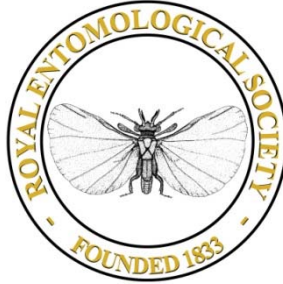


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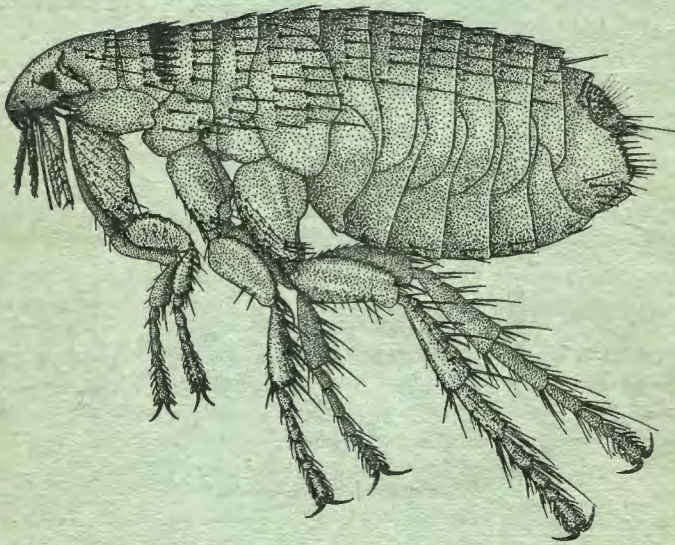
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SIPHONAPTERA

By

F. G. A. M. SMIT

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SIPHONAPTERA

By F. G. A. M. SMIT

INTRODUCTION

FLEAS are small (1–8 mm. long), wingless insects with a holometabolous metamorphosis (egg-larva-pupa-adult); their bodies are strongly compressed laterally, usually heavily sclerotised, hairy and shiny and light-rufous to almost black in colour. They are parasitic in the adult stage only, sucking blood from mammals and birds. The larvae are legless, elongate, eyeless, with fairly sparse but strong bristles and they have biting mouthparts; they are not parasitic, but feed on organic matter which they find mainly in their usual abode, the nest or dwelling-place of the host. The free pupa is contained in a cocoon.

The Order Siphonaptera is at present divided into two superfamilies, which together comprise sixteen families. The number of described species and subspecies from the whole world is just over 1550. Fifty-six species and subspecies, representing five families and twenty-eight genera, have been found in the British Isles. Nearly all the fleas dealt with in this volume are indigenous to the British Isles, while a few were introduced in recent times and have been successful in establishing themselves. Very occasional immigrants, imported with their hosts to Zoological Gardens, which cannot breed and maintain themselves under the conditions prevailing in this country, are excluded from the keys; to this category belong *Hectopsylla psittaci* Frauenfeld (South America), *Ctenocephalides felis strongylus* (Jordan) (East Africa), *Delopsylla crassipes* Jordan (East Africa) and *Bradiopsylla echidnae* (Denny) (Australia), which have been found in the Zoological Gardens, London. It should be noted that animals in zoological gardens have generally lost their specific fleas occurring on them in the country of their origin, and have acquired cosmopolitan species such as *Ctenocephalides felis felis* (cat-flea) and *Nosopsyllus fasciatus* (rat-flea).

ACKNOWLEDGMENTS

I am deeply indebted to the Hon. Miriam Rothschild and Mr. G. H. E. Hopkins for reading the manuscript and making useful suggestions, and to Mr. R. S. George for testing several of the keys.

COLLECTING

Collecting fleas means collecting hosts and material from nests, dens or dwelling-places of hosts. An adequate knowledge of the biology, ecology and systematics of mammals and birds will therefore be advantageous. In this respect many mammalogists and ornithologists are in a specially favourable position to collect parasites.

Where possible, it is always advisable to collect fleas from large numbers of individuals of a particular host, and also to collect such a host from different localities, for many a species of host harbours several species of fleas, and certain species of flea may have a very patchy distribution or may be confined to a small area while the host is found more or less continuously over a large area.

Collecting mammal fleas.—Fleas leave a host fairly soon after it has died, though this depends a good deal on the temperature of the air: in cold weather fleas remain on the dead host for a much longer time than in warm weather. One must, therefore, obtain the host either alive or shortly after its death. Small mammals are caught in traps; larger animals, such as the fox and badger, can best be shot. For trapping one can use either cage- or box-traps or the ordinary breakback or snap-traps. Cage-traps are rather expensive and bulky; equally good results can be obtained from the smaller snap-traps, if an adequate number are set. Whatever sort of trap one uses, one should always take care to set the trap "sharp". Traps should be put out before dusk, and it is advisable to mark the spot where the trap is set, e.g. by twisting a small piece of cotton wool round a twig of a neighbouring bush; the traps should be put out in such a way that they do not catch the eye of passers-by. With bread as bait one can easily collect wood-mice, bank voles and even shrews, but pieces of bacon, cheese, apple, potato and coconut are also suitable. Early the following morning, preferably not much later than shortly after sunrise, one should collect the trapped animals; during the long winter nights one should also inspect the snap-traps late at night with the aid of a good torch. Trapped animals should be put in small rectangular white cotton bags (about 6 in. \times 8 in.) without touching them. This can be done by taking up the trap carefully and lowering it into the open bag in such a way that the animal's body gets into the bag; then the trap is loosened and drawn out, thus leaving the animal and the fleas in the bag, which should now be closed with a piece of string. It is advisable to put only one animal in one bag; if the number of bags available proves insufficient, take care not to put two different species of host into one bag. If the host is still alive, it must be killed from the outside of the bag, e.g. by a blow, by pressing its throat for a few minutes or by putting the bag in a tin or jar and adding several drops of ether or chloroform. The latter procedure must in any case be carried out with the dead animals in the bags after having taken these home. Keep the killing-tin or jar tightly covered for about ten minutes and then take out and empty the bag on a sheet of white paper or in a white basin. Inspect the inside of the bag and search the animal for parasites by brushing with a long needle or a pair of pincers against the grain of the fur. Pick up the fleas and other parasites by touching them with a (lanceolate) needle or a similar instrument wetted with alcohol or spirit (do not use a brush), and convey them to a tube with 70–80 per cent. alcohol or methylated spirit. Put a label in the tube (see under "Labelling", p. 4).

Although killing off bats in small numbers is not likely to affect their population density, one can also collect bat fleas by exposing bats to fumes of chloroform in a tin or jar for a very short time, and then not only collect the fleas from the bottom of the container, but also search the narcotised animal for fleas. One can do likewise with other useful or harmless animals, such

as the hedgehog (though this animal may also be dusted with D.D.T.). If the chloroforming is done with care (a small dose for a short time), then it is possible to keep both the animal and the fleas alive.

A large dead animal can be hung over a large basin of clean water; the fleas will leave the body and fall on the water, where they will float for some time and from where they can be easily collected.

Before using a collecting-bag again, make sure that no fleas or other parasites are left in it.

Collecting bird fleas.—Although many birds carry one or a few fleas, the best way to obtain bird fleas is to collect birds' nests, which often contain large numbers of fleas. Fleas from the bodies of birds can be obtained without killing the birds by exposing their bodies to chloroform fumes (see the description of the apparatus used at the Fair Isle Bird Observatory: 1954, *Brit. Birds* 47: 234–235, pl. 44).

Collecting fleas from nests.—Nests of birds and mammals are the most rewarding source for the flea collector. Nest linings, especially, should be collected by putting these in a bag, but if a nest is small it is advisable to take the whole nest. The underground nests of various small mammals, which are usually situated not very far below the surface, may be dug out with a spade or trowel. Handy tools in connection with this work are long forceps, which will be found useful in obtaining such nests as that of the sand martin. It is important to ascertain, if possible, what species of bird or mammal inhabited the nest.

There are two ways of getting fleas and other nidicoles out of the nests: (a) Sieve the material bit by bit in a white bowl and search for fleas, which can be picked up by touching them with a wetted flat needle, or more easily with an exhaustor, connected to a vacuum pump; (b) put the nest material in a photo-thermoelector, e.g. a Tullgren funnel. Never fumigate nest material, for it is difficult to spot dead fleas in method (a) and method (b) works only with living organisms. Nests often contain many flea larvae from which adults may be bred if the nest is slightly damped and kept in a cool and dark place, preferably in a box; examine the material at intervals for emerged fleas. If nests are to be transported or forwarded, the cotton bag containing the nest should be wrapped in a quantity of fresh grass to conserve the moisture.

PRESERVING

Collected fleas are kept, prior to mounting, in small glass tubes containing 70–80 per cent. alcohol or methylated spirit (formalin is not suitable); they can be stored indefinitely in this way. The tubes can best be kept in jars, as used for sterilising fruit and vegetables. If storage is to be for many years, it seems to be an advantage to preserve the specimens dry instead of in alcohol: stick the specimens (which preferably should not be dried out) with paste or water-soluble gum to a narrow strip of card (e.g. Bristol board), after first having written the data on the reverse side of the strip; allow the paste or gum to dry and then put the strip into a tube in which it should just fit and close firmly with a cork. I have made good microscopic preparations of specimens which had been kept dry, stuck on card, for seventy years, while it is more difficult to make satisfactory preparations of specimens which have been in alcohol for a great many years.

LABELLING

The parasites from each individual host should be stored separately in a tube, containing a small paper label on which is written in pencil or Indian ink (in clear script!): (a) Name of the host (when the material is from a nest this should be stated), (b) locality (add altitude for mountainous regions), (c) date, (d) name of collector, (e) ecological data, e.g. in a field, in a wood, nest on the ground, etc.

MOUNTING

Most fleas can only be studied and identified satisfactorily if they are mounted properly on slides (fig. 1), but one may be able to identify the less heavily sclerotised specimens without any previous treatment. The following method of mounting is still the best known. Pass the specimens (which should be kept in the same tube while changing the fluids; pin the label on the cork) successively through the following liquids:

(a) Water; one hour.

(b) 20 per cent. solution of potassium hydroxide (KOH) at room temperature; one or more (generally two) days, till the specimens are somewhat transparent.

(c) Water; a few minutes.

(d) 5-10 per cent. aqueous solution of glacial acetic acid; half an hour.

(e) Water (renew once); half an hour.

If permanent mounts are not desired, the specimens can, at this stage, be studied on a slide in water (under a coverslip) and afterwards returned to a tube containing alcohol.

(f) Put the specimens from one tube on a clean microscope-slide, a short distance from each other. Remove with blotting-paper any superfluous water round the specimens, but avoid letting them become dry. Arrange with the aid of two fine mounted needles, under a dissecting microscope or a powerful lens, the legs in proper position, i.e. downwards and free from each other. Put on a coverslip, or a quarter-piece of a slide, and let 96 per cent. alcohol (or dehydrated methylated spirit) run from a small pipette underneath the coverslip. Since the alcohol evaporates fairly quickly, more should be added from time to time. Very large and thick fleas should be covered with half a slide, since the pressure of a coverslip would not be sufficient; leave for about half an hour.

(g) Take the specimens off the slide and put them in absolute alcohol (or 96 per cent.); one hour or longer.

(h) Oil of cloves; at least for some hours, preferably a day or even longer. If the specimens, which for the first hour or so will float on the surface of the oil, do not eventually sink, they should be pushed below the surface with a needle, or shake the tube gently.

(i) Xylol (renew once); about ten minutes.

(j) Mount the specimens in Canada balsam, dissolved in xylol. It is customary, for the sake of uniformity, to mount every flea on its right hand side on the slide, and it is advisable not to place more than one specimen under one coverslip. In order to get a nice preparation, the specimen should be placed exactly on the centre of the slide; then put a clean coverslip on top of it, taking care that the specimen is beneath the centre of the slip.

Now put a drop of fairly thin balsam on the slide, touching the edge of the slip; opposite this place another drop of balsam so that the balsam will spread quickly underneath the coverslip; the space between coverslip and slide should be entirely filled with balsam.

(k) Dry the slides on a hot-plate or in an oven at 80–90° C. for about half an hour.

(l) After a few days scratch off all balsam outside the coverslip, using a stiff razorblade. The slides may be ringed with Canada balsam if circular coverslips have been used; this ringing is not essential but it gives the slide a finished look and also protects the edge of the coverslip. Once ringed, the slides must be dried again at 80–90° C., but only for a few minutes.

(m) Label the slides and write (in clear script) the data from the tube label in Indian ink on the slide labels; after determination the name of the flea should be added. Store the slides in slide-boxes or cabinets.

One should always handle fleas with care, and, for instance, lift them individually out of fluids with a lanceolate needle or a similar instrument, so as not to damage specimens through loss of setae.

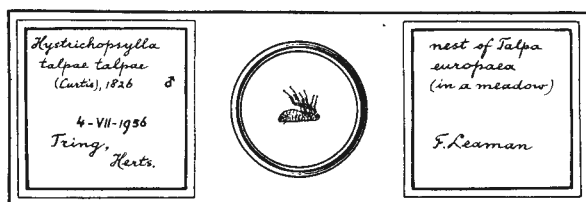


FIG. 1.—Example of a microscopic preparation of a flea.

MORPHOLOGY

As in all insects, the body of fleas consists of three main divisions: head, thorax and abdomen, but unlike all other insects, the body is strongly laterally compressed and therefore fleas are studied from a side view and not from a dorsal or ventral view. The two sides of the flea being symmetrical, descriptions and drawings of most of its structures are generally concerned with one side only. The head (fig. 2, *h*) is usually a compact structure, but in some fleas is divided secondarily by a separation above and between the bases of the antennae into an anterior and a posterior part (fracticipit head). The thorax (fig. 2, *th*) consists of three segments and the abdomen (fig. 2, *a*) of ten.

The technical terms, employed in the keys, of the structures of taxonomic importance are listed below in an illustrated glossary. Purely for the sake of uniformity the terminology I have followed is that which has been used in Hopkins and Rothschild, *An Illustrated Catalogue of the Rothschild Collection of Fleas*, Vol. II (1956), but with a few exceptions: terms relating to parts of the spermatheca, since these authors are adopting my terminology for this organ in subsequent volumes of their catalogue; seta for bristle or hair; antesensillar seta for antepygidial bristle; stipes for maxilla.

GLOSSARY

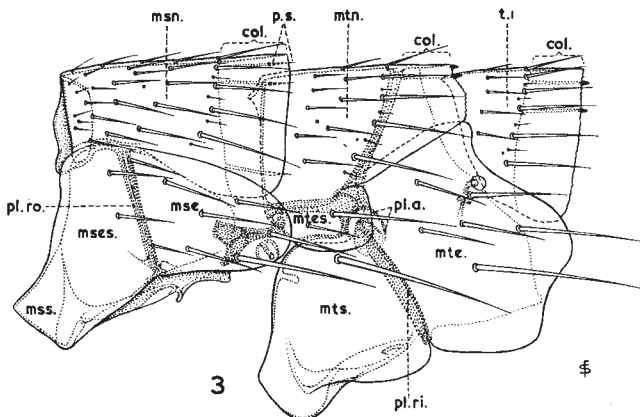
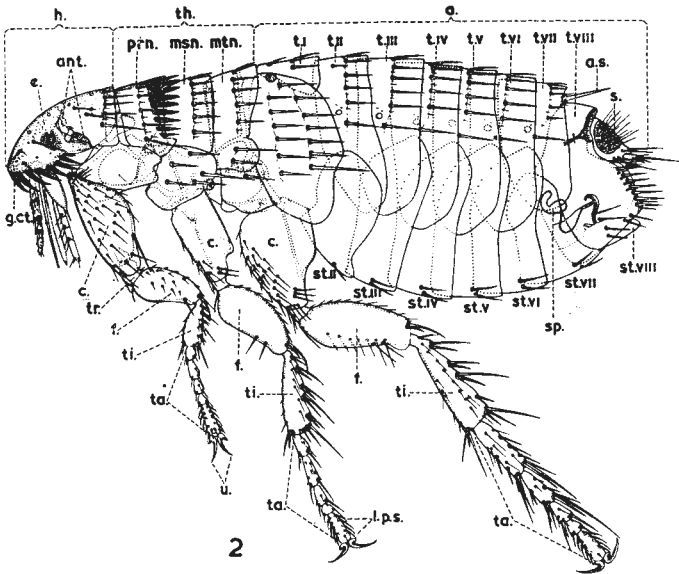
- Acetabular seta* (fig. 9, 137, *ac. s.*).—One or two (sometimes more) setae, often long, placed on the body of the clasper near or at its posterior margin and usually behind the acetabulum (fig. 137, *ac.*).
- Alveolus*.—The cup-like pit from which a seta arises.
- Anal stylet* (figs. 10, 11, *an. sty.*).—An elongate structure bearing one long apical seta and often also one or a few preapical small setae, present in most female fleas on each side of tergum X, behind the sensillum.
- Antenna* (figs. 2, 4, *ant.*).—In nearly all fleas the antennae show sexual dimorphism: in the male they are used to grip the female during copulation and in this sex they are therefore longer than in the female and on the inner side of the club densely covered with minute setae. In a few fleas only, e.g. *Pulex irritans* (fig. 7), the antennae are not sexually dimorphic and in such species they therefore presumably play no role in the act of copulation.
- Antennal fossa* (fig. 5, *ant. f.*).—A deep groove on each side of the head in which the antenna rests.
- Antesensillial seta* (antepygidial bristle) (figs. 2, 8–11, *a. s.*).—One or more usually very strong setae placed dorsally at or near the posterior margin of tergum VII; in some fleas, e.g. males of *Rhadinopsylla*, they are absent.
- Apical lobe of sternum IX* (fig. 9, *a. l. st. IX*).—The apical half of the distal arm of sternum IX, which is differentiated from the anterior half in male Ceratophyllidae.
- Apodeme of tergum IX* (figs. 8, 9, 137, *ap. t. IX*).—The dorsal internal part of tergum IX of male fleas.
- Blind duct* (ductus obturatus) (figs. 10–13, *d. o.*).—This duct usually begins at the bursa copulatrix (but sometimes from the duct of spermatheca) and ends blindly.
- Body of the clasper*.—See under *Clasper*.
- Bursa copulatrix* (figs. 11–13, *b. c.*).—The copulatory pouch of the female, from which begins the duct of spermatheca (and often also the blind duct).
- Central tuber* (trabecula centralis) (figs. 5, 52, *c. t.*).—A short rod of chitin connecting internally the walls of the antennal fossae; this tuber is visible in cleared specimens as a circular spot, often dark coloured.
- Clasper*.—The modified tergum IX of the male flea, forming a sexual clasping organ; the main part, called the *body of the clasper*, bears cephalad an internal apodeme, the *manubrium* (figs. 8, 9, 137, *m.*), and caudad it may form a “*fixed process*” (figs. 9, 137, *f. p.*); in the Ceratophylloidea a *movable process* (figs. 9, 137, *m. p.*) articulates with the inner side of the body of the clasper at the *acetabulum* (fig. 137, *ac.*), while in Pulicoidea (represented in Europe only by the Pulicidae) there are two movable processes, which are usually called P² and P³, the fixed process being P¹ (fig. 8).
- Club (clava) of antenna* (fig. 14, *clv.*).—The compact antennal segments beyond the pedicel. The club consists of ten segments, but the first segment is the small petiole (fig. 14, *ptl.*) which connects the club with the pedicel; it is customary not to count the petiole in the number of segments of the club which is therefore assumed to be nine. In the genus *Rhadinopsylla* the club consists of only seven or eight segments because several of the basal segments are fused (fig. 58).
- Collar* (fig. 3, *col.*).—The posterior marginal flange of a segment which overlaps the anterior portion of the succeeding segment.

Comb (ctenidium).—A row of spines.

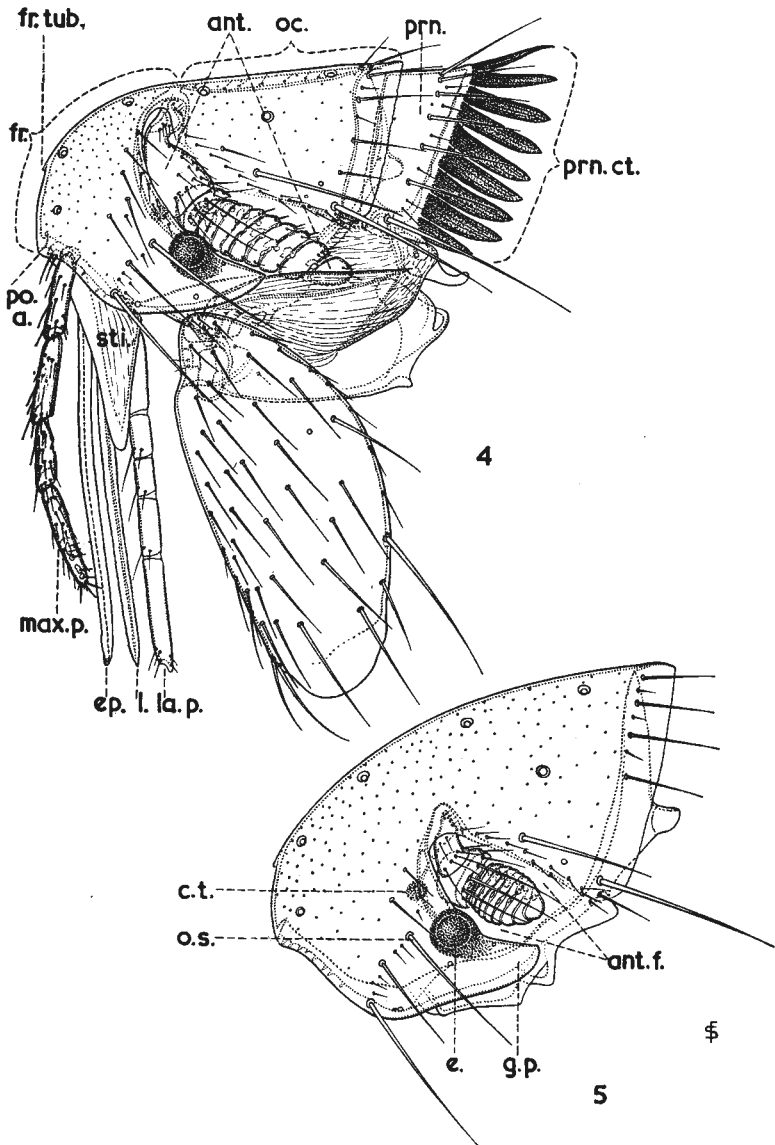
Coxa (fig. 2, c.).

Distal arm of sternum IX.—See under *Sternum IX.*

Duct of bursa copulatrix (ductus bursae copulatricis, or ductus bursae) (figs. 11, 12, d. b. c.).—The duct between vagina and the bursa copulatrix.



FIGS. 2-3.—2. *Ctenocephalides felis felis*, ♀. 3. *Leptopsylla segnis*, ♂. Mesothorax, metathorax and tergum I. For an explanation of the abbreviations used in these and other figures, see the list of abbreviations on p. 16.



FIGS. 4-5, *Nosopsyllus fasciatus*. 4, Head, prothorax and fore coxa, ♂; 5, Head, ♀.

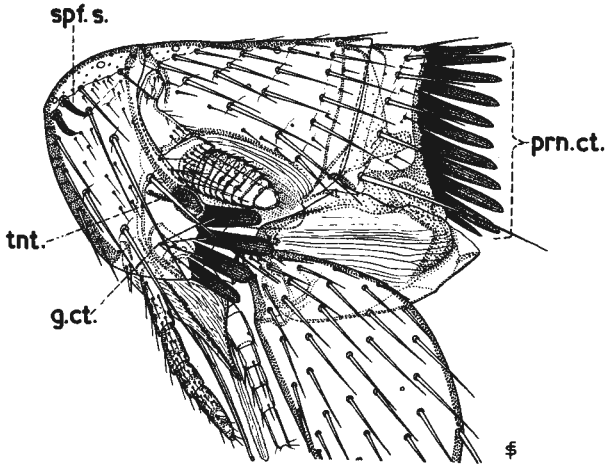


Fig. 6. *Leptopsylla segnis*. Head, prothorax and fore coxa, ♂.

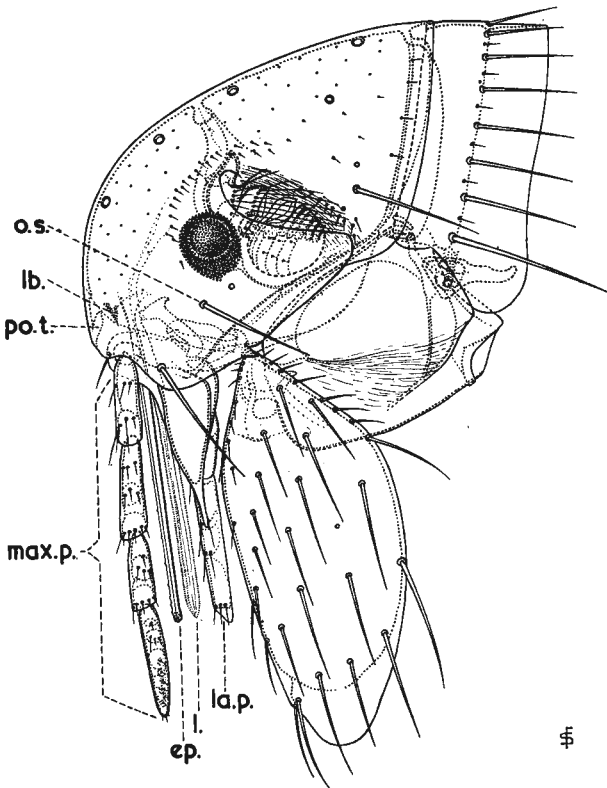
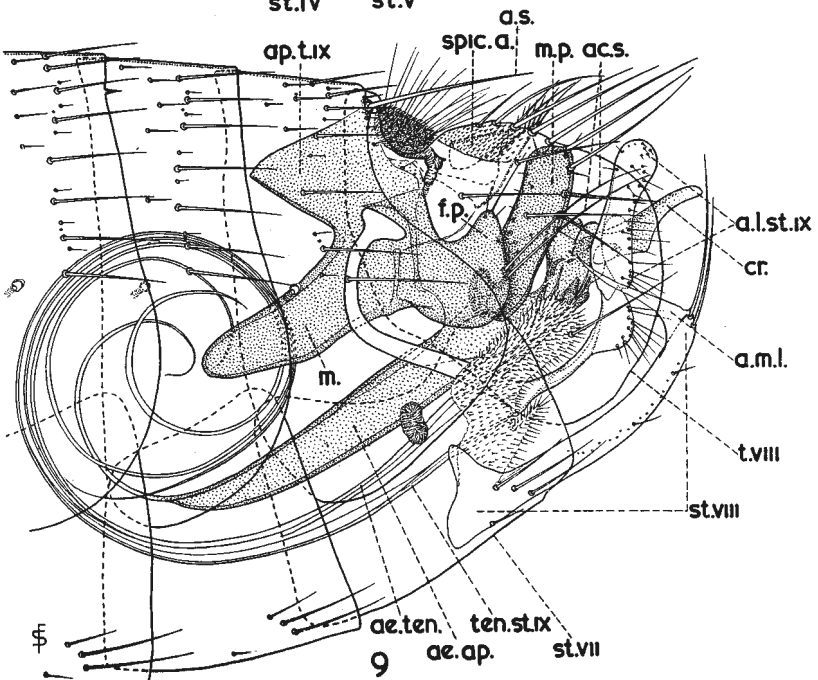
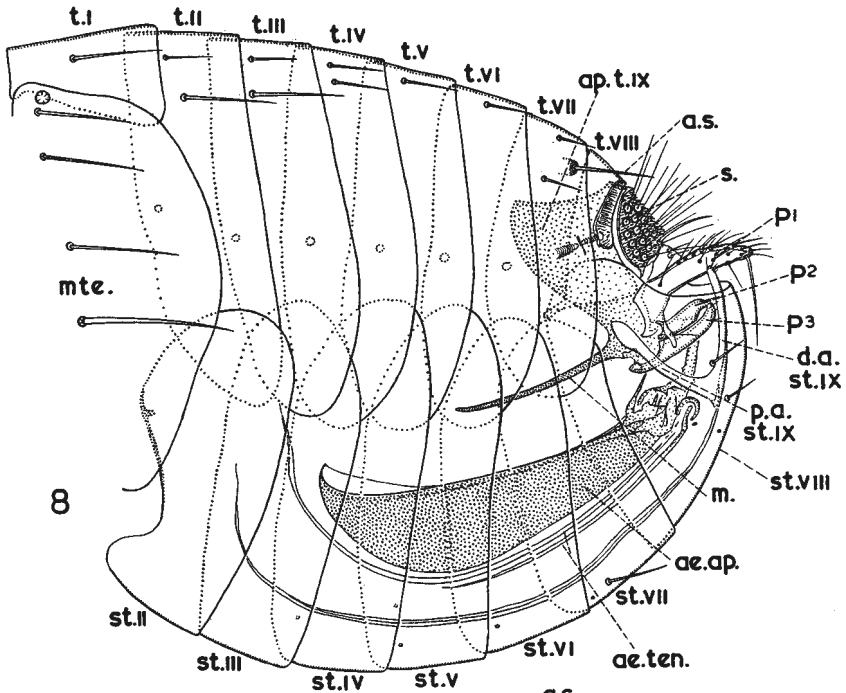


Fig. 7. *Pulex irritans*. Head, prothorax and fore coxa, ♂.

- Duct of spermatheca* (ductus spermathecae) (figs. 11–13, *d. s.*).—The duct between the bursa copulatrix and the spermatheca ; its length varies considerably according to the species and in some fleas the part of this duct near the bursa copulatrix is widened or surrounded by structures of an apparently glandular nature.
- Epipharynx* (figs. 4, 7, *ep.*).—An unpaired piercing organ, sclerotized along the anterior margin which may bear characteristic thickenings in the lower half.
- Eye* (figs. 2, 5, *e.*).—Eyes are either present (though sometimes vestigial) or absent ; loss of eyes is particularly common among subterranean nest-fleas.
- False comb of tibia.*—A row of subspiniform setae along the posterior (dorsal) margin of a tibia.
- Femur* (fig. 2, *f.*).
- Fixed process of the clasper.*—See under *Clasper*.
- Frons* (fig. 4, *fr.*).—The more dorsal and anterior area of the preantennal portion of the head.
- Frontal tubercle* (fig. 4, *fr. tub.*).—A small triangular projection of the frontal margin, very variable in shape and in structure (in a number of species it is absent, while in the genus *Ischnopsyllus* it is deciduous).
- Gena.*—The ventral area of the preantennal part of the head.
- Genal comb* (genal ctenidium) (figs. 2, 6, *g. ct.*).—A comb of spines along the ventral marginal area of the gena (horizontal comb ; see fig. 32) or along its posterior marginal area (oblique or vertical comb ; see respectively figs. 55 and 6).
- Genal process* (fig. 5, *g. p.*).—The ventro-posterior part of the gena, its dorsal margin bordering the antennal fossa.
- Interantennal suture.*—A suture running over the head between the bases of the antennal fossae ; if this suture is present the head is stated to be fracticipit, while an integricipit head lacks it.
- Labial palp* (figs. 4, 7, *la. p.*).—This palp usually consists of five segments, though this number may be reduced to one ; in rare instances it may exceed five.
- Labrum* (fig. 7, *lb.*).—A very small sclerite, connected to the preoral tuber by a membrane.
- Lacinia* (figs. 4, 7, *l.*).—The stiletto-shaped part of the maxilla (formerly called the mandible) ; it has fine or coarse serrate margins and is as long as the epipharynx ; the combination of the two laciniae plus the epipharynx forms the piercing-sucking tube.
- Lateral plantar setae.*—See under *Tarsus*.
- Manubrium.*—See under *Clasper*.
- Maxillary palp* (figs. 4, 7, *max. p.*).—This palp always consists of four segments.
- Mesonotum* (figs. 2, 3, *msn.*).—The dorsal sclerite of the second (middle) thoracic segment ; it never bears a comb, but there may be pseudosetae under its collar.
- Metanotum* (figs. 2, 3, *mtn.*).—The dorsal sclerite of the third thoracic segment ; this may have a comb (e.g. in *Ischnopsyllus*), but in most species it has not, or only a few spinelets.



FIGS. 8-9.—8, *Ichidnophagu gallinacea*. Abdomen of male. 9, *Ceratophyllus gallinae gallinae*. Terminalia of male.

Metepimeron (fig. 3, *mte.*).—A large sclerite, containing dorsally the first abdominal spiracle; it has taken the place of the lost first abdominal sternum.

Metepisternum (fig. 3, *mtes.*).—This sclerite is more or less fused with the lower part of the metanotum.

Movable process of the clasper.—See under *Clasper.*

Occiput (fig. 4, *oc.*).—The whole of the postantennal area of the head is called the occiput for the sake of convenience.

Ocular seta (figs. 5, 7, *o. s.*).—The large seta placed nearest to the eye, below or in front of it.

Pedicel of antenna (fig. 14, *ped.*).—The second antennal segment.

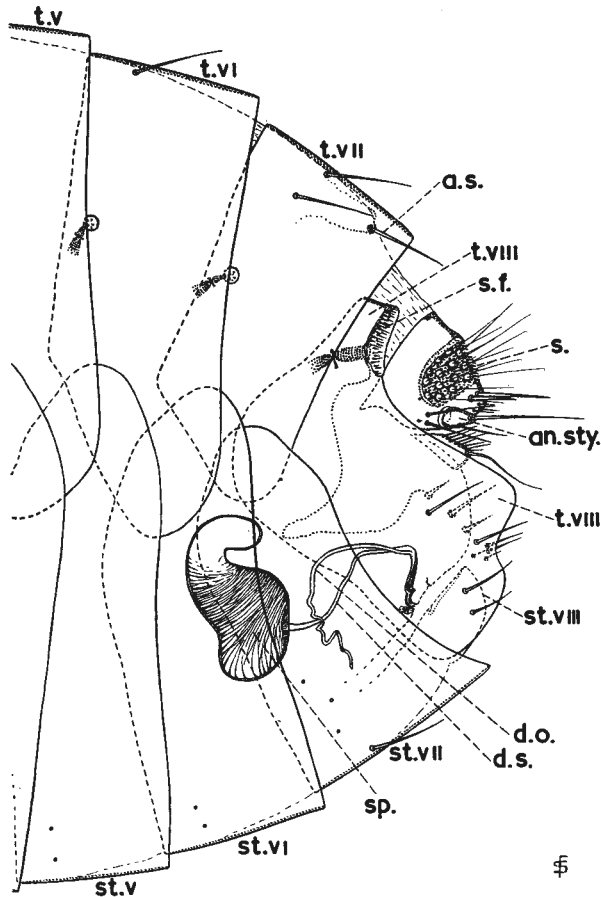


FIG. 10.—*Echinophaga gallinacea.* Terminalia of female.

