoogeographical regions. In it are found several of those species which occur about human habitations and attack man. The hosts upon which Pulicidae occur are found among the lowest and highest of the mammals, and are representative of many orders.

KEY TO THE GENERA OF PULICIDAE

1. Coxae of third pair of legs with a row or patch of spinelets on the inside 2
   Coxae of the third pair of legs without spinelets on the inside 17
2. Pronotal comb of spines wanting 3
   Pronotal comb of spines present 12
3. With a frontal tubercle 4
   Without a frontal tubercle 6
4. Anterior angle of genal margin produced into a lobe 5
   Anterior angle of genal margin not so produced; frons subangulate to angulate ..... *Ornithopsylla* Rothschild
5. Epipharynx and mandibles normal; metanotum not shorter than mesonotum. An African genus. *Moeopsylla* Rothschild
   Epipharynx and mandibles slender; metanotum much shorter than mesonotum and devoid a row of setae
   Delopsylla Jordan

6. Eyes present 7
   Eyes wanting; head without dorsal incrassations
   Rooseveltiella Fox
7. Genal lobe formed into an acute, more or less spinelike, process; pronotum broader than metanotum. Occurring in Africa
   Pariodontis Jordan & Rothschild
   Genal lobe not formed into such a process 8
8. Fifth tarsal segment of all legs with only three pairs of lateral plantar bristles. From North America
   Actenopsylla Jordan & Rothschild
   Fifth tarsal segment of all of the legs with four pairs of lateral plantar bristles 9
9. Mesosternite very broad and divided into two areas by a vertical chitinous thickening or apodeme 10
   Mesosternite rather narrow, not divided into two areas by a vertical chitinous thickening 11
10. Posterior area of hind coxa expanded distally so as to form a slight lobe ..... *Xenopsylla* Glinkiewicz
    Synosternus Jordan
    Posterior area of hind coxa not expanded distally, with its free margin tapering from middle to apex
    Procaviopsylla Jordan
11. Posterior region of head without rows of setae; setae of body normal ..... *Pulex* Linnaeus
    Posterior region of head with 2 oblique series of setae in addition to row on hind margin; body setae extremely stout. Known only from Africa ..... *Parapulex* Wagner
12. Genal comb wanting; club of antennae subcapitate with segmental sutures extending less than half way across the same
    Hoplopsyllus Baker
    Genal comb present 13
13. Genal comb reduced to 3 or less spines; pronotal comb much reduced 14
    Genal comb composed of more than 3 spines 15
14. Labial palpus scarcely reaching apex of 3rd. segment of maxillary palpus; vertical rod of mesosternite not confluent with anterior margin. Occurring only in Madagascar
    Centetipsylla Jordan
    Labial palpus reaching much beyond apex of 3rd. segment of maxillary palpus; vertical rod of mesosternite confluent with anterior margin before reaching apex. *Archaeopsylla* Dampf
15. Genal comb and ventral margin of gena about horizontal; upper margin of antennal fossa in the male with a patch of spinelets ..... *Ctenocephalus* Kolenati

Genal comb and ventral margin of gena more nearly vertical than horizontal; upper margin of antennal fossa without spinelets..... 16

16. Frontal incrassation of head extending upward to or beyond the ocular seta; frons somewhat angulate dorsally; mandibles heavily chitinized.....*Spilopsyllus* Baker
Cediopsylla Jordan

Frontal incrassation extending upward scarcely beyond the oral seta and falling far short of ocular seta; front with rounded margin throughout; mandibles normal. Only from Sumatra.....*Nesolagobius* Jordan & Rothschild

17. With a pronotal comb..... 18
Without a pronotal comb..... 19

18. Labial palpus four segmented; femora without lateral setae
Callistopsyllus Jordan & Rothschild

Labial palpus five segmented, the fifth segment being equal to or longer than II, III & IV taken together; lobe on posterior margin of third coxa sharp pointed or acute
Megarthroglossus Jordan & Rothschild

19. Frontal tubercle present..... 20
Frontal tubercle absent; tarsus V of all the legs with five pairs of lateral plantar bristles..*Coptopsylla* Jordan & Rothschild

20. Eyes present; antepygidial bristles wanting; antennal groove closed behind. Australian genus.....*Lycopsylla* Rothschild
Eyes absent; antennal groove open behind
Anomiopsyllus Baker

Generic Synonym in the Pulicidae

Loemopsylla Jordan & Rothschild, 1908 = *Xenopsylla* Glinkiewicz, 1907.

Genus Xenopsylla Glinkiewicz

In *Xenopsylla* there is no pronotal comb; the frontal tubercle is wanting; eyes are present; the antennal groove is without a patch of spinelets along its upper border, and the mesosternite is divided into two areas by a vertical chitinous thickening. The genus is related to *Pulex*, but differs from it in having the mesosternite divided. No less than thirty species have been described in this genus. Of this number only two have been reported from the New World, probably both being introduced.

The Oriental Rat Flea, *Xenopsylla cheopis* Rothschild (Fig. 90), is the flea chiefly concerned in the transmission of bubonic plague in the Old World. According to Jordan and Rothschild (1908) this flea probably had its original home in the Nile Valley. It has been introduced into all the continents and into many countries on its rat hosts.

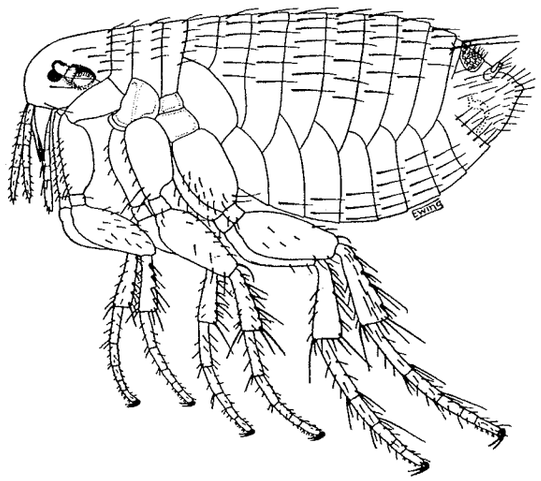

Figure 90. The oriental rat flea, *Xenopsylla cheopis;* female, ×30. (Original)

Fleas becoming infected with the bacillus of plague on diseased rats leave these rodent hosts and attack man, thus transmitting the disease germs. The germs are passed through the body of the flea and are ejected with partly digested blood from the anus. After being so ejected upon the skin they are rubbed in by scratching.

Other species of *Xenopsylla*: *X. astia* Rothschild is a common Asiatic rat flea but is a much poorer transmitter of the plague than *X. cheopis*. *X. brasiliensis* Baker occurs in South America, having been introduced, it appears, from the western part of Africa where it occurs on rats.

Genus Pulex Linnaeus

Pulex differs from *Xenopsylla* in having an undivided mesosternite and from *Actenopsylla* Jordan & Rothschild in having the club of the antenna unsegmented on the ventral side. This genus has been so reduced by establishing new genera for some of its former species that today it contains but two species, *P. irritans* Linnaeus and *P. concepati* Cunha. The former species is supposed to have man as its native host.

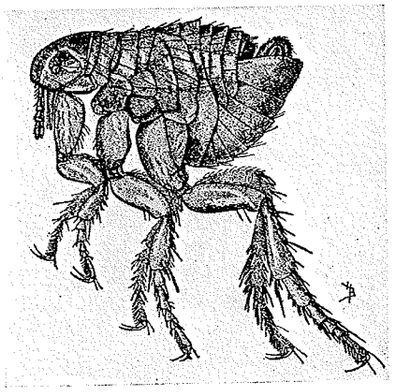

Figure 91. The house, or human flea, *Pulex irritans*. (Bureau of Entomology)

The Human Flea, *Pulex irritans* Linnaeus, is an old and well known pest of man. This flea is probably the one most commonly implicated in the attacks on man in Europe, but has a somewhat restricted distribution in the United States being found particularly in California but occurs sparingly in the Mississippi Valley. It is found in many places in Africa and Asia and has been reported from South America.

Genus Ctenocephalus Kolenati

In *Ctenocephalus* there is a heavy, well developed horizontal genal comb, and the third pair of legs has a row or patch of spinelets on the inside. Nine species belong to the

genus, which was formerly restricted to the Old World. Although many animals are attacked by members of the genus most of them have a strong preference for carnivores.

The Dog Flea, *Ctenocephalus canis* (Curtis), attacks man almost as readily as the human flea. It is very common in the Middle Atlantic States where it is the chief species implicated in the attacks on man.