Phallosome.—The genital or intromittent apparatus of male fleas; this is usually extremely complicated structurally and it is not necessary to refer to it in the fleas dealt with in this volume. The more conspicuous parts of the phallosome are the *aedeagal apodeme* (also called the penis-plate) (figs. 8, 9, *ae. ap.*), the *aedeagal tendons* (or tendons of phallosome) (figs. 8, 9, *ae. ten.*) and the *crochet* (fig. 9, *cr.*).

Pleural arch of metanotum (fig. 3, *pl. a.*).—A rounded socket of a sclerotisation in which fits the dorsal end of the metapleural vertical ridge (fig. 3, *pl. ri.*); in a few fleas (true nest fleas, which are poor jumpers) the pleural ridge is fused with the pleural arch and then the latter is said to be absent.

Pleural rod of mesopleurum (fig. 3, *pl. ro.*).—An internal chitinous rod which divides the mesopleuron into an anterior *mesepisternum* (fig. 3, *msep.*) and a posterior *mesepimeron* (fig. 3, *msep.*).

Preoral angle (fig. 4, *po. a.*).—The angle formed by the frontal margin and the ventral or genal margin of the head.

Preoral comb (preoral ctenidium) (figs. 90–93).—A genal comb of two spines in the Ischnopsyllidae (bat-fleas) placed at the preoral angle.

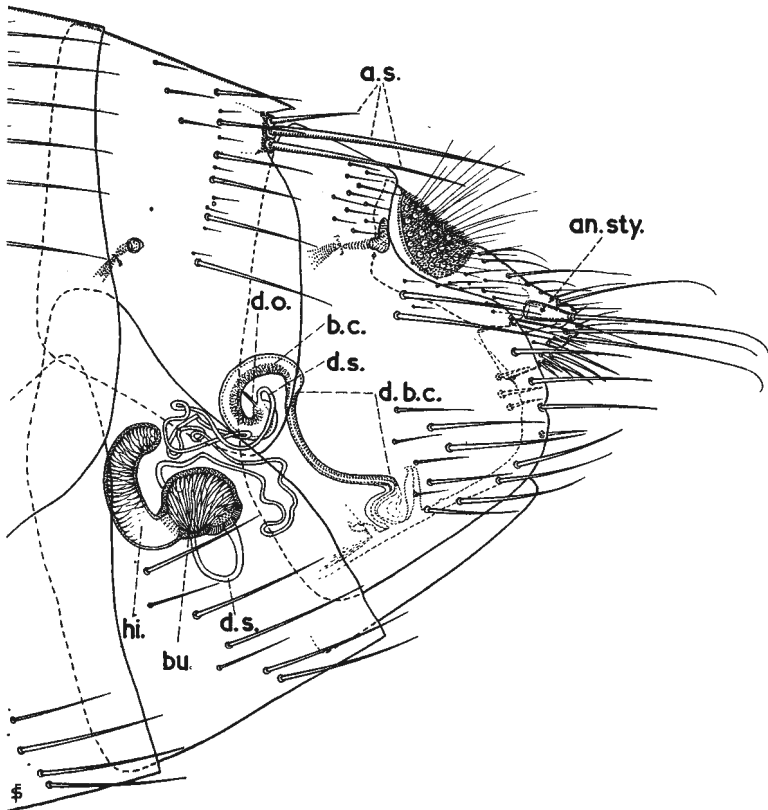


FIG. 11.—*Nonopsyllus fuscivatus*. Terminalia of female.

Preoral tuber (fig. 7, *po. t.*).—An internal sclerotisation (or thickening) of the lower end of the frontal margin at the preoral angle.

Pronotal comb (pronotal ctenidium) (figs. 4, 6, *prn. ct.*).—A comb of spines along the posterior margin of the pronotum.

Pronotum (figs. 2, 4, *prn.*).—The dorsal sclerite of the first thoracic segment.

Proximal arm of sternum IX.—See under *Sternum IX.*

Pseudoseta (fig. 3, *p. s.*).—A slender spine-like structure which does not arise from an alveolus; in many fleas there is a row of a few or more pseudosetae under the collar of the mesonotum.

Scape of antenna (fig. 14, *sc.*).—The well-developed first segment of the antenna.

Sensillum (figs. 2, 8, 10, *s.*).—A sharply defined area of tergum IX, densely clothed with very short spicules and in this field are a number of pits (sensory organs, *trichobothria*) from each of which arises a long and thin seta.

Seta.—A hair or bristle, arising from an alveolus.

Spermatheca (figs. 2, 10, *sp.*).—The semen receptacle is of very great taxonomic importance; it consists of a widened main part, the *bulga* (figs. 11–13, *bu.*), containing the orifice for the duct, and a terminal usually long and narrow sausage-shaped *hilla* (figs. 11–13, *hi.*). The latter bears in some species a sclerotised knob at the apex, the *papilla* (fig. 12, *pa.*).

Spicules.—Minute sharply pointed outgrowths of the cuticle.

Spiculate area (fig. 9, *spic. a.*).—A field of spicules on the inner side of the dorsal part of tergum VIII, present in many species of the family Ceratophyllidae.

Spine.—A well-developed, heavily sclerotised outgrowth of the cuticle, not arising from an alveolus; a row of spines forms a comb (ctenidium).

Spinelet.—A much shortened, usually triangular, spine.

Spiniform seta (fig. 6, *spf. s.*).—A seta which is much thickened and often tapering abruptly to a fine point.

Spiracular fossa (fig. 10, *s. f.*).—The cuticular pits of the body wall into which the abdominal spiracles are sunk; this fossa can be very large on tergum VIII (especially in the female).

Sternum II–VII (fig. 2, St. II–St. VII).—The ventral sclerites of abdominal segments; the sternum of the first segment is absent (its place being taken by the large metepimeron), and the basal sternum is therefore sternum II. The sterna have generally less setae than the terga, and no intercalary setae. The shape and chaetotaxy of sternum VII of the female is of great taxonomic importance.

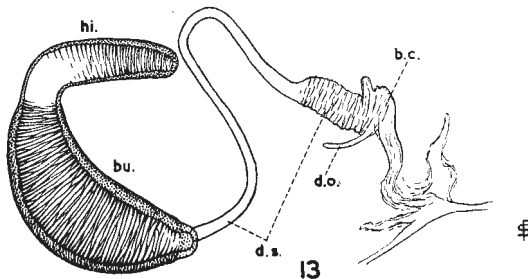
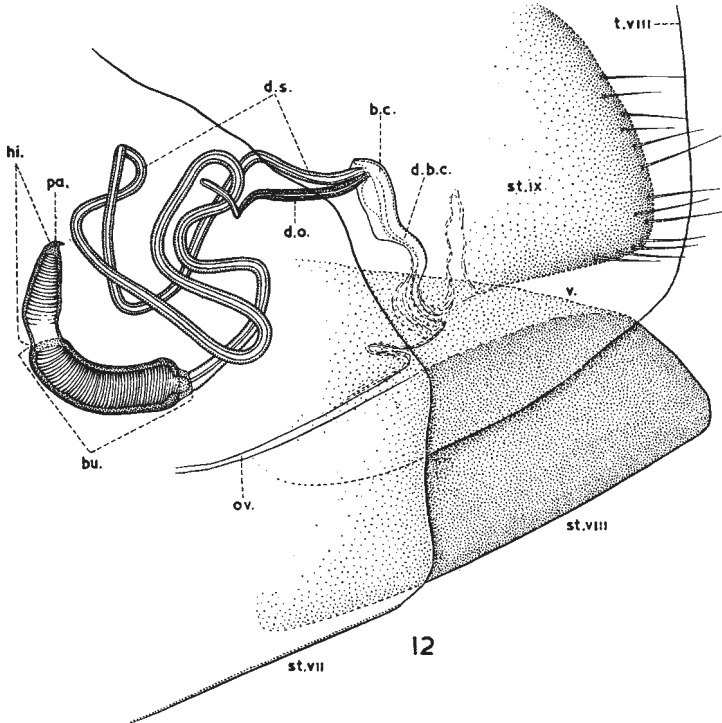
Sternum VIII. Male (figs. 8, 9, 137, St. VIII).—The size of this sternum is correlated with that of tergum VIII, so that, e.g. in Ceratophyllidae (large tergum VIII), it is long and narrow or vestigial, and in Pulicidae (small tergum VIII) it is large; in many Ceratophyllidae the narrow sternum has an *apical membranous lobe* (fig. 9, *a.m.l.*), characteristic for the species. *Female* (figs. 10, 12, St. VIII): Sternum VIII is always strongly reduced in this sex and only its ventral and apical part is sclerotised; at most there are a few small setae at the apex, but in many species this sternum bears no setae.

Sternum IX. Male.—This sternum is strongly modified in male fleas, roughly hook-shaped, and consisting of a narrow anterior “vertical” *proximal arm* (basal arm in

Hopkins and Rothschild) (figs. 8, 137, *p.a. St. IX*) and a ventral "horizontal" distal arm (apical arm in Hopkins and Rothschild) (figs. 8, 137, *d.a. St. IX*). *Female* (fig. 12, *St. IX*): In this sex sternum IX is feebly sclerotised and in most fleas covered entirely by tergum VIII; it sometimes bears a few small setae at or near its posterior margin.

Stipes (fig. 4, *sti.*).—The triangular portion of the maxilla, bearing the maxillary palp.

Striarium (fig. 59, *str.*).—An area of densely placed parallel fine cuticular ridges on the outer surface of either the metepimeron or the basal abdominal sternum.



FIGS. 12, 13.—12. *Ceratophyllus hirundinis hirundinis*. Genitalia of female.
13. *Ceratophyllus garei*. Genital ducts and spermatheca.

Tarsus (fig. 2, *ta.*).—The tarsus of each leg always consists of five segments; its last segment bears a pair of *claws* (ungues) (fig. 2, *u.*) and the number and position of its *lateral plantar setae* (fig. 2, *l. p. s.*) are often characteristic for a genus or a species.

Tendon of sternum IX (fig. 9, *ten. st. IX*).—In a number of male fleas, e.g. Ceratophyllidae, the distal arm of sternum IX possesses a long and very narrow apodemal tendon.

Tentorial rod (fig. 6, *tnt.*).—A thin rod of the tentorium, visible in members of some genera in front of the eye.

Terga I–VII (fig. 2, *T.I–T.VII*).—The dorsal sclerites of the abdominal segments. The first seven terga are not modified; they bear at least one row of setae and in each of the gaps between the large setae of the main (posterior) row is a minute seta, the intercalary seta. In nearly all species of *Ischnopsyllus* terga I–VI bear a comb, and *Hystrihopsylla talpae* has a comb on terga II–IV, but in the majority of species the terga lack a well developed comb, though in many fleas there are one or several spinelets each side at the posterior margin of at least the anterior terga. Terga II–VIII bear a spiracular fossa each side; the spiracular fossa of tergum I has been transferred to the metepimeron. Tergum VII usually bears one or more antesensillial setae.

Tergum VIII.—In the *male* (figs. 8, 9, *T. VIII*) this tergum may be either large (e.g. Ceratophyllidae), small (e.g. Pulicidae) or of a medium size (e.g. Leptopsyllinae). In the *female* (figs. 2, 10, 12, *T. VIII*) it is always very large and covers most or all of sternum VIII; its shape and chaetotaxy are often characteristic for a species.

Tibia (fig. 2, *ti.*).

Trochanter (fig. 2, *tr.*).

EXPLANATIONS OF ABBREVIATIONS USED IN FIGURES

<i>a.</i> , abdomen.	<i>ep.</i> , epipharynx.
<i>ac.</i> , acetabulum.	<i>f.</i> , femur.
<i>ac. s.</i> , acetabular seta.	<i>f. p.</i> , fixed process of clasper.
<i>ae. ap.</i> , aedeagal apodeme.	<i>fr.</i> , frons.
<i>ae. ten.</i> , aedeagal tendon.	<i>fr. tub.</i> , frontal tubercle.
<i>a. l. st. IX</i> , apical lobe of sternum IX (male).	<i>g. ct.</i> , genal comb.
<i>a. m. l.</i> , apical membranous lobe of sternum VIII (male).	<i>g. p.</i> , genal process.
<i>an. sty.</i> , anal stylet.	<i>h.</i> , head.
<i>ant.</i> , antenna.	<i>hi.</i> , hilla of spermatheca.
<i>ant. f.</i> , antennal fossa.	<i>l.</i> , lacinia of maxilla.
<i>ap. t. IX</i> , apodeme of tergum IX (male).	<i>la. p.</i> , labial palp.
<i>a. s.</i> , antesensillial seta.	<i>lb.</i> , labrum.
<i>a. spic.</i> , spiculose area of tergum VIII (male).	<i>l. p. s.</i> , lateral plantar seta
<i>b. c.</i> , bursa copulatrix.	<i>m.</i> , manubrium.
<i>bu.</i> , bulga of spermatheca.	<i>max. p.</i> , maxillary palp.
<i>c.</i> , coxa.	<i>m. p.</i> , movable process of clasper.
<i>clv.</i> , club (clava) of antenna.	<i>mse.</i> , mesepimeron.
<i>col.</i> , collar.	<i>msep.</i> , mesepisternum.
<i>cr.</i> , crochet of aedeagus.	<i>msn.</i> , mesonotum.
<i>c. t.</i> , central tuber.	<i>msst.</i> , mesosternum.
<i>d. a. st. IX</i> , distal arm of sternum IX (male).	<i>mtc.</i> , metepimeron.
<i>d. b. c.</i> , duct of bursa copulatrix.	<i>mtes.</i> , metepisternum.
<i>d. o.</i> , blind duct (ductus obturatus).	<i>mtn.</i> , metanotum.
<i>d. s.</i> , duct of spermatheca.	<i>mts.</i> , metasternum.
<i>e.</i> , eye.	<i>oc.</i> , occiput.
	<i>o. s.</i> , ocular seta.
	<i>ov.</i> , oviduct.
	<i>pa.</i> , papilla of spermatheca.
	<i>p. a. st. IX</i> , proximal arm of sternum IX (male).

ped., pedicel of antenna.
pl. a., pleural arch of metathorax.
pl. ri., pleural ridge of metapleurum.
pl. ro., pleural rod of mesopleurum.
po. a., preoral angle of head.
po. t., preoral tuber.
prn., pronotum.
prn. ct., pronotal comb.
p. s., pseudoseta.
ptl., petiole of antenna.
s., sensillum.
sc., scape of antenna.
s. f., spiracular fossa.
sp., spermatheca.

spf., spiniform seta.
st., sternum.
sti., stipes of maxilla.
str., striarium.
t., tergum.
ta., tarsus.
ten. st. IX, tendon of sternum IX
 (male).
th., thorax.
ti., tibia.
tnt., tentorium.
tr., trochanter.
u., tarsal claw.
v., vagina.

GENERAL REMARKS

Beginners who find a flea which apparently does not correspond exactly with the drawings in this handbook should not hastily assume it is a "new" species, or even new to the British fauna. Apart from normal individual variation (which may be considerable) abnormalities occur due to the following reasons :

(a) Where two closely-related species are found together in a nest, each in reasonable numbers, one may find specimens which are intermediate between the two species concerned, which indicates that hybridisation takes place between some species of fleas. To find intermediates between the subspecies in an area where they meet is, of course, a common occurrence.

(b) Dwarf forms occur, which may be morphologically slightly different from normal-sized specimens.

(c) Male fleas may be partially or wholly castrated, but this is an extremely rare phenomenon in the British Isles.

(d) Freak specimens will occasionally be found, and the monstrosity may pertain to any structure.

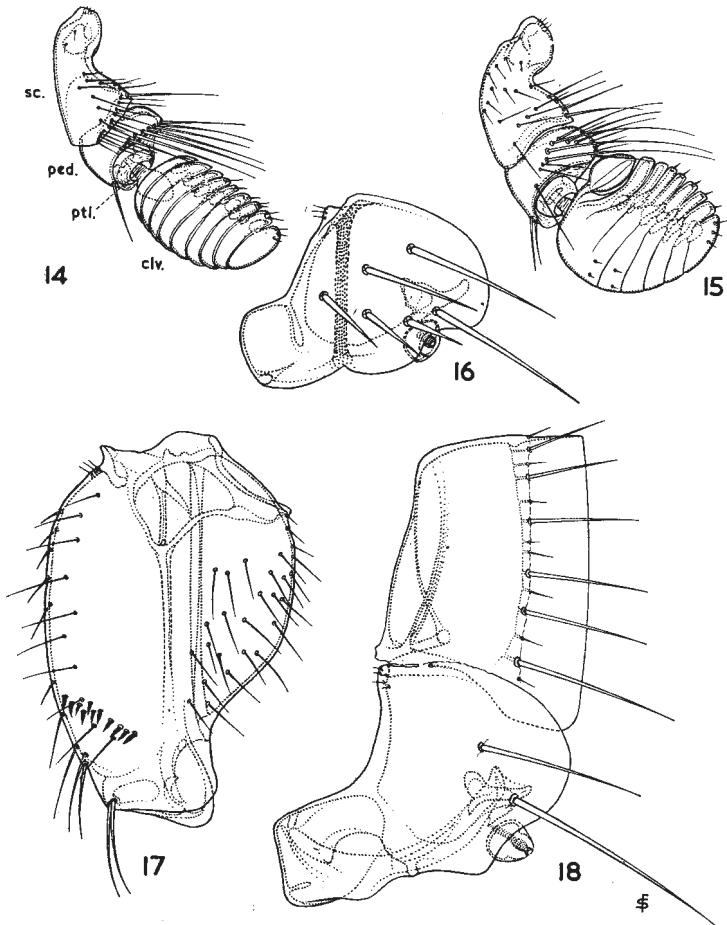
On the other hand, considerable differences should not be ignored merely because of an erroneous assumption that the flea-fauna of Britain is completely known.¹ Although fleas have been collected more intensively around Tring than in most other areas of the world, a species not previously known in Britain was collected less than 20 miles from Tring as recently as 1952, while another addition to the British list was collected in Scotland in October 1955. In the forty years since the last comprehensive account of the British fleas was published (Rothschild, 1915, *Ent. mon. Mag.* 51 : 49-112), eleven species, excluding casual immigrants found only in Zoological Gardens, have been added to the list.

It should be noted that the figures were drawn at different scales, a complicated structure usually necessitating a larger drawing than a relatively simple structure.

¹ Some species which might as yet be found to occur in the British Isles are : *Chaetopsylla globiceps* (Taschenberg) and *C. trichosa* Kohaut (respectively on fox and badger ; hardly any fleas have been collected from these hosts in Scotland), *Ctenophthalmus ussimalis* (Taschenberg) (on the mole and on voles), *Rhinolophopsylla unipunctinata unipunctinata* (Taschenberg) (on the horseshoe bats), *Nycteridopsylla pentactena* (Kolenati) (on the long-eared bat and the barbastelle) and *Peromyscopsylla bidentata* (Kolenati) (on voles).

KEY TO FAMILIES

- 1 Hind coxa with a row or group of small spiniform setae on the lower part of the inner side (fig. 17). Mesonotum without pseudosetae under its collar (fig. 18); metanotum and terga without marginal spinelets. Terga II-VII each with only one row of setae (fig. 2). Sensilium with 14 pits each side. Sternum IX of male without an apodemal tendon (Superfamily **Pulicoidea**)PULICIDAE (p. 19)
- Hind coxa without such spiniform setae. Mesonotum with pseudosetae under its collar (fig. 3). Terga II-VII each with more than one row of setae (fig. 9). Sensilium usually with more than 14 pits each side (Superfamily **Ceratophylloidea**) 2
- 2 Head with a preoral comb, consisting of two downward pointing spines (figs. 90-93, 97). Bat fleasISCHNOPSYLLIDAE (p. 43)
- Genal comb, if present, not preoral3



FIGS. 14-18.—14. *Spilopsyllus cuniculi*. Antenna, ♂ 15. *Ctenocephalides felis felis*. Antenna, ♂. 16. *Ctenocephalides canis*. Mesosternosome, ♂. 17. *Pulex irritans*. Inner aspect of hind coxa, ♀. 18. *Pulex irritans*. Mesothorax, ♂.

- 3 Metanotum without marginal spinelets (fig. 59). Sternum IX of male without an apodemal tendon.....HYSTRICHOPSYLLIDAE (p. 30)
- Metanotum with marginal spinelets. Sternum IX of male with an apodemal tendon4
- 4 Without a genal comb; no tentorial rod in front of the eye; the uppermost of the three setae in the ocular row is placed in front of the eye (figs. 122, 125, 132, 183). Sternum VIII of male narrow, sometimes vestigial CERATOPHYLLIDAE (p. 56)
- With or without a genal comb; a tentorial rod present in front of the eye (which may be vestigial or absent); upper seta of the ocular row at or near the margin of the antennal fossa, above the eye (figs. 6, 116, 120). Sternum VIII of male large, not strongly modifiedLEPTOPSYLLIDAE (p. 52)

Superfamily **PULICOIDEA**

Family **PULICIDAE**

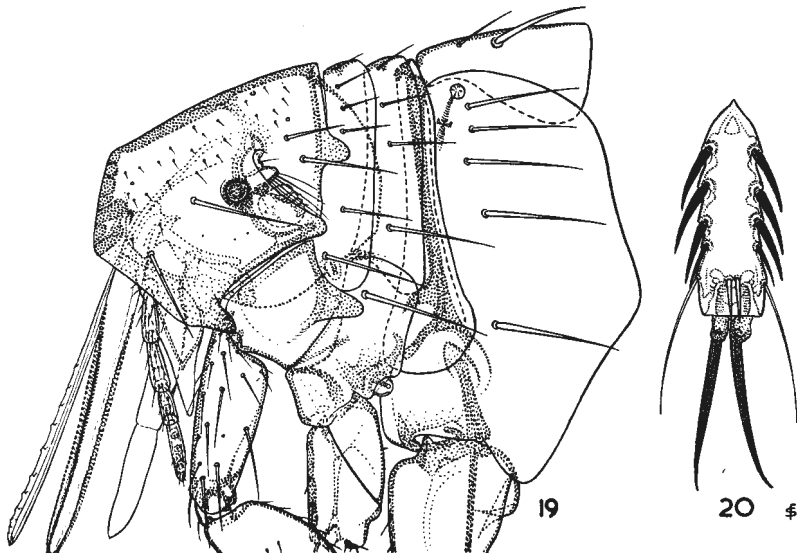
KEY TO SUBFAMILIES

- 1 Antennal club symmetrical, clearly segmented, its basal segments of normal shape (fig. 14).....SPILOPSYLLINAE (p. 28)
- Antennal club asymmetrical, i.e., the basal segments are more or less fused anteriorly and its first segment is foliaceous (fig. 15).....2
- 2 Mesopleurum without an internal pleural rod (fig. 18)PULICINAE (p. 19)
- This pleural rod present (fig. 16).....3
- 3 Without combs.....XENOPSYLLINAE (p. 22)
- With a genal and a pronotal comb.....ARCHAEOPSYLLINAE (p. 24)

Subfamily **PULICINAE**

KEY TO GENERA

- 1 Frons angulate; labial palp membranous, one-segmented; metanotum dorsally much shorter than tergum I (fig. 19).....**Echidnophaga** Olliff (p. 20)
- Frons smoothly rounded; labial palp rigid, four-segmented (fig. 7); metanotum dorsally about as long as tergum I.....**Pulex** Linnaeus (p. 21)



FIGS. 19, 20.—*Echidnophaga gallinacea*. 19, Head, thorax and tergum I, ♀; 20, Last hind tarsal segment, ♀.

Genus *Echidnophaga* Olliff

With seventeen described species and subspecies, eight of which occur in the Australian Region (on echidnas, marsupials and rabbits), five in the Ethiopian Region (on warthogs, meerkats, ground squirrels and bats), and three are Palaearctic (on gerbils, rats, fox and badger), while the species dealt with here has been transported into all zoogeographical regions with domestic poultry. This species is commonest in the Ethiopian Region; it is absent from the cooler areas, including nearly the whole of Europe; it is also apparently still absent in large areas of the Neotropical Region.

Frons angulate; genal lobe directed backwards; laciniae very broad and coarsely serrate; occiput with two setae and usually with a well-developed lobe at the posterior margin in the female only; thorax dorsally narrower than tergum I (fig. 19); fifth tarsal segment with three pairs of stout, equally spaced, lateral plantar setae and a smaller fourth pair, and with two subapical plantar setae (fig. 20); claws of tarsus without a large basal projection (fig. 20); ♂, the two movable processes P² and P³ of the clasper not quite reaching to the middle of the fixed process P¹, the latter bearing a long and downward-pointing apical seta (fig. 8); ♀ sternum VII and spermatheca (rather variable in shape) as shown in fig. 10. Length²: ♂ 1·1-1·25 mm., ♀ 1·25-1·5 mm. . . . *gallinacea* (Westwood)

Hitherto only found once in the British Isles, namely 2 ♀ on a migrating white wagtail (Motacilla alba alba) on Skokholm Island, 1952; the bird must have acquired these fleas during its sojourn in Africa. In its normal range of distribution common on poultry and other birds, also on a large variety of small mammals. A stick-tight flea (as are the other members of the genus), i.e., the female is sedentary since she buries her piercing mouthparts into the skin of the host (usually on bare spots of the head of the host) and is not easily removed. This pest of poultry is not likely to establish itself in this country since this flea prefers a warmer climate than that usually prevailing in the British Isles; this is reflected in its known distribution.



FIG. 21.—*Pulex irritans*. Clasper and sternum IX.

² The length given for all species is that of mounted specimens.

Genus *Pulex* Linnaeus

Five of the six known species occur in the Neotropical Region and the southern part of the Nearctic Region and the species here dealt with is cosmopolitan. The genus is divided into subgenus *Juxtapulex* Wagner, containing three species which are parasites of the peccary, armadillo and tapir, and *Pulex* s. str., with three species, two of which occur on rodents.

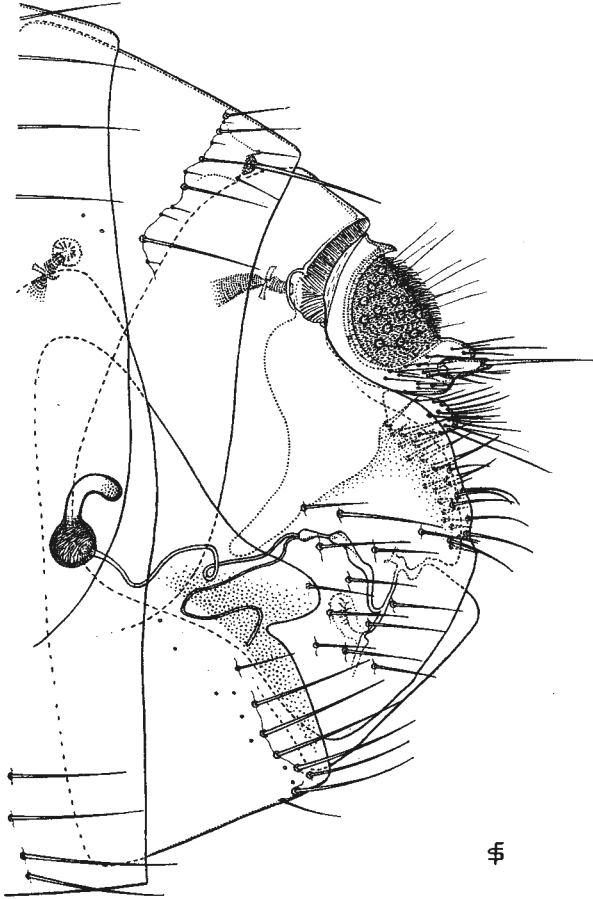


FIG. 22.—*Pulex irritans*. Terminalia of female.

Subgenus *Pulex* s. str.

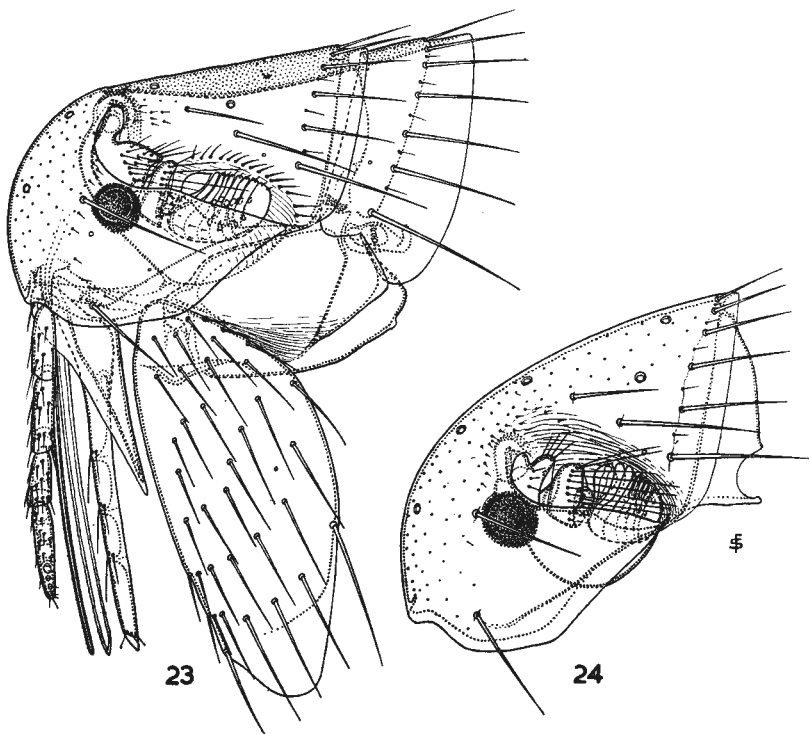
Frons smoothly rounded; ocular seta placed below the conspicuous eye; one small spinelet at the genal margin (seldom two, sometimes none); occiput with only one strong seta (fig. 7). ♂ clasper with a broad process P¹ which covers the two movable processes (fig. 21). ♀ spermatheca with a globular bulga and a curved hilla (fig. 22); outline of sternum VII as in fig. 22, but usually hardly visible in mounted specimens. Length: ♂ 2-2.5 mm., ♀ 2.5-3.5 mm. . . *irritans* Linnaeus

Associated with man and human habitations. Owing to improvement of the standard of hygiene the human flea is much less frequently encountered in urban districts than formerly. It is sometimes found on domestic animals (accidentally) and may occur in large numbers in pig-sties, while in nature it occurs rather frequently on carnivores such as the badger (*Meles meles*) and the fox (*Vulpes vulpes*). Man may well be a secondary host (though extremely suitable if his abode is not kept clean), since no Primates are known to have fleas of their own. Having faithfully followed man all over the world, the human flea is cosmopolitan.

Subfamily XENOPSYLLINAE

Genus *Xenopsylla* Glinkiewicz

Chiefly concentrated in the Ethiopian Region and the warmer parts of the Palaearctic Region; with about sixty species and subspecies, the majority of which live on Muridae, a few on other hosts and three have become bird-parasites.



FIGS. 23, 24.—*Xenopsylla cheopis*. 23, Head, prothorax and fore coxa, ♂ ;
24, Head, ♀.

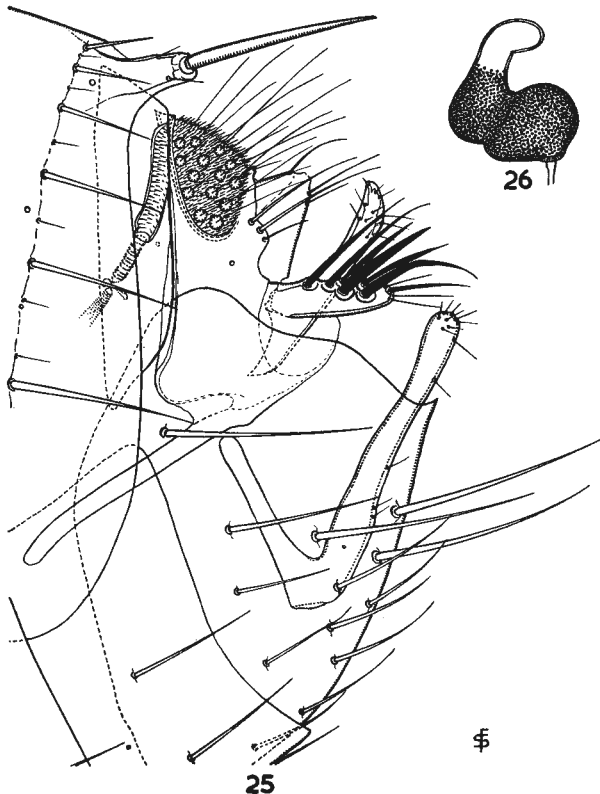
KEY TO SPECIES

- 1 ♂ antesensillial seta on a marginal cone (fig. 25); process P¹ of the clasper with seven or eight strong setae, one of which is stouter than the others and precedes an elbowed seta (fig. 25); process P² longer than P¹ and slightly bent upwards towards its apex (fig. 25); sternum IX straight (fig. 25); ♀ antesensillial seta not marginal; bulga of spermatheca for the greater part almost globular and much wider than the base of the hilla (fig. 26). Length: ♂ 1.25-1.75 mm., ♀ 1.75-2.5 mm.

brasiliensis (Baker)

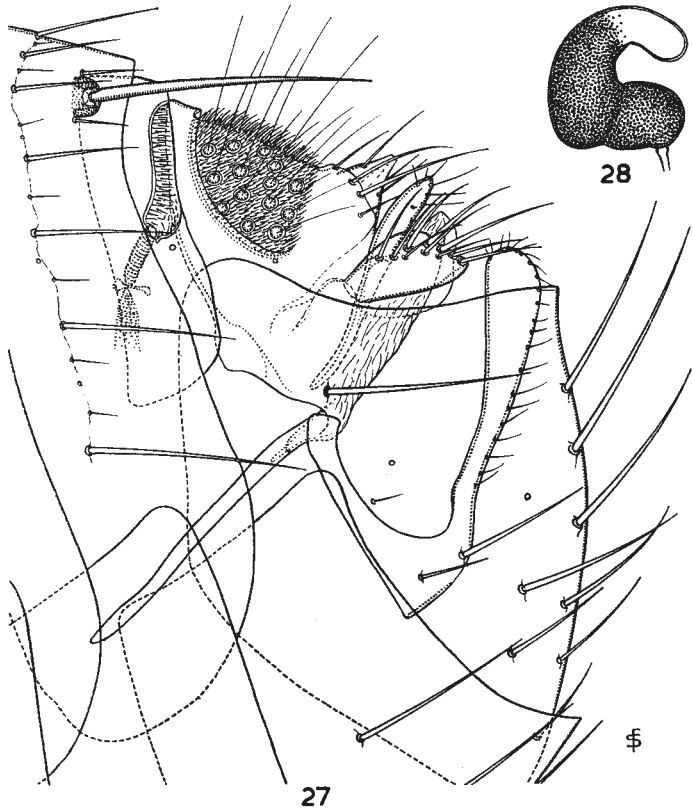
This is originally an Ethiopian rat flea, but it has now become established in many other parts of the world through the agency of ship rats (chiefly Rattus rattus). Hitherto only found once in the British Isles on rats in Cardiff docks.

- Antesensillial seta of both sexes not marginal (fig. 27). ♂ process P¹ of the clasper rather broad, with a straight or slightly concave apical margin and a number of fairly slender setae (fig. 27); process P² with its tip a little curved downwards, never upwards (fig. 27); sternum IX straight and widened towards the apex, which is not much or hardly at all turned upwards (fig. 27). ♀ bulga of spermatheca somewhat longer than broad, not broader than the base of the hilla, while the lower margin of bulga and hilla are about level (fig. 28). Length: ♂ 1.5 mm., ♀ 1.75-2.5 mm.....**cheopis** (Rothschild)



FIGS. 25, 26.—*Xenopsylla brasiliensis*. 25, Terminal segments of male; 26, Spermatheca.

This rat flea, the well-known vector of bubonic plague, is cosmopolitan, but cannot maintain itself in the British Isles. It is carried all over the world by ship rats (chiefly *Rattus rattus*) and has therefore been found here in the following ports: Plymouth, Bristol, Liverpool, Manchester, Hull, Cardiff and London; in the latter locality it was not found in the docks, but on brown rats (*Rattus norvegicus*) in the underground part of Guy's Hospital where central heating provided favourable conditions for the flea to breed—similar conditions made breeding also possible in one place in Liverpool. Also found once at Blakeney Point, Norfolk, which is not a port of importance, but it may have arrived there on rats from coasters.



FIGS. 27, 28.—*Xenopsylla cheopis*. 27, Terminal segments of male; 28, Spermatheca.

Subfamily ARCHAEOPSYLLINAE

KEY TO GENERA

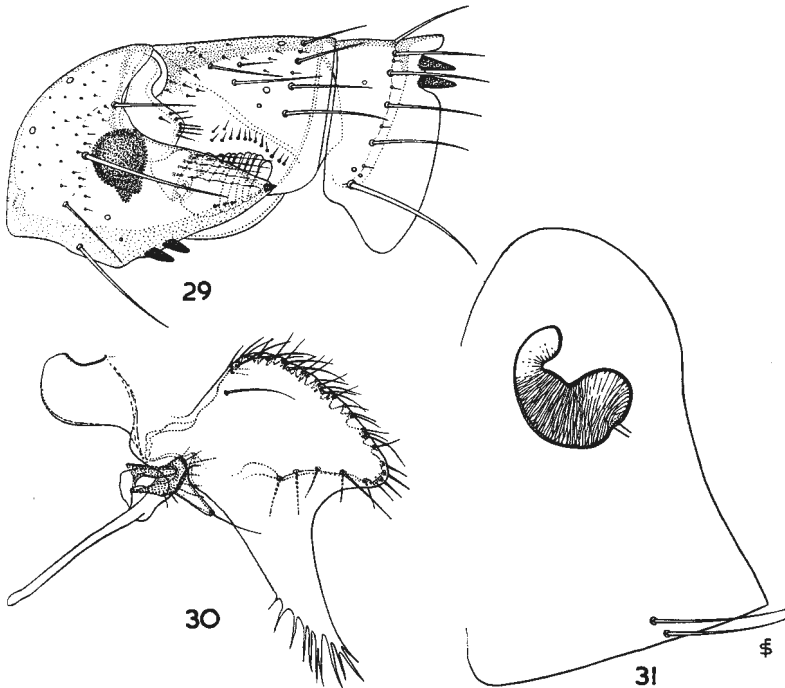
- 1 Genal comb consisting of 1-3 (usually 2) short spines; pronotal comb of 2-9 spines, occasionally reduced to one, very rarely absent (fig. 29)
Archaeopsylla Dampf (p. 25)
- Genal comb consisting of about 8-9 pointed spines, which are bent backwards; pronotal comb of 14-18 spines (figs. 32, 33, 37, 38)
Ctenocephalides Stiles and Collins (p. 25)

Genus *Archaeopsylla* Dampf

Parasites of the mammalian genus *Erinaceus* (hedgehogs) and consisting of only two very closely related species, one in the European and Mediterranean subregions of the Palaearctic Region, and the other in the Manchurian subregion.

♂ clasper with a broad process P¹, the ventral part of which forms a broad and fringed membrane (fig. 30). ♀ spermatheca broad, its bulga dorsally strongly indented and about twice as long as the hilla (fig. 31). Length: ♂ 2-2.5 mm. ♀ 2.5-3.5 mm.....*erinacei erinacei* (Bouché)

The principal and only host is the hedgehog (*Erinaceus europaeus*), on which this monoxenous flea is often found in large numbers; its range of distribution here is the same as that of its host: throughout the British Isles, except in the extreme north-west and on high ground; not in the off-lying isles, except, by importation in Mull, Bute, the Shetlands and probably the Orkneys. Europe (except the Iberian peninsula, where it is replaced by the subspecies *erinacei maura* Jordan and Rothschild) east to the Volga provinces and Transcaucasia, Turkey, Syria and Palestine.



FIGS. 29-31.—*Archaeopsylla erinacei erinacei*. 29, Head and pronotum, ♂; 30, Clasper; 31, Sternum VII and spermatheca.

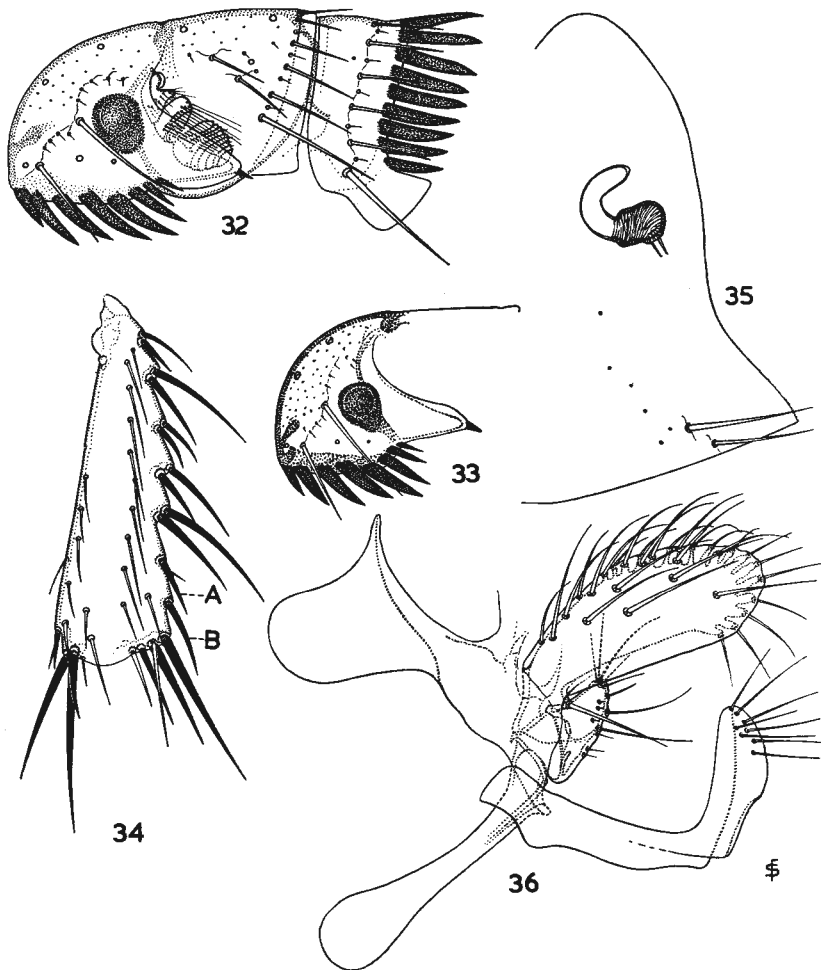
Genus *Gtenucephalides* Stiles and Collins

World-wide, but concentrated in the Ethiopian Region, containing nine species. Parasites especially of Carnivores, but a few on other hosts, e.g. one species on the goat.

KEY TO SPECIES

- 1 Head strongly rounded anteriorly in both sexes; first spine of genal comb about half as long as the second (figs. 32, 33). Hind tibia normally with the setae A and B, as shown in fig. 34. ♂ manubrium with a dilated apex (fig. 36). ♀ apical part of hilla of spermatheca long (fig. 35, cf. fig. 40). Length: ♂ 2-2.5 mm., ♀ 2-3.25 mm. ***canis* (Curtis)**

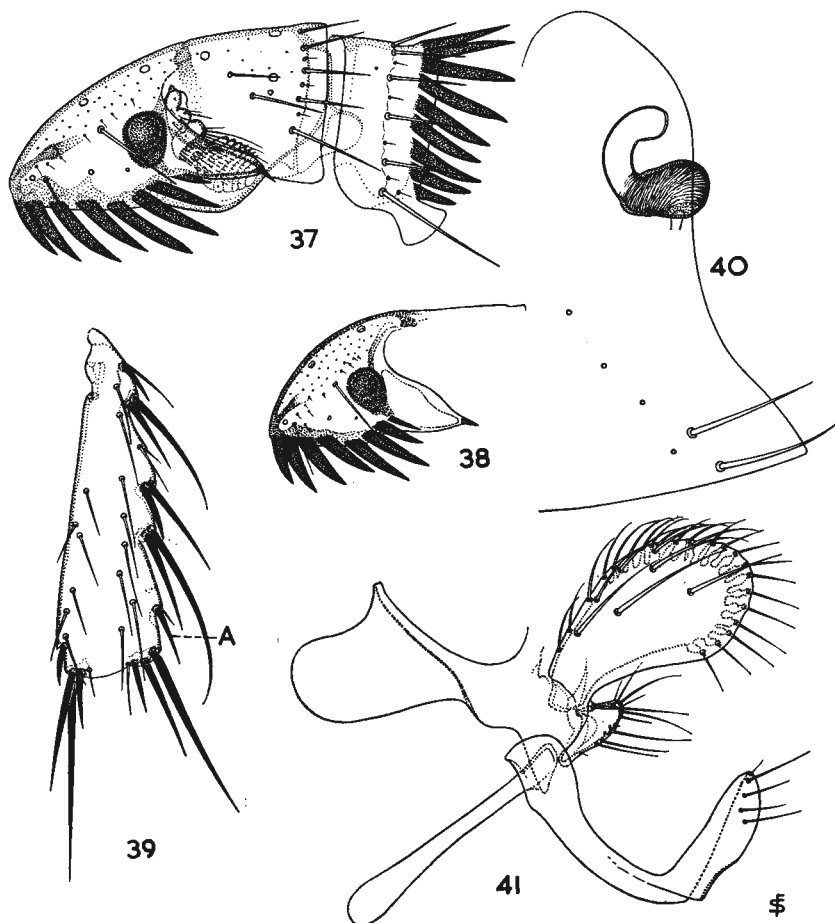
The principal hosts of the dog flea are the dog and the fox; occurrence on the cat is due to contamination, dogs and cats usually living in close association. A common flea and more or less cosmopolitan, though rare in the Oriental and Ethiopian Regions.



FIGS. 32-36.—*Ctenocephalides canis*. 32, Head and pronotum, ♀; 33, Preantennal part of head, ♂; 34, Hind tibia, ♀; 35, Sternum VII and spermatheca; 36, Clasper and sternum IX.

- Head not strongly convex anteriorly, hence more elongate than that of *canis*; first spine of genal comb only a little shorter than the second (figs. 37, 38). Hind tibia normally only with seta A (fig. 39). ♂ manubrium not or only a little dilated apically (fig. 41). ♀ apical part of hilla of spermatheca short (fig. 40, cf. fig. 35). Length: ♂ 2-2.5 mm., ♀ 2-3.25 mm. *felis felis* (Bouché)

The principal host of the cat flea in Europe is the domestic cat, but it may also be found on the dog. A very common cosmopolitan flea, occurring in the tropics on a large variety of animals (usually fairly large ones). It bites man readily and is often the species responsible for infestations of fleas in houses. In East Africa *C. felis strongylus* (Jordan) is found, in south-west Africa *C. felis damarensis* Jordan and *C. felis orientis* (Jordan) occurs from Ceylon to the Admiralty Islands but not in Australia.



FIGS. 37-41.—*Ctenocephalides felis felis*. 37, Head and pronotum, ♀; 38, Preantennal part of head, ♂; 39, Hind tibia, ♀; 40, Sternum VII and spermatheca; 41, Clasper and sternum IX.

Subfamily SPILOPSYLLINAE

KEY TO GENERA

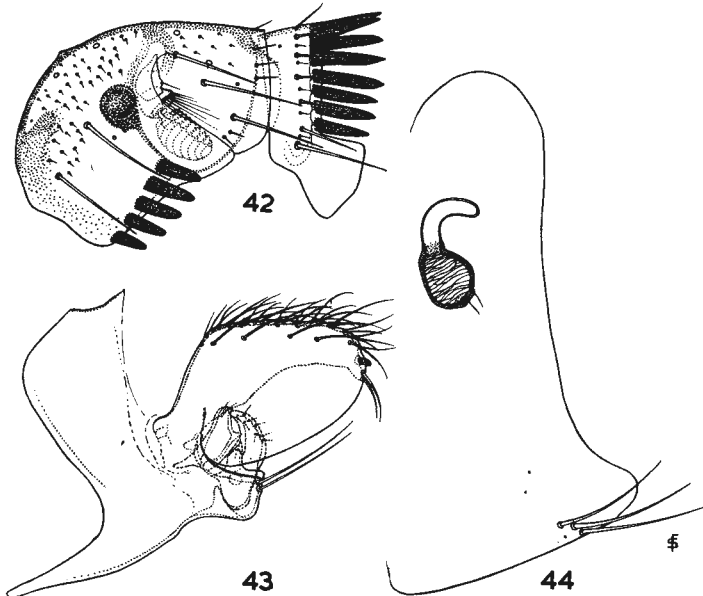
- 1 With a genal comb of 4-6 blunt spines and a pronotal comb of 12-17 spines (fig. 42); labial palp of two feebly sclerotised segments; laciniae coarsely serrated
Spilopsyllus Baker (p. 28)
- Without genal and pronotal comb (figs. 45, 46); labial palp consisting of four segments, the apical two of which are fused; laciniae finely serrated
Ornithosylla Rothschild (p. 29)

Genus *Spilopsyllus* Baker

European and Mediterranean subregions of the Palaearctic Region; the genus is monotypic and the true host of the species is the rabbit.

♂ process P¹ of clasper large, with a short blunt apical spiniform seta; this process covers the two processes P² and P³ entirely (fig. 43). ♀ sternum VII with a ventral lobe; bulga of spermatheca a little longer than broad, its hilla longer than the bulga (fig. 44). Length: ♂ 1.5-2 mm., ♀ 1.5-2.25 mm. . . *cuniculi* (Dale)

This is the monoxenous rabbit flea; it is found on its principal host, the rabbit (Oryctolagus cuniculus), throughout the British Isles (though absent on rabbits on Skokholm Island), either on the inside of the ears, where it attaches itself with the powerful laciniae (one often finds a mass of these fleas on the ears of rabbits), or on the head and to a lesser degree on the main part of the body. When occurring accidentally on hares and cats, they are usually found attached to the inner side of the ears. A common species, known as a vector of myxomatosis. Holland, Belgium, France, Germany, Poland, Czechoslovakia, Austria, Italy, Spain, Morocco.



FIGS. 42-44.—*Spilopsyllus cuniculi*. 42, Head and pronotum, ♀; 43, Clasper; 44, Sternum VII and spermatheca.

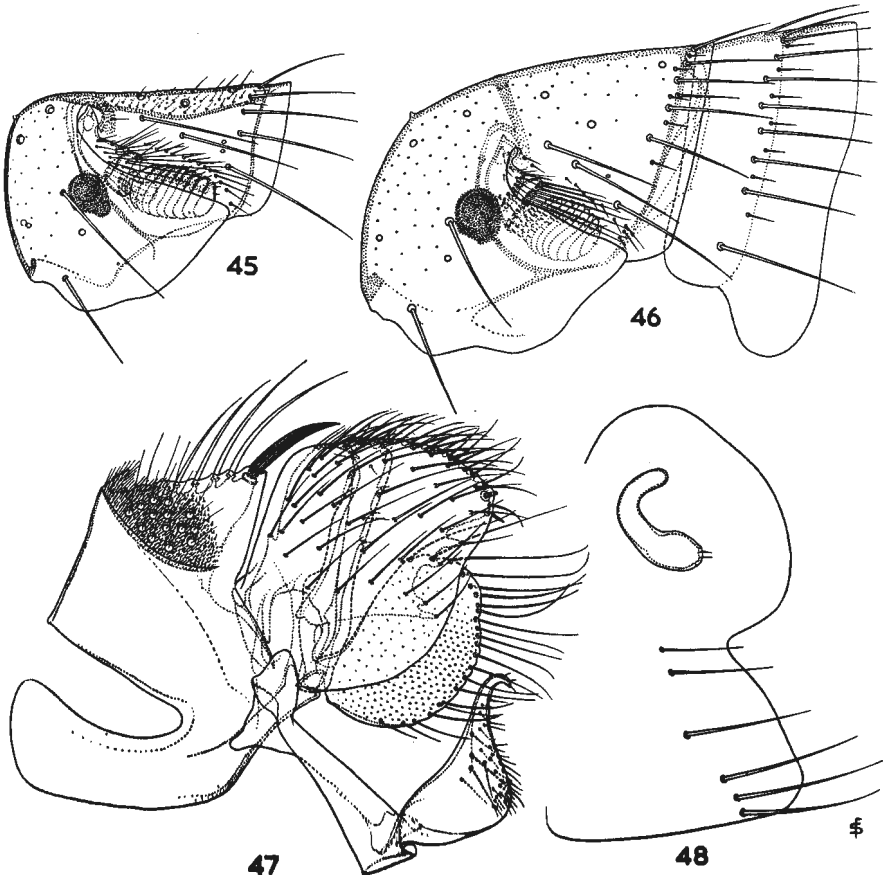
Genus *Ornithopsylla* Rothschild

Confined to the British Isles, monotypic ; on sea-birds living in burrows in sandy soil on islands off the coast of the two main islands.

♂ clasper with three processes, of which two large and bearing long setae and one long and narrow with an upturned apex and only a few minute setae (fig. 47) ; distal arm of sternum IX gradually widening, but apically tapering to a small downward-curved hook, with many setae on the distal half of the expanded portion (fig. 47). ♀ posterior margin of sternum VII with a lateral sinus ; bulga of spermatheca pyriform, longer than wide, gradually merging into the slender and curved hilla (fig. 48). Length : ♂ 2-2.75 mm., ♀ 2.5-3.5 mm.

laetitiae Rothschild

The true host is probably the Manx shearwater (*Puffinus puffinus*), but in several instances the flea has also been found in association with the puffin (*Fratercula arctica*) ; both birds often make use of the same burrow and since they appear to have similar nesting habits (although the puffin uses hardly any nesting material) it might be that both birds are true hosts of this flea. It is also recorded from the storm petrel (*Hydrobates pelagicus*). Only known from isles west of the coast of England and Wales, and off the Irish coast : Scilly Isles, Skokholm, Skomer, Bardsey, Great Skellig Rock and Ireland's Eye.



FIGS. 45-48.—*Ornithopsylla laetitiae*. 45, Head, ♂ ; 46, Head and pronotum, ♀ ; 47, Clasper and sternum IX ; 48, Sternum VII and spermatheca.

Superfamily CERATOPHYLLOIDEA

Family HYSTRICHOPSYLLIDAE

Parasites of insectivores and rodents.

KEY TO SUBFAMILIES

- 1 Antennal club consisting of 7 or 8 segments (fig. 58). Pleural ridge of metathorax either interrupted or very short (fig. 59). Striarium, if present, on metepimeron (fig. 59).....RHADINOPSYLLINAE (p. 33)
- Antennal club of 9 segments. Pleural ridge of metathorax normally developed...2
- 2 Last segment of all tarsi with 5 pairs of lateral plantar setae. Female (of species occurring in Britain) with two spermathecae.....HYSTRICHOPSYLLINAE (p. 30)
- Last segment of all tarsi with 4 pairs of lateral plantar setae and one pair of basal plantar setae in between the members of the first lateral pair, or with only 4 lateral pairs (in the last hind tarsal segment of nearly all European *Ctenophthalmus* only 3, but with a pair of plantar setae in between the first pair of laterals). Female with one spermatheca.....CTENOPHTHALMINAE (p. 35)

Subfamily HYSTRICHOPSYLLINAE

KEY TO GENERA

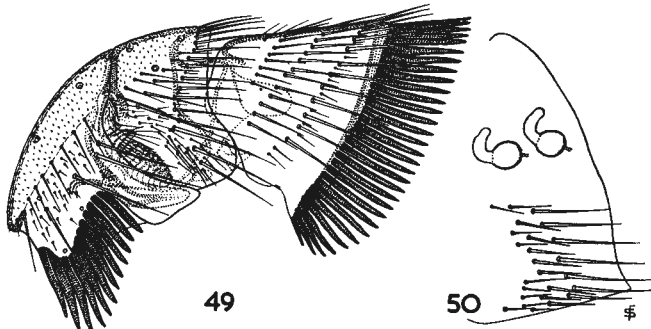
- 1 Genal comb consisting of more than 5 long spines; eye vestigial (fig. 49). Terga II-IV with well developed combs. Very large fleas
Hystrichopsylla Taschenberg (p. 30)
- Genal comb of 4 relatively short and blunt spines; eye fairly large (fig. 52). Terga II-V with spinelets only. Medium-sized fleas...*Typhloceras* Wagner (p. 32)

Genus *Hystrichopsylla* Taschenberg

Most of the twelve known species of this Holarctic genus, which are all very large fleas, are not strongly associated with a particular host (occurring on insectivores as well as on rodents). Only one subspecies is found in Western Europe.

Subgenus *Hystrichopsylla* s. str.

The genal comb consists of 9-11 spines in the male, 10-12 in the female; the pronotal comb of 42-52 spines in the male, 45-58 in the female (fig. 49). Terga II-IV each with a comb, those on terga III and IV are dorsally not continuous. ♂ normally with 3 antesensilial setae each side (sometimes 2 or 4). Fixed process of the clasper with 2-5 small spiniform setae; movable process basally more or less fused with the body of the clasper (fig. 51). ♀ normally with 4 antesensilial setae each side (sometimes 3 or 5). Posterior margin of sternum VII somewhat



FIGS. 49, 50.—*Hystrichopsylla talpae talpae*. 49, Head and pronotum, ♀; 50, Sternum VII and spermathecae.

undulate; the two spermathecae are alike (fig. 50). Length: ♂ 3.5-5 mm., ♀ 4-6 mm.....*talpae talpae* (Curtis).

Common (but not found in large numbers, either on the hosts or in their nests) throughout Great Britain, on the mole (*Talpa europaea*), bank vole (*Clethrionomys glareolus*) and common shrew (*Sorex araneus*); less frequently on the wood-mouse (*Apodemus sylvaticus*) and *Microtus*. It is difficult to determine which is the principal host of this large flea. It occurs commonly on the mole (especially in its nest), but is also regularly found on voles and the common shrew; in Ireland, where the mole, common shrew and voles are absent, it occurs on the woodmouse; this may indicate that originally this flea was associated with *Apodemus* or its ancestors. Jersey, Guernsey, Holland, Belgium, Luxemburg, France, western and southern Germany, western Poland, parts of Switzerland, Austria and Czechoslovakia. Replaced by *H. talpae orientalis* Smit in Denmark, Norway, eastern Germany, Poland, Czechoslovakia, Hungary, northern Italy, parts of Switzerland and Austria, Bulgaria, Turkey, and extending eastward to the Krasnoyarsk region of the U.S.S.R. and south to the Altai, Tian-Shan and Caucasus mountains.

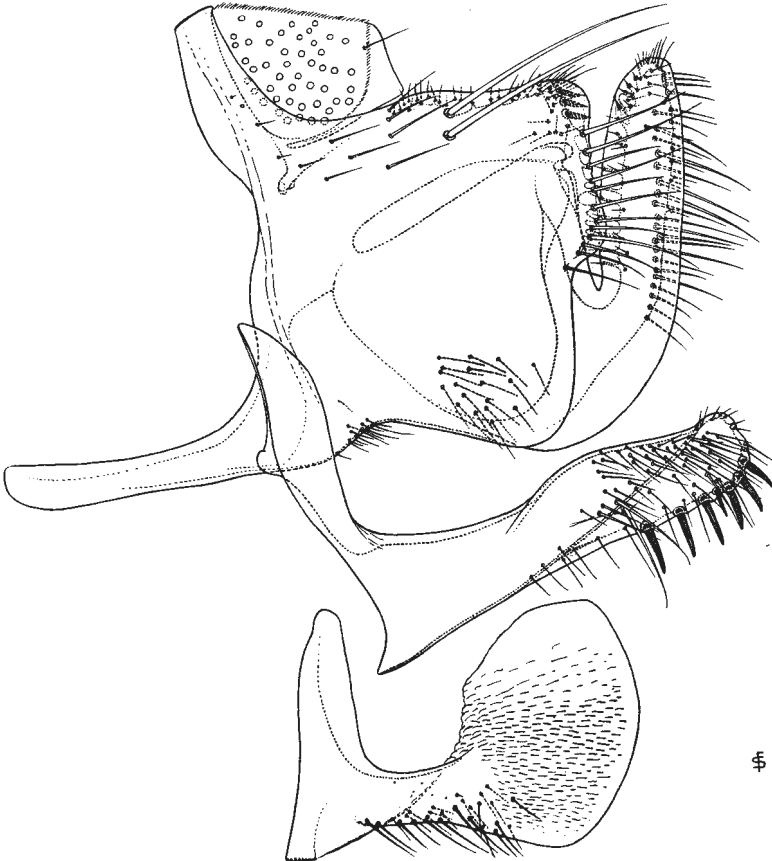


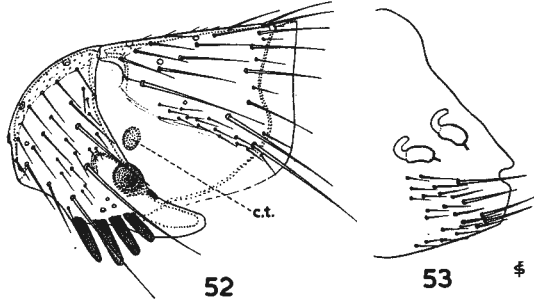
FIG. 51.—*Hystrichopsylla talpae talpae*. Clasper, sterna IX and VIII.

Genus *Typhloceras* Wagner

Palearctic; one of the two species of this genus occurs in the British Isles. Parasites of *Apodemus*.

♂ posterior margin of sternum VIII divided into two lobes by a sinus. Movable process of the clasper long and narrow, almost straight (fig. 54). ♀ sternum VII with a small and shallow sinus; the two spermathecae alike (fig. 53). Length: ♂ 2.25–2.75 mm., ♀ 2.5–3.5 mm. *poppei* Wagner

Throughout the British Isles, monoxenous on the wood-mouse (*Apodemus sylvaticus*); fairly common, but far less often met with than are other species of mousefleas. Jersey, Holland, Belgium, France, Switzerland, Germany, Denmark, Yugoslavia, Czechoslovakia, Poland, Greece and Algeria.



FIGS. 52, 53.—*Typhloceras poppei*. 52, Head, ♂ (antenna omitted); 53, Sternum VII and spermathecae.

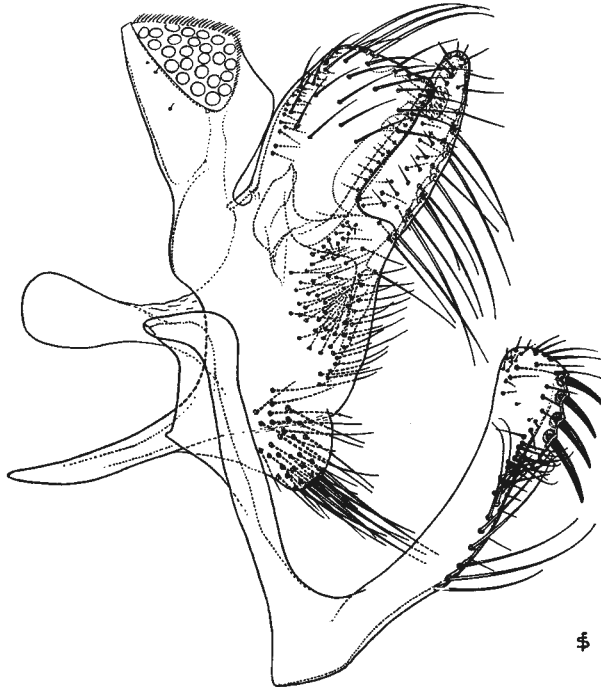


FIG. 54.—*Typhloceras poppei*. Clasper and sternum IX.

Subfamily RHADINOPSYLLINAE

Genus *Rhadinopsylla* Jordan and Rothschild

Males without antesensilial setae, while females generally have two such setae each side. Holarctic; with about fifty species and subspecies. The members of this genus are nest fleas and are therefore infrequently met with on the actual hosts, which are chiefly rodents. The adults of the majority of the species are found chiefly in the winter.

Subgenus *Actenophthalmus* C. Fox

(= *Rectofrontia* Wagner)

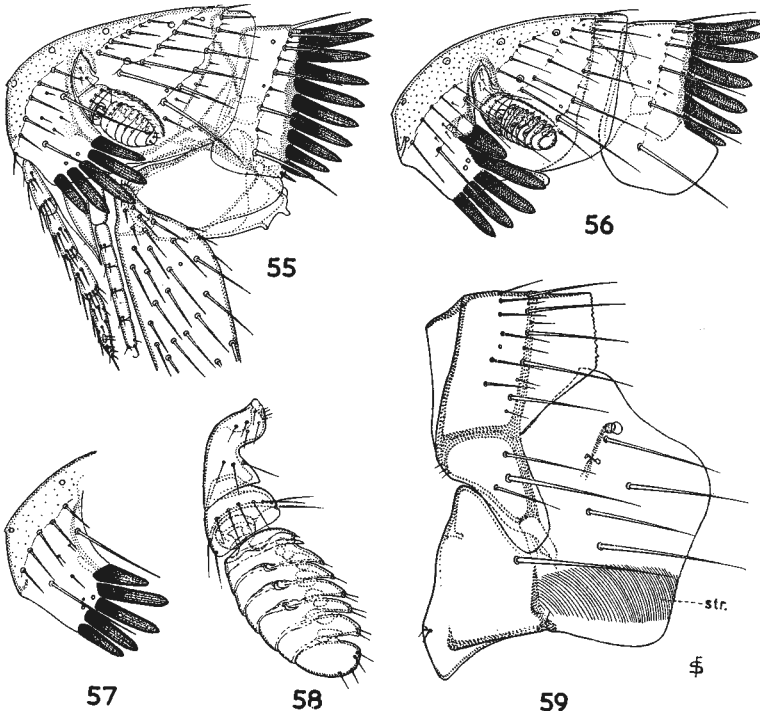
KEY TO SPECIES

- 1 Pronotal comb consisting of 14 spines. Uppermost of the 5 genal spines much shorter and broader than the lower ones (fig. 56). ♂ distal arm of sternum IX with a large number of slender setae (fig. 60); clasper as in fig. 60. ♀ posterior margin of tergum VII below the antesensilial setae concave; sternum VII with a fairly deep sinus (fig. 61). Length: ♂ 1.75–2.25 mm., ♀ 2–2.75 mm.

pentacantha (Rothschild)

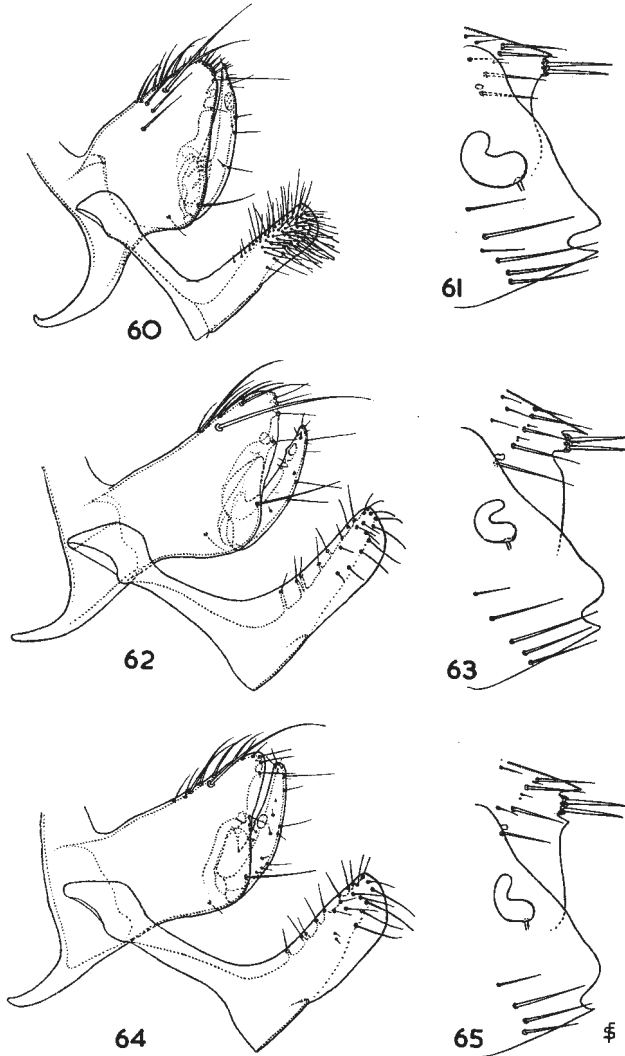
Fairly common throughout the British Isles on voles (*Clethrionomys*, *Microtus*) and the wood-mouse (*Apodemus sylvaticus*), less frequent and doubtless accidental on the mole (*Talpa europaea*); in Ireland recorded from the wood-mouse. Jersey, Guernsey, Holland, Germany, Denmark, Belgium, France, Spain, Austria, Poland and Czechoslovakia.

- Pronotal comb normally with 20–22 spines.....2



FIGS. 55-59. 55. *Rhadinopsylla isacantha*. Head, prothorax and fore coxa, ♀. 56. *Rhadinopsylla pentacantha*. Head and pronotum, ♀. 57. *Rhadinopsylla integella*. Pronotal part of head, ♀. 58. *Rhadinopsylla pentacantha*. Antenna, ♀. 59. *Rhadinopsylla pentacantha*. Metathorax, ♂.

- 2 Uppermost spine of the genal comb of about the same width basally as the lower ones (fig. 55). ♂ apex of movable process of the clasper not reaching to the apex of the fixed process, the small circular depression of this process not far from the apex (fig. 62). ♀ posterior margin of tergum VII convex below the antesensorial setae, which stand on a distinct pedestal; sternum VII with a sinus (fig. 63). Length: ♂ 2-2.25 mm., ♀ 2-2.5 mm. *isacantha* (Rothschild)



FIGS. 60-65.—60, 61. *Rhadinopsylla pentacantha*. 60, Clasper and sternum IX; 61, Tergum VII, sternum VII and spermatheca. 62, 63. *Rhadinopsylla isacantha*. 62, Clasper and sternum IX; 63, Tergum VII, sternum VII and spermatheca. 64, 65. *Rhadinopsylla integella*. 64, Clasper and sternum IX; 65, Tergum VII, sternum VII and spermatheca.