The Cat Flea, *Ctenocephalus felis* (Bouché) (Fig. 92), has habits similar to the dog flea but has a different dis-

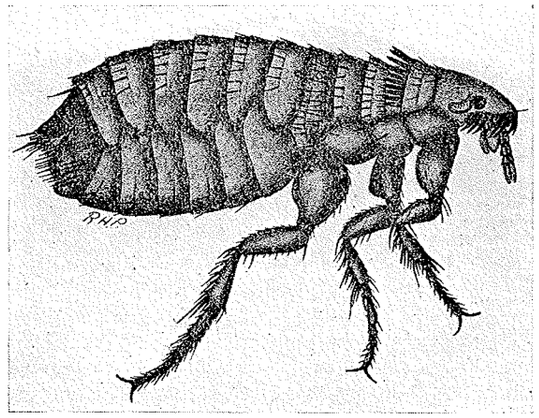

Figure 92. *Ctenocephalus felis;* much enlarged. (Lugger)

tribution. This species may be recognized from *C. canis* in having the head about twice as long as high instead of being about one and a half times as long, and in having the front spine in the genal comb as long as the second, while in *C. canis* it is much shorter.

Family DOLICHOPSYLLIDAE

In this family, the largest of the order Siphonaptera, are placed many genera similar in most respects to those going in the Pulicidae but differing technically from them in having more than a single row of setae to each abdominal tergite.

Many of the genera show degeneration in the reduction or loss of the eyes, others show special adaptation in the development of spines on the abdomen, or in extra setae on the head or in peculiar or even fantastic modifications of the genital armature.

As here recognized twenty-eight genera are included in the family. These are divided into three subfamilies, which are very closely related and to some taxonomists will appear to be more or less arbitrary divisions.

KEY TO THE SUBFAMILIES AND GENERA OF DOLICHOPSYLLIDAE

1. Head provided with a genal comb ..... CTENOPHTHALMINAE, new subfamily 3
   Head without genal comb 2
2. Head without any notch or tubercle on front margin; eyes usually present ..... UROPSYLLINAE 9
   Head with a notch or tubercle on front margin; eyes frequently wanting ..... DOLICHOPSYLLINAE 16
3. Genal comb composed of 4 to 6 spines 4
   Genal comb composed of 2 or 3 spines 6
4. Mesosternite not divided; 5 spines in genal comb, the third spine pale and overlapping the second; eyes wanting ..... *Micropsylla* Dunn & Parker
   Mesosternite divided; none of the spines in genal comb overlapping 5
5. Last tarsal segment of all the legs with four pairs of lateral plantar setae; front margin of head evenly rounded; genal comb of 4 to 6 spines ..... *Rhadinopsylla* Jordan & Rothschild
   Last tarsal segment of all the legs with six pairs of lateral plantar setae; front margin of head more or less angulate ..... *Actenophthalmus* Fox
6. Eyes present; genal comb with only 2 spines 7
   Eyes wanting, or vestigial; genal comb usually with 3 spines ..... *Ctenophthalmus* Kolenati
7. The two genal spines crossing each other; last tarsal segment on all the legs with 4 lateral plantar setae ..... *Chiastopsylla* Rothschild
   The two genal spines not crossing each other 8
8. Setae on posterior borders of tibiae mostly in pairs ..... *Mesopsylla* Dampf

   Setae on posterior borders of tibiae mostly unpaired and forming sort of a comb; frontal tubercle present ..... *Caenopsylla* Rothschild
9. Antepygidial bristles wanting; ventral margin of head dilated into a lobe behind the palpi. Known only from Tasmana ..... *Uropsylla* Rothschild
   Antepygidial bristles present; ventral margin of head usually without lobe behind the palpi 10
10. Without pronotal comb ..... *Notiopsylla* Jordan & Rothschild
    With a pronotal comb 11
11. Fifth tarsal segment dilated and lengthened beyond the fourth pair of lateral spines; tarsal claws very long, almost as long as the fifth tarsal segment ..... *Malacopsylla* Weijenberg
    Without such tarsal characters 12
12. A single row of setae on pronotum. Occurring in Australia ..... *Choristopsylla* Jordan & Rothschild
    At least two rows of setae on pronotum 13
13. Pronotal comb with not more than 6 spines. On echidnas ..... *Bradiopsylla* Jordan & Rothschild
    Pronotal comb with more than 12 spines 14
14. None of the setae in the first row on the frons short and spinelike 15
    Two of the setae in the first row on the frons are short, stout and spinelike. Occurring in Australia ..... *Acanthopsylla* Jordan & Rothschild
15. Finger of clasper of male turned up at apex; female without process between antepygidial bristles ..... *Pygiopsylla* Rothschild
    Finger of clasper of male turned down at apex; female with conspicuous process between the two pairs of antepygidial bristles ..... *Stivalius* Jordan & Rothschild
16. With a row or patch of spinelets on the inside of coxa III 17
    Without such a row or patch of spinelets 18
17. At the most with only 1 short oblique row of setae on the occiput; fifth tarsal segment of all legs with five pairs of lateral plantar bristles; eyes present and well developed ..... *Odontopsyllus* Baker
    With 2 or more oblique rows of setae on the occiput; fifth tarsal segment with only 4 pairs of lateral plantar bristles; eyes vestigial ..... *Catallagia* Rothschild
18. Antepygidial bristles wanting, at least in the female; labial palpus usually with over 5 segments 19
    Antepygidial bristles present; labial palpus usually with 5 or less segments 20

19. Labial palpus with 10 or more segments; club of antennae short; gravid females with distended abdomens
Vermipsylla Schimkewitsch

Labial palpus with 7 or less segments; club of antennae long
Trichopsylla Kolenati

20. Pronotal comb wanting; fifth tarsal segment of all the legs with only 4 pairs of lateral plantar bristles; eyes present 21

Pronotal comb present; fifth tarsal segment of some, or all, of the legs with more than 4 pairs of lateral plantar bristles; eyes frequently vestigial or absent. 22

21. Club of antennae long, symmetrical, with segmentation all the way round; usually with several setae along lower margin of gena. Occurring in South America and Australia
Parapsyllus Enderlein

Club of antennae short, asymmetrical, with segmentation less marked on front side; genal process with only 2 setae behind the eye. . . . . *Rhopalopsyllus* Baker

22. Fifth tarsal segment of all the legs with 6 pairs of lateral plantar setae, the third pair being dislocated toward the inside and its place taken by a more slender lateral pair
Dasypsyllus Baker

None of the legs with fifth tarsal segment having more than 5 pairs of lateral plantar setae. 23

23. Frontal tubercle large and spadelike; spinelets on some of abdominal segments. Known only from Africa
Listropsylla Rothschild

Frontal tubercle smaller, not spadelike; spinelets frequently wanting on abdominal segments. 24

24. One or two antepygidial bristles on each side. 25

At least 3 antepygidial bristles on each side in the female. 27

25. Pronotal comb normal, composed of long spines. 26

Pronotal comb composed of very short spines that are no more heavily chitinized than the pronotum itself; antepygidial bristles 1 or 2 on a side. . . . . *Boreopsyllus*, new genus

26. Female with 2 antepygidial bristles; 3 or 4 setae in ocular row
Rostropsylla Wagner & Joff

Female with only 1 antepygidial bristle. Reported only from Africa. . . . . *Xiphiopsylla* Jordan & Rothschild

27. Females with 4 antepygidial bristles on each side, males with 3 on each side, the 2 outer ones being almost as long and stout as the middle ones; seventh tergite with a median process (much more conspicuous in the male) over pygidium
Dolichopsylla Baker

Females with only 3 antepygidial bristles on each side males usually with only one large antepygidial bristle. 28

28. Head with 3 rows of setae on frons and occiput; clasper of male with a bristle at insertion of finger. Restricted to the Palaearctic Region. . . . . *Amphipsylla* Wagner

Frons usually with 1 or 2 rows of setae, if third row is present it is composed of spinelike setae; clasper of male with two bristles at insertion of finger. 29

29. All three antepygidial setae in males spinelike. 30

One or both of the outer 2 of the 3 antepygidial setae in the males, minute or wanting. 32

30. First antennal segment of male greatly enlarged, globose; eighth sternite of male broken up into several, or many, whiplike laciniae; 5 or more setae in frontal row. Large oriental fleas. . . . . *Aceratophyllus*, new genus

Without such characters. 31

31. End of beak overreaching considerably the trochanters of the first pair of legs; 3 setae in ocular row. . *Paraceras* Wagner

End of beak not reaching beyond trochanters; appendage of receptaculum seminis not sacshaped
Ophthalmopsylla Wagner & Joff

32. Seventh tergite of male with a long, marginally denticulate, median process which extends backward between the antepygidial bristles; eighth sternite of male broken up into whiplike laciniae. Medium to large oriental species
Macrostylophora, new genus

Seventh tergite of male without any such median process; eighth sternite of male not broken up into whiplike laciniae 33