Rare, only known from England (Berkshire, Buckinghamshire, Hampshire and Surrey), although its true host, the bank vole (*Clethrionomys glareolus*), occurs throughout Great Britain; once taken from a mole. A winter flea. Holland, Belgium, France, Italy (?), Germany, Czechoslovakia and Finland (?).

- Uppermost spine of genal comb basally distinctly broader than the lower ones (fig. 57). ♂ apex of movable process of the clasper almost reaching to the apex of the fixed process, the small circular depression situated in the middle of the movable process (fig. 64). ♀ posterior margin of tergum VII forming a short triangular lobe immediately below the antensensillar setae, the rest of the margin is slightly concave or practically straight; sternum VII with a small, rather variable sinus (fig. 65). Length: ♂ 1.5-2 mm., ♀ 2-2.5 mm.

(= *casta* (Jordan)) **integella** Jordan and Rothschild

Hitherto only known from Scotland (Argyllshire, Angus and Perthshire) and its distribution may well be confined to the Highlands; a winter parasite of voles (in Scotland found on *Clethrionomys glareolus* and *Microtus agrestis*). Germany, Norway, Sweden, S.E. France, Switzerland, Austria, northern Italy, Hungary, Czechoslovakia, Poland and in many forest districts of the European parts of the U.S.S.R., beyond the Ural Mts. and in western Siberia. A closely related species, *R. fraterna* (Baker), occurs in North America.

Subfamily CTENOPHTHALMINAE

KEY TO GENERA

- 1 Genal comb consisting of 3 straight and pointed spines, placed close together and directed backwards (fig. 78). Labial palp with 5 segments. Last segment of fore and mid tarsi with 4 pairs of lateral plantar setae, that of the hind tarsus with 3 but with a pair of basal plantar setae in between the members of the first lateral pair. **Ctenophthalmus** Kolenati (p. 38)
- Genal comb consisting of 4 spines. Last segment of all tarsi with 4 pairs of lateral plantar setae and a pair of basal plantar setae in between the members of first lateral pair. 2
- 2 Genal comb horizontal, the spines of subequal size and the posterior spine is curved upwards and covers part of the narrow genal process (fig. 66). Labial palp with 4 segments. **Doratopsylla** Jordan and Rothschild (p. 35)
- Genal comb vertical, the second spine from above is the longest and most sharply pointed of the four (fig. 69-71). Labial palp with 5 segments
Palaeopsylla Wagner (p. 36)

Genus **Doratopsylla** Jordan and Rothschild

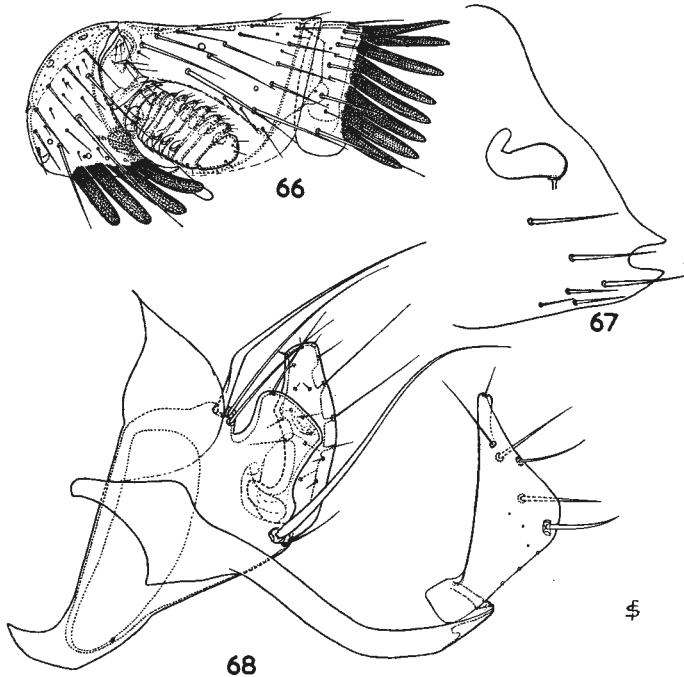
Holarctic, with five species and subspecies; parasites of shrews (Soricidae).

Pronotal comb in both sexes consisting of 16 long spines (fig. 66). ♂ fixed process of the clasper divided into two lobes, the upper of which is very short and blunt, bearing 3 setae of which the uppermost is flattened, lanceolate and twisted; the lower lobe roughly quadrate, bearing one strong acetabular seta (fig. 68); movable process only very slightly curved, its anterior margin with a short projection in the middle (fig. 68). ♀ sternum VII with a distinct sinus near the ventral margin; bulga of spermatheca clearly differentiated from the shorter hilla (fig. 67). Length: ♂ 1.5-2 mm., ♀ 1.75-2.5 mm.

dasyacnema dasyacnema (Rothschild)

Common throughout Great Britain on shrews, especially the common shrew (*Sorex araneus*); not recorded from Ireland, where only the pygmy shrew (*Sorex minutus*) occurs, but this shrew flea may yet be found there. The preponderance of males on the hosts is striking: on an average one finds nearly twice as many males as females of this flea (the sex-ratio of this species in the nests of the hosts is not known). Hol-

land, Belgium, France, Switzerland, Denmark, Germany, Austria, Czechoslovakia, Poland, Yugoslavia, Bulgaria, Finland, European U.S.S.R. and east to the West Siberian plain. Replaced by subspecies *D. d. euspis* Jordan and Rothschild in southern Switzerland, northern Italy, south-east Czechoslovakia and Hungary.



Figs. 66-68.—*Doratopsylla dasyncnema dasyncnema*. 66, Head and pronotum, ♂; 67, Sternum VII and spermatheca; 68, Clasper and sternum IX.

Genus *Palaeopsylla* Wagner

With sixteen species and subspecies in the Palaearctic Region and three species in the Oriental Region; parasites of insectivores (moles and shrews).

KEY TO SPECIES

- 1 Second genal spine from above narrowing suddenly beyond its middle; internal marginal incassation of frons very narrow; pronotal comb of 18 blunt spines which are distinctly curved (fig. 71, cf. fig. 69). ♂ movable process of the clasper a little curved upwards, with a blunt apex; proximal arm of sternum IX with a widened knee-shaped part (fig. 72). ♀ posterior margin of sternum VII divided by a large sinus into a broad upper and a pointed and more projecting lower lobe (fig. 73). Length: ♂ 1.5-2 mm., ♀ 1.75-2.25 mm.

soricis soricis (Dale)

Very common throughout Great Britain on shrews, especially on the common shrew (*Sorex araneus*); in Ireland on the pygmy shrew (*Sorex minutus*—the

only shrew occurring there). Holland, Belgium, France, Switzerland, Germany, Denmark, Finland, Poland, Czechoslovakia, Yugoslavia, Austria, in the U.S.S.R. occurring to Tian-Shan, Altai Mts. and western Transbaikalia. *P. s. gromovi* Argyropulo occurs in north-west Caucasus (*P. s. starki* Wagner, from the Bryansk Region in the U.S.S.R. appears to be a synonym of the nominate subspecies).

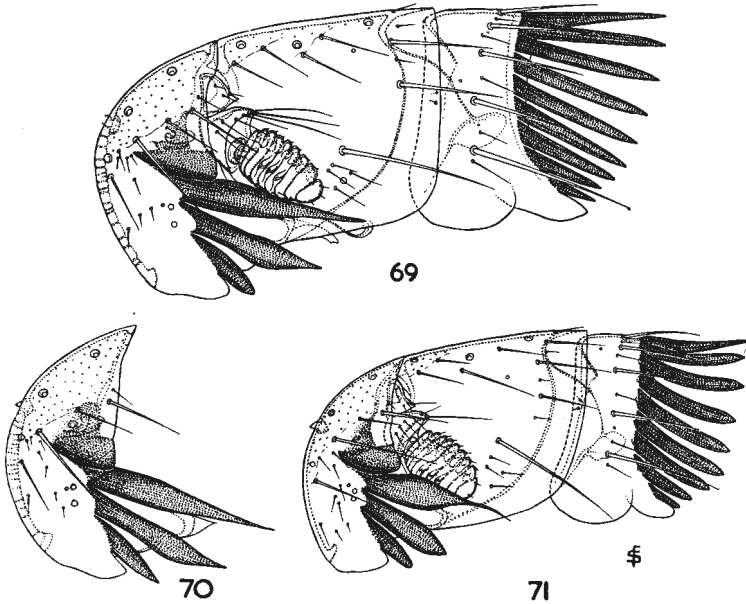
Second gonial spine from above tapering gradually; internal marginal incassation of frons broader (figs. 69, 70); pronotal comb with 18 straight and sharply pointed spines (fig. 69).....2

- 2 ♂ movable process of the clasper rather strongly bent upwards, with a truncate apex; proximal arm of sternum IX with a rounded widened part (fig. 76). ♀ posterior margin of sternum VII with a small but distinct sinus below its dorsal angle, the lobe above the sinus small and rounded, the margin below the sinus slightly concave or straight (fig. 77). Length: ♂ 1.75–2.25 mm., ♀ 2–2.75 mm. (= *gracilis* (Taschenberg)) (= *minor cornubiensis* Turk.).... **minor minor** (Dale)

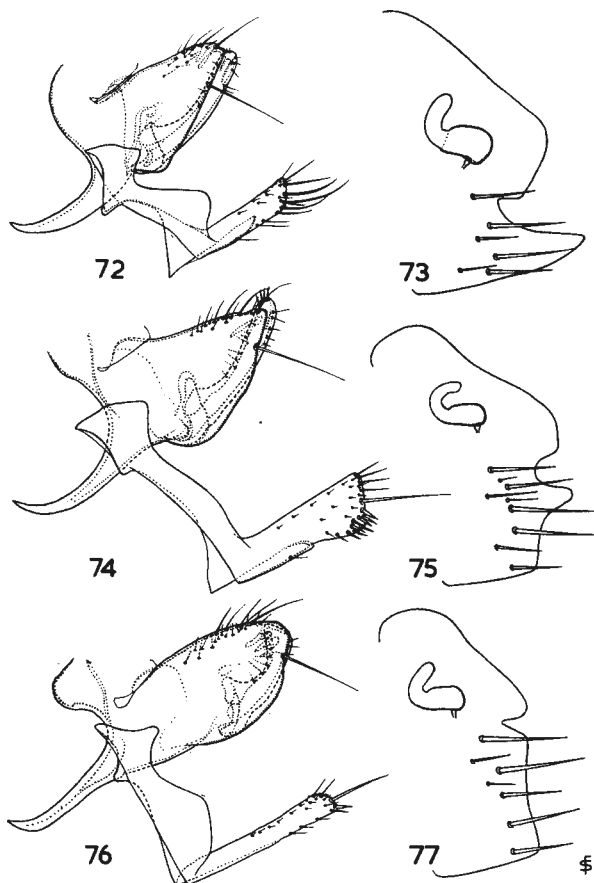
Very common throughout Great Britain, monoxenous on the mole (*Talpa europaea*—absent from Ireland). Jersey, Holland, Belgium, France, Spain, Germany, Switzerland, Czechoslovakia and Finland. One other subspecies is known, *P. m. alpestris* Argyropulo, from north-west Caucasus.

- ♂ movable process of the clasper long and almost straight, with a rounded apex; proximal arm of sternum IX not widened, with subparallel margins; distal arm of sternum IX gradually widening towards its apex, which bears a number of small spiniform setae at its ventro-apical margin (fig. 74). ♀ posterior margin of sternum VII with a rather small lobe midway between its dorsal and ventral angle (fig. 75). Length: ♂ 2–2.5 mm., ♀ 2.25–3 mm..... **kohauti** Dampf

Rather rare in England, but apparently somewhat less so in Scotland; monoxenous on the mole (*Talpa europaea*—absent from Ireland). Denmark, Germany, Austria, Yugoslavia, Czechoslovakia, Poland and European U.S.S.R.



FIGS. 69–71.—69. *Palaeopsylla minor minor*. Head and pronotum, ♀. 70. *Palaeopsylla kohauti*. Preantennal part of head, ♀. 71. *Palaeopsylla soricis soricis*. Head and pronotum, ♀.



FIGS. 72-77.—72, 73.—*Palaeopsylla soricis soricis*. 72, Clasper and sternum IX; 73, Sternum VII and spermatheca. 74, 75. *Palaeopsylla kohauti*. 74, Clasper and sternum IX; 75, Sternum VII and spermatheca. 76, 77. *Palaeopsylla minor minor*. 76, Clasper and sternum IX; 77, Sternum VII and spermatheca.

Genus *Ctenophthalmus* Kolenati

Holarctic and Ethiopian Regions, with about 140 species and subspecies (the largest genus of fleas); mostly parasites of rodents.

KEY TO SUBGENERA

1 Spiracular fossa of tergum VIII Y-shaped (figs. 80, 81)

***Ctenophthalmus* s. str.** (p. 39)

— Spiracular fossa of tergum VIII broad and with a convex outer margin (figs. 88, 89)

***Euctenophthalmus* Wagner** (p. 39)

Subgenus *Ctenophthalmus* s. str.

KEY TO SPECIES

- 1 ♂ fixed process of the clasper divided into two lobes separated by a very narrow sinus (fig. 85), the upper of these lobes broad, with a large number of slender setae and a rounded apex; the lower lobe large, trapezoidal, bearing one seta at its ventral margin and not extending beyond the tip of the upper lobe; movable process of the clasper with a broad, rounded apex (fig. 85). ♀ posterior margin of sternum VII with a very broad lobe (fig. 86*a-e*), and sometimes with a much smaller, but also broad, lobe below the large lateral one (fig. 86*f-h*). Length: ♂ 2-2.5 mm., ♀ 2.25-2.75 mm.. **bisocdentatus occidentalis** Smit

Common throughout Great Britain, monoxenous on the mole (Talpa europaea—absent from Ireland). Holland, Belgium, western and southern Germany. The nominate subspecies C. b. bisocdentatus Kolenati occurs in southern Sweden, Denmark, northern and eastern Germany, Poland, European U.S.S.R. (Leningrad Region), Finland, Czechoslovakia, Rumania, Yugoslavia, Austria, Switzerland, France and Jersey.

- ♂ upper lobe of fixed process of the clasper rather narrow, with only a few setae at the apex and the ventral margin; the sinus between the two lobes very distinct (figs. 82-84). Movable process with a rather narrow apex (fig. 82). ♀ posterior margin of sternum VII with a broad, rounded dorsal lobe, below which a small but long lobe (fig. 79).....2
- 2 ♂ lower lobe of the fixed process of the clasper without a deep sinus; at most a sinus is indicated and then the width of the part below it is usually greater than half the width of the lower lobe of the fixed process (figs. 82, 83). The females of this and of the following subspecies are indistinguishable (fig. 79). Length: ♂ 1.75-2 mm., ♀ 2-2.5 mm. (= *agyrtes nobilis* (Rothschild)) (= *agyrtes celticus* Jordan and Rothschild.) **nobilis nobilis** (Rothschild)

Concentrated in the south-east and east of England, but also occurring in coastal localities in south England, Wales, east Scotland and east and north-west Ireland. Also found in eastern France. Hosts: see under the following subspecies.

- ♂ lower lobe of the fixed process of the clasper with a marked sinus, the width of the lobe below the sinus being less than half the width of the lower lobe of the fixed process (fig. 84). Length: as in the nominate subspecies

nobilis vulgaris Smit

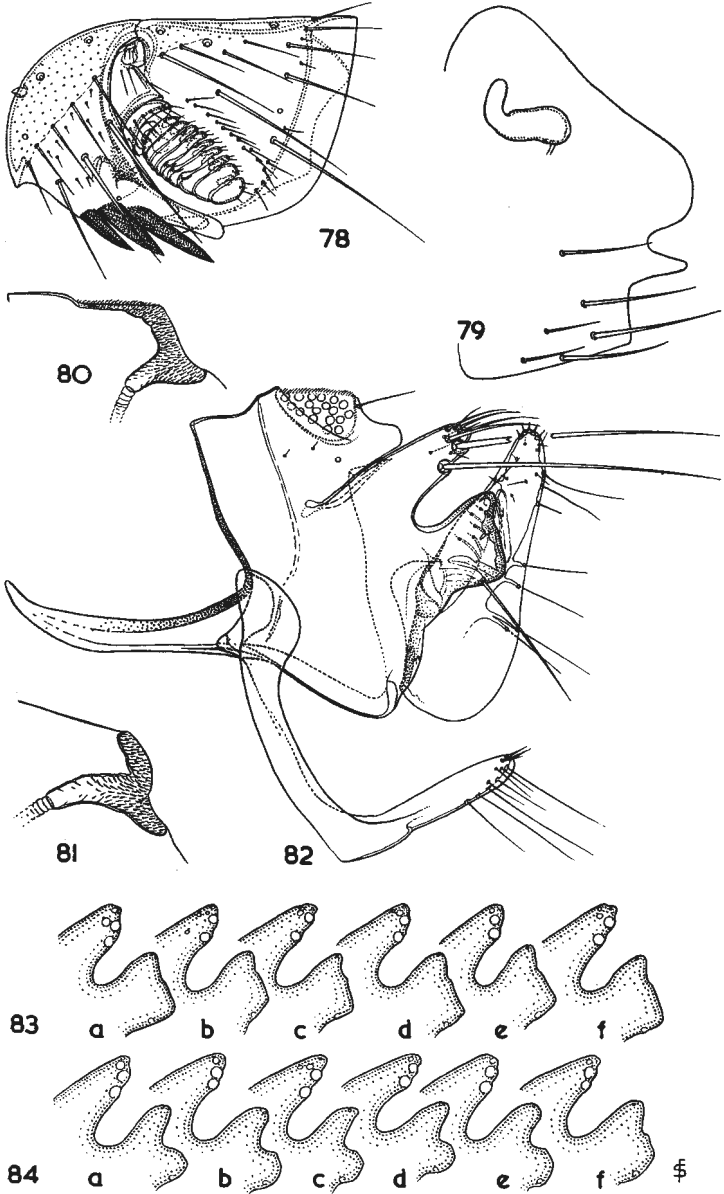
South-west, west and north-west England, Wales, Scotland (except in part of Aberdeenshire where C. n. nobilis occurs), Orkneys, Fair Isle, Hebrides, north-west Ireland. Channel Isles and west and central France. Both subspecies form with the many subspecies of the continental Ctenophthalmus agyrtes a superspecies; everywhere they are the commonest fleas of small rodents and insectivores. A principal host cannot easily be given for these fleas (though there are indications that they were originally parasites of Apodemus or its ancestors); they appear to be commonest on wood-mice (Apodemus) and voles (Microtinae), but not much less common on the mole and they are also regularly found on shrews.

Subgenus *Euctenophthalmus* Wagner

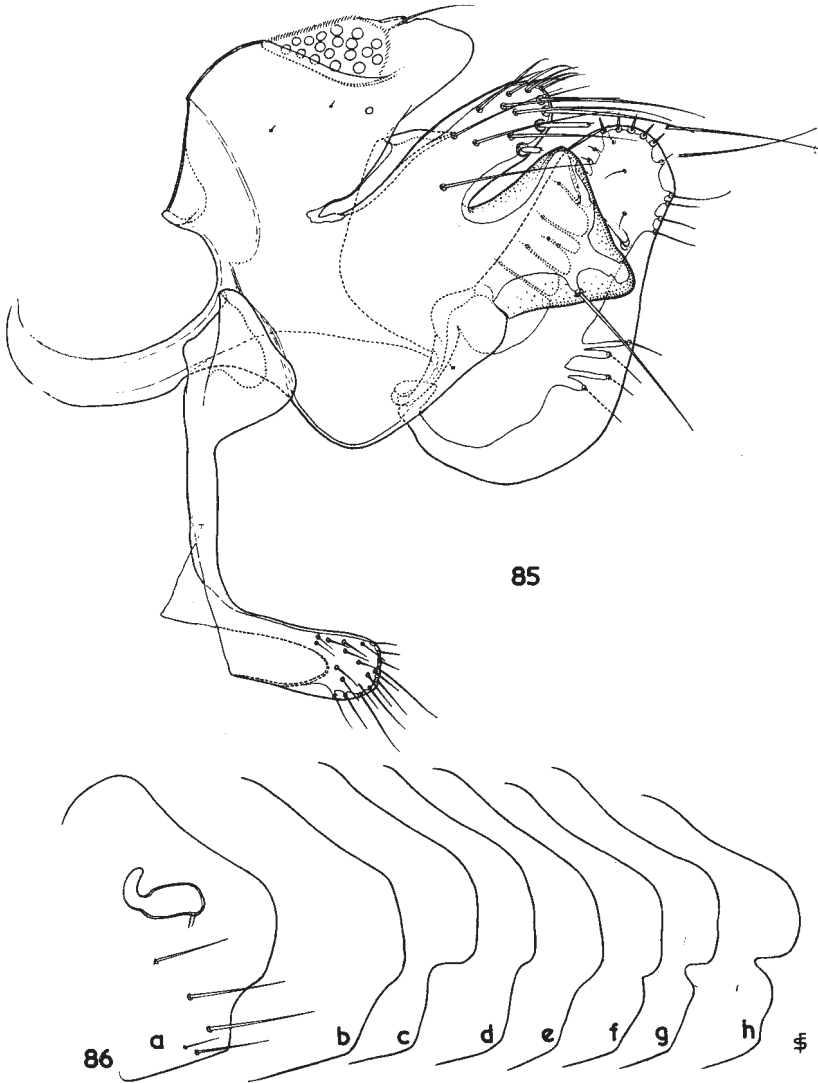
- ♂ basal part of the movable process narrow (fig. 87), the process resembling an axe. ♀ sternum VII with a small dorsal lobe above the sinus and a row of normally 4 setae with often a few additional setae in front of the most ventral of the four (fig. 89). Length: ♂ 1.5-2 mm., ♀ 1.75-2.25 mm.

congener congener (Rothschild)

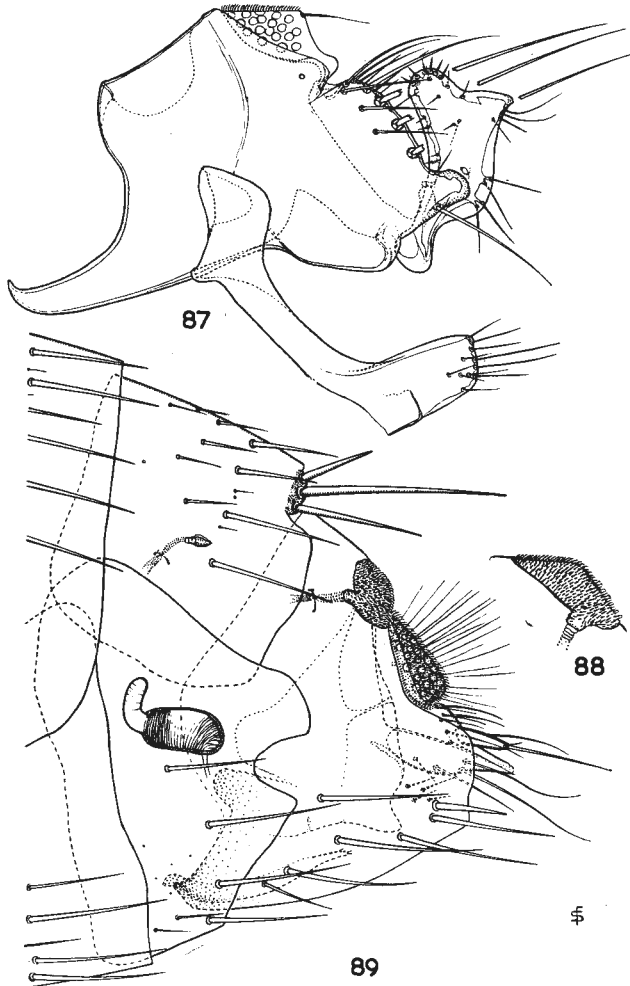
Only known from England (Hertfordshire and Sussex) and probably restricted to the south-east and east of England, although its host, the bank vole (Clethrionomys glareolus), occurs throughout Great Britain. Holland, Belgium, Luxemburg, France, Germany, Switzerland, Austria, Yugoslavia, Czechoslovakia and Poland. C. congener is a Eurasian species, divided into a number of subspecies.



FIGS. 78-84.—78-83.—*Ctenophthalmus nobilis nobilis*. 78, Head, ♂; 79, Sternum VII and spermatheca; 80, Spiracular fossa of tergum VIII, ♂; 81, Spiracular fossa of tergum VIII, ♀; 82, Clasper and sternum IX; 83 a-f, Fixed process of six claspers, to show variation. 84 a-f.—*Ctenophthalmus nobilis vulgaris*. Fixed process of six claspers, to show variation.



FIGS. 85, 86.—*Ctenophthalmus bisoctodentatus occidentalis*. 85, Clasper and sternum IX (the upper lobe of the fixed process is usually a little longer than in the specimen drawn); 86 a-h, Sternum VII and spermatheca, and the outline of seven sterna VII to show variation.



FIGS. 87-89.—*Ctenophthalmus congener congener*. 87, Clasper and sternum IX; 88, Spiracular fossa of tergum VIII, ♂; 89, Terminalia of female.

Family ISCHNOPSYLLIDAE

This family is parasitic exclusively on bats.

Subfamily ISCHNOPSYLLINAE

KEY TO GENERA

- 1 Tergum VII with a row of spiniform antesensillial setae which form a false comb (fig. 94). Head without a translucent submarginal band on its preantennal part; with a permanent frontal tubercle; stipes with a pointed apex; genal process with a broad rounded apex (figs. 90-92). With a comb on pronotum, metanotum and terga I and II, but combs of metanotum and of terga I and II reduced in a few species to 1-3 spinelets each side. ♂ body of the clasper with one acetabular seta. ♀ duct of spermatheca without a dilated part
Nycteridopsylla Oudemans (p. 49)
- Tergum VII with normal antesensillial setae (fig. 95). Head with a translucent submarginal band on its preantennal part; with a deciduous frontal tubercle; stipes with a truncate apex; genal process with a pointed apex (fig. 93). With a well-developed comb on pronotum, metanotum and on the first 4 or 6 terga. ♂ body of the clasper with two acetabular setae. ♀ duct of spermatheca partly dilated.....**Ischnopsyllus** Westwood (p. 43)

Genus **Ischnopsyllus** Westwood

Associated with the bat-family Vespertilionidae, subfamily Vespertilioninae.

KEY TO SUBGENERA

- 1 With 6 combs on thorax and abdomen together (on pronotum, metanotum and terga I-IV).....**Hexactenopsylla** Oudemans (p. 43)
- With 8 combs on thorax and abdomen together (on pronotum, metanotum and terga I-VI).....**Ischnopsyllus** s. str. (p. 43)

Subgenus **Hexactenopsylla** Oudemans

With three species in the Palaearctic Region, one in the Oriental Region, and one species occurring in both Regions.

♂ movable process of the clasper resembling an inverted boot (fig. 99). ♀ sternum VII without a sinus; spermatheca with a large bulga which is about as long as its hilla (fig. 98). Length: ♂ 2-2.5 mm., ♀ 2.25-2.75 mm.

hexactenus (Kolenati)

Common on its principal hosts, the long-eared bat (Plecotus auritus), which occurs throughout the British Isles (though less common in the Scottish Highlands) and the barbastelle (Barbastella barbastellus), which has only been found in England and Wales; there are no Scottish records yet of this flea. Sometimes accidentally on species of Myotis. Holland, Germany, Denmark, Belgium, France, Switzerland, Austria, Italy, Hungary, Poland, Czechoslovakia, Yugoslavia and in the U.S.S.R. east to Transbaikalia inclusive.

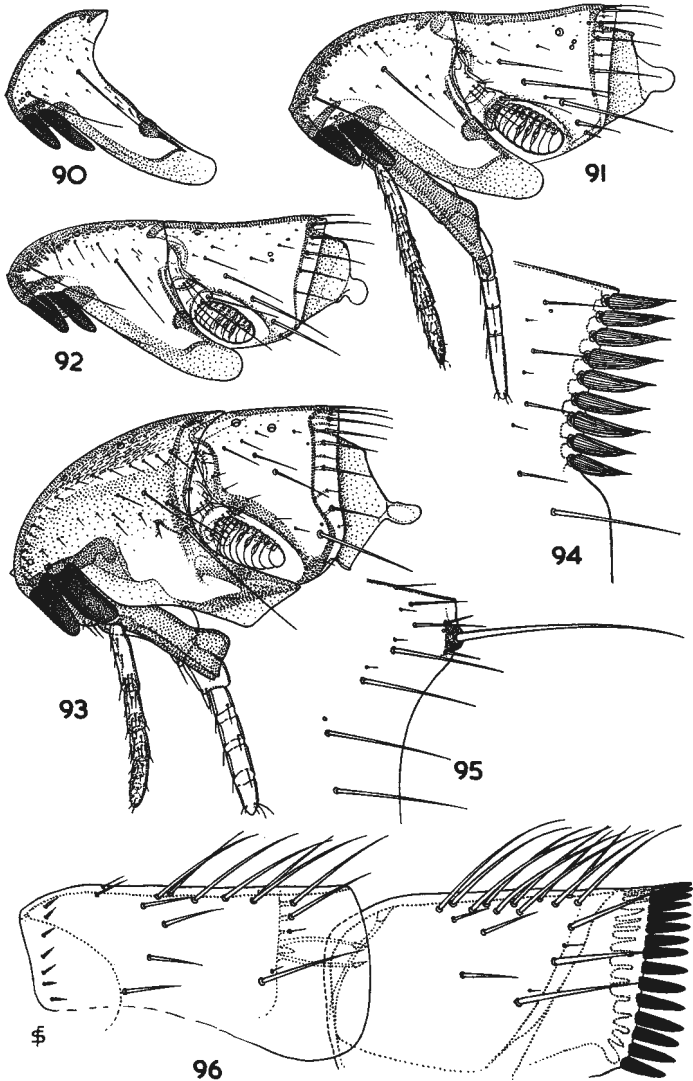
Subgenus **Ischnopsyllus** s. str.

With thirteen species and subspecies in the Palaearctic Region and one species in the Ethiopian Region.

KEY TO SPECIES

Males

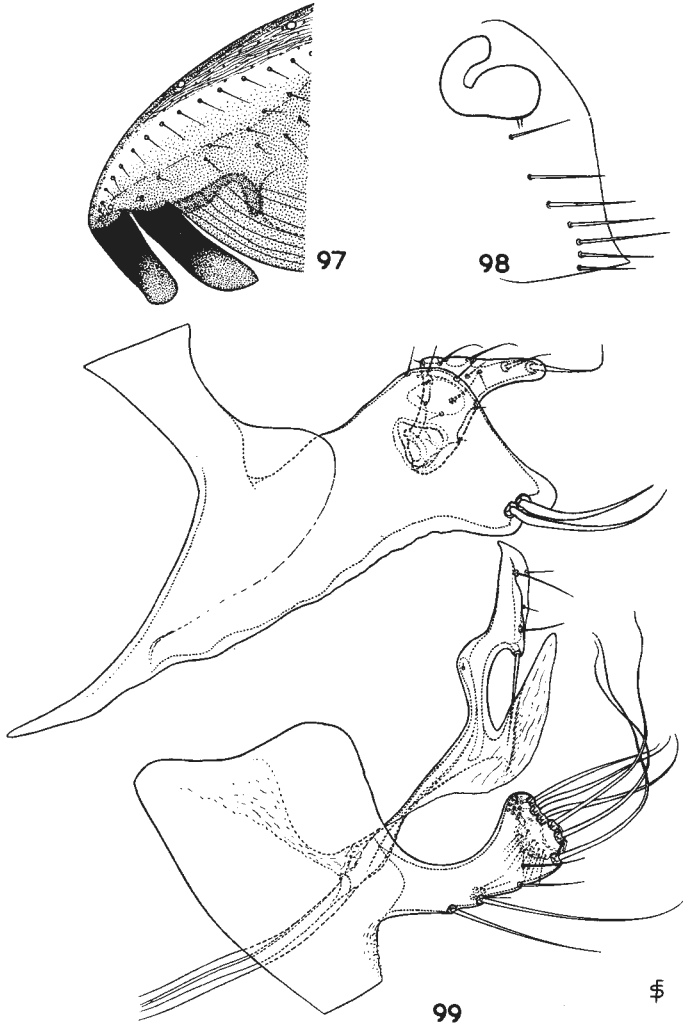
- 1 Mesonotum and metanotum each with a variable number of fairly long and semi-erect dorsal setae (fig. 96).....2
- Mesonotum and metanotum without such semi-erect setae.....3



FIGS. 90-96.—90, 91.—*Nycteridopsylla eusarca*. 90, Preantennal part of head, ♂; 91, Head, ♀. 92, *Nycteridopsylla longiceps*. Head, ♀. 93, *Ischnopsyllus elongatus*. Head, ♀. 94, *Nycteridopsylla longiceps*. Antsensillial setae, ♀. 95, *Ischnopsyllus octactenus*. Antsensillial setae, ♀. 96, *Ischnopsyllus octactenus* Mesonotum and metanotum, ♂.

- 2 Comb of metanotum with about as many spines as that of tergum I. Movable process of the clasper roughly quadrate, with a posterior apical angle of about 90° (fig. 100). Length: 2.5-3 mm..... *intermedius* (Rothschild)

Common on its principal host, the serotine bat (*Eptesicus serotinus*), which is mainly found south of the Thames (the flea is known from this bat in Hampshire, Kent, Sussex and the Isle of Wight). This bat flea has also been collected north of the Thames (Cheshire, Essex, Suffolk and Yorkshire) from the noctule (*Nyctalus noctula*) and from Leisler's bat (*Nyctalus leisleri*) which agree in habits with the serotine bat in that they roost and hibernate principally in holes in trees. Holland, Germany, Denmark, Belgium, France, Spain, Switzerland, Austria, Italy, Czechoslovakia, Hungary, Rumania, Poland, Yugoslavia, Bulgaria, Greece, the Azores, European U.S.S.R., Caucasus, Ural Mts.



Figs. 97-99.—*Ischnopsyllus hexactenus*. 97, Anterior part of head, ♂; 98, Sternum VII and spermatheca; 99, Clasper, sternum IX and sternum VIII.

- Comb of metanotum with nearly twice as many spines as that of tergum I. Movable process of the clasper semilunar, with a rounded apical margin and only one apical angle (fig. 101). Length: 2.25-2.5 mm. *octactenus* (Kolenati)
- Common throughout the British Isles, as is its principal host, the pipistrelle (Pipistrellus pipistrellus); sometimes found on Leisler's bat (Nyctalus leisleri); neither of these bats hibernates in caves and since the flea does not normally occur on "cave-bats", the few records from Natterer's bat (Myotis nattereri) and the whiskered bat (Myotis mystacinus) may be considered as accidental occurrences or due to misidentification of the flea, the female of which was for long confused with I. simplex (a true parasite of these two Myotis spp.). Holland, Germany, Denmark, France, Switzerland, Spain, Italy, Austria, Czechoslovakia, Poland, Yugoslavia, Bulgaria, Greece, Morocco, southern European U.S.S.R., Caucasus and Central Asia.*
- 3 Sensilium without an oblong ventral process (fig. 102); dorsal margin of the body of the clasper with a long stout seta (fig. 102). Movable process of the clasper with a rounded posterior margin, with only one apical angle; apical margin of sternum VIII incurved below the apical hook and several of the long apical setae of this sternum are flattened (fig. 102). Length: 2-2.5 mm.
- simplex simplex Rothschild**

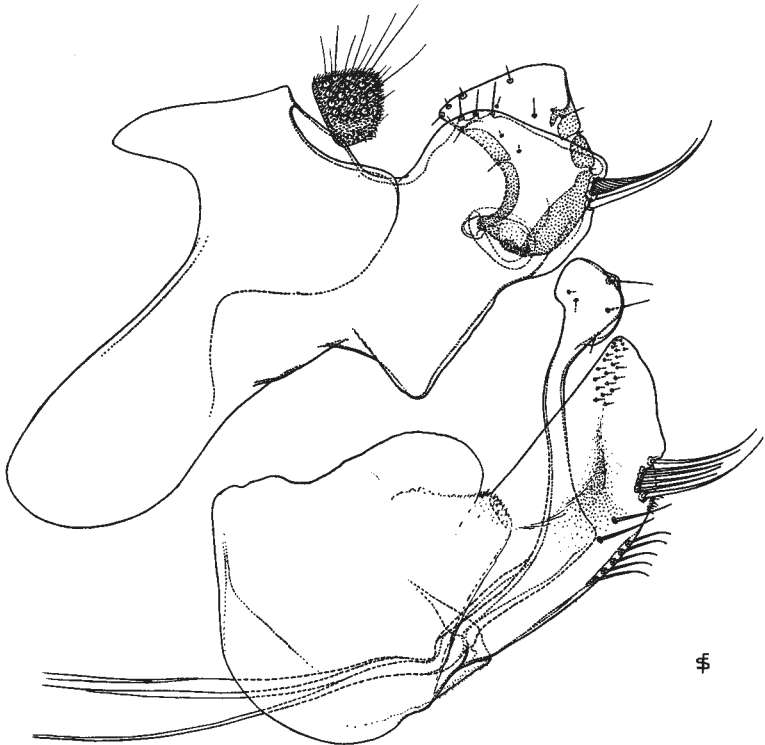


FIG. 100.—*Ischnopsyllus intermedius*. Clasper, sensilium, sternum IX and sternum VIII.

A common flea of the whiskered bat (*Myotis mystacinus*) and Natterer's bat (*Myotis nattereri*), both occurring in England, Wales and Ireland, but rarely in Scotland, hence this flea is not yet known from Scotland. The relatively few records of this bat-flea from the barbastelle (*Barbastella barbastellus*), Daubenton's bat (*Myotis daubentoni*), long-eared bat (*Plecotus auritus*) and both horseshoe bats (*Rhinolophus ferrumequinum* and *R. hipposideros*) are possibly cases of accidental infestation. Holland, Germany, Belgium, France, Switzerland, Czechoslovakia. *I. s. mysticus* Jordan has been found in Austria, Norway and Holland. Sensillum prolonged ventrally into a long and fairly broad, densely spiculate process (fig. 103). Dorsal margin of the body of the clasper without a long seta; movable process triangular, and its apical margin concave and both apical angles are sharp (fig. 103). Length: 2.75–3.5 mm.....*elongatus* (Curtis)

Common on its principal host, the noctule (*Nyctalus noctula*), which occurs only in England and Wales; the flea has only been found in England so far. Twice found on the serotine bat (*Eptesicus serotinus*) in Sussex; neither the noctule nor the serotine bat roosts or hibernates in caves. Holland, Germany, Denmark, Austria, Italy, Poland, Hungary, Yugoslavia, Czechoslovakia, Rumania, Bulgaria, European U.S.S.R., Caucasus, Central Asia and Japan.

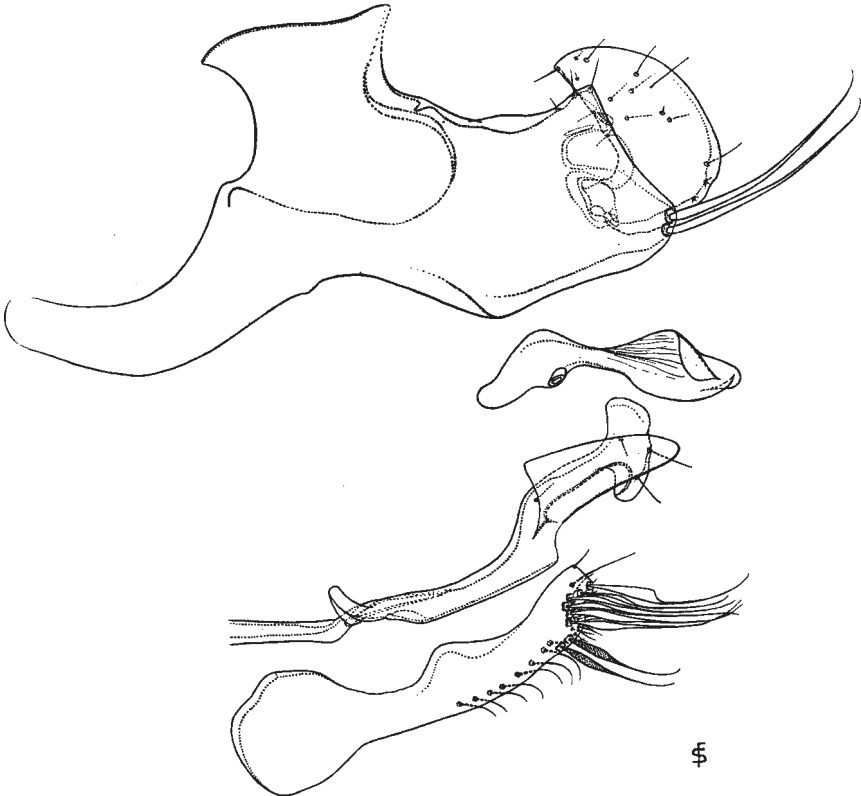


FIG. 101.—*Ischnopsyllus octactenus*. Clasper, aedeagal crochet, sternum IX and sternum VIII.

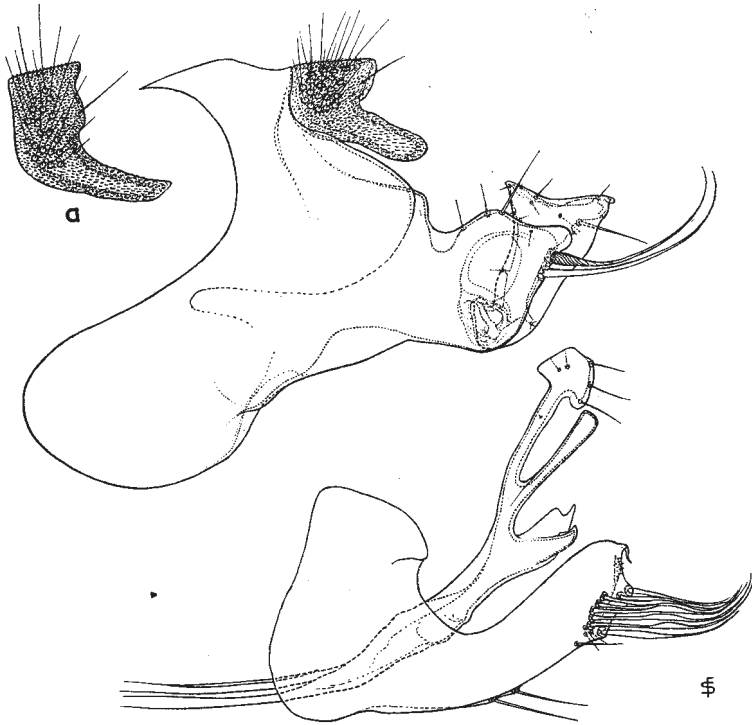


FIG. 103.—*Ischnopsyllus elongatus*. Clasper, sensillum (fig. 103a shows a fully flattened sensillum), sternum IX and sternum VIII.

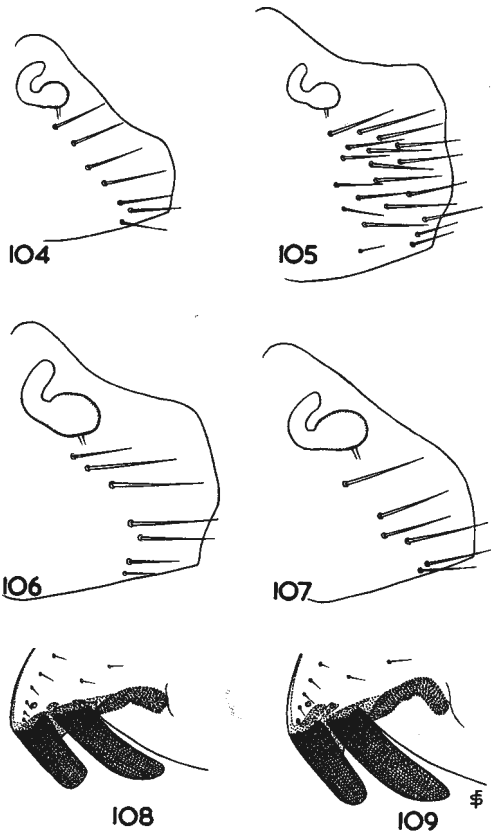
Genus *Nycteridopsylla* Oudemans

Holarctic, with twelve species; associated with the bat-family Vespertilionidae, subfamily Vespertilioninae, but usually not on bats which hibernate in caves.

KEY TO SPECIES

- 1 Frontal part of head long and narrow in both sexes; frontal tubercle inverted (i.e., with its point directed upwards, as in fig. 92). ♂ with 9 (sometimes 8 or 10) antesensillar setae each side; movable process of the clasper about twice as long as broad, with subparallel margins and an oblique blunt apex (fig. 110); the fixed process is rather variable in shape. ♀ with 8 (sometimes 9 or 10) antesensillar setae each side; sternum VII with one sinus (fig. 111). Length: ♂ 1.75–2.25 mm., ♀ 2–2.5 mm. *longiceps* Rothschild

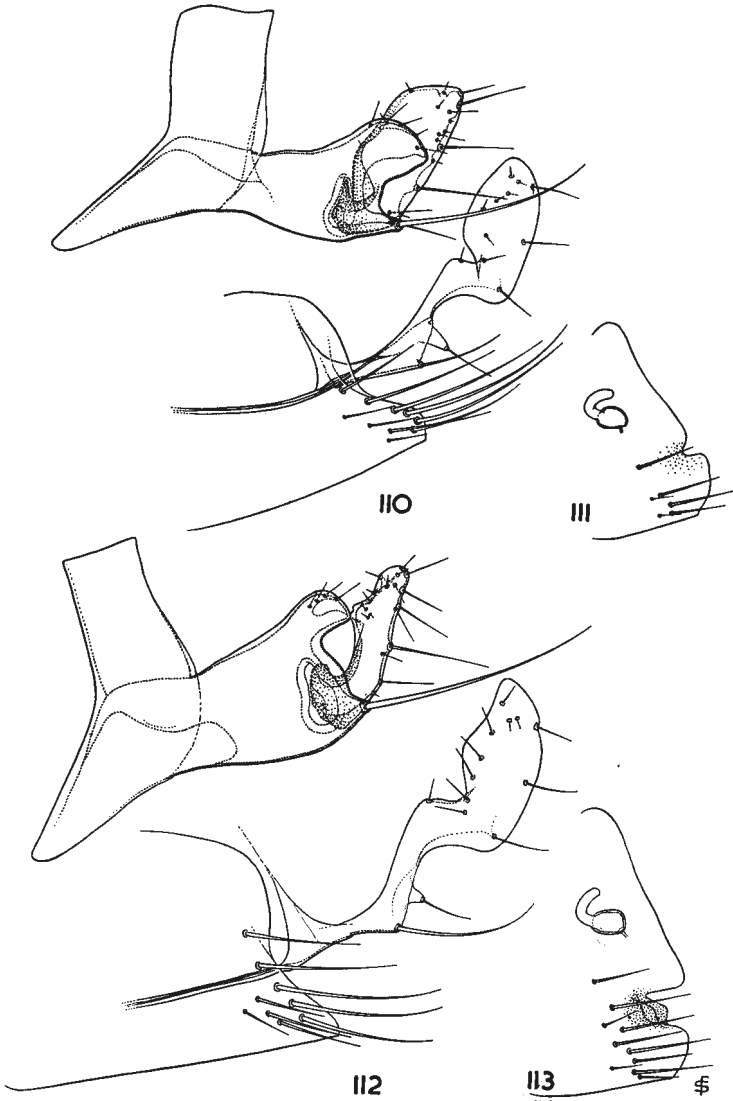
Occurs principally on the pipistrelle (*Pipistrellus pipistrellus*), which is common throughout the British Isles, but the long-eared bat (*Plecotus auritus*) also appears to be a suitable host. Not a very common flea, recorded only from the southern half of England and from Ireland. Holland, Germany, Denmark, Spain, Italy, Poland and Turkey.



FIGS. 104-109.—104-107.—Sternum VII and spermatheca of: 104. *Ischnopsyllus intermedius*. 105. *Ischnopsyllus elongatus*. 106. *Ischnopsyllus simplex simplex*. 107. *Ischnopsyllus octactenus*. 108, 109.—Preoral region of head of: 108. *Ischnopsyllus simplex simplex*, ♀. 109. *Ischnopsyllus octactenus*, ♀.

- Frontal part of head strongly sloping in the male (fig. 90), less so in the female (fig. 91); frontal tubercle triangular. ♂ with 7 (sometimes 6) antesensillar setae each side; movable process of the clasper 3-4 times as long as broad, its anterior margin angulate above the middle (fig. 112). ♀ with 8 (sometimes 6-9) antesensillar setae each side; sternum VII with a double sinus, the part adjoining the sinus is strongly sclerotised (fig. 113). Length: ♂ 1.75-2.25 mm., ♀ 2-3 mm. (= *eusarca major* Rothschild.) *eusarca* Dampf

The noctule (*Nyctalus noctula*), occurring in England and Wales only, is the true host of this rare bat-flea, which has only been found in Britain in Cambridgeshire and Kent. Holland, Denmark, Germany, Austria, Italy, Yugoslavia, Czechoslovakia, Poland, European U.S.S.R. (Stavropol, Caucasus).



Figs. 110-113.—110, 111.—*Nycteridopsylla longiceps*. 110, Clasper, sternum IX and sternum VIII; 111, Sternum VII and spermatheca. 112, 113.—*Nycteridopsylla eusarca*. 112, Clasper, sternum IX and sternum VIII; 113, Sternum VII and spermatheca.

Family LEPTOPSYLLIDAE

KEY TO SUBFAMILIES

- 1 Head fracticipit, with a vertical genal comb of 2 or 4 spines; eye vestigial (figs. 6, 116).....LEPTOPSYLLINAE (p. 52)
 - Head integricipit, without a genal comb; eye developed (fig. 120)
 AMPHIPSYLLINAE (p. 54)

Subfamily LEPTOPSYLLINAE

KEY TO GENERA

- 1 Genal comb consisting of 4 spines (fig. 6); central tuber present, situated in the head under the posterior portion of the pedicel (hence not shown in fig. 6) or a little further backwards.....**Leptopsylla** Jordan and Rothschild (p. 52)
 - Genal comb consisting of 2 spines (fig. 116); central tuber absent
Peromyscopsylla I. Fox (p. 53)

Genus **Leptopsylla** Jordan and Rothschild

Palearctic and Ethiopian Regions, with eighteen species and subspecies.
 Parasites of rodents, especially of the subfamily Murinae.

The vertical genal comb consists of 4 spines, while two of the setae near the frontal angle are spiniform (fig. 6). Male genitalia as in fig. 114. Sternum VII of female and spermatheca as shown in fig. 115. The tibiae bear at their dorso-posterior margin a row of spiniform setae, forming a false comb. Length: ♂ 1.5-2 mm., ♀ 2-2.5 mm.....**segnis** (Schönherr)

The common and cosmopolitan flea of the house-mouse (Mus musculus), occurring throughout the British Isles; in some parts of the world it also lives on rats. The wood-mouse (Apodemus sylvaticus) can act as a suitable temporary host when sharing territories of the house-mouse (houses and sheds) during the winter months.

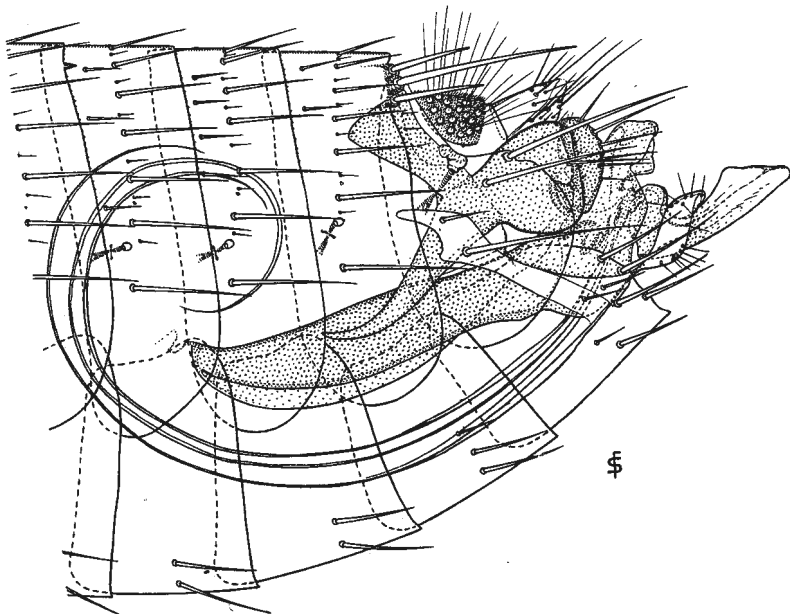


FIG. 114.—*Leptopsylla segnis*. Terminalia of male.

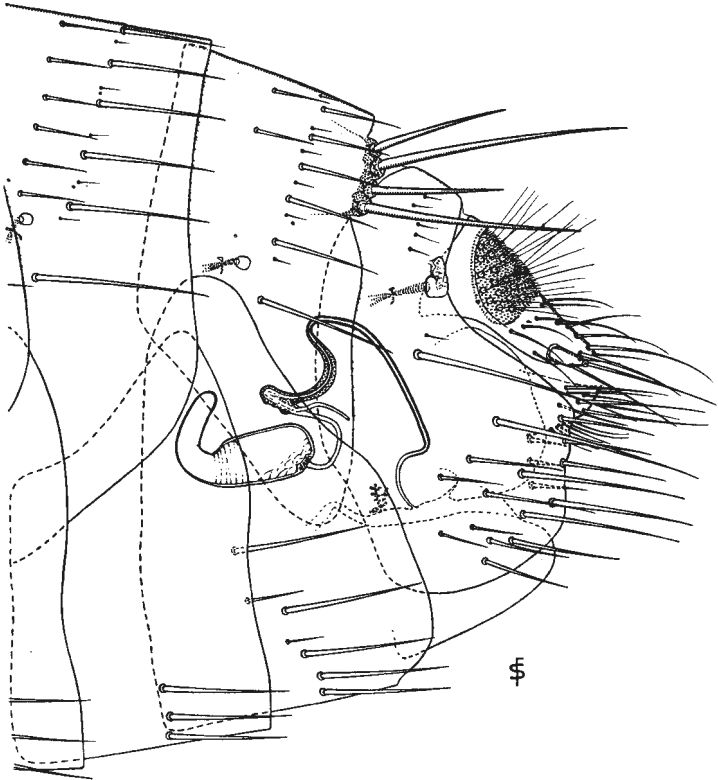
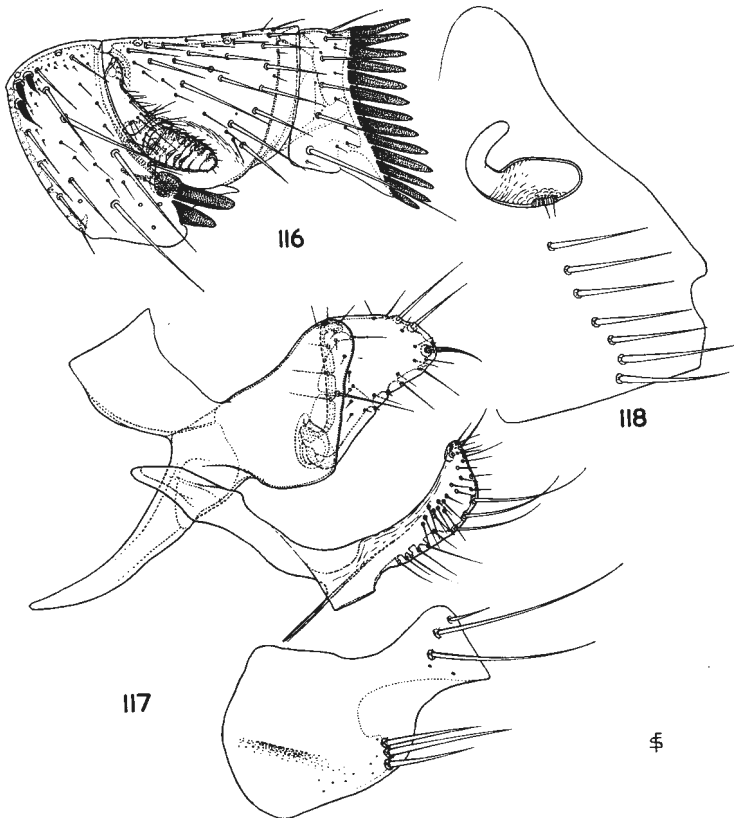


FIG. 115.—*Leptopsylla segnis*. Terminalia of female.

Genus *Peromyscopsylla* I. Fox

Holarctic, with twenty species and subspecies, of which one has spread into the Oriental Region. Closely related to *Leptopsylla*; parasitic on small rodents, especially of the subfamilies Murinae and Microtinae.

Frons normally with 3 spiniform setae; genal process curved dorsad, clearly visible above the upper spine of the genal comb, not covered by this dorsal genal spine (fig. 116). ♂ movable process of the clasper about one and a half times as long as broad, widening from base towards apex (fig. 117). ♀ normally with 5 antesensilial setae each side; posterior margin of sternum VII without a sinus, bulga of spermatheca about as long as the hilla (fig. 118). Length: ♂ 2-2.5 mm., ♀ 2.25-3 mm. *silvatica spectabilis* (Rothschild) *Not very common; throughout Great Britain on the bank vole (Clothriomys glareolus) and field vole (Microtus agrestis) (not recorded from Wales; not in Ireland where voles are absent). Outside Great Britain this subspecies is only known from the Cantabrian Mts. in North Spain (Lusitanian distribution). Replaced by P. s. silvatica (Meinert) in Norway, Sweden, Denmark, Germany, Czechoslovakia, Bulgaria, European U.S.S.R. and western Siberia, by P. s. fallax (Rothschild) in France, southern Germany, Switzerland, Austria and Italy.*



FIGS. 116–118.—*Peromyscopsylla silvatica spectabilis*. 116, Head and pronotum, ♂; 117, Clasper, sternum IX and sternum VIII; 118, Sternum VII and spermatheca.

Subfamily AMPHIPSYLLINAE

Genus **Frontopsylla**

Palearctic. Almost exclusively on small rodents, but the members of the following subgenus occur mainly on birds.

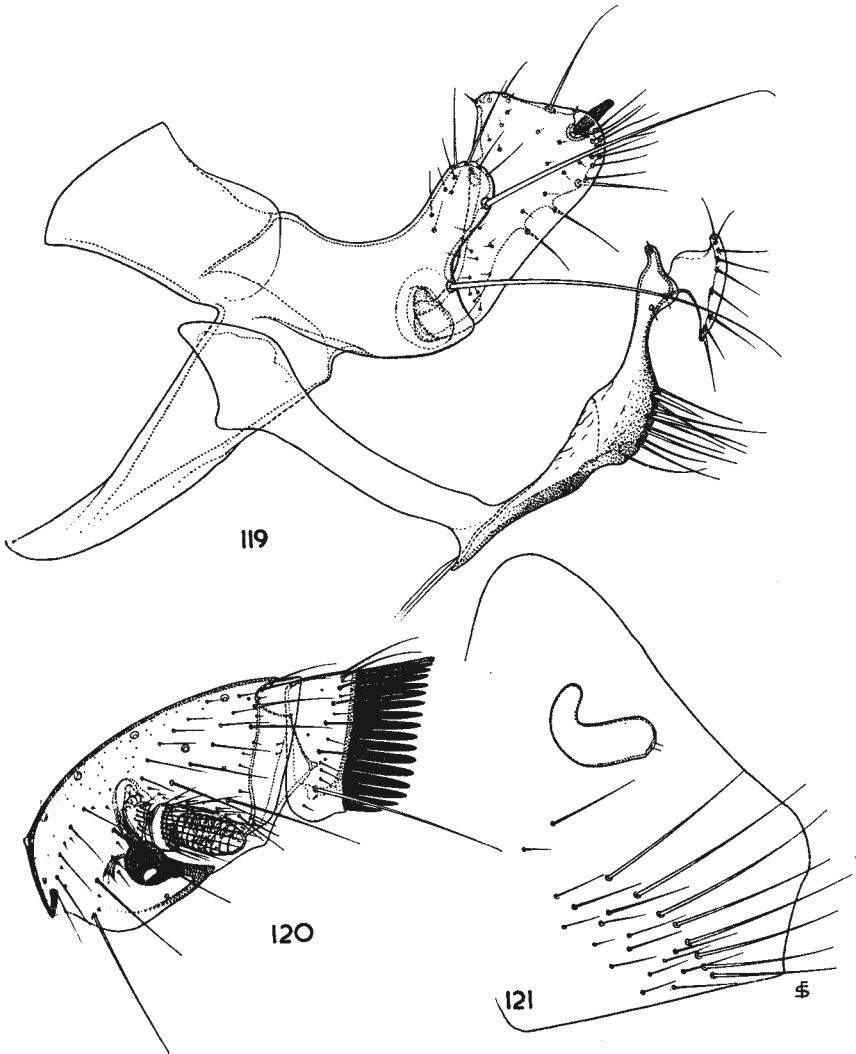
Subgenus **Orfrontia** Ioff

With eight species and subspecies; parasites of birds which nest in burrows or on rocks and cliffs.

Pronotal comb consisting of 33–37 spines (fig. 120); metanotum dorsally shorter than pronotum. ♂ fixed process of the clasper much longer than broad; movable process broadening gradually to a straight apical margin, the anterior angle well marked and the posterior apical angle rounded off, the spiniform seta at the latter angle much less than half as long as the apical margin of the process (fig. 119). ♀ posterior margin of sternum VII strongly oblique and almost

straight in its dorsal two-thirds, then turning downwards and forwards, its ventral portion slightly concave; spermatheca without a sharp distinction between bulga and hilla (fig. 121). Length: ♂ 2.5-2.75 mm., ♀ 2.75-3.25 mm.

laeta (Jordan and Rothschild)
 Only known from the coast of Kincardineshire and Berwickshire (Scotland), where it is common in nests of the house-martin (*Delichon urbica*) on cliffs (not occurring in nests of the same species under eaves of buildings). Switzerland, Caucasus.



FIGS. 119-121.—*Frontopsylla laeta*. 119, Clasper and sternum IX; 120, Head and pronotum, ♀; 121, Sternum VII and spermatheca.

Family CERATOPHYLLIDAE

KEY TO GENERA

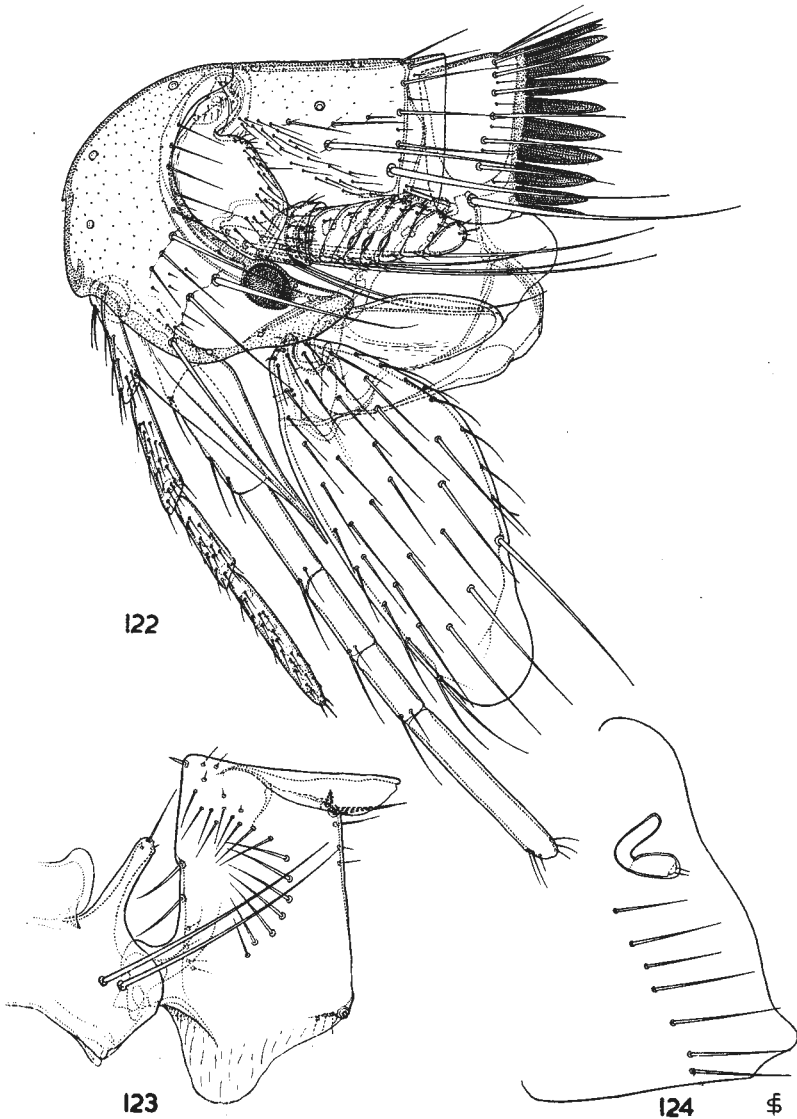
- 1 Pronotal comb consisting of at least 24 spines. Bird-fleas 2
- Pronotal comb consisting of less than 24 spines. Mammal-fleas 4
- 2 Preantennal and postantennal regions of head each with 3 rows of setae (fig. 132).
Last segment of all tarsi with 5 pairs of lateral plantar setae, the third pair of
which is shifted on to the plantar surface (fig. 133). ♂ movable process of the
clasper with several spiniform setae (fig. 135). ♀ hilla of spermatheca with
a terminal papilla (fig. 134) *Dasypsyllus* (Baker) (p. 61)
- Preantennal and postantennal regions of head each with less than 3 rows of setae
(fig. 183). None of the 5 pairs of lateral plantar setae displaced on to the plantar
surface (figs. 188, 190) 3
- 3 Inner surface of mid and hind coxa with a row of slender setae near the anterior
margin from near the apex to near the base. ♂ tergum VIII without a spiculose
area; tendons of sternum IX and of the phallosome short, making less than half
a convolution. ♀ bulga of spermatheca barrel-shaped (fig. 131)
Callopsylla subgenus *Orneacus* Jordan (p. 59, 61)
- Inner surface of mid and hind coxa with seta only in the lower half. ♂ tergum
VIII with a spiculose area; tendons of sternum IX and of the phallosome
making at least half a convolution (fig. 9). ♀ bulga of spermatheca not barrel-
shaped (figs. 162, 197) *Ceratophyllus* Curtis (p. 72)
- 4 First hind tarsal segment longer than the second, third and fourth together (figs.
126, 127). Frontal tubercle vestigial or absent (fig. 125). Metathorax without
a pleural arch *Tarsopsylla* Wagner (p. 59)
- First hind tarsal segment shorter than the second, third and fourth together.
Frontal tubercle more distinct. Metathorax with a pleural arch 5
- 5 Labial palp extending far beyond the fore trochanter; antennal scape of male
very large, pedicel with a few very long setae on the inner side, reaching far
beyond the apex of the club (fig. 122) *Paraceras* Wagner (p. 56)
- Labial palp reaching at most to the fore trochanter. Antennal scape of male not
abnormally large 6
- 6 Outer surface of fore femur with one or no lateral setae . . . *Orchopeas* Jordan (p. 66)
- Outer surface of fore femur with a number of small lateral setae 7
- 7 Spiracular fossa of tergum VIII large, especially in the female (figs. 149, 152, 155)
Megabothris Jordan (p. 67)
- Spiracular fossa of tergum VIII of normal size (fig. 143) 8
- 8 ♂ sternum VIII long and narrow, with a long membranous process (fig. 142).
♀ bulga of spermatheca longer than hilla which bears a distinct terminal papilla
(figs. 143, 144) *Malaraeus* Jordan (p. 64)
- ♂ sternum VIII much more reduced or vestigial, without an apical membranous
process. ♀ bulga of spermatheca at most as long as hilla which lacks a papilla . . 9
- 9 ♂ sternum VIII vestigial and indistinct, without setae (figs. 137, 139). ♀ bulga of
spermatheca globular, bursa copulatrix forming a spiral (figs. 140, 141)
Nosopsyllus Jordan (p. 61)
- ♂ sternum VIII reduced and narrow, but triangular proximally, its distal narrow
portion often without setae (fig. 156). ♀ bulga of spermatheca pyriform (figs. 157,
158); bursa copulatrix not forming a spiral (fig. 158)
Monopsyllus Kolenati (p. 67)

Genus *Paraceras* Wagner

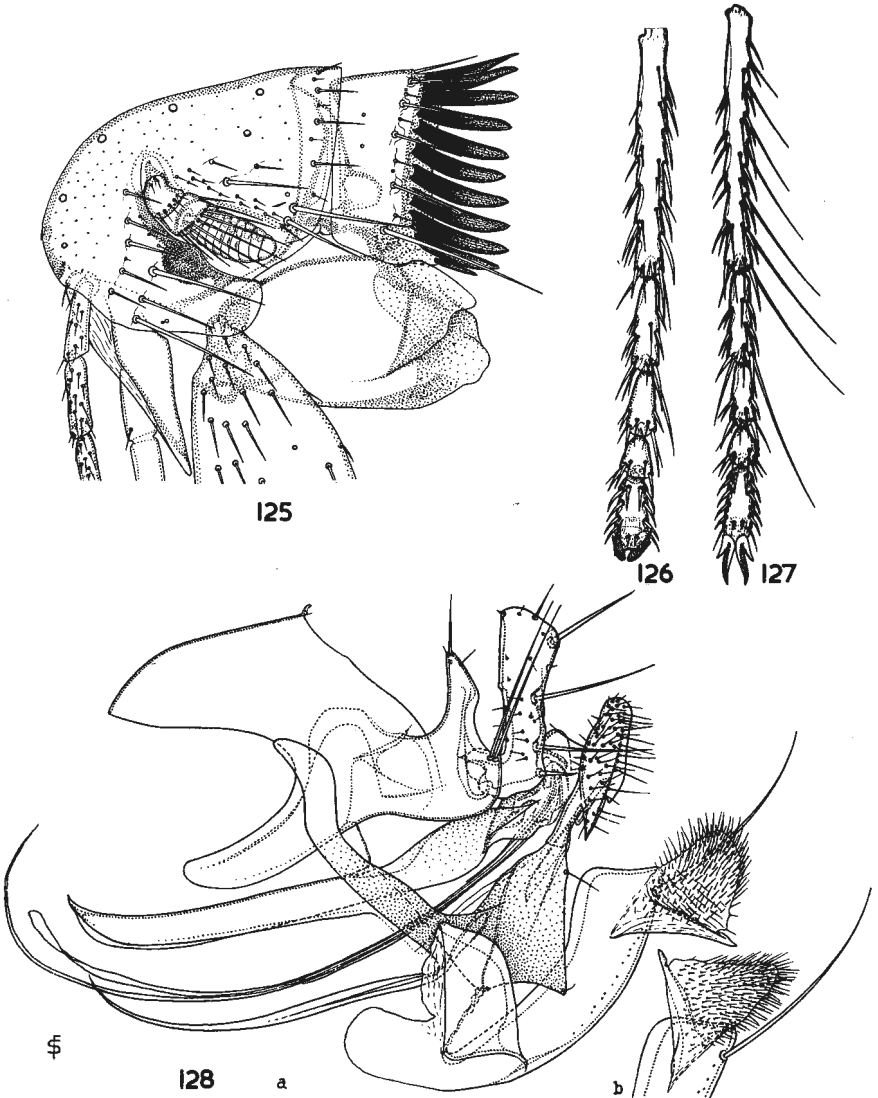
The majority of the ten known representatives of this Palaearctic and Oriental genus occurs on carnivores (Canoidea and Feloidea), but two species, one in Burma and one in China, apparently parasitise Sciuridae (rodents). The following subspecies is found in Europe.