33. The first segment of the last tarsus longer than the second, third and fourth combined. . . . . *Tarsopsylla* Wagner

The first segment of the last tarsus shorter than the second, third and fourth combined. 34

34. First pair of plantar setae of 5th. segment of last tarsi situated ventrally, almost between the second pair; antepygidial setae in male-2, in female-3. . . . . *Myoxopsylla* Wagner

First pair of plantar setae of 5th. segment of last tarsi situated laterally as are the other pairs. 35

35. The end of the beak overreaching considerably the trochanter of the first pair of legs. . . . . *Oropsylla* Wagner & Joff

End of beak not reaching beyond the trochanters. 36

36. Ocular seta situated below upper margin of eyes. In the male a row of longer setae is present on the outer margin of the 2nd. segments of the antennae. . . . . *Ceratophyllus* Curtis

Ocular seta situated above the eye on the margin of the antennal groove. Setae on outer margin of 2nd. segments of antennae not long in male..... 37

37. Prefrontal row of setae present; two occipital rows well developed; trabecular centralis broad. From Siberia
Ctenophyllus Wagner

Prefrontal row of setae wanting..... 38

38. Tooth in frontal tubercle tuberculate; two occipital rows of setae.....*Frontopsylla* Wagner & Joff

Tooth in frontal tubercle frequently wanting; only a rudimentary occipital row of setae..*Paradoxopsyllus* Miyajima

Generic Synonyms in the Dolichopsyllidae

Typhlopsylla Taschenberg, 1880 = *Ctenophthalmus* Kolenati, 1845.

Spalacopsylla Oudemans, 1908 = *Ctenophthalmus* Kolenati, 1845.

Goniopsyllus Baker, 1905 (name preoc.) = *Notiopsylla* Jordan & Rothschild, 1914.

Megapsylla Baker, 1898 = *Malacopsylla* Weijenberg, 1881.
Chaetopsylla Kohaut, 1903 = *Trichopsylla* Kolenati, 1863.
Oncopsylla Wahlgren, 1903 = *Trichopsylla* Kolenati, 1863.
Rothschildiella Enderlein, 1912 = *Rhopalopsyllus* Baker, 1905.
Ctenonotus Kolenati, 1863 = *Ceratophyllus* Curtis, 1832.
Monopsyllus Kolenati, 1857 = *Ceratophyllus* Curtis, 1832.

Genus Ceratophyllus Curtis

Into the genus *Ceratophyllus* are placed a large percentage of all the fleas. Recently a number of genera have been split off from this genus (Wagner, 1927), but the number of species thus removed has been small. The fleas of the genus, which occurs on both birds and mammals, belong to that division of the subfamily Dolichopsyllinae in which the frontal tubercle is small and angulate and the number of antepygidial bristles is three in both sexes, but in the males the outer two are much reduced. Several of the species are of economic importance. Those occurring on American birds have been reviewed by Jordan and Rothschild (1920).

The Common Rat Flea, *Ceratophyllus fasciatus* Bosc.,

is the flea most commonly found on rats in Europe and North America, and for this reason is the one most concerned in plague transmission in these two continents. In this species the eye is well developed; there are about eighteen spines in the pronotal comb; there are three evenly spaced setae in the lower genal row. Jordan and Rothschild (1921) have made a particular study of the taxonomy of the species and related ones of the genus *Ceratophyllus*.

The California Ground Squirrel Flea, *Ceratophyllus acutus* Baker, is a species that is of importance in plague

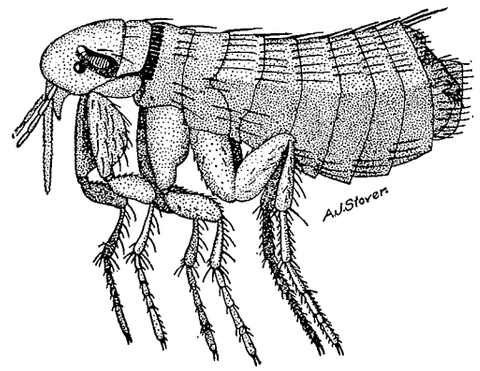

Figure 93. *Ceratophyllus niger*. (Ewing)

transmission in California. In it the eye is slightly reduced from its normal round shape; there are about sixteen spines in the pronotal comb; the three setae in the lower genal row are not evenly spaced, for the middle one is much closer to the upper than the lower.

The Common European Chicken Flea, *Ceratophyllus gallinae* Schrank, is a common parasite on fowls and certain wild birds in central and northern Europe. The species is characterized by the presence of a row of four to six bristles on the inner surface of the hind femur, by the pronotal comb being very slightly shorter than the pronotum and by the

rounded apex of the seventh sternite. The presence of this species in the northeastern part of the United States has been definitely established (Ewing, 1924). In the state of Maine this flea has been reported as being very injurious to chickens.

The Western Chicken Flea, *Ceratophyllus niger* Fox (Fig. 93), occurs in the western part of North America, particularly along the Pacific Slope but has never been reported from the central part of the continent.

Other species of *Ceratophyllus*: *C. gallinulae* Dale is an European species found in the nests of many birds and on the grouse. It has been reported from Canada. *C. columbae* Gervais is found in Europe on wild and domestic doves. *C. fringillae* Walk. occurs in the nests of English sparrows in Europe but not in North America. *C. gibsoni* Fox, a species very near to *C. gallinae*, was described from a hen house in Canada.

Family HYSTRICHOPSYLLIDAE

In the genera of the family Hystrichopsyllidae the frontal region is separated from the occiput by a suture, the head is without a pair of ventral flaps on each side and the occiput is without the dorsal incrassation near the middle. The members of the family prefer rodents as hosts. Some of them are very large and heavily clothed with setae arranged in rows, others have combs of spines on the abdomen, and in a number of the genera the females possess two receptacula seminis.

Key to the Genera of Hystrichopsyllidae

1. With lateral apical spines on some of the abdominal segments extending about as far down on the sides as the spiracles; cephalic combs usually present; tergites well clothed with setae arranged in transverse rows 2
   Without lateral apical spines on abdominal segments, or with some short spines which do not extend down on the sides for more than two-thirds the distance to the spiracles 7

2. Cephalic combs wanting; labial palpus with 7 segments; females with 2 receptacula seminis
   Atyphloceras Jordan & Rothschild
   Cephalic combs present 3
3. Eyes well developed; genal comb of 6 or less spines. Reported only from Palaearctic Region . . . . . *Typhloceras* Wagner
   Eyes vestigial or absent 4
4. With a minute, rounded, vestigial, frontal tubercle; head with oblique comb of flattened spines near posterior border of frons; labial palpus of 5 segments; apical spines on 4 to 5 of abdominal segments . . . *Dinopsyllus* Jordan & Rothschild
   Frontal tubercle absent 5
5. Abdomen with one complete comb of long spines, in addition to small short spines 6
   Abdomen without any comb of long spines and with only incomplete combs of short spines; genal comb of about 8 spines; females with 2 equal receptacula seminis
   Hystrichopsylla Taschenberg
6. Fifth tarsal segment of all legs with 5 pairs of lateral plantar bristles; females with 2 receptacula seminis
   Ctenoparia Rothschild
   Fifth tarsal segment of all legs with only 4 pairs of lateral plantar bristles; labial palpus with only 2 segments; posterior borders of all tibiae densely studded with short transverse rows of dark, stout setae; females with only 1 receptaculum seminis . . . . . *Stenoponia* Jordan & Rothschild
7. Hind coxae with a row or patch of spinelets on the inside. 8
   Hind coxae without such a row or patch of spinelets, or if present frontal tubercle also present 13
8. Labial palpus with 5 or more segments 9
   Labial palpus with 4 or less segments 11
9. Genal comb vertical, composed of over 3 flattened spines which do not cross each other 10
   Genal comb composed of 2 spines which cross each other
   Phalacropsylla Rothschild
10. No apical abdominal spines near or on median line; abdominal tergites without incrassations . . . . . *Nearctopsylla* Rothschild
    Apical abdominal spines on median line; abdominal tergites with a heavy transverse incrassation . . . . . *Corypsylla* Fox
11. Antepygidial bristles 3 on a side; genae vertical or almost so and forming fully one-half of the anterior margin of head
    Hypsophthalmus Jordan & Rothschild

Antepygidial bristles 2 or 1 on each side..... 12

12. Antepygidial bristles 2 on each side; head with genal and frontal combs; frons reclining backward
Cleopsylla Rothschild
Antepygidial bristles 1 on a side...*Chimaeropsylla* Rothschild

13. Head with at least 1 comb of stout spines; cephalic setae not in combs, all or nearly all normal, setiform..... 14
Head without a comb, but all of the cephalic setae are enlarged toward their bases; labial palpus of 4 segments and surpassing the first coxae.....*Stenistomera* Rothschild

14. Frontal tubercle or notch present, although sometimes reduced..... 15
Frontal tubercle wanting..... 17

15. Genal comb consisting of 3 or more spines, none of them overlapping..... 16
Genal comb reduced to 2 spines, 1 of which overlaps the other; frons much reduced.....*Neopsylla* Wagner

16. Genal comb horizontal or nearly so and composed of spines of the usual type; frontal tubercle much reduced; frons with 2 rows of conspicuous setae
Doratopsylla Jordan & Rothschild
Genal comb vertical and spines flattened and somewhat leaflike; frontal tubercle protruding and conspicuous; frons with only 1 or 2 conspicuous setae.....*Palaeopsylla* Wagner

17. Front margin of head subangulate; tibiae with a longitudinal row of stout setae along the posterior margin
Leptopsylla Jordan & Rothschild
Front margin of head rounded, not subangulate..... 18

18. With 2 or more antepygidial bristles on a side..... 19
With only 1 antepygidial bristle on a side
Agastopsylla Jordan & Rothschild

19. With 3 antepygidial bristles on a side; head comb composed of 2 parallel spines; frons produced into a slight process in front of the maxillary palpi.....*Acropsylla* Rothschild
With only 2 antepygidial bristles on a side although an additional small hair may be present..... 20

20. Head comb with 5 spines.....*Chiliopsylla* Rothschild
Head comb with only 4 spines..... 21

21. First spine of genal comb almost completely covered by second
Neotyphloceras Rothschild
First spine of genal comb not covered by second
Adoratopsylla Ewing

GENERIC SYNONYMS IN THE HYSTRICHOPSYLLIDAE

Stenopsylla Cunha, 1914 = *Doratopsylla* Jordan & Rothschild, 1912.

Ctenopsyllus Kolenati, 1863 (name preoc.) = *Leptopsylla* Jordan & Rothschild, 1911.

Genus LEPTOPSYLLA Jordan & Rothschild

In *Leptopsylla* the head is subangulate in front and the frontal tubercle absent; genal combs are present, and in addition there are a few toothlike spines near the front of the head. The tibiae are provided with a longitudinal row of stout setae along the posterior margin. The hind coxae are without spinelets on the inside. The genus includes slightly over a dozen species and is reported from all the major continents except South America.

The Mouse Flea, *Leptopsylla musculi* Dugés, occurs on mice and rats. The presence of two short curved toothlike spines, near the front angle of the head identifies this species, which is a common flea of the Old World.

Family MACROPSYLLIDAE

In this family are included a few genera in which the front part of the head is divided by the continuation of the vertical suture which passes downward from the top margin beyond the bases of the antennae to the oral region. Thus the frons proper is divided from the genae. In this family the occipital region has a transverse dorsal incrassation; there are no oral flaps; the thorax is not reduced.

Only four genera are included, two of which have but a single species each, one of the remaining genera has five species and the other eight. The family is restricted to Australia and South America.

KEY TO THE GENERA OF MACROPSYLLIDAE

1. Frons divided by a suture and the distal portion bearing numerous spines around the border in the form of a "crown"
2

Frons without any such "crown" of spines; labial palpus composed of 11 or more segments; females with 2 receptacula seminis, one being smaller than the other
Macropsylla Rothschild

2. Maxillae elongate-triangular; hind coxae without row of spines on inner surface. Occurring in Australian Region..... 3
Maxillae irregularly elongate-oval; hind coxa with a row of spines on the inner surface. Neotropical in distribution
Craneopsylla Rothschild

3. Frontal cap depressed, nearly horizontal; genal comb represented only by the spinelike upper angle of genal margin; abdominal combs on first 4 tergites
Stephanopsylla Rothschild
Frontal cap not depressed, more nearly vertical; genal comb present.....*Stephanocircus* Skuse

Family ISCHNOPSYLLIDAE

Members of the family Ischnopsyllidae may be recognized from those of any other family by a single character, *i.e.*, the presence of a pair of chitinous flaps on each side of the head which hang down from the ventral margin opposite the oral cavity. Although these flaps are doubtless only genal spines that have become a little more flattened than usual, their fixed number and their position at the extreme anterior end of the genal margin makes them of much taxonomic importance. In this family the frons is considerably reduced, the eyes are usually greatly reduced or absent, and the antepygidial bristles reduced to a single pair or wanting. The family is confined entirely to bats, hence is best represented in the tropics and is absent from subarctic and arctic regions.

Key to the Genera of Ischnopsyllidae

1. Maxillae sharp pointed, or acuminate at the lower distal angle..... 2
Maxillae truncate, lower distal angle not acuminate or but slightly so..... 6

2. Head very short, semicircular, higher than long; prothorax extremely short; setae on posterior margin of tibiae subequal and forming a comb.....*Thaumapsylla* Rothschild

Head longer than high, not semicircular; prothorax not greatly shortened..... 3

3. Frontal tubercle present; abdominal sternites and tergites with strong transverse incrassations
Ptilopsylla Jordan & Rothschild
Frontal tubercle absent..... 4

4. Antepygidial bristle present..... 5
Antepygidial bristle absent; abdominal tergite VII with an apical comb; eyes rudimentary..*Nycteridopsylla* Oudemans

5. Second antennal segment enlarged exteriorly and covering about half of the club; frons with internal subdorsal longitudinal incrassation; oral flaps rounded at the apex
Hormopsylla Jordan & Rothschild
Second antennal segment short, not covering base of club; oral flaps long, tapering, acuminate
Sternopsylla Jordan & Rothschild

6. Abdomen without either a true comb, or a false comb made up of enlarged setae of a transverse row, but vestiges of combs in the form of minute teeth may be present..... 7
Abdomen with a true comb (ctenidium) or a false comb composed of enlarged setae..... 10

7. Epimeron of metathorax normal, without comb..... 8
Epimeron of metathorax with a comb. Known only from Africa.....*Chiropteropsylla* Oudemans

8. Occiput without dorsal incrassations. Confined to the Old World.....*Rhinolophopsylla* Oudemans
Occiput with dorsal incrassations..... 9

9. Posterior margin of occiput with several short, stout, pointed, spinelike bristles.....*Araeopsylla* Jordan & Rothschild
Posterior margin of occiput without spinelike bristles; external dorsal setae of tibiae subequal and forming a comb; bases of abdominal segments each with an incrassation; vestiges of 5 or more abdominal combs present
Lagaropsylla Jordan & Rothschild

10. Abdomen with false combs formed by the thickening of some of the setae in one of the transverse rows; antepygidial bristles present; abdominal segments with a transverse dorsal incrassation.....*Myodopsylla* Jordan & Rothschild
Abdomen with true combs of subequal toothlike spines
Ischnopsyllus Westwood

Generic Synonyms in the Ischnopsyllidae

Nychopsyllus Eysell, 1913 = *Ischnopsyllus* Westwood, 1833.

Nycteridiophilus Dalla Torre, 1915 = *Ischnopsyllus* Westwood, 1833.
Typhlopsylla Taschenberg, 1880 = *Ischnopsyllus* Westwood, 1833.
Hexactenopsylla Oudemans, 1909 = *Ischnopsyllus* Westwood, 1833.

Family HECTOPSYLLIDAE

No less than four established family names for this family have been invalidated through the application of the rules of nomenclature. The present name, Hectopsyllidae, was first proposed by Baker (1904) for the single genus *Hectopsylla* Frauenfeld. With this genus, however, should be included *Echidnophaga* Olliff and *Tunga* Jarocki.

In the family Hectopsyllidae is exhibited the greatest degree of fixed parasitism and degeneration found in the Siphonaptera. In all members the thorax has become greatly reduced, the legs weakened and the abdomen of the female distended to increase her power of reproduction. In the genus *Tunga* Jarocki the abdominal spiracles have been much reduced in size and obliterated on segments II and III of the female.

Key to the Genera of Hectopsyllidae

1. Coxa III with a thickly studded patch of short spinelets on the inside; second and third abdominal segments provided with spiracles; anal segment of female with style
Echidnophaga Olliff
Coxa III without a patch of spinelets on inside; second and third abdominal segments sometimes without spiracles in the female..... 2
2. Femur III without a toothlike projection near base; abdominal segments II & III of female without spiracles; frons produced into an angular tubercle along anterior margin
Tunga Jarocki
Femur III with a toothlike projection at its base; abdominal segments II & III of female with spiracles; anterior margin of frons evenly rounded..... *Hectopsylla* Frauenfeldt

Generic Synonyms in Hectopsyllidae

Argopsylla Enderlein, 1901 = *Echidnophaga* Olliff, 1886.