Pronotal comb in both sexes with 20-22 spines (fig. 122). ♂ the modified segments are of a complicated structure and the large clasper is shown in fig. 123.
♀ sternum VII and spermatheca as in fig. 124. Length: ♂ 2.5-3.5 mm.,
♀ 3-4.5 mm. *melis melis* (Walker)

Common in England, Wales and Ireland, principally on the badger (*Meles meles*), but there are a few records of this flea from the fox (*Vulpes vulpes*) and the earth of the latter may suit the flea's ecological requirements; both hosts occur throughout most of the British Isles, but the flea has not yet been recorded from Scotland where it is not likely to be absent. Holland, Belgium, France, Spain, Denmark, Germany, Austria, Czechoslovakia, Poland, Hungary, Yugoslavia, Rumania, Finland, Sweden, European U.S.S.R., Iran; in Asian U.S.S.R., (Tian-Shan, Altai, Transbaikalia) it is replaced by *P. m. flabellum* Wagner, and in China and Japan by *P. m. sinensis* (Liu).



FIGS. 122-124.—*Paraceras meles meles*. 122, Head, prothorax and fore coxa; 123, Process of clasper; 124, Sternum VII and spermatheca.



FIGS. 125-128.—*Tarsopsylla octodecimentata octodecimentata*. 125, Head and prothorax, ♀; 126, Hind tarsus, ♀; 127, Hind tarsus, ♂; 128a, Clasper, sternum IX, sternum VIII and phallosome; 128b, Apex of sternum VIII to show the upturned apical lobe.

Genus *Tarsopsylla* Wagner

This Holarctic genus, which is associated with Sciuridae, contains only one polytypic species, consisting of one subspecies in the Palaearctic Region and one in the Nearctic Region.

Pronotal comb in the male with 18–21 spines, in the female with 20–22. This is an easy species to identify owing to its long first hind tarsal segment, which shows a remarkable sexual dimorphism in chaetotaxy: the males have long slender posterior setae on each first tarsal segment (fig. 127), while in the female these setae are short (fig. 126). Male genitalia as in fig. 128. ♀ Sternum VII and spermatheca as in fig. 129. Length: ♂ 3–3.5 mm., ♀ 3.5–4 mm.

octodecimdentata octodecimdentata (Kolenati).

Scotland (Perthshire and Aberdeenshire), monoxenous on the red squirrel (*Sciurus vulgaris*); being a nest-flea, it is found on its host only in small numbers. Holland, Germany, France, Spain, Switzerland, Austria, Hungary, Czechoslovakia, Yugoslavia, Bulgaria, Estonia, Poland, Finland, Norway, Sweden, U.S.S.R. (northern slopes of the Caucasus, Altai, Siberia), Mongolia. Replaced in North America by *T. o. coloradensis* (Baker).

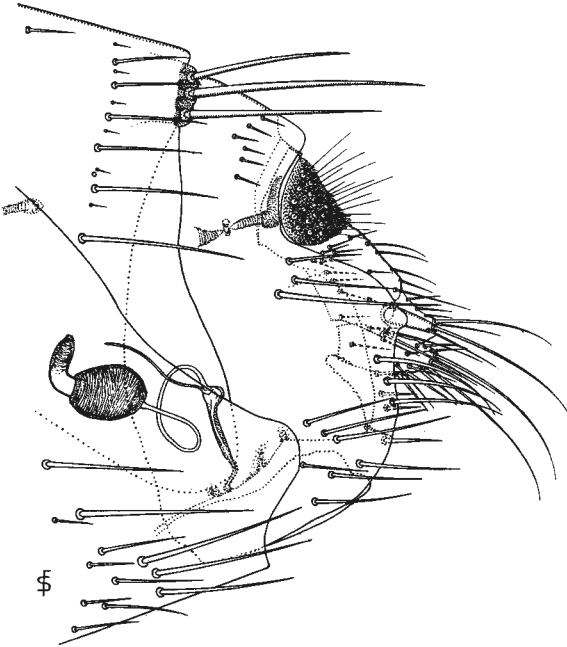
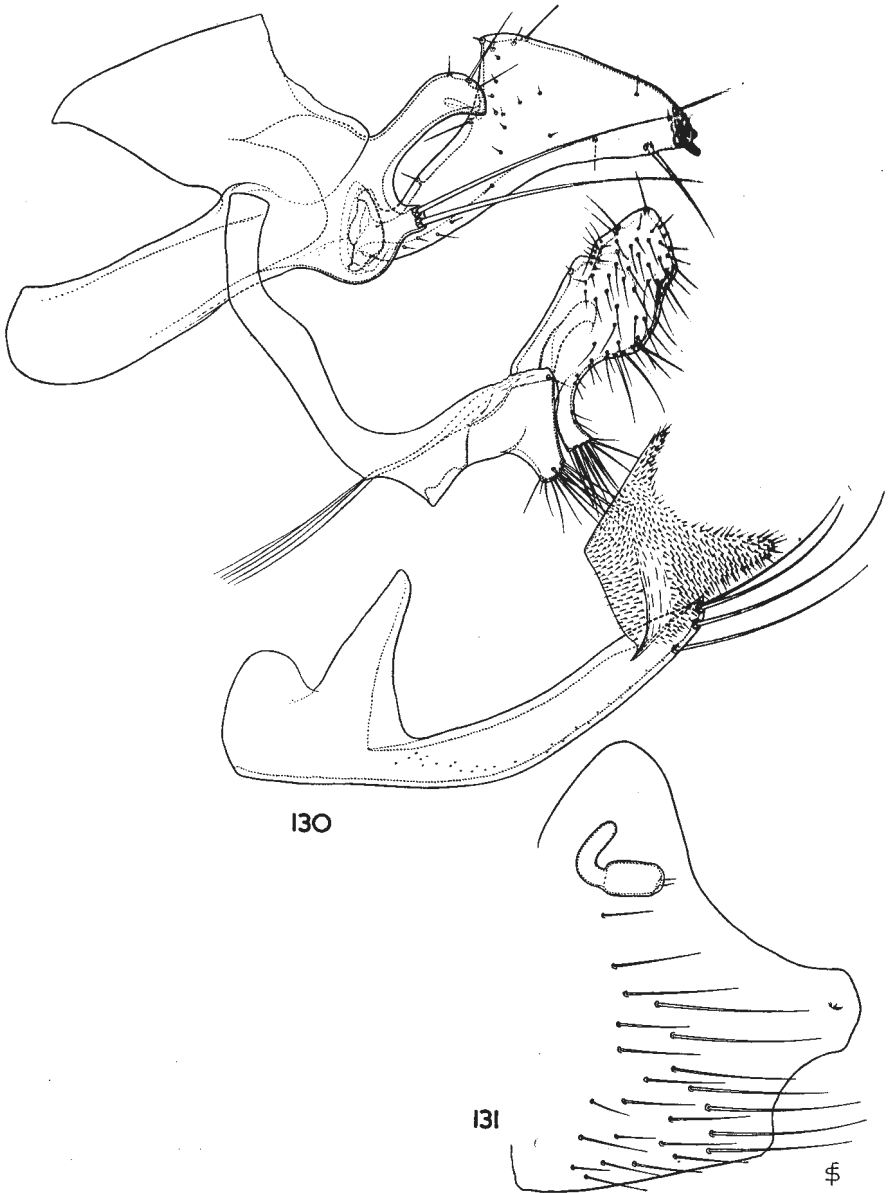


FIG. 129.—*Tarsopsylla octodecimdentata octodecimdentata*. Terminalia of female.

Genus *Callopsylla* Wagner

Palaearctic; the thirteen known representatives are divided into four subgenera: *Callopsylla* s.str., with nine species living chiefly on rodents in mountainous areas from the Pyrenees to China; *Paracallopsylla* Ioff, with one species on carnivores in Tibet; *Typhlocallopsylla* Ioff, with one species on the Siberian mole in Central and northern Asia, and the following subgenus with three species parasitic on birds.



FIGS. 130, 131.—*Callopsylla waterstoni*. 130, Clasper, sternum IX and sternum VIII; 131, Sternum VII and spermatheca.

Subgenus **Orneacus** Jordan

With three species, two of which occur in nests, built on rocks and cliffs, of the house-martin, while the third has been recorded from pigeons and other birds.

Pronotal comb with 32-36 spines. ♂ movable process of the clasper triangular, widest at the apex and with two stout, short and blunt spiniforms at the apico-distal angle (fig. 130). ♀ posterior margin of sternum VII forming a broad truncate lobe; bulga of spermatheca barrel-shaped and shorter than the hilla (fig. 131). Length: ♂ 2.5-3 mm., ♀ 2.5-3.25 mm. (= *rothschildi* (Waterston)) **waterstoni** (Jordan)

Only known from the coast of Kincardineshire, Scotland, where it is common in nests of the house-martin (Delichon urbica) on cliffs; a monozenous house-martin flea which, like Frontopsylla laeta, is not recorded from martins' nests under eaves of buildings. Found once in Switzerland.

Genus **Dasypsyllus** Baker

A genus of bird fleas, with nine species and subspecies. It has representatives in the Holarctic, Neotropical and Oriental Regions; one subspecies occurs in Britain.

Pronotal comb in both sexes normally with 32-36 spines. ♂ tergum VIII without a spiculose area. Movable process of the clasper broad, with a projecting ventro-apical angle where it bears a curious twisted spiniform seta, above which two normal spiniforms; there are two more spiniform setae, at the posterior margin, which are short (fig. 135). ♀ tergum VII strongly concave below the antesensorial setae, with a very short main row of setae (fig. 134); sternum VII with a deep sinus, the part adjoining the sinus is more strongly sclerotised and therefore darker than the rest of the sternum; spermatheca as in fig. 134. Length: ♂ 2-3 mm., ♀ 2.5-3.5 mm. **gallinulae gallinulae** (Dale)

Very common throughout the British Isles; a parasite of a large number of birds, especially of the Order Passeriformes, principally those which build their nests in low positions, e.g. in bushes and shrubs; it is common in nests of: the wren (Troglodytes troglodytes), blackbird (Turdus merula), thrushes (Turdus spp.), warblers (Sylvia, Phylloscopus, Acrocephalus), buntings (Emberiza spp.), pipits (Anthus spp.), tits (Parus spp.), robin (Erithacus rubecula), chaffinch (Fringilla coelebs), hedge-sparrow (Prunella modularis) and tree-creeper (Certhia familiaris). Iceland, Jersey, Holland, Germany, Denmark, Belgium, France, Portugal, Switzerland, Austria, Poland, Czechoslovakia, Finland, Azores, Madeira, European U.S.S.R. (Caucasus, Carpathian Mts.), Himalayas. D. g. zilianus Peus has been described from specimens from Greece, and D. g. perpinnatus (Baker) from North American material; forms very closely related to these subspecies are known from Peru, Ecuador, Venezuela, Panama, Philippines and Ceylon.

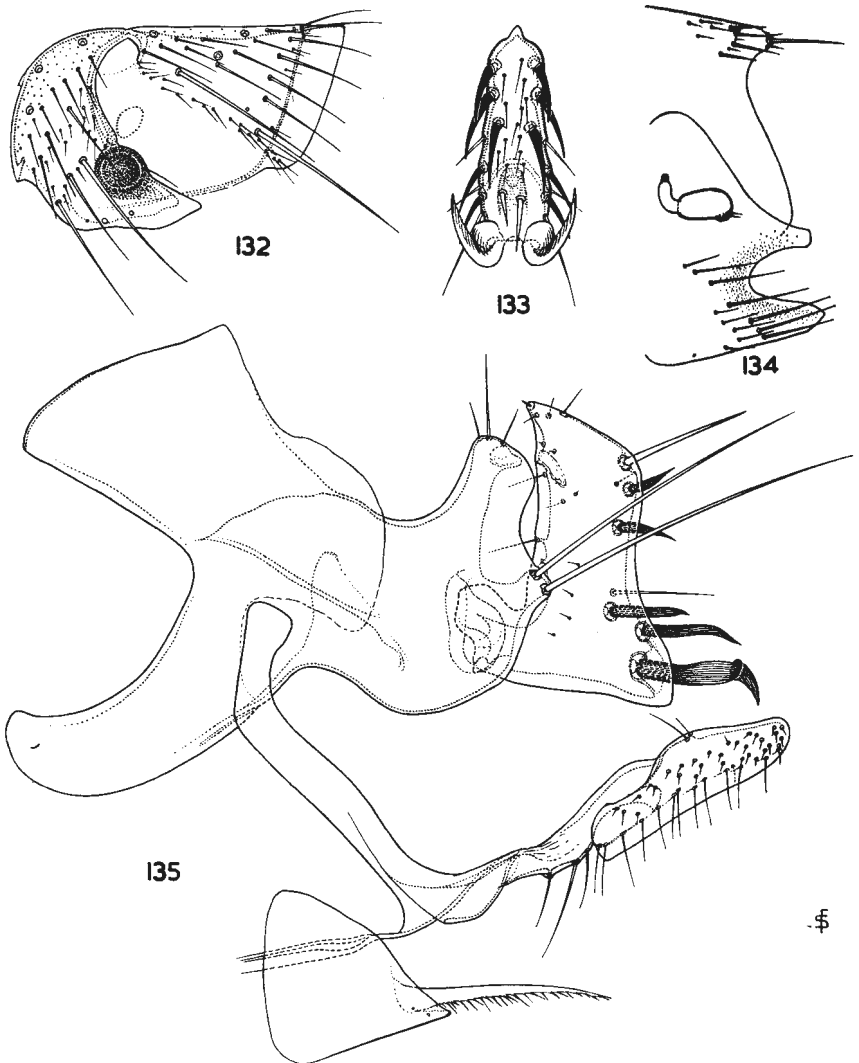
Genus **Nosopsyllus** Jordan

Palaeartic, Ethiopian and Oriental Regions, with about forty species and subspecies. Parasites of rodents (Murinae, Sciurinae and Gerbillinae).

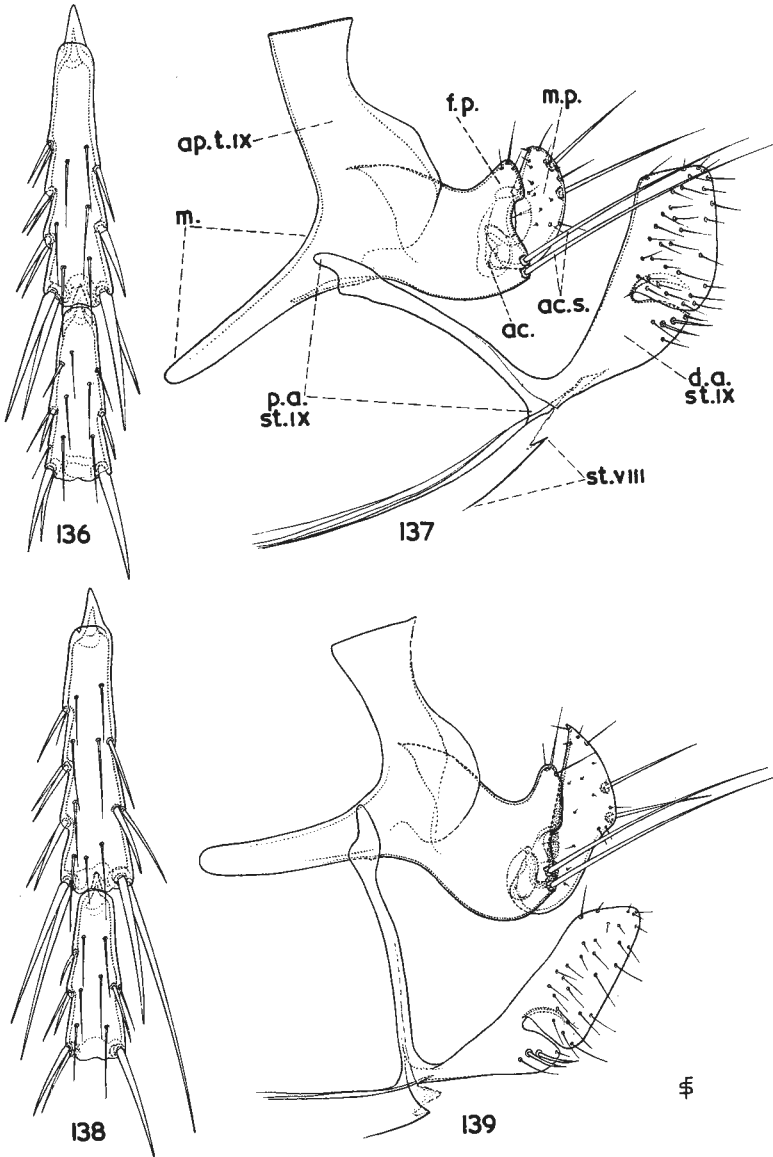
KEY TO SPECIES

- 1 None of the apical setae of the second hind tarsal segment reaching beyond the apex of the third segment (fig. 136). ♂ movable process of the clasper about twice as long as broad, usually with a rather blunt apex (fig. 137). ♀ posterior margin of sternum VII practically straight (fig. 140). Length: ♂ 2-2.5 mm., ♀ 2.25-3 mm. **fasciatus** (Bosc)

Common throughout the British Isles. This cosmopolitan rat flea occurs principally on Rattus spp.; secondary hosts (several of which may be only temporary) on which it occurs not uncommonly are the wood-mouse (Apodemus sylvaticus), house-mouse (Mus musculus) and voles (Microtinae).



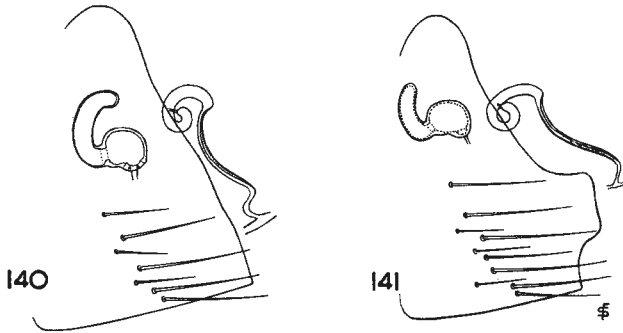
FIGS. 132-135.—*Dasyptyllus gallinulae gallinulae*. 132, Head, ♂ (antenna omitted); 133, Last hind tarsal segment, ♂; 134, Tergum VII, sternum VII and spermatheca; 135, Clasper, sternum IX and sternum VIII.



FIGS. 136-139.—136, 137.—*Nosopsyllus fasciatus*. 136, Segments II and III of hind tarsus, ♂; 137, Clasper, sternum VIII and sternum IX. 138, 139.—*Nosopsyllus londiniensis*. 138, Segments II and III of hind tarsus, ♂; 139, Clasper, sternum VIII and sternum IX.

- Longest apical seta of the second hind tarsal segment reaching beyond the apex of the third segment (fig. 138). ♂ movable process of the clasper about thrice as long as broad, with a pointed apex (fig. 139). ♀ posterior margin of sternum VII with a fairly large truncate lobe (fig. 141). Length: ♂ 1.75–2.25 mm., ♀ 2–3 mm. *londiniensis* (Rothschild)

A more or less cosmopolitan flea, mainly associated with the house-mouse (*Mus musculus*) and the black rat (*Rattus rattus*); especially on the latter host it is carried all over the world by ships and it is therefore found in ports or localities near ports. A flea of domestic hosts, it is not much influenced by climatic factors and therefore breeds successfully in the British Isles, although the original home of the species is considered to be round the Mediterranean Sea. This rat flea has been found in the following localities, which all either are ports or situated not far from ports: London, Dover, Hastings, Newport (Isle of Wight), Gloucester, Cardiff, Liverpool, Longton nr. Preston and Aberdeen.



FIGS. 140, 141.—140.—*Nosopsyllus fasciatus*. Sternum VII, ductus bursae and bursa copulatrix, and spermatheca. 141. *Nosopsyllus londiniensis*. Sternum VII, ductus bursae and bursa copulatrix, and spermatheca.

Genus *Malaraeus* Jordan

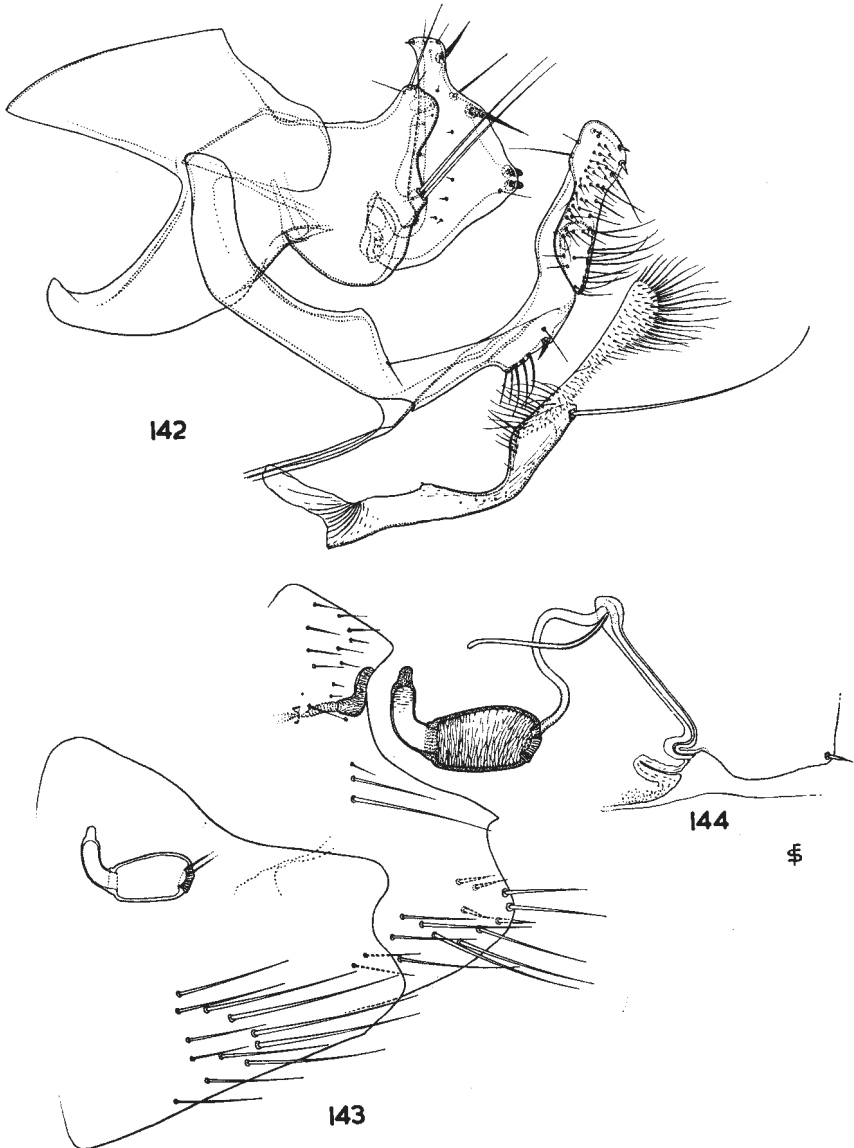
This Holarctic genus which parasitises rodents, is divided into two subgenera.

Subgenus *Amalaraeus* Ioff

♂ movable process of the clasper with two blunt, short spiniform setae at the ventro-posterior angle and between these and the apex two longer and pointed spiniform setae. Holarctic, with nine species and subspecies. Parasitic on Microtinae.

Pronotal comb in both sexes with 20–22 spines. ♂ with 3 antesensillial setae, the upper of which is vestigial and the lower short and thick. Sternum VIII narrow, with a convex ventral margin and a strongly concave dorsal margin; it bears one long apical seta and a long and fringed membranous process (fig. 142). Clasper and sternum IX as in fig. 142. ♀ with 3 normally-developed antesensillial setae. Sternum VII with a rather deep, but variable sinus; dorso-posterior angle of tergum VIII forming a triangular projection; hilla of spermatheca with a papilla (figs. 143, 144); ductus bursae long and straight (fig. 144). Length: ♂ 2–2.5 mm., ♀ 2.5–3 mm. *penicilliger mustelae* (Dale)

Common throughout Great Britain on its principal host, the bank vole (*Clethrionomys glareolus*), although *Microtus* spp. also appear to be true hosts; not infrequently, but accidentally, on *Apodemus*. This subspecies is confined to Great Britain. The species is Holarctic and is divided into the following subspecies:



FIGS. 142-144.—*Malaræus penicilliger mustelae*. 142, Clasper, sternum IX and sternum VIII; 143, Sternum VII, tergum VIII and spermatheca; 144, Genital ducts and spermatheca.

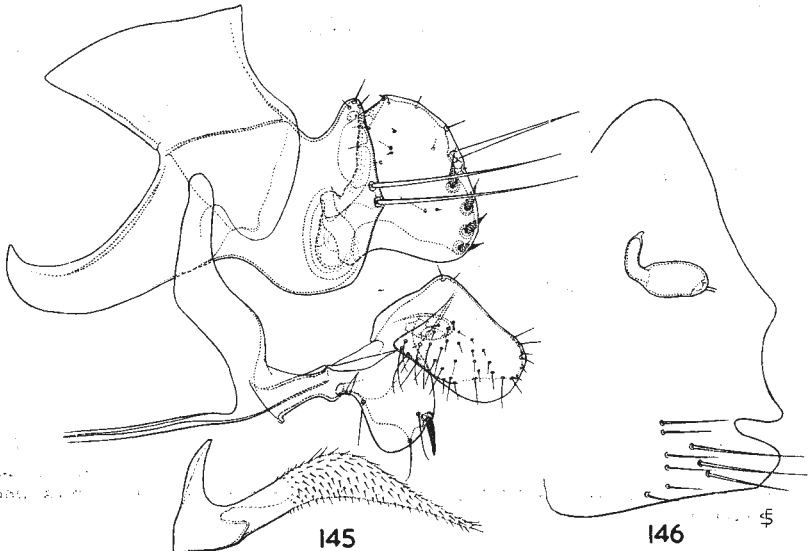
M. p. penicilliger (Grube) (northern Europe, Siberia—on *Clethrionomys*), *M. p. dissimilis* Jordan (Kamchatka, N.W. North America—on *Clethrionomys*), *M. p. athabascae* Holland (N.W. Territories, Canada—on *Clethrionomys*), *M. p. syrtae* Ioff (Tian-Shan, at high altitudes—on *Stenocranius*), *M. p. vallis* Ioff (Tian-Shan, in valleys—on *Clethrionomys*), *M. p. demotus* Ioff (? = *pedias* (Rothschild); northern Europe—on *Clethrionomys*), *M. p. kratochvili* Rosický (Czechoslovakia—on *Clethrionomys*) and *M. p. arvicolae* Ioff (Yakutia, Caucasus—on *Arvicola*; this may be a full species).

Genus *Orchopeas* Jordan

Nearctic, with sixteen species and subspecies; one species introduced in the British Isles. Parasites of *Sciurinae* and *Cricetinae* (rodents).

♂ sternum VIII without setae, the distal arm is transformed into a long, densely spiculose membranous process (fig. 145); movable process of the clasper roughly quadrate, rather variable in shape, with 4 conspicuous short and lanceolate spiniform setae on the inner side near its posterior margin, the lowest of which is placed at the ventro-posterior angle of the process; above the uppermost spiniform is one stout seta (fig. 145); sternum IX as in fig. 145. ♀ posterior margin of sternum VII with a narrow sinus which is rather variable in depth (fig. 146); tergum VIII with 3 genital setae (i.e., thickened setae on the inner side of this tergum), one of which is placed at the ventral margin; bulga of spermatheca barrel-shaped, hilla with a papilla (fig. 146). Length: ♂ 2-2.5 mm., ♀ 2.5-3 mm. (= *wickhami* (Baker).) *howardi howardi* (Baker)

This Nearctic species was introduced with its true host, the grey squirrel (Sciurus carolinensis); both host and parasite have been extremely successful in establishing themselves in the greater part of the British Isles, and the flea has spread to the red squirrel (Sciurus vulgaris) and the edible dormouse (Glis glis). Southern parts of Canada, most of the U.S.A., northern Mexico; O. h. texensis Eads has been described from Texas, and O. h. bolivari Barrera from Mexico.



FIGS. 145, 146.—*Orchopeas howardi howardi*. 145, Clasper, sternum IX and sternum VIII; 146, Sternum VII and spermatheca.

Genus *Megabothris* Jordan

Holarctic, with twenty species and subspecies. Mostly parasitic on rodents (especially Microtinae, also on Sciurinae, Murinae and Cricetinae), but a few species on Carnivores (Mustolinae).

KEY TO SPECIES

Males

- 1 Movable process of the clasper triangular, with one long spiniform seta at the ventral angle of the posterior margin (fig. 147). Length: 2-2.5 mm.

turbidis (Rothschild)

Common, only in England and Wales (becoming scarcer northwards), on the bank vole (*Clethrionomys glareolus*) and the wood-mouse (*Apodemus sylvaticus*); voles are very likely the original hosts of this flea. Jersey, Denmark, Holland, Belgium, Luxembourg, France, Switzerland, Germany, Austria, Yugoslavia, Czechoslovakia, Poland, Bulgaria, Finland, European U.S.S.R. to the Ural and in the Caucasus, also in western Siberia, Altai Mts. and west Transbaikalia.

- Movable process rectangular, with one long and two very short spiniform setae. . . 2
2 Movable process broad, with 2 short obtuse spiniform setae close together at the dorso-posterior angle and a longer spiniform seta at the ventral angle of the posterior margin (fig. 150). Length: 2-3 mm. *walkeri* (Rothschild)

Fairly common throughout Great Britain on the bank vole (*Clethrionomys glareolus*), field vole (*Microtus agrostis*) and the water vole (*Arvicola terrestris*) (not in Ireland in view of the absence of voles). This flea (as well as most other members of the genus) apparently prefers nests with a relative high humidity, hence its distribution is rather erratic. Holland, Belgium, Germany, Denmark, Switzerland, Austria, Poland, Czechoslovakia, Finland, European U.S.S.R., Transcaucasia, Ural, Kazakhstan and western Siberia.

- Movable process elongate, with one of the two short obtuse spiniform setae placed near the dorso-posterior angle and well separated from the other which is situated much farther down the posterior margin (fig. 153). Length: 2.5-2.75 mm.

rectangulatus (Wahlgrön)

Scotland (Argyllshire, Aberdeenshire, Angus, Perthshire)³, on the bank vole (*Clethrionomys glareolus*) and field vole (*Microtus agrestis*); apparently a common species. Norway, Sweden, Austria, Czechoslovakia, European U.S.S.R., western Siberia, Tuva, Tian-Shan, Altai, Irkutsk region, Yakutia, Transbaikalia and Mongolia.