Xestopsylla Baker, 1904 = *Echidnophaga* Olliff, 1886.
Rhynchoprion Oken, 1815 = *Tunga* Jarocki, 1838.
Sarcophaga Westwood, 1836 = *Tunga* Jarocki, 1838.
Dermatophylus Lucas, 1839 = *Tunga* Jarocki, 1838.
Sarcopsyllus Kolenati, 1857 = *Tunga* Jarocki, 1838.
Rhynchopsylla Taschenberg, 1880 = *Hectopsylla* Frauenfeldt, 1860.
Rhynchopsyllus Haller, 1880 = *Hectopsylla* Frauenfeldt, 1860.
Hectopsyllus Verrill, 1882 = *Hectopsylla* Frauenfeldt, 1860.
Hectoropsyllus Oudemans, 1906 = *Hectopsylla* Frauenfeldt, 1860.

Genus Echidnophaga Olliff

The presence of a thickly studded patch of short spinelets on the inside of the third coxa distinguishes this genus from the other two genera of the family Hectopsyllidae. Nine species are included in the genus which was originally confined to the Old World. One species, *E. gallinacea* Westwood, has been introduced into tropical America.

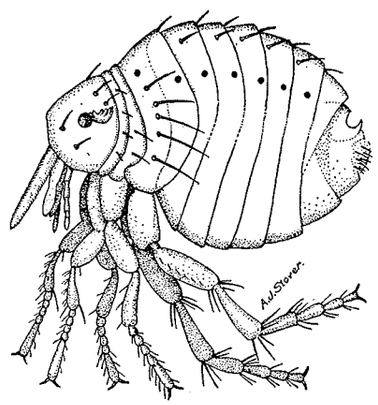

Figure 94. The sticktight, *Echidnophaga gallinacea*. (Ewing)

The Sticktight, or Tropical Hen Flea, *Echidnophaga gallinacea* Olliff (Fig. 94), occurs on poultry as well as on many wild birds. The fleas attach themselves to the face, ear lobes and wattles (Fig. 95). According to Parman the female discharges her eggs with some force. These usually drop off and give rise to typical larvae. This species is distributed throughout the southern part of the United States from Florida to California.

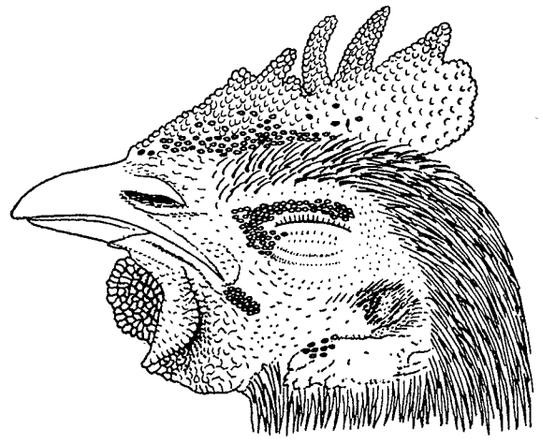

Figure 95. Head of chicken infested with *Echidnophaga gallinacea.* (Riley & Johannsen, after Enderlein)

Genus Tunga Jarocki

The absence of spinelets on the inside of the hind coxae and the toothlike projection near the base of the third femur is sufficient for the distinguishing of the members of the genus *Tunga* from those of the other two genera of the family. But three species, *T. caecatus* Enderlein, *T. caecigena* Jordan and Rothschild and *T. penetrans* (Linnaeus) are included in this genus.

The Chigoe, or Jigger Flea, *Tunga penetrans* (Linnaeus) (Fig. 96), attacks man and some other animals. It penetrates the skin, and females in such a position produce many eggs which drop to the ground. The feet are most subject to attack, and the presence of the fleas under the skin causes much irritation. This flea which is called the jigger or jigger flea should not be confused with the chigger which is a mite, *Trombicula irritans* (Riley), of somewhat similar habits. The chigoe occurs in the tropics of both the New and Old Worlds.

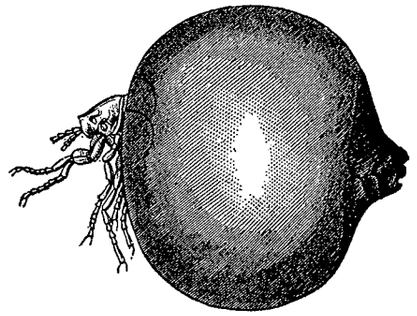

Figure 96. The jigger flea, *Tunga penetrans;* gravid female. (Lugger, after Karsten)

General Measures for the Control or Reduction in Numbers of Fleas

Fleas may frequently be prevented from infesting the premises about human habitations or if present may be greatly reduced in numbers by some simple precautions. If dogs are kept the soil about their kennels or runways should be treated with salty water occasionally. If dogs or cats are allowed to sleep in the house they should be given a mat or rug to lie upon. This mat or rug should be regularly taken out and shaken and left for a few hours in the sun. In addition an occasional spraying with kerosene would be of benefit. Riley and Johannsen (1915) suggest the thorough sweeping of houses at frequent intervals, and keeping the floors as bare as possible. Trash, litter or straw should be removed regularly from coops, hen houses, barn floors etc. and burned. Basements to houses, if concreted, should be scrubbed occasionally with hot soapy water, preferably medicated with some carbolic acid.

To Destroy Fleas in a Barn or Hen House

In the country, barns and hen houses often become a source of flea infestation, and if the fleas are not promptly destroyed in these buildings they may later overrun the

whole premises. In such situations the fleas may be destroyed by a persistent effort. First all straw and litter should be raked up, taken away and burned. Then if the floors are of dirt they should be mudded down with salty water. In the case of hen houses this treatment should be followed by spraying the walls with kerosene, putting on enough of the latter to make a film. The doors and windows should be shut to prevent too rapid an evaporation of kerosene. Usually this treatment is sufficient. If necessary kerosene may be put on a second time, possibly drenching the floor also.

To Protect Dogs and Cats Against Fleas

In cities dogs and cats are the chief sources of flea infestation, and when they are allowed their freedom are especially liable to bring fleas into the house or on the premises of their owners. This can be avoided by keeping them confined for the summer months except when they are taken out either on a leash or in an automobile. If they are allowed to run free they should be dusted with pyrethrum or some good commercial brand of insect powder at frequent intervals. In addition to this they should be bathed frequently in warm water using a medicated soap, such as carbolic acid soap. Their sleeping and lounging quarters should be inspected and treated if necessary. The floors of dog kennels should be sprayed with kerosene, and the dirt in runways treated with salt.

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CHAPTER VI

APPENDIX

DESCRIPTION OF NEW GENERA OF ECTOPARASITES

IN THIS appendix there are given the formal descriptions of the new genera proposed in the text proper. They are arranged according to the order and family to which each belongs. Although each new genus proposed in the text was placed in the keys, thus showing both its most important diagnostic characters and its nearest generic affinities, this was all that was done in most instances. New genera are here described in each of the five major groups of ectoparasites except the ticks.

ACARINA

Family PARASITIDAE

Geneiadolaelaps, New Genus

Body sparsely clothed with medium setae. Chelicerae large, stout, and with a tuft or brush of setae situated on the second segment distally near the insertion of the movable chela. Dorsal plate not entirely covering the body, unsculptured. Genito-ventral plate of female not covering most of the abdomen below, with three pairs of setae. Anal plate longer than broad and with three setae. Metapodal plates very small, or wanting. Neither the first or second pair of legs in either sex calcarate.

Type: *Laelaps barbatus* Ewing.

It is believed that the presence or absence of a brush of setae on the chelicerae near the insertion of the movable chela can be used as a generic character. In regard to this character, as with most of the other generic characters of Parasitinae, the female sex should be chiefly concerned.

The females of most *Laelaps* species show either one seta or no seta near the base of the movable chela.

Macrolaelaps, New Genus

Body as a whole sparsely clothed with stout setae, which tend to become thickly set along the lateral margins. Chelicerae of female (Fig. 3) very large, somewhat swollen and with a brush of setae situated near the base of the movable arm. Dorsal plate covering most of the body and irregularly sculptured over the region of the cephalothorax. Sternal plate large, heavily chitinized and extending well between third coxae. Genito-ventral plate of female large, much expanded beneath the fourth coxae and with four pairs of setae. Anal plate almost circular, with three setae, the last or unpaired one, being much the largest. Metapodal plates small to minute. First and second pairs of legs enlarged but not calcarate. First femora with long spines above.

Type: *Laelaps sanguineus* Vitzthum.

Macrolaelaps differs from *Geneiadolaelaps* chiefly in having the dorsal plate sculptured but also in the large size of the contained species and in having the chelicerae of the female swollen or greatly enlarged.

Echinolaelaps, New Genus

Body beset with rather stout setae. Chelicerae of female (Fig. 3) stout but not swollen, brush of setae wanting but in its place a single seta may be present; seta of fixed arm modified. Dorsal plate covering most of the body, unsculptured. Sternal plate large, well chitinized and with thickened lateral margins. Genito-ventral plate very large and extending to the anal plate, its posterior margin being excavated to receive the anterior part of the latter; pairs of setae on genito-ventral plate, four. Anal plate somewhat subtriangular, with three setae, the posterior unpaired one

being much the stoutest. Metapodal plates minute. First and second legs somewhat enlarged but not calcarate.

Type: *Lealaps echidninus* Berlese.

Echinolaelaps differs from *Macrolaelaps* particularly in the absence of sculpturing on the dorsal plate. Also in *Macrolaelaps* the genito-ventral plate as a rule is smaller and does not match the anal plate as it does in *Echinolaelaps*. The true *Laelaps* species should be of the type of *L. agilis* Koch.

Atricholaelaps, New Genus

Body rather sparsely clothed with moderate setae. Chelicerae without brush of setae. Dorsal plate not sculptured. Sternal plate about as broad as long and broadest between second and third coxae. Genito-ventral plate falling far short of anal plate, anterior margin weak, less than four pairs of setae present. Anal plate subtriangular, not broader than long, with three setae. Metapodal plates minute or wanting. Neither the first or second legs in either sex calcarate, or with spines above. Coxae and most, or all, of the other leg segments without spines.

Type: *Laelaps reithrodontis* Ewing.

Vitzthum (1926) established the subgenus *Tricholaelaps* for his *Laelaps comatus* which has all the setae slender and hairlike and four pairs of them on the genito-ventral plate. Many species of *Laelaps* that are devoid of spinelike setae have less than four pairs of setae on the genito-ventral plate. They are placed in *Atricholaelaps*.

Eubrachylaelaps, New Genus

Body very short, about as broad as long, and slightly emarginate behind, sparsely clothed with moderate setae. Shoulders reduced but present. Chelicerae without brush of setae. Dorsal plate without sculptures. Sternal plate broader than long, with large pores and spinelike setae.

Genito-ventral plate much reduced and with only a single pair of setae. Anal plate drawn out into a process behind and bearing three setae. Metapodal plates not conspicuous. Neither the first or second pairs of legs calcarate in either sex. Second and third coxae without spurs.

Type: *Laelaps hollisteri* Ewing.

This genus is nearest *Mesolaelaps* Hirst, from which it differs in having only a single pair of setae on genito-ventral plate and in having the body slightly emarginate behind.

Family Dermanyssidae

Neoliponyssus, New Genus

Chelicerae of female shearlike, both chelae present. Dorsal plate of female entire, not wholly covering the body above. Sternal plate small, with only two pairs of setae. Genito-ventral plate small, with a single pair of setae. Peritremal plate extending backward and inward like a sickle to the rim of fourth coxal pit. Anal plate eggshape in outline. Legs not very stout; femora of first and second pairs not spined above. Coxae without spines.

Type: *Liponyssus gordonensis* Hirst.

Neoliponyssus is most nearly related to *Liponyssus* Kolenati, in its restricted use, but differs from this genus in having but two pairs of setae on the sternal plate instead of three, and in a few minor characters.

Family Trombidiidae

Neoschöngastia, New Genus

Chelicerae each without a row of teeth above but each may possess a single, dorsal, subapical tooth. Palpal claw with three prongs distally, the middle one being much the largest. Dorsal plate poorly chitinized and tending to break up into smaller platelets, without any median anterior process and provided with only five setae in addition to

the pseudostigmatic organs. Pseudostigmatic organs capitate, there being an abrupt demarcation between the head and the pedicel. Anterior eyes of a couplet much larger than the posterior.

Type: *Schöngastia americana* Hirst.

Neoschöngastia is created for those species of *Schöngastia* that do not have the row of teeth above on each chelicera. Most of such species, if not all of them, have a trifurcate palpal claw.

Odontacarus, New Genus

Each chelicera with a row of backwardly directed teeth on the upper margin of chela, and some upturned teeth on the lower margin (Fig. 16). Palpal claw bifurcate, the two divisions unequal. Dorsal plate without median anterior process and with only five setae in addition to the pseudostigmatic organs, which are flagelliform and pectinate.

Type: *Trombicula dentata* Ewing.

Odontacarus is related to *Schöngastia* in its type of chelicerae and to *Trombicula* in its type of palpal claw. Only the type species included.

Family Listrophoridae

Alabidocarpus, New Genus

Body flattened laterally, or compressed. Maxillae without hair-clasping apparatus. Legs of the first two pairs flattened, curved, without caruncles and without indication of segmentation and heavily chitinized. They are thus adapted for hair-clasping. Sternal region between second and third pairs of legs without hair-fitting, valvelike structure. Third and fourth pairs of legs not formed into hair claspers; third pair ending in one long and two short clawlike structures. Last pair of legs of male not enormous.

Type: *Labidocarpus megalonyx* Trouessart.

Because of the fundamental difference in the distal armature of the third pair of legs among the species of *Labidocarpus* it is believed that the genus should be divided. Besides the type, *L. minor* Trouessart and *L. compressus* Ewing are included in the genus.

MALLOPHAGA

Family Laemobothriidae

Eulaemobothrion, New Genus

Head as in *Laemobothrion*. Forehead subrectangular, with sides slightly incurved; front margin of clypeus broadly emarginate, or incurved; clypeus itself bearing several peglike setae on or near its anterior margin. Prothorax well developed, but not as broad as head, sides almost straight. Last two segments of thorax grouped with the abdomen as they are in *Laemobothrion*, so that the lateral contours of these segments are continuous with those of the abdomen. Abdomen composed of nine segments. Male genital armature with rodlike basal plate, prominent, incurved free parameres and slender endomeres.

Type: *Laemobothrion nigrum* Burmeister.

This genus is established for those species of *Laemobothrion* which infest water birds. It is recognized from *Laemobothrion*, which should be restricted to birds of prey, by the emarginate clypeus and the peglike setae on the same. Dr. E. A. Chapin first suggested this division of the old genus *Laemobothrion*.

Family Philopteridae

Incidifrons, New Genus

Head large, with conspicuous rounded temples and prominent forehead, with slightly incurved sides. Clypeus deeply incised or notched in front, the notch being flanked by converging, hyaline flaps. Signatural plate conspicuous, undivided. Trabeculae large. Antennae short and similar

in the two sexes. Fused pterothorax broader than long, sides divergent, posterior margin either outwardly rounded or angulate. Abdomen stout, with nine segments, the last being very small; abdominal spiracles conspicuous, six pairs. Legs stout; claws dissimilar.

Type: *Philopterus pertusus* Nitzsch.

This genus is established for the reception of several species that have the peculiar characters of the clypeus described above. Doubtless it should be and will be further divided as its elements lack some of the unity of characters as well as similarity of host relationship desired in a natural genus.

Austrophilopterus, New Genus

Head large, with trapezoidal forehead and large, rounded temples. Clypeal region marked off by a broad and backwardly rounded suture and bearing dorsally just in front of this clypeal suture two pairs of short, stout, erect spines. Trabeculae large, triangular. Antennae short, the same in the two sexes. Fused pterothorax much broader than long, sides strongly divergent and posterior margin either outwardly rounded or angulate. Abdomen stout, of nine segments in both sexes; some of the tergites in female interrupted. Abdominal spiracles conspicuous, situated dorsally in tergites, six pairs present. Genital armature of male with short, platelike basal plate; short, hooked, free parameres and poorly developed endomeres. Legs short, as in *Philopterus*.

Type: *Philopterus cancellosus* (Carriker).

This genus, established for Carriker's species occurring on toucans, is very distinct on account of the peculiar characters of the clypeus.

Columbicola, New Genus

Head long and slender. Forehead well developed, with sides almost straight, and clypeal suture present; clypeus

rounded and bearing above two pairs of spines, the front pair being flattened and porrect and the hind pair being recurved. Trabeculae small and similar to tubercles. Antennae different in the two sexes, those of the male with the third segment appendiculate. Postantennal region of head slender, temples poorly developed, rounded. Pterothorax rectangular and bearing a tuft of long setae on each posterior angle. Abdomen very slender and with heavily chitinized pleural plates, in female with eight segments and in male with nine. Abdominal spiracles very small, six pairs. Genital armature of male with broad basal plate, almost straight, free parameres and poorly developed endomeres.

Type: *Esthiopterum columbae* (Linnaeus).

This new genus is distinguished from *Esthiopterum* in its restricted sense by the presence of the characteristic dorsal spines on the clypeus. But few of the species remaining in *Esthiopterum* have the extremely slender body of those of *Columbicola*.