Females

- 1 Sternum VII with a large and deep sinus, its dorsal and ventral lobes almost equally narrow (fig. 152). Basal part of the duct of spermatheca surrounded by a large glandular structure (fig. 151). Length: 2.5-3 mm. *walkeri* (Rothschild)

- Sternum VII with a shallow sinus; basal part of the duct of spermatheca without a glandular structure. 2

- 2 Sternum VII with a lateral and a ventral sinus (fig. 149). Bulga of spermatheca with parallel sides; duct of spermatheca basally not much widened, blind duct almost undeveloped (fig. 148). Length: 2-2.75 mm. *turbidus* (Rothschild)

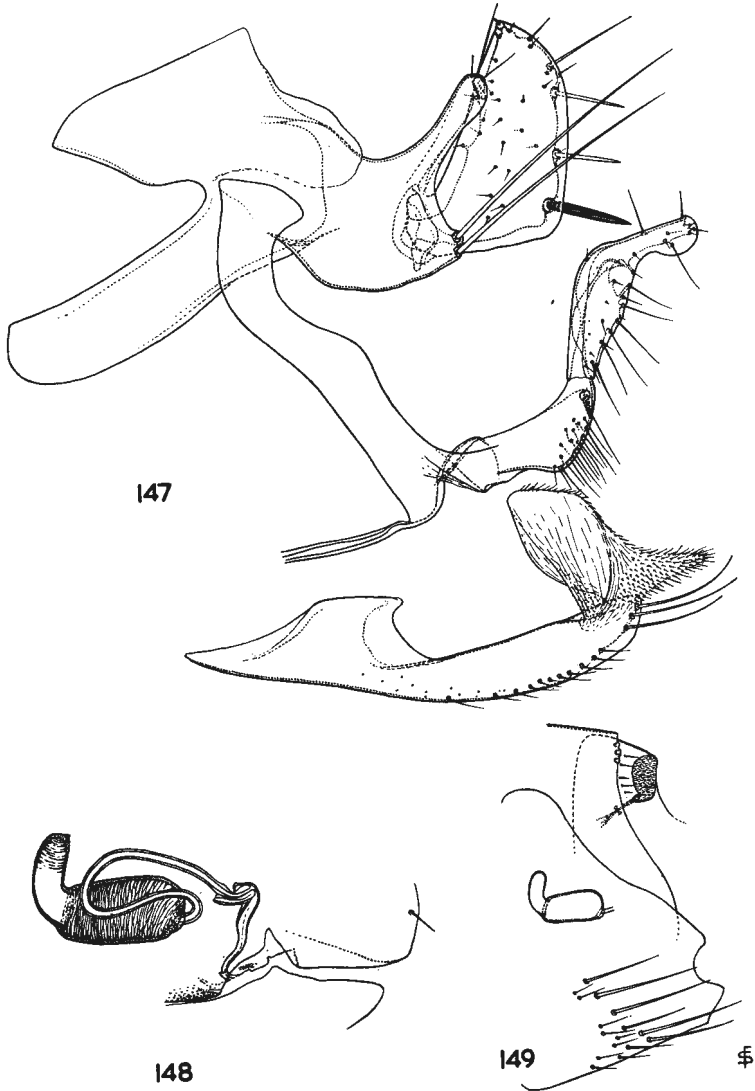
- Sternum VII without a ventral sinus, the lower end of the posterior margin forming a right angle with the ventral margin (fig. 155). Bulga of spermatheca narrower at the junction of the hilla than proximally; duct of spermatheca basally distinctly widened; blind duct fairly long (fig. 154). Length: 2.5-3.25 mm.

rectangulatus (Wahlgrön)

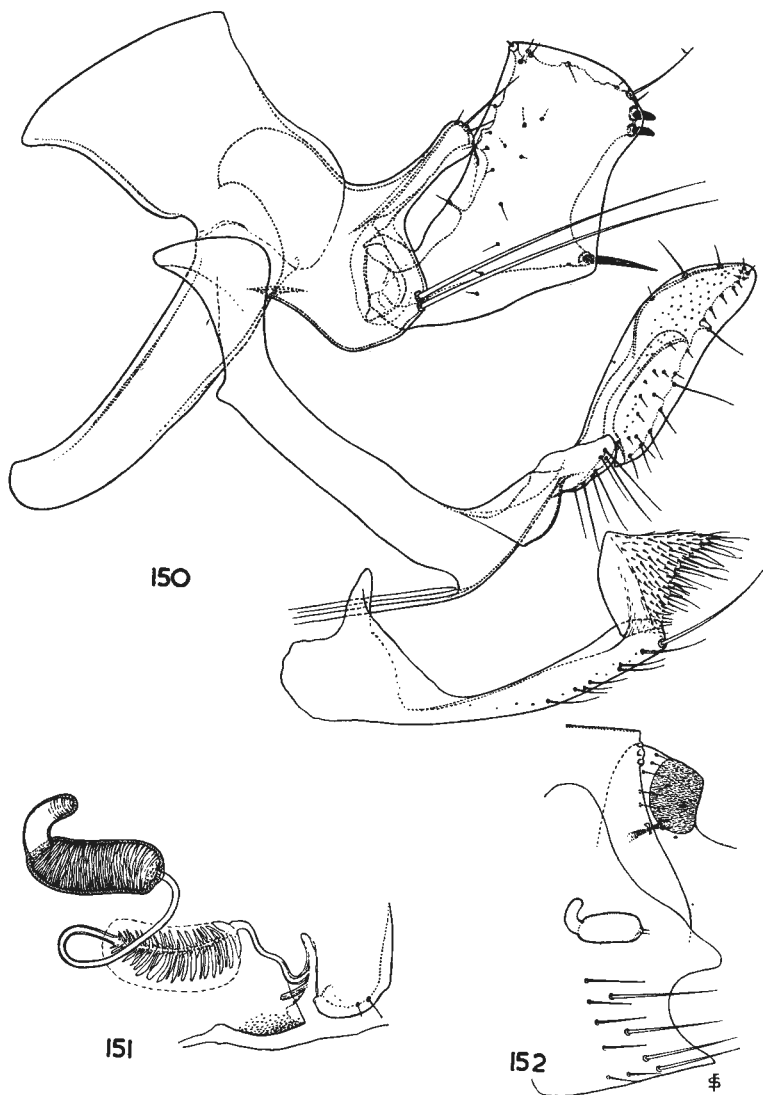
Genus *Monopsyllus* Kolenati

This Holarctic genus is mainly parasitic upon rodents, particularly Sciuridae. With about thirty species and subspecies of which only one subspecies occurs in western Europe. The small *sciurorum*-group of species might be regarded as a subgenus (*Monopsyllus* s.str.) of *Ceratophyllus*.

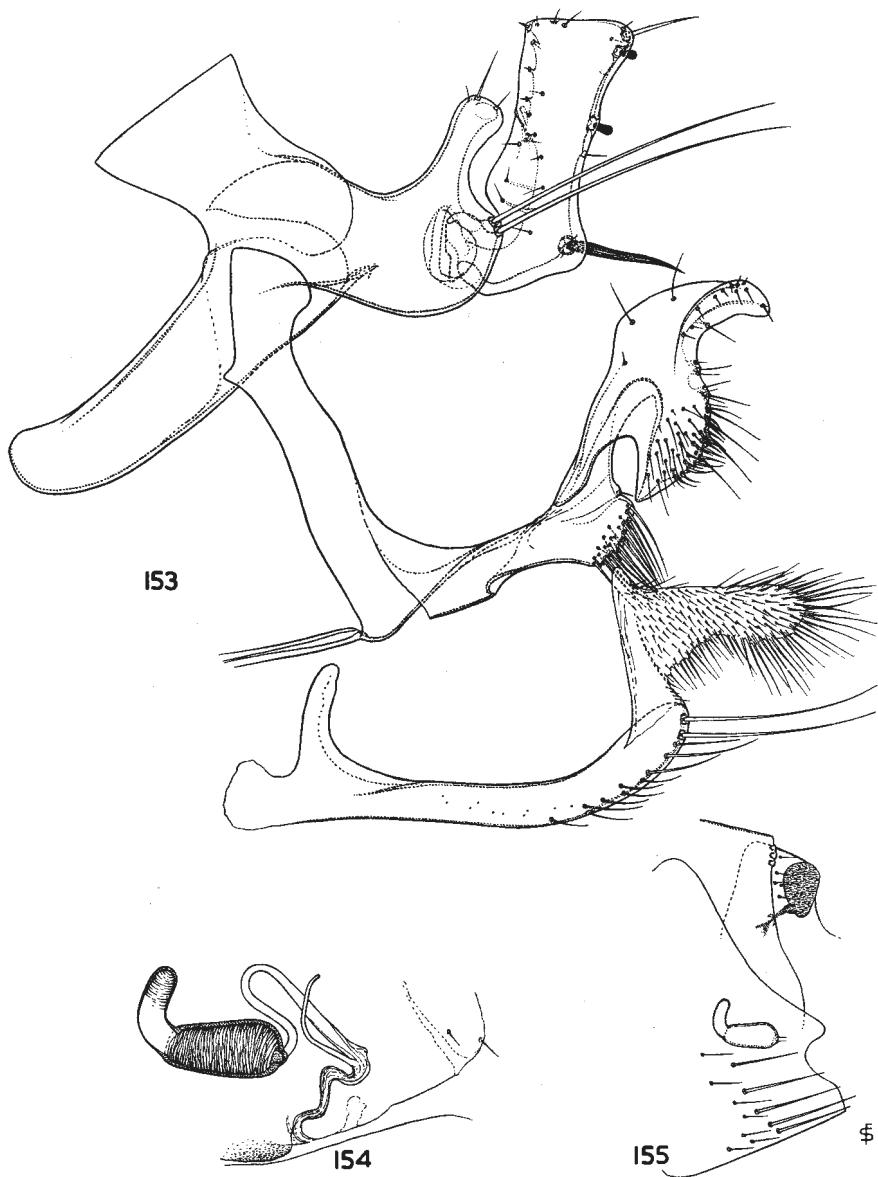
³ In the Tring collection is a specimen stated to be from Braunton, Devon; this find needs confirmation.



FIGS. 147-149.—*Megabothris turbidus*. 147, Clasper, sternum IX and sternum VIII; 148, Female genitalia; 149, Tergum VII, dorsal part of tergum VIII, sternum VII and spermatheca.



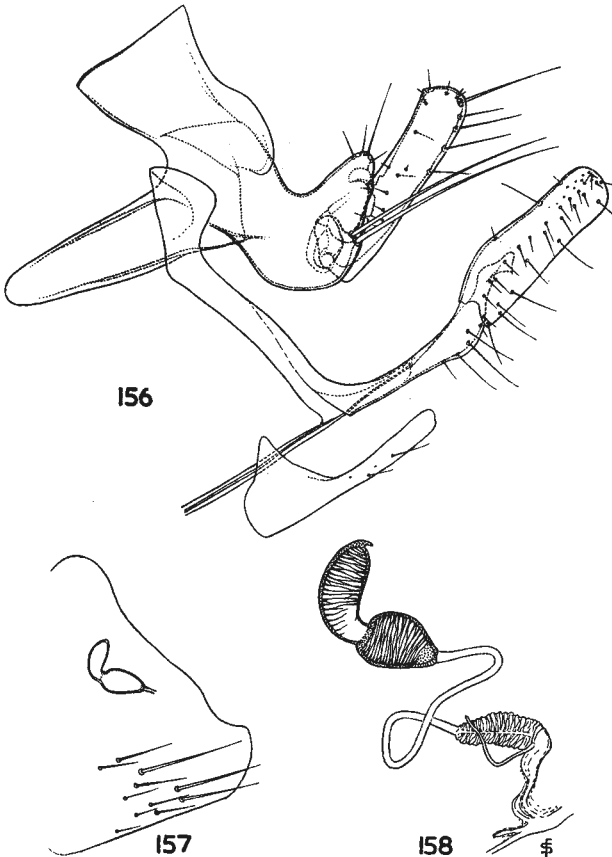
FIGS. 150-152.—*Megabothris walkeri*. 150, Clasper, sternum IX and sternum VIII; 151, Female genitalia; 152, Tergum VII, dorsal part of tergum VIII, sternum VII and spermatheca.



FIGS. 153-155.—*Megabothris rectangularatus*. 153, Clasper, sternum IX and sternum VIII; 154, Female genitalia; 155, Tergum VII, dorsal part of tergum VIII, sternum VII and spermatheca.

Pronotal comb in both sexes consisting of 18–21 spines. ♂ sternum VIII very narrow and short, rather feebly sclerotised and very variable in shape (fig. 156). Clasper and sternum IX as in fig. 156. ♀ sternum VII without a sinus, its posterior margin forming a broad rounded ventral lobe which generally is angulate dorsally (fig. 157); spermatheca very characteristic, see fig. 158. Length: ♂ 2–2.75 mm., ♀ 2.5–3.5 mm. *sciurorum sciurorum* (Schrank)

Very common throughout the British Isles on its principal host, the red squirrel (Sciurus vulgaris), but where this host has been replaced by the grey squirrel (Sciurus carolinensis) it also occurs on the latter; likewise on the introduced edible dormouse (Glis glis) (in Herts. and Bucks.). The pine marten (Martes martes) often acquires this flea through killing squirrels and is a secondary host; the flea being a parasite of a host with arboreal habits and which frequently visits birds' nests, it fairly often straggles on to birds. Holland, Germany, Denmark, Belgium, France, Spain, Switzerland, Austria, Hungary, Yugoslavia, Czechoslovakia, Poland, Bulgaria, Finland, Norway, Sweden, Palestine, Azores, European U.S.S.R., Ural, Caucasus. M. s. asiaticus Ioff occurs in Central Asia. (M. s. bolivari Gil Collado, from Spain, is a synonym of the nominate subspecies.)



Figs. 156–158.—*Monopsyllus sciurorum sciurorum*. 156, Clasper, sternum IX and sternum VIII; 157, Sternum VII and spermatheca; 158, Female genitalia.

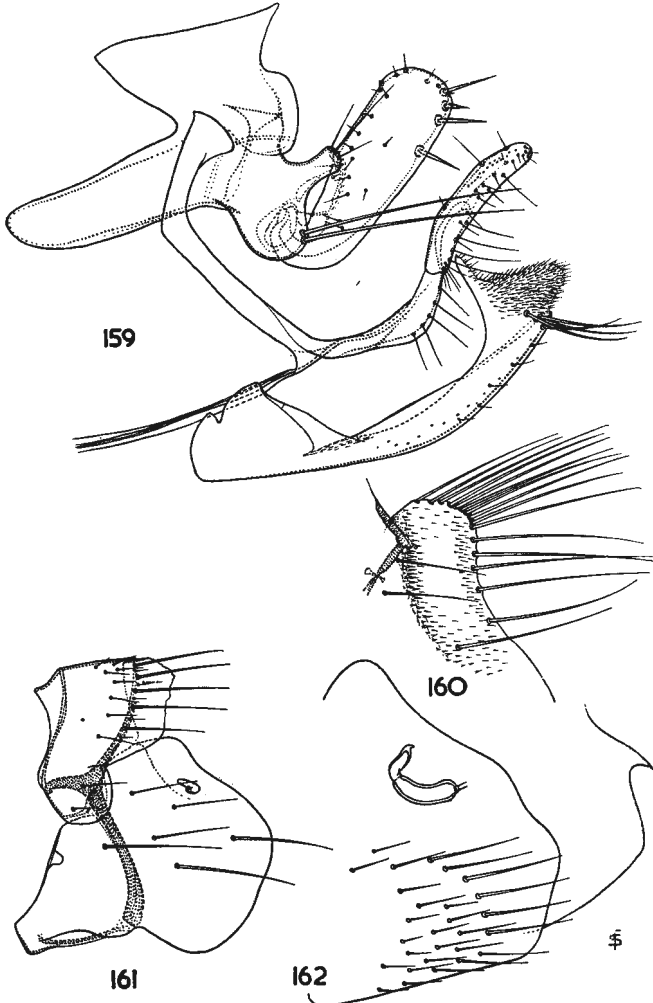
Genus *Ceratophyllus* Curtis

Holarctic, but a few forms occur in the northernmost part of the Neotropical Region. There are approximately fifty species and subspecies in this genus, nearly all of which are parasites of birds.

KEY TO SPECIES

Males

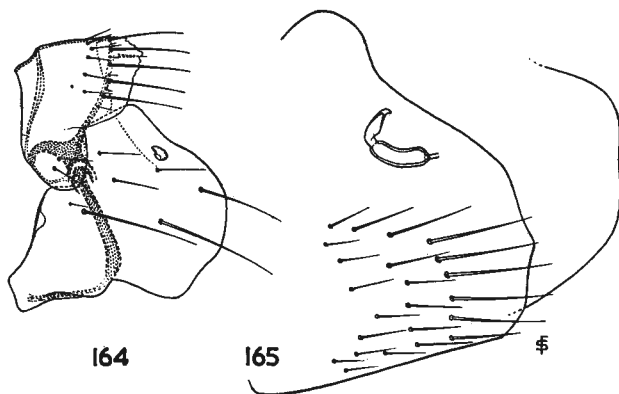
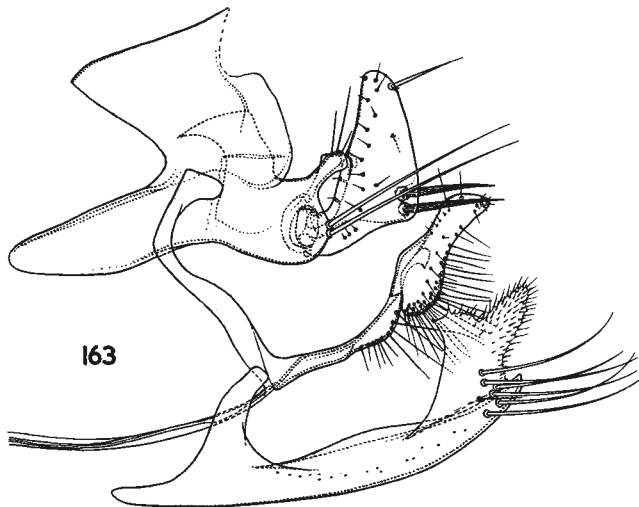
- 1 Pleural arch of metathorax absent (fig. 161). Dorsal part of tergum VIII narrow and strongly convex, its spiculose area being much higher than broad, and its vertical posterior margin distinctly concave (fig. 160). Movable process of the clasper straight and rather broad, with a few subspiniform setae at the posterior margin below the apex (fig. 159); sterna VIII and IX as in fig. 159. Length: 2-2.5 mm. (= *dalei* Rothschild).....**rusticus** Wagner



FIGS. 159-162.—*Ceratophyllus rusticus*. 159, Clasper, sternum IX and sternum VIII; 160, Spiculose area of tergum VIII, ♂; 161, Metathorax, ♀; 162, Sternum VII, spermatheca, and outline of part of tergum VIII.

Common, doubtless throughout England and Scotland, but not yet recorded from Wales and Ireland; a monoxenous parasite of the house-martin (*Delichon urbica*), occurring in both nests on cliffs and under eaves of buildings. Holland, Germany, Denmark, Belgium, France, Switzerland, Austria, Yugoslavia, Czechoslovakia, Poland, Finland, U.S.S.R. (Georgia, North Caucasus and Azerbaijan).

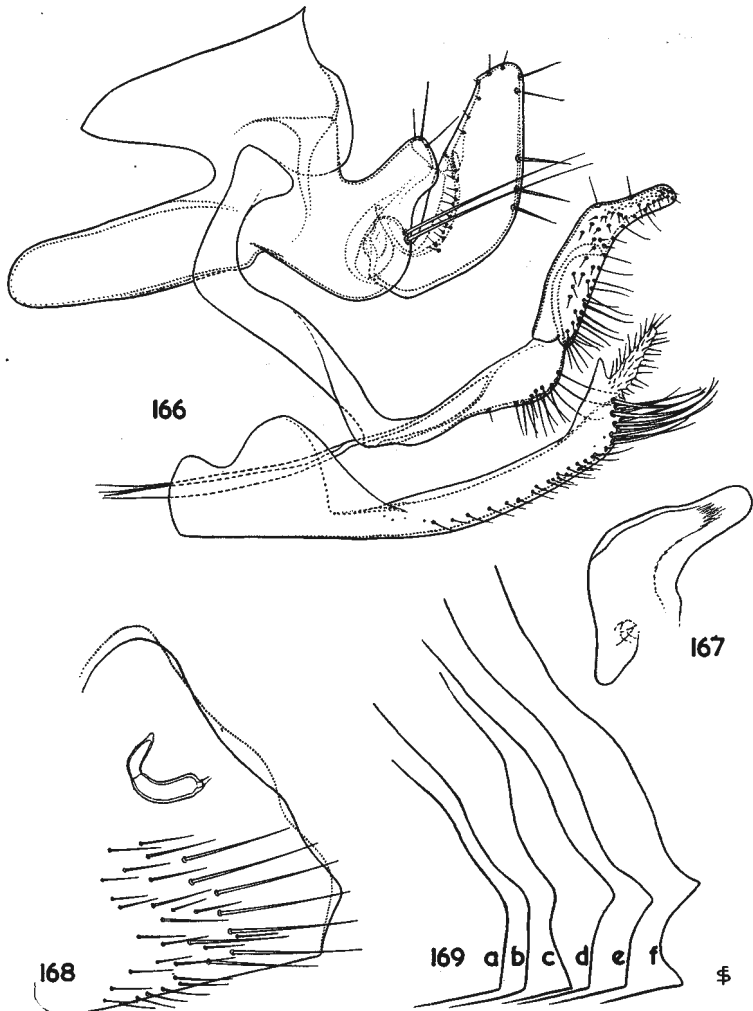
- Pleural arch of metathorax present (fig. 164)..... 2
- 2 Movable process of the clasper triangular, with two spiniform setae placed closely together at the angle of the posterior margin (fig. 163); sterna VIII and IX as in fig. 163. Length: 2.25-2.75 mm..... *hirundinis hirundinis* (Curtis)
Very common throughout the British Isles, a monoxenous parasite of the house-martin (*Delichon urbica*), which has only been found in nests under eaves, not in those on natural sites (but reported from nests on rocks in the U.S.S.R.). Holland, Germany, Denmark, Sweden, Belgium, France, Switzerland, Austria, Poland, Hungary, Yugoslavia, Czechoslovakia, Bulgaria, U.S.S.R. (Kiev, Voronesh, Moscow, Caucasus, Georgia and Azerbaijan), Finland, Kashmir, Afghanistan and Algeria. A slightly different form, *C. h. oiticus* Peus, has been described from Greece.
- Movable process not so distinctly triangular and without spiniform setae..... 3



FIGS. 163-165.—*Ceratophyllus hirundinis hirundinis*. 163, Clasper, sternum IX and sternum VIII; 164, Metathorax, ♀; 165, Sternum VII, spermatheca, and outline of part of tergum VIII.

- 3 Dorsal margin of the apical lobe of sternum IX distinctly angulate, the part beyond this angle narrower (figs. 166, 170). Spiculose area of tergum VIII triangular, large, and extending along the posterior margin (figs. 172, 174). Movable process bearing at its widest point 3 (sometimes 4) setae (figs. 166, 170); the inner surface of this process is minutely and densely spiculose.....4
- Dorsal margin of the apical lobe of sternum IX not markedly angulate; spiculose area not extending along the posterior margin of tergum VIII. Movable process smooth on the inner side, without spicules.....5
- 4 Spiculose area about as long as high (fig. 174). Movable process of the clasper about 2.7 times as long as wide (fig. 166). Apical lobe of the distal arm of sternum IX nearly four times as long as wide, its ventral margin straight for the greater part of its length; apical portion narrow (fig. 166). Apex of the crochet of phallosome broad and rounded (fig. 167). Length: 2.5-3 mm.

styx styx Rothschild

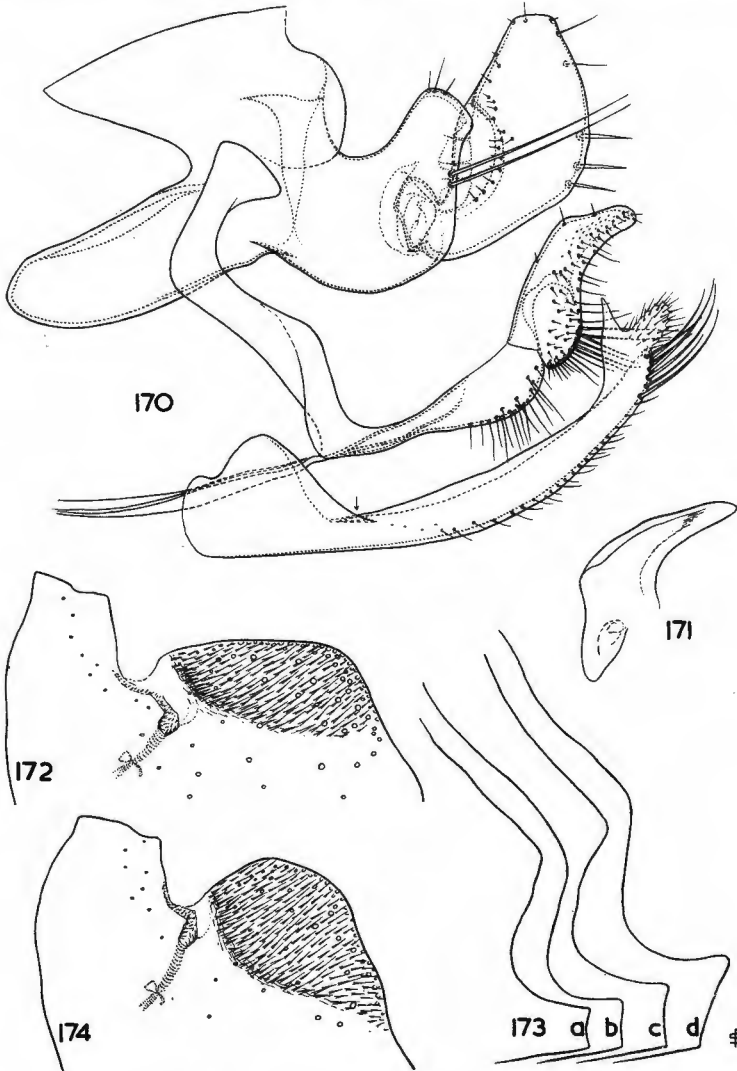


FIGS. 166-169.—*Ceratophyllus styx styx*. 166, Clasper, sternum IX and sternum VIII; 167, Aedeagal crochet; 168, Sternum VII and spermatheca; 169a-f, Outlines of sternum VII, to show variation.

Very common, a monoxenous flea of the sand martin (*Riparia riparia*). This continental subspecies has been found in the south and south-east of England, Holland, Belgium, Luxemburg, France, Germany, Denmark, Central Sweden, Poland, Austria, Switzerland, Czechoslovakia, U.S.S.R. (regions of Moscow, Gorkov, Kyzlordin, Kustanai and Stavropol).

- Spiculose area about 1.7 times as long as high (fig. 172). Movable process broad, about 1.8 times as long as wide (fig. 170). Apical lobe of distal arm of sternum IX nearly thrice as long as wide, the basal half of its ventral margin strongly convex and the apical half concave; apical portion wider than in *C. s. styx* (fig. 170). Apex of the crochet of phallosome fairly narrow and tapering to a blunt point (fig. 171). Length: 2.5-3 mm.....*styx jordani* Smit

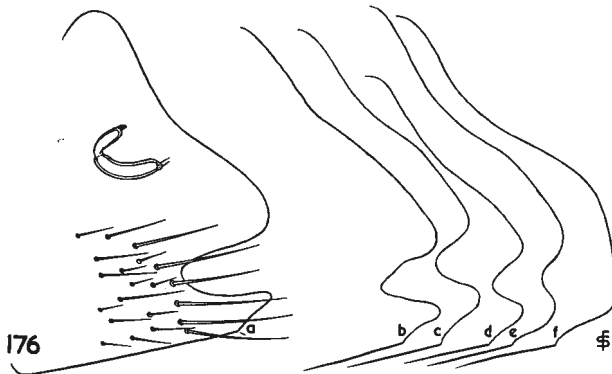
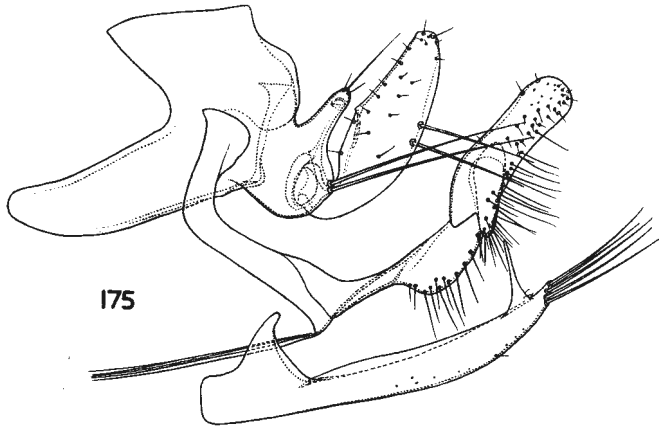
A very common monoxenous flea of the sand martin (*Riparia riparia*). This subspecies is confined to the British Isles.



FIGS. 170-174.—170-173.—*Ceratophyllus styx jordani*. 170, Clasper, sternum IX and sternum VIII; 171, Aedeagal crochet; 172, Spiculose area of tergum VIII, ♂; 173 a-d, Outlines of sternum VII, to show variation. 174. *Ceratophyllus styx styx*. Spiculose area of tergum VIII, ♂.

- 5 Membranous process of sternum VIII preapical (figs. 175, 177).....6
 - Membranous process of sternum VIII apical (figs. 180, 187, 189, 192, 195, 198)....7
 6 Spiculate area of tergum VIII fairly well developed. Membranous process of sternum VIII short and very narrow, apex of sternum VIII with 5 or 6 slender setae each side (fig. 175). Apical lobe of the distal arm of sternum IX with subparallel margins (fig. 175). Fixed process of the clasper narrow; movable process widest at the middle, where it has two long setae at the posterior margin (fig. 175). Length: 2-2.5 mm.....**farreni farreni** Rothschild

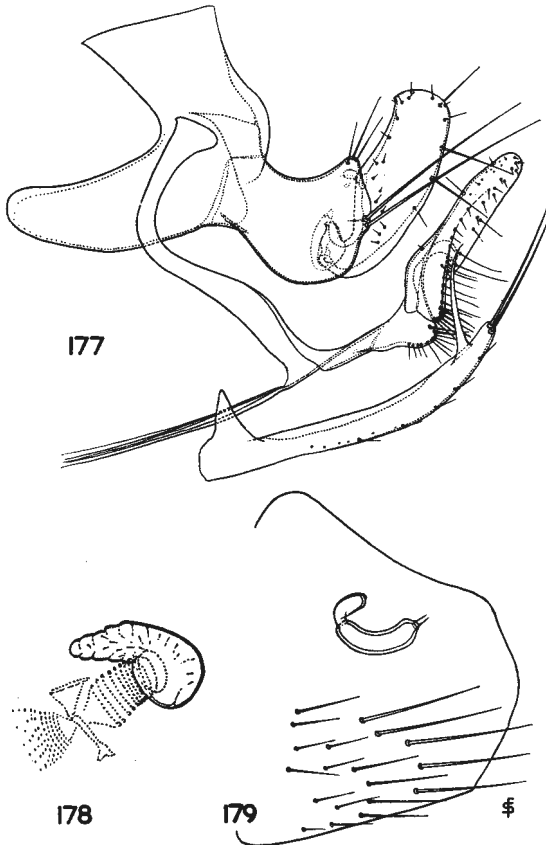
Common throughout the British Isles, a monoxenous flea of the house-martin (Delichon urbica), occurring in nests under eaves as well as in those on cliffs and rocks. Greater part of Europe and the U.S.S.R. (Kiev, Moscow and Voronezh regions, Ciscaucasia, Transcaucasia, Transbaikalia); replaced by C. f. chaoi Smit and Allan in the Far East.



FIGS. 175, 176.—*Ceratophyllus farreni farreni*. 175, Clasper, sternum IX and sternum VIII; 176 a-f, (a) Sternum VII and spermatheca, and (b-f) outlines of sternum VII to show variation.

- Spiculose area of tergum VIII very narrow. Membranous process of sternum VIII long and narrow (fig. 177), apex of sternum VIII normally with two long setae each side (fig. 177). Apical part of the distal arm of sternum IX tapering gradually; fixed process of the clasper triangular; movable process not markedly narrowing apically, none of its setae strongly developed (fig. 177). Length: 2.5-2.75 mm.....rossittensis rossittensis Dampf

Hitherto only known here from England (Hertfordshire, Northamptonshire and Cumberland). The principal hosts of this rather uncommon flea are the carrion crow (*Corvus corone*) and the hooded crow (*Corvus cornix*); since owls frequently make use of deserted crows' nests it has also been found on owls (in England on the barn-owl (*Tyto alba*)). Also taken once from the nest of the sparrow-hawk (*Accipiter nisus*) at Tring. On the continent this subspecies has been found in Holland, Germany and Lithuania; a closely related subspecies, *C. r. swansoni* Liu, is found in North America.



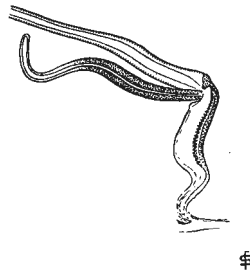
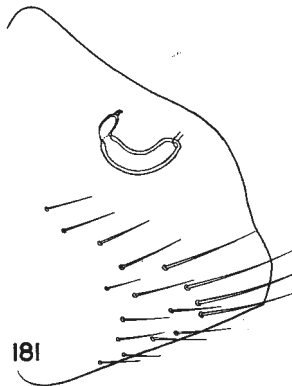
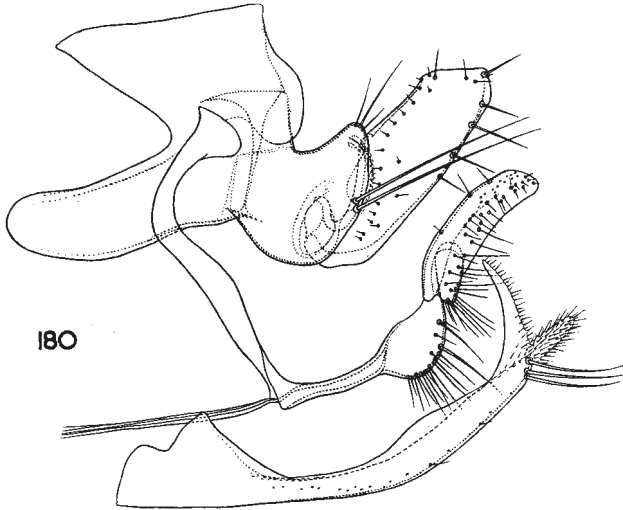
Figs. 177-179.—*Ceratophyllus rossittensis rossittensis*. 177, Clasper, sternum IX and sternum VIII; 178, Spiracle of tergum VII, ♀; 179, Sternum VII and spermatheca.

- 7 Apical margin of the movable process of the clasper, which is about thrice as long as wide, very oblique, its posterior margin with 5 or 6 small setae along the upper half; apical membranous process of sternum VIII with a narrow spiculate apical lobe (fig. 180); basal portion of the apical lobe of sternum IX not wider than the apical portion (fig. 180). Length: 2.5-2.75 mm.

vagabundus insularis Rothschild

Fairly common throughout the British Isles, occurring in nests of sea-birds such as the herring-gull (*Larus argentatus*), puffin (*Fratercula arctica*), fulmar petrel (*Fulmarus glacialis*), shag (*Phalacrocorax aristotelis*) and cormorant (*Phalacrocorax carbo*), but inland especially in nests of the jackdaw (*Corvus monedula*) and crows (*Corvus spp.*). On the continent only known from Belgium and North Germany. *C. v. vagabundus* (Boheman) occurs in Sweden, Finland, Spitsbergen, Central Asia and Canada, while *C. v. alpestris* Jordan is found in Switzerland.