Pectenosoma, New Genus

Head broad, with short and evenly rounded forehead and large, angulate temples. Clypeal suture wanting. Trabeculae small, fixed tubercles. Antennae short and similar in the two sexes. Pterothorax fused, much broader than long, sides strongly divergent and posterior margin outwardly rounded and angulate. Abdomen broad and stout, of seven segments in both sexes, the first and second segments being fused into one; abdominal spiracles minute, six pairs present. Some of the abdominal sclerites with combs of toothlike tubercles. Genital armature of male small, basal plate broad, parameres free, almost straight. Legs short but scarcely stout; claws almost equal but slightly curved.

Type: *Goniocotes verrucosus* Taschenberg.

The outstanding peculiarity of *Pectenosoma* is the presence of combs of tubercles on many of the sclerites of the body.

Pterocotes, New Genus

Forehead greatly reduced, broadly rounded, without signatural plate or clypeal suture. Trabeculae reduced to rounded tubercles. Antennae of male with first segment greatly enlarged and third segment produced laterally beyond its articulation with the fourth into a chitinous, clawlike hook. Temporal lobes large winglike, angular processes which extend backward and laterally far beyond the front margin of thorax. Eyes wanting. Prothorax large; pterothorax much broader, being the broadest part of the body. Abdomen short but not swollen; tergal and sternal plates not interrupted in the middle. Genital armature of male very peculiar; basal plate divided into two broadly separated but converging chitinous strips, each of which passes almost uninterruptedly into a styliform paramere; endomeres formed into a slender, needlelike pseudopenis. Legs short and rather weak, with long, slender, weak and almost straight and almost subequal tarsal claws.

Type: *Goniodes aberrans* Carriker.

This genus is unique, it is believed, in the type of the male genital armature and in the type of tarsal claws. The enormously expanded temporal lobes are of less generic importance.

Family Trichodectidae

Felicola, New Genus

Head with a narrow hair-groove below. Forehead triangular, sides almost straight. Antennae not large, three segmented, the same in the two sexes. Temporal lobes somewhat squarish. Abdomen swollen, segments provided with pleural plates. Legs short, weak. Genital armature of male poorly developed; genital plate, broad, poorly chitinized; parameres long, almost straight, stylets.

Type: *Trichodectes subrostratus* Nitzsch.

This genus is distinguished from the others of its family by the shape of the forehead and by the genital armature of the male.

Bovicola, New Genus

Forehead much broader than long and rounded but not evenly so. Antennae three segmented and the same in both sexes. Temporal lobes broadly and evenly rounded. Abdomen swollen; broadest in front of the middle; all segments with pleural plates. Abdominal spiracles large, equal; six pairs present. Genital armature of male well developed; basal plate with lateral, marginal, rodlike chitinizations; parameres free, curved; endomeres heavily chitinized, free distally, scooplike. Legs moderate; tarsal claws long, slender and very sharp.

Type: *Trichodectes caprae* Gurlt.

This genus is established for the bovine-infesting species of *Trichodectes*. It is differentiated largely on the shape of the head and antennal characters.

Geomydoecus, New Genus

Head very broad and with conspicuous hair-groove below. Forehead broader in the male than in the female, of peculiar shape; where the hair-groove reaches the front margin it is emarginate; at the sides the forehead is outwardly rounded except where an apodemal arm of the internal skeleton joins the marginal chitinization, at this point the lateral margin, on each side, is slightly emarginate. Antennae different in the two sexes; in the female, second segment with lateral process; in the male all three segments enlarged, while the first has a lateral process and the third is curved and tipped with short spines. Abdomen swollen, only first three segments with pleural plates. Genital armature very large and very peculiar; genital armature itself surrounded by a large U-shaped chitinous strip, each leg

of the U arising from the base of basal plate and uniting with its fellow along the posterior border of abdomen; parameres united distally.

Type: *Trichodectes geomydis* Osborn.

This genus is very distinct in the antennal characters and in those of the genital armature.

Neotrichodectes, New Genus

Forehead irregularly rounded except for the frontal notch at the junction with the hair groove. Heavy internal skeleton joins lateral, chitinized margin of forehead a short distance in front of antennae. Hair groove almost closed below in front of mandibles by lateral flaps. Antennae very different in the two sexes, second segment in female without lateral process and first in male without the same. Abdomen swollen, without pleural plates. Genital armature of type found in *Geomydoecus*, having the armature proper surrounded by an U-shaped structure; basal plate with lateral margins thickened into rodlike structures; parameres united, forming a stout pseudopenis; endomeres poorly developed.

Type: *Trichodectes mephitidis* Packard.

This genus is clearly related to *Geomydoecus* from which it is differentiated by the antennae in both sexes lacking lateral processes and in having no pleural plates at all to the abdomen.

ANOPLURA

Family Haematopinidae

Hoplophthirus, New Genus

Head long, about twice as long as broad. Forehead broader than long, domeshaped. Antennae conspicuous, the same in the two sexes; second segment about equal to fourth. Temples not enlarged.

Thorax broader than long; thoracic spiracles medium in size and lateral in position; sternum entire, almost as

broad as long and laterally emarginate opposite the second coxae.

Abdomen very broad, subcircular; tergal and sternal plates wanting; pleural plates on segments II–VII; second abdominal segment without a pair of ventral tubercle-bearing plates; abdominal setae very large and few in number; of the discal setae there are two longitudinal rows above and two below, there being but a single seta in a row to one segment. Genital armature of male with slender basal plate, parameres thickened distally and a true and pseudopenis present.

Legs long; tibiae and tarsi of the first two pairs of about the same width throughout; tarsal claws I and II each provided with a conspicuous tooth on its inside near the tip.

Type: *Enderleinellus euxeri* Ferris.

This genus is established exclusively for the type species, chiefly because of the peculiar leg characters.

Cyclophthirus, New Genus

Forehead almost as broad as long, rounded in front; antennae the same in the two sexes, without toothlike processes; first segment only slightly enlarged, without spine or tubercle. Postantennal region of head only slightly swollen.

Thorax as broad as long; posterior coxae more or less platelike, enlarged and contiguous; sternum broad and short, undivided.

Abdomen subcircular; pleural plates on segments II–V; tubercle bearing pair of plates on ventral surface of second abdominal segment not disc-like and tubercles themselves not cylindrical. Genital armature of male characteristic. Basal plate an inverted "Y" with parameres articulating with the ends of the branch of "Y"; pseudopenis present, articulating with ends of parameres; endomere well developed, inner plate horseshoe shape.

First and second pairs of legs smaller than the third pair and subequal. Tibia I and II broadened at their distal ends and tarsi I and II at their proximal ends, and forming with their tarsal claws clasping structures; tarsal claws on first and second legs with a tooth.

Type: *Enderleinellus suturalis* (Osborn).

Besides the type species this genus includes *Enderleinellus marmotae* Ferris, *E. osborni* Kellogg & Ferris and probably *E. tamiasis* Fahrenholz.

Rhinophthirus, New Genus

Head long, covered with scales below; forehead longer than broad, coneshaped, with heavy chitinous plates covering the sides. Antennae short, scarcely equal to the width of the head; second segment longest, but it is broader than long. Postantennal region of head necklike.

Thorax small, broader than long; sternum divided along median line.

Abdomen elongate; sternal and tergal plates wanting; pleural plates on first three abdominal segments; second abdominal segment provided ventrally with a pair of subcircular tubercle-bearing plates, each of the tubercles bearing distally a seta. Abdominal setae few in number but large, forming a single transverse row of typical segments. Genital armature of male entirely surrounded by an accessory genital plate. Basal plate inverted Y-shape; parameres stout, almost straight; endomeres complicated.

Legs of posterior pair much enlarged and heavily chitinized; tarsal claws of first two pairs of legs slender and bifurcate at tip.

Type: *Enderleinellus heliosciuri* Ferris.

The peculiar nature of the forehead, the very short antennae and the peculiar and complicated genital armature particularly characterize *Rhinophthirus*. Possibly only the type species should be included in it.

Euenderleinellus, New Genus

Head longer than broad; forehead greatly reduced with outwardly rounded margin. Antennae short, about as long as the width of the head, the same in the two sexes; second segment longest, but fourth the broadest except for the basal segment. Temples slightly developed.

Thorax small; sternum almost divided along the median line; coxae III platelike, touching each other.

Abdomen oblong; tergal and sternal plates wanting; pleural plates wanting on segments V and VI; second abdominal segment with a pair of circular, tubercle-bearing plates ventrally, each tubercle bearing a seta distally. Abdominal setae large, not truncate, a single transverse row of them on each typical segment. Genital armature of male not surrounded by genital plate; basal plate short, forked distally; parameres long and curved; endomeres poorly developed.

Legs short; third pair greatly thickened; tarsal claws I and II simple.

Type: *Enderleinellus larisci* Ferris.

Besides the type species this genus includes *Enderleinellus menetensis* Ferris, *E. platyspicatus* Ferris and *E. zonatus* Ferris. It is most nearly related to *Rhinophthirus* but differs from that genus in the shape of forehead, gential armature etc.

Ahaematopinus, New Genus

Forehead much broader than long and coneshaped; antennae stout, the same in the two sexes, first segment without any spine-bearing tubercle or spine, second segment the longest. Temples slightly developed.

Thorax small; thoracic spiracles larger than the abdominal spiracles; sternum entire.

Abdominal segments provided with tergal and sternal plates in both of the sexes; typical abdominal segments of

female with two transverse rows of normal setae, of male with one transverse row; six pairs of abdominal spiracles present, last pair not reduced. Pleural plates of segment II not divided, and this segment without any paired ventral plates. Genital armature of male surrounded by a bar of chitin from genital plate; basal plate not rodlike; parameres prominent, curved, not united distally; endomeres well developed.

Type: *Neohaematopinus inornatus* (Kellogg and Ferris).

Besides the type species this genus includes *Polyplax insulsa* Ferris and *Polyplax oxyrrhynchus* Cummings.

Ferrisella, New Genus

Head of the usual shape in Hoplopleurinae. Antennae the same in the two sexes; first segment without spine and tubercle; second segment the longest. Postantennal region very slightly swollen.

Thorax rather small, about as broad as long; sternum broad, undivided; thoracic spiracles rather small.

Abdomen large and long, with eight pairs of pleural plates, the typical ones being two lobed; second pair bilobed posteriorly and bearing on its posterior margin between the lobes a pair of setae; sternal plate of second abdominal segment not enlarged and overlapping the third segment; sternal plate of third segment without lateral spines. Females with three transverse rows of similar pointed setae on most of abdominal segments.

First pair of legs smaller than the second, and second smaller than the third; segments of third pair much enlarged, the coxae flattened and almost contiguous.

Type: *Hoplopleura ochotonae* Ferris.

Besides the type species the following should be included in this genus: *Hoplopleura disgrega* Ferris, *H. malaysiana* Ferris and *H. emarginata* Ferris.

Ctenura, New Genus

Forehead reduced, somewhat trapezoidal in shape, the front margin being about straight. Antennae similar in the two sexes; first segment without spine or tubercle; second segment longest; fourth segment much broadened distally to accommodate the large sensory pit. Postantennal region, swollen, much broader than long.

Thorax large, broader than the head; sternum shield-shape, undivided; thoracic spiracles very large and entirely lateral.

Abdomen much enlarged, with overlapping pleurites on all segments, those of the last pair extending beyond the tip of last segment in the male. Tergal plates large, in the male overlapping; three to a segment in the female and two in the male. Female with three transverse rows of setae above and below on typical segments; male with two above and one below. Last abdominal segment of female with posterior comb of setae-bearing tubercles. Genital armature of male with slender basal plate, large free parameres, and endomeres united into a pseudopenis.

Legs as in the other genera of Hoplopleurinae.

Type: *Hoplopleura pectinata* Cummings.

The shape of the head, the size of the thorax and the position of the thoracic spiracles as well as the posterior comb of the female are important characters in this genus. Only the type species is included.

Euhoplopleura, New Genus

Forehead small, rounded. Antennae the same in the two sexes; first segment enlarged, but without spine or tubercle; second the longest; third but slightly broader than the fourth. Postantennal region not swollen.

Thorax broader than long; sternum undivided, with median process; thoracic spiracles medium, dorsal in position.

Abdomen large, with eight pairs of pleural plates, and six pairs of spiracles; second pair of pleural plates bilobed posteriorly and each bearing on its posterior margin between the lobes a pair of setae; typical pleural plates with only two posterior lobes; third abdominal sternite with three divergent spines on each side of median line. Typical abdominal segments of female with three transverse rows of pointed setae above and below; males with two below and one above on typical segments. Pseudopenis of male genital armature articulating with ends of parameres.

Legs as in the other genera of Hoplopleurinae.

Type: *Hoplopleura trispinosa* Kellogg and Ferris.

This genus is separated from the others of the Hoplopleurinae by possessing three divergent spines each side, below on the third abdominal segment and the peculiar method by which the pseudopenis articulates with the ends of the parameres.

Ctenopleura, New Genus

Forehead small, somewhat squarish, front margin only slightly rounded outwardly. Antennae the same in the two sexes; first segment without spine or tubercle; second much the longest; third with small sensory pit and only slightly broader than the fourth.

Thorax with straight, posteriorly divergent sides; sternum broad, undivided; thoracic spiracles large, lateral.

Abdomen large and densely beset with large pointed setae, there being three transverse rows of these above and below in the female. Pleural plates eight pairs, very large, typical ones with four large posterior lobes and with the pleural setae situated on processes. Third abdominal sternite with three divergent spines on each side of median line. Pseudopenis of male genital armature not articulating with ends of parameres.

Legs as in the other genera of Hoplopleurinae, but the posterior coxae are more enlarged and each possesses a posterior tubercle.

Type: *Hoplopleura cryptica* Ferris.

This genus is related to *Euhoplopleura* in having three divergent spines in a group on the third abdominal sternite, but has quite different pleural plates and male genital armature.

Prolinognathus, New Genus

With the general characters of the subfamily Linognathinae and in addition:

Forehead as broad as long, not rounded. Antennae with the last two segments almost completely fused, hence appearing four segmented. Postantennal region not swollen.

Thorax very broad. Sternum reduced and divided transversely into three small plates.

Abdomen swollen; spiracles not situated in tubercles; abdominal setae long, setiform, arranged into two dorsal and two ventral longitudinal rows. No vestiges of pleural plates present. Genital armature of male with slender and slightly forked basal plate, large free parameres and lightly chitinized endomeres.

Legs stout, with heavily chitinized tarsi and tarsal claws.

Type: *Linognathus caviae-capensis* (Pallas).

This genus is established for the *Linognathus* species of the ungulates of the family Procaviidae. The most characteristic thing about the genus is the four segmented, or incompletely five segmented, antennae.

SIPHONAPTERA

Family Dolichopsyllidae

Boreopsyllus, New Genus

Front margin of head rounded. Frontal tubercle normal, triangular, sharply pointed. Labial palpi five segmented. Frons with two oblique rows of setae; postantennal region

with one oblique row. Genae extended downward somewhat; genal comb wanting. Eyes well developed. Antennae with symmetrical club, sutured between segments all the way round. Pronotum with two complete transverse rows of setae and a comb of short setae of the same texture as the sclerite itself. Abdomen long; typical tergites with three or four transverse rows of setae. Females with a single antepygidial seta on each side, and a small chitinous projection from the margin of the seventh tergite between them. Third femora without spinelets on the inside; all of the tibiae with pairs of setae arranged transversely on their posterior margins; fifth tarsal segment on all of the legs with five pairs of lateral plantar setae but the two most distal pairs on front legs much smaller than the others.

Type: *Amphipsylla hadweni* Ewing.

This genus is established for the type species only, which was taken from a gull, *Xema sabinei*, on Puffin Island, Alaska. The peculiar pronotal comb and the presence of but one antepygidial bristle on each side are the outstanding characters.

Aceratophyllus, New Genus

With the general characters of *Ceratophyllus* and in addition: Integument heavily chitinized, dark brown or black. Individuals large and with long thoraces. Frontal tubercle distinct but very small. Occiput in both sexes with one transverse row of setae in addition to the vertical marginal row. In the male, three long setae are situated on the front rim of the antennal fossa near the base of the antenna, while the first segment of the latter is greatly enlarged and globose. All three of the antepygidial bristles in the male are stout and spinelike, but the two outer ones are much shorter than the middle one. The eighth sternite of the male is broken up into several, or many, whiplike laciniae.

Type: *Ceratophyllus javanicus* Ewing.

In addition to the type species this genus includes: *Ceratopyllus fimbriatus* Jordon and Rothschild and *C. lupatus* Jordan and Rothschild. The genus appears to be confined to the Oriental Region.

Macrostylophora, New Genus

With the general characters of *Ceratophyllus* and in addition to these the following: Body large. Abdominal tergites I–IV with apical spines. Lateral pair of antepygidial bristles minute, not spinelike. Seventh sternite of male with a long, marginally denticulate, median process extending backward between the two seta of antepygidial bristles. Eighth sternite of male broken up into whiplike laciniae; movable finger broad and truncate distally and bearing at its upper angle a large knifelike seta.

Type: *Ceratophyllus hastatus* Jordan & Rothschild.

This genus is erected for the type species only which is split off from the *fimbriatus* group (formerly of *Ceratophyllus*) on account of the process of the seventh tergite and the peculiar claspers.

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THIS BOOK

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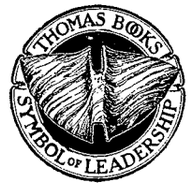

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