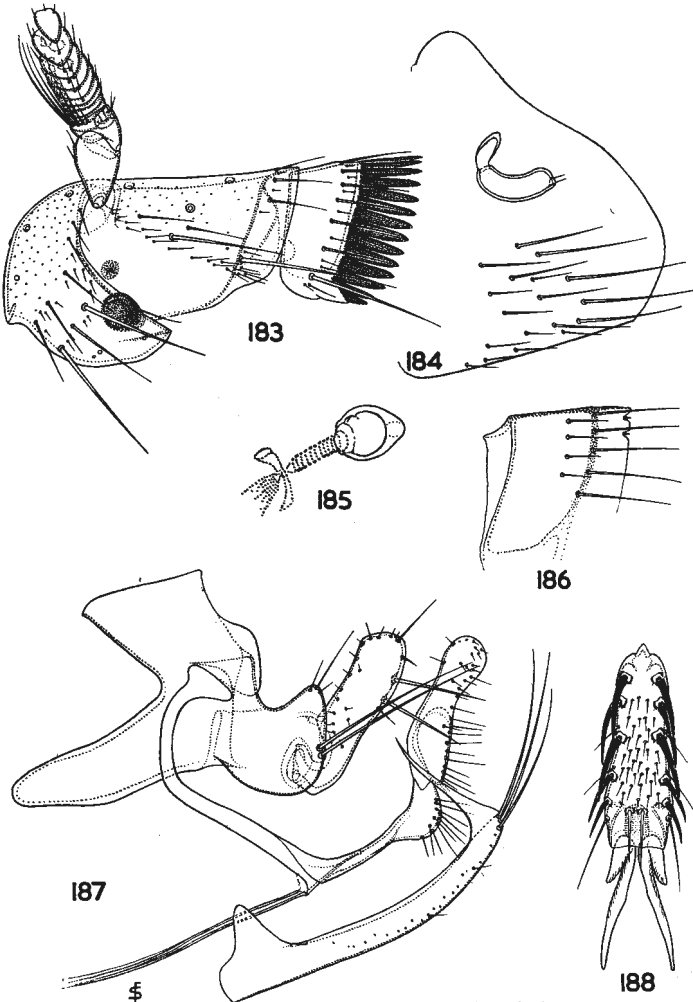
- Not so8
 8 Fixed process of the clasper triangular (figs. 187, 189); membranous process of sternum VIII very narrow (figs. 187, 189); tendons of sternum IX and of phallosome making at least one convolution (fig. 9).....9



FIGS. 180-182.—*Ceratophyllus vagabundus insularis*. 180, Clasper, sternum IX and sternum VIII; 181, Sternum VII and spermatheca; 182, Female genital ducts.

- Fixed process large and broad, with a truncate apex (figs. 192, 195, 198); membranous process of sternum VIII very broad basally and either long or extremely short (figs. 192, 195, 198); tendons of sternum IX and of phallosome making less than one convolution.....10
- 9 Apical membranous process of sternum VIII forming a right angle with the long axis of the sternum; apex of this sternum normally with two long setae each side; two of the setae on the posterior margin of the movable process well-developed; apical lobe of distal arm of sternum IX with a widened apex (fig. 187). Length: 2-2.5 mm.....*gallinae gallinae* (Schrank)

The commonest bird flea throughout the British Isles, recorded from about 75 different hosts; it prefers relatively dry nests in shrubs or in trees, and is especially common in those of: starling (Sturnus vulgaris), sparrow (Passer domesticus), owls (Athene, Asio, Strix, Tyto), crows (Corvus spp.), tits (Parus spp.), sparrow-hawk



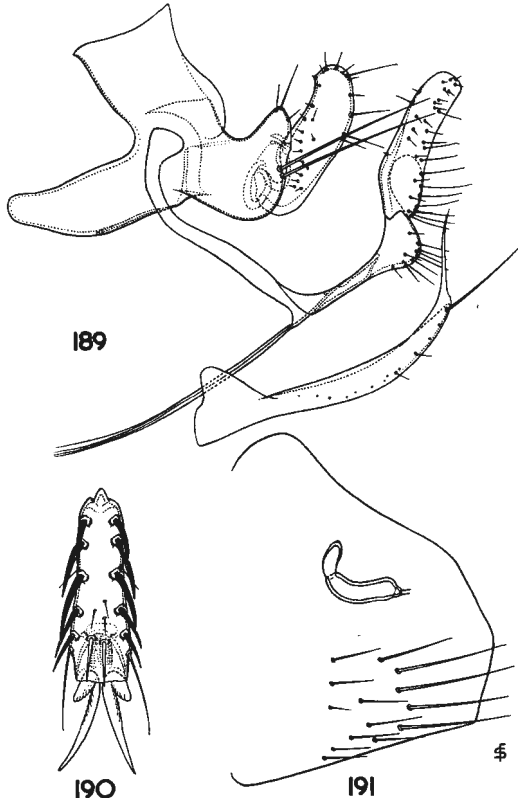
FIGS. 183-188.—*Ceratophyllus gallinae gallinae*. 183, Head and pronotum, ♂; 184, Sternum VII and spermatheca; 185, Spiracle of tergum VII, ♀; 186, Metanotum, ♀; 187, Clasper, sternum IX and sternum VIII; 188, Last hind tarsal segment, ♂.

(*Accipiter nisus*), magpie (*Pica pica*), wagtails (*Motacilla* spp.) and nuthatch (*Sitta europaea*); this flea is frequently found in association with *Dasypsyllus gallinulae*. It is the common flea of poultry and often becomes a real pest in hen-houses; it attacks man readily, as most other bird fleas do. Throughout Europe, to the Caucasus and western Siberia; also introduced into eastern U.S.A. and New Zealand. Replaced in the south-eastern part of European U.S.S.R. and Central Asia by *C. g. tribulis* Jordan, in Korea and the Maritime territory of the U.S.S.R. by *C. g. dilatatus* Dudolkina.

- Apical membranous process of sternum VIII forming more or less a continuation of the sternum; apex of this sternum normally with only one slender seta each side; none of the setae of the movable process very strong; apical lobe of sternum IX with subparallel margins (fig. 189). Length: 1.75–2.25 mm.

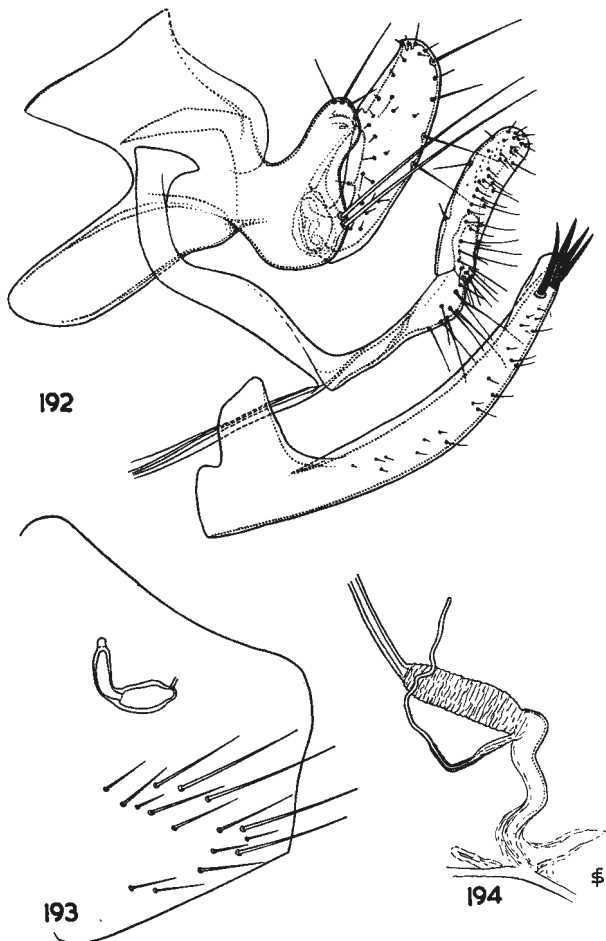
fringillae (Walker)

Common, doubtless throughout the British Isles, but not yet recorded from Wales and Ireland. A specific flea of the house sparrow (*Passer domesticus*) and possibly of the starling (*Sturnus vulgaris*), but not infrequently found in very dry nests of a number of other birds, especially Passerines. Jersey, Holland, Germany, Denmark, Belgium, France, Switzerland, Austria, Yugoslavia, Czechoslovakia, Greece, Palestine, Finland, Poland, U.S.S.R. (Ciscaucasia, nr. the Aral Sea, Ust-Urt, Tadzhik).



FIGS. 189–191.—*Ceratophyllus fringillae*. 189, Clasper, sternum IX and sternum VIII; 190, Last hind tarsal segment, ♂; 191, Sternum VII and spermatheca.

- 10 Apical membranous process of sternum VIII very small, apex of this sternum with several dark stout spiniform setae and without slender setae (fig. 192). Movable process of the clasper and sternum IX as in fig. 192. Length: 2.5-3 mm..... *columbae* (Gervais)
Fairly common, throughout the British Isles; a specific flea of the rock dove (Columba livia) and of the domestic pigeon. Holland, Germany, Denmark, Sweden, France, Spain, Czechoslovakia, Austria, Italy, Yugoslavia, Poland, Finland, European U.S.S.R. (Kiev, Caucasus).
- Apical membranous process of sternum VIII much larger; apex of this sternum with at least one slender seta each side besides shorter, stout, spiniform seta (figs. 195, 198)..... 11

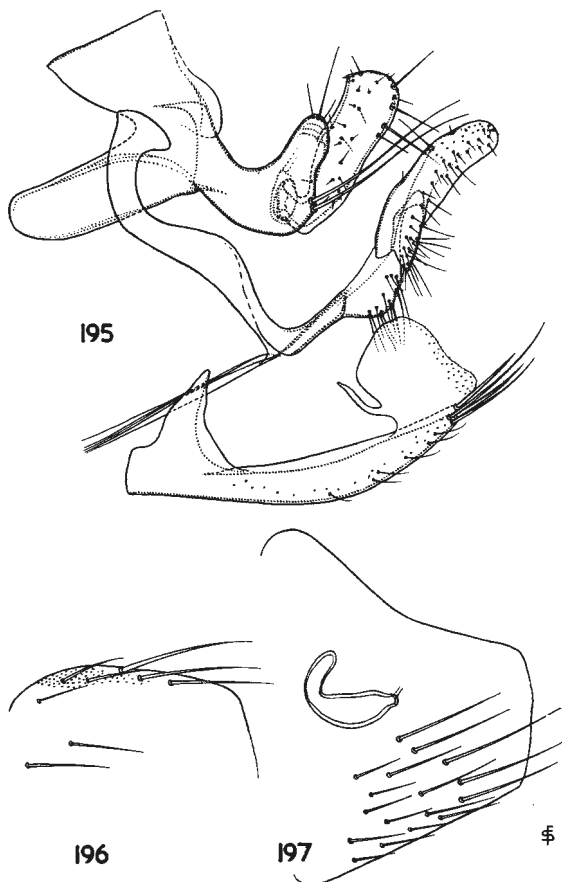


Figs. 192-194.—*Ceratophyllus columbae*. 192, Clasper, sternum IX and sternum VIII; 193, Sternum VII and spermatheca; 194, Female genital ducts.

- 11 Spiculose area of tergum VIII very narrow (fig. 196); membranous process of sternum VIII very broad, with a fingerlike process on its anterior margin (fig. 195); movable process and sternum IX as in fig. 195. Length: 2-2.5 mm.

garei Rothschild

Common throughout the British Isles, but apparently absent from some of the small islands off the coast where *C. borealis* is dominant. Birds' nests in damp places on or a little above the ground are those preferred by this common flea, such as the nests of the reed-bunting (*Emberiza schoeniclus*), sky-lark (*Alauda arvensis*), meadow-pipit (*Anthus pratensis*), bearded tit (*Panurus biarmicus*), grasshopper-warbler (*Locustella naevia*), ring ouzel (*Turdus torquatus*), ducks (*Anas*, *Spatula*, *Aythya*, *Somateria*, *Melanitta*, *Mergus*), snipe (*Capella gallinago*), dunlin (*Calidris alpina*), redshank (*Tringa totanus*), ringed plover (*Charadrius hiaticula*), lapwing (*Vanellus vanellus*), gulls (*Larus spp.*), and red grouse (*Lagopus scoticus*). Germany, Holland, Denmark, Belgium, France, Czechoslovakia, Norway, Lapland, Finland, Poland, Iceland, Greenland, northern U.S.S.R. to Kamchatka, Caucasus, Altai, Transbaikalia, Mongolia, Maritime Territory of the U.S.S.R., Canada, Utah.

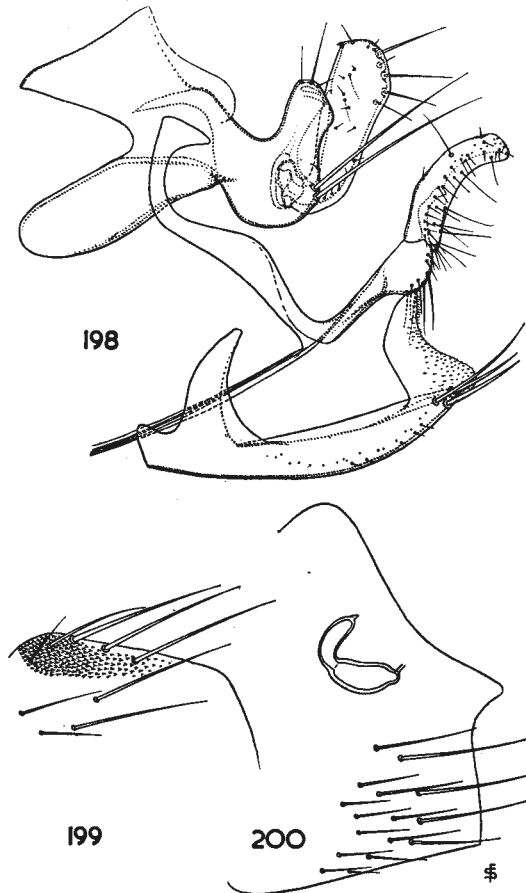


Figs. 195-197.—*Ceratophyllus garei*. 195, Clasper, sternum IX and sternum VIII; 196, Dorsal part of tergum VIII, ♂; 197, Sternum VII and spermatheca.

- Spiculose area of tergum VIII broad (fig. 199); membranous process of sternum VIII less broad and usually without a finger-like process (fig. 198); movable process and the characteristic sternum IX as in fig. 198. Length: 2–2.75 mm.

borealis Rothschild

Common in birds' nests on rocks and cliffs, and under stones in cool places. In Britain rarely far from the sea, e.g. in nests of wheatear (*Oenanthe oenanthe*), rock-pipit (*Anthus spinoletta*), dipper (*Cinclus cinclus*), herring-gull (*Larus argentatus*), white wagtail (*Motacilla alba*), pied flycatcher (*Muscicapa hypoleuca*), redstart (*Phoenicurus phoenicurus*), arctic tern (*Sterna macrura*) and gannet (*Sula bassana*); especially common in the nest of the wheatear in islands west and north of Great Britain, but also inland. Holland, the isle of Sylt (N. Germany), Switzerland, Italian Dolomites, France, Iceland, Greenland, Finland, Karelian Isthmus, Greece, Caucasus, Azerbaijan.



FIGS. 198–200.—*Ceratophyllus borealis*. 198, Clasper, sternum IX and sternum VIII; 199, Dorsal part of tergum VIII, ♂; 200, Sternum VII and spermatheca.

Females

- 1 Bulga of spermatheca cylindrical (fig. 12); the basal part of the duct of spermatheca basally not strongly dilated or wrinkled (fig. 12)..... 2
- Bulga of spermatheca swollen (fig. 13); duct of spermatheca basally distinctly dilated and wrinkled (fig. 13)..... 10
- 2 Pleural arch of metathorax absent (fig. 161). Dorso-posterior angle of tergum VIII forming a sharp hook (fig. 162); sternum VII and spermatheca as in fig. 162. Length: 2.25-3 mm..... **rusticus** Wagner
- Pleural arch of metathorax well-developed (fig. 164)..... 3
- 3 Collar of metanotum membranous (figs. 161, 164)..... 4
- Collar of metanotum well-developed (fig. 186)..... 5
- 4 Dorso-posterior angle of tergum VIII broadly rounded; sternum VII without a sinus, but usually with a small lateral lobe (fig. 165); sternum IX with many small setae (fig. 12). Length: 2.5-3 mm..... **hirundinis hirundinis** (Curtis)
- Dorso-posterior angle of tergum VIII rounded-off more acutely; sternum VII usually with a deep sinus, which, however, may be small or even absent (fig. 176 *a-f*); sternum IX with only a few small setae. Length: 2.25-3.5 mm.
farreni farreni Rothschild
- 5 Posterior margin of sternum VII distinctly angulate, with about 30 or more setae on its lateral surface..... 6
- Posterior margin of sternum VII without this angle or with a much less distinct one, with no more than 20 setae on its lateral surface..... 7
- 6 Sternum VII without a prominent ventral lobe, but with a rather variable lateral lobe below which the margin may be either straight or concave (figs. 168, 169). Length: 2.5-3.25 mm..... **styx styx** Rothschild
- Sternum VII with a broad ventral lobe, above which the margin is deeply sinuate (fig. 173). Length: 2.5-3.25 mm..... **styx jordani** Smit
- 7 Posterior margin of sternum VII partially almost straight; hilla of spermatheca very short (fig. 181); part of the ductus bursae strongly sclerotised longitudinally (fig. 182). Length: 2.75-3.5 mm..... **vagabundus insularis** Rothschild
- Posterior margin of sternum VII more rounded; ductus bursae not strongly sclerotised..... 8
- 8 Planta of all tarsi with only a few minute setae (fig. 190); tergum II usually with 3 spinelets each side; posterior margin of sternum VII with two rounded angles (fig. 191). Length: 1.75-2.5 mm..... **fringillae** (Walker)
- Planta of all tarsi with numerous small setae (fig. 188); with 2 (occasionally 3) spinelets each side on tergum II..... 9
- 9 Spiracular fossa of tergum VII circular (fig. 185). Sternum VII strongly and smoothly rounded; hilla of spermatheca tapering (fig. 184). Length: 2.5-3 mm..... **gallinae gallinae** (Schrank)
- Spiracular fossa of tergum VII as in fig. 178. Sternum VII with a more angulate margin; hilla of spermatheca with a blunt apex (fig. 179). Length: 3-3.75 mm.
rossittensis rossittensis Dampf
- 10 Sternum VII with a distinct lobe (fig. 200); spermatheca very characteristic, see fig. 200. Length: 2.5-3.5 mm..... **borealis** Rothschild
- Sternum VII normally without a distinct lobe..... 11
- 11 Upper side of bulga of spermatheca slightly concave, lower side strongly convex; hilla without a papilla; wall of bulga usually not very thick (figs. 13, 197). Spines of pronotal comb about as long as the length of the pronotum. Sternum VII as in fig. 197. Blind duct short and feebly sclerotised (fig. 13). Length: 2.5-3.5 mm..... **garei** Rothschild
- Spines of pronotal comb about half as long as the length of the pronotum. Sternum VII as in fig. 193. Upper and lower side of bulga of spermatheca convex; hilla with a papilla; wall of bulga thick (fig. 193). Blind duct long and partly sclerotised (fig. 194). Length: 2.5-3.5 mm..... **columbae** (Gervais)

HOST-ASSOCIATIONS OF FLEAS IN BRITAIN

Fleas are ectoparasites of warm-blooded vertebrates (mammals and birds) and their entire development, from egg to adult, takes place in the nest or dwelling-place of the host. Since these ecological milieus may differ considerably according to the host species, the immature stages of each species of flea are adapted to a certain environment. Most fleas are not strictly host-specific, but are nest-specific, since they must to a large extent be dependent on ecological factors governing their development, more so than on the species or type of warm-blooded animal from which the adults obtain their food; the adult's choice of blood is often rather varied and seems of secondary importance in determining host-specificity. In many cases the adult fleas appear to feed on any available animal, though this will usually be the one that built and occupies the nest; under abnormal circumstances they may find themselves on other hosts and in many instances they then suck blood from these accidental hosts, even if the temperature of the blood is different from that of the normal host (e.g., bird fleas will readily feed on man).

In the case of the bird fleas, we find that in Britain birds which construct nests on the ground, particularly those in damp surroundings, such as the ducks, waders, gulls, etc., are the principal hosts for *Ceratophyllus garei*, whereas birds which build dry, aerial nests, such as the starlings, tits and sparrow-hawks, are most heavily parasitised by *C. gallinae*; and species such as the warblers, which build in relatively low plants and bushes, are favoured by *Dasypsyllus gallinulae*. Furthermore, *C. vagabundus* is chiefly found in nests on rocks round the coast. The fleas *Frontopsylla laeta* and *Callopsylla waterstoni* have so far been found only in those house-martins' nests which are built on rocks and cliffs, and not in nests of the same species of bird built under eaves of buildings. However, other factors, notably an apparent competition between species of fleas, various methods of dispersal and host preferences all influence the proportions of these bird fleas in the various hosts' nests.

In the following host-flea index those fleas are listed that are typically the dominant species for each category of hosts.⁴ Certain birds will be found under more than one heading, according to their diversity in nesting-habitat. It must, however, be clearly understood that from time to time *Ceratophyllus gallinae* may be found in wet nests, or *C. garei* or *C. borealis* in dry, aerial nests, and it is quite usual to find three different species such as *C. borealis*, *C. gallinae* and *D. gallinulae* in one and the same nest—for example that of the wheatear.

E = England; W = Wales; S = Scotland; I = Ireland (all including their surrounding smaller islands).

⁴ Certain hosts have had to be considered separately because they have a flea specific to themselves. Thus the rabbit (often classed as a rodent) has a flea peculiar to itself and must be considered as a separate category; pigeons, nesting in various situations, also have a flea which is not found on other birds nesting in similar places.

MAMMALS

I. Mammals which make no proper nest (Man and domestic animals).

(1) *Homo sapiens* L.—Man; (2) *Canis familiaris* L.—Dog; (3) *Felis catus* L.—Cat; (4) *Sus scrofa domestica* L.—Pig.

Ctenocephalides canis—2: EWSI.

Ctenocephalides felis felis—2: ESI; 3: EWSI.

Pulex irritans—1: EWSI; 2: ESI; 4: E.

II. Carnivores with a subterranean nest.

(1) *Meles meles* (L.)—Badger; (2) *Vulpes vulpes* (L.)—Fox.

Ctenocephalides canis—2: EWSI.

Paraceras melis melis—1: EWI; 2: EI.

Pulex irritans—1: E; 2: E.

III. Small mammals with a subterranean nest.

Insectivores

SORICIDAE: (1) *Sorex araneus* L.—Common shrew; (2) *Sorex minutus* L.—Pygmy shrew; (3) *Neomys fodiens* (Pennant)—Water shrew.

Doratopsylla dasyncnema dasyncnema—1: EWS; 2: E; 3: S.

Palaeopsylla soricis soricis—1: EWS; 2: ESI; 3: EWS.

TALPIDAE: *Talpa europaea* L.—Mole.

Ctenophthalmus bisocodentatus occidentalis—EWS.

Hystrihopsylla talpae talpae—EWS.

Palaeopsylla minor minor—EWS.

Palaeopsylla kohauti—ES.

Rodents

MURINAE: (1) *Apodemus sylvaticus* (L.)—Wood-mouse; (2) *Apodemus flavicollis* (Melchior)—Yellow-necked wood-mouse.

Ctenophthalmus nobilis spp.—1: EWSI; 2: E.

Hystrihopsylla talpae talpae—1: ESI.

Rhadinopsylla pentacantha—1: EWSI.

Typhloceras poppei—1: ESI.

MICROTINAE: (1) *Arvicola terrestris* (L.)—Water vole; (2) *Clethrionomys glareolus* (Schreber)—Bank vole; (3) *Clethrionomys rufocanus* (Sundevall)—Large-toothed bank vole; (4) *Microtus agrestis* (L.)—Field vole; (5) *Microtus orcadensis* Millais—Orkney vole.

Ctenophthalmus congener congener—2: E.

Ctenophthalmus nobilis spp.—1: ES; 2: EWS; 3: S; 4: EWS; 5: S.

Hystrihopsylla talpae talpae—1: ES; 2: EWS; 4: EWS; 5: S.

Malariaeus penicilliger mustelae—2: EWS; 3: S; 4: EWS; 5: S.

Megabothris rectangulatus—2: ES, 4: S.

Megabothris turbidus—2: EW, 4: E.

Megabothris walkeri—1: ES, 2: ES, 4: EWS.

Peromyscopsylla silvatica spectabilis—2: ES; 4: ES.

Rhadinopsylla integella—2: S; 4: S.

Rhadinopsylla isacantha—2: E.

Rhadinopsylla pentacantha—2: EWS; 4: EWS.

IV. Small rodents with nest on or close to the ground.

In the field⁵ : (1) *Mus musculus* L.—House-mouse ; (2) *Rattus norvegicus* (Berkenhout)—Brown rat.

Ctenophthalmus nobilis spp.—1 : EWS ; 2 : EWSI.

Nosopsyllus fasciatus—1 : EWS ; 2 : EWSI.

In or around buildings and human habitations : (1) *Mus musculus* L.—House-mouse ; (2) *Rattus norvegicus* (Berkenhout)—Brown rat ; (3) *Rattus rattus* (L.)—Black rat.

Leptopsylla segnis—1 : ESI ; 2 : EW ; 3 : EW.

Nosopsyllus fasciatus—1 : EWS ; 2 : EWSI ; 3 : EW.

Nosopsyllus londiniensis—1 : ES ; 2 : EW ; 3 : E.

Xenopsylla brasiliensis—[3] : W.

Xenopsylla cheopis—2 : EW ; 3 : EW.

V. Arboreal rodents nesting in shrubs and trees.

(1) *Sciurus vulgaris* L.—Red squirrel ; (2) *Sciurus carolinensis* Gmelin—Grey squirrel ; (3) *Glis glis* (L.)—Edible dormouse ; (4) *Muscardinus avellanarius* (L.)—Dormouse.

Monopsyllus sciurorum sciurorum—1 : EWSI ; 2 : EI ; 3 : E ; 4 : E.

Orchopeas howardi howardi—1 : E ; 2 : EWI ; 3 : E.

Tarsopsylla octodecimdentata octodecimdentata—1 : S.

VI. *Oryctolagus cuniculus* (L.)—Rabbit.

Spilopsyllus cuniculi—EWSI.

VII. *Erinaceus europaeus* L.—Hedgehog.

Archaeopsylla erinacei erinacei—EWSI.

VIII. Bats.

Roosting in holes in buildings, under roofs,⁶ etc., and hibernating in caves : (1) *Myotis daubentoni* (Kuhl)—Daubenton's bat ; (2) *Myotis mystacinus* (Kuhl)—Whiskered bat ; (3) *Myotis nattereri* (Kuhl)—Natterer's bat ; (4) *Rhinolophus ferrumequinum* (Schreber)—Greater horseshoe bat ; (5) *Rhinolophus hipposideros* (Bechstein)—Lesser horseshoe bat.

Ischnopsyllus simplex simplex—1 : E ; 2 : EW ; 3 : EWI ; 4 : E ; 5 : E.

⁵ The harvest-mouse *Micromys minutus* (Pallas) would come into this section ; its nest is built interwoven among shrubs or stalks, or in standing corn less than a foot from the ground, but is apparently unsuitable (too dry ?) for fleas to breed in (only a few specimens of the very common mouse-flea *Ctenophthalmus nobilis* have been collected from this host).

⁶ One should bear in mind that the use by bats of buildings as a roosting place during their period of activity (i.e., the breeding-period of a number of bat fleas), or for hibernation, is a relatively recently acquired habit, which makes it difficult to determine the original natural roosting or hibernating sites of several bats ; this habit facilitates an interchange of fleas between species of bats which originally may not have come in contact with each other. The widespread erection of buildings has no doubt assisted the spread of a number of insectivorous bats, just as it caused the spread of the house-martin, which is really a bird of rocks and cliffs.

Roosting under roofs, in crevices in buildings or trees, etc., hibernating under roofs or in crevices or small holes in caves near the entrances (not true "cave-bats"): (1) *Barbastella barbastellus* (Schreber)—Barbastelle; (2) *Plecotus auritus* (L.)—Long-eared bat.

Ischnopsyllus hexactenus—1 : E ; 2 : EI.

Roosting and hibernating principally in crevices and cracks of rocks, buildings, etc. (not in caves): *Pipistrellus pipistrellus* (Schreber)—Pipistrelle.

Ischnopsyllus octactenus—EWSI.

Nycteridopsylla longiceps—EI.

Roosting and hibernating principally in holes in trees⁷: (1) *Eptesicus serotinus* (Schreber)—Serotine bat; (2) *Nyctalus leisleri* (Kuhl)—Leisler's bat; (3) *Nyctalus noctula* (Schreber)—Noctule.

Ischnopsyllus elongatus—1 : E ; 3 : E.

Ischnopsyllus intermedius—1 : E ; 2 : E ; 3 : E.

Nycteridopsylla eusarca—3 : E.

BIRDS

I. Nest on or close to the ground.

(1) *Carduelis flavirostris* (L.)—Twite; (2) *Emberiza calandra* L.—Corn-bunting; (3) *Emberiza cirulus* L.—Cirl bunting; (4) *Emberiza citrinella* L.—Yellow bunting; (5) *Emberiza schoeniclus* (L.)—Reed-bunting; (6) *Lullula arborea* (L.)—Wood-lark; (7) *Alauda arvensis* L.—Sky-lark; (8) *Anthus pratensis* (L.)—Meadow-pipit; (9) *Anthus trivialis* (L.)—Tree-pipit; (10) *Phylloscopus sibilatrix* (Bechstein)—Wood-warbler; (11) *Phylloscopus trochilus* (L.)—Willow-warbler; (12) *Locustella naevia* (Boddaert)—Grasshopper-warbler; (13) *Turdus torquatus* L.—Ring-ouzel; (14) *Erithacus rubecula* (L.)—Robin; (15) *Saxicola rubetra* (L.)—Whinchat; (16) *Saxicola torquata* (L.)—Stonechat; (17) *Falco columbarius* L.—Merlin; (18) *Circus pygargus* (L.)—Montagu's Harrier; (19) *Anas acuta* L.—Pintail; (20) *Anas platyrhynchos* L.—Mallard; (21) *Spatula clypeata* (L.)—Shoveler; (22) *Aythya fuligula* (L.)—Tufted duck; (23) *Somateria mollissima* (L.)—Common eider; (24) *Melanitta nigra* (L.)—Common scoter; (25) *Mergus serrator* L.—Red-breasted merganser; (26) *Scolopax rusticola* L.—Woodcock; (27) *Capella gallinago* (L.)—Snipe; (28) *Calidris alpina* (L.)—Dunlin; (29) *Actitis hypoleucos* (L.)—Common sandpiper; (30) *Tringa totanus* (L.)—Redshank; (31) *Charadrius hiaticula* L.—Ringed plover; (32) *Vanellus vanellus* (L.)—Lapwing; (33) *Larus argentatus* Pontoppidan—Herring-gull; (34) *Larus canus* L.—Common gull; (35) *Larus fuscus* L.—Lesser black-backed gull; (36) *Larus marinus* L.—Great black-backed gull; (37) *Larus ridibundus* L.—Black-headed gull; (38) *Stercorarius parasiticus* (L.)—Arctic skua; (39) *Gallinula chloropus* (L.)—Moorhen; (40) *Lagopus scoticus* (Latham)—Red grouse; (41) *Phasianus colchicus* L.—Pheasant; (42) *Perdix perdix* (L.)—Common partridge; (43) *Alectoris rufa* (L.)—Red-legged partridge; (44) *Gallus gallus domesticus* (L.)—Domestic fowl.

⁷ *Myotis bechsteini* (Kuhl), of which no fleas are yet known, belongs apparently to this category although in The Netherlands it appears to hibernate in caves only.

Ceratophyllus gallinae gallinae—1: S; 4: ESI; 5: E; 7: S; 9: S; 10: E; 11: ES; 12: E; 14: ES; 15: S; 16: W; 17: S; 38: S; 39: E; 40: S; 41: E; 42: E; 44: ES.

Ceratophyllus garei—2: S; 3: E; 4: E; 5: E; 7: ESI; 8: ES; 12: E; 13: E; 14: W; 18: E; 19: S; 20: ES; 21: S; 22: E; 23: ES; 24: S; 25: I; 26: S; 27: S; 28: S; 30: S; 31: S; 32: S; 33: S; 34: S; 35: S; 36: I; 38: S; 39: ES; 40: ES; 41: ES; 42: ES; 43: E.

Dasypsyllus gallinulae gallinulae—1: S; 2: E; 3: E; 4: ES; 5: E; 6: E; 7: SI; 8: ES; 9: S; 10: S; 11: EWS; 12: EWS; 14: EWSI; 15: S; 16: ES; 26: S; 32: S; 39: ES; 40: S; 41: S.

II. Nest in shrubs or bushes.

(1) *Garrulus glandarius* (L.)—Jay; (2) *Chloris chloris* (L.)—Greenfinch; (3) *Carduelis cannabina* (L.)—Linnet; (4) *Carduelis carduelis* (L.)—Goldfinch; (5) *Pyrrhula pyrrhula* (L.)—Bullfinch; (6) *Fringilla coelebs* L.—Chaffinch; (7) *Emberiza cirulus* L.—Cirl bunting; (8) *Emberiza citrinella* L.—Yellow bunting; (9) *Aegithalos caudatus* (L.)—Long-tailed tit; (10) *Lanius collurio* L.—Red-backed shrike; (11) *Phylloscopus collybita* (Vieillot)—Chiffchaff; (12) *Acrocephalus schoenobaenus* (L.)—Sedge-warbler; (13) *Sylvia atricapilla* (L.)—Blackcap; (14) *Sylvia borin* (Boddaert)—Garden-warbler; (15) *Sylvia communis* Latham—Whitethroat; (16) *Sylvia curruca* (L.)—Lesser whitethroat; (17) *Turdus ericetorum* Turton—Song-thrush; (18) *Turdus merula* L.—Blackbird; (19) *Prunella modularis* (L.)—Hedge-sparrow; (20) *Troglodytes troglodytes* (L.)—Wren.

Ceratophyllus gallinae gallinae—1: E; 2: ES; 3: E; 4: E; 6: ESI; 8: ESI; 9: E; 11: E; 12: S; 14: S; 15: ES; 16: S; 17: EWSI; 18: ESI; 19: ESI; 20: ESI.

Dasypsyllus gallinulae gallinulae—1: E; 2: ESI; 5: E; 6: ESI; 7: E; 8: ES; 9: E; 10: E; 11: ES; 12: EWS; 13: ES; 14: WS; 15: EWS; 16: E; 17: ESI; 18: EWS; 19: EWSI; 20: EWSI.

III. Nest in trees.

(1) *Corvus corone* L.—Carrion crow; (2) *Corvus frugilegus* L.—Rook; (3) *Pica pica* (L.)—Magpie; (4) *Carduelis carduelis* (L.)—Goldfinch; (5) *Carduelis spinus* (L.)—Siskin; (6) *Passer domesticus* (L.)—House-sparrow; (7) *Turdus viscivorus* L.—Mistle-thrush; (8) *Asio otus* (L.)—Long-eared owl; (9) *Accipiter nisus* (L.)—Sparrow-hawk; (10) *Columba palumbus* L.—Wood-pigeon.

Ceratophyllus gallinae gallinae—1: E; 2: S; 3: E; 4: E; 5: ES; 6: EWSI; 7: ESI; 8: E; 9: ES; 10: E.

Ceratophyllus rossittensis rossittensis—1: E; 9: E.

IV. Nest in hole of tree, nesting-box or in any other aerial artificial hole.

(1) *Corvus monedula* L.—Jackdaw ; (2) *Sturnus vulgaris* L.—Starling ; (3) *Passer domesticus* (L.)—House-sparrow ; (4) *Passer montanus* (L.)—Tree-sparrow ; (5) *Motacilla alba* L.—White wagtail ; (6) *Certhia familiaris* L.—Tree-creeper ; (7) *Sitta europaea* L.—Nuthatch ; (8) *Parus caeruleus* L.—Blue tit ; (9) *Parus major* L.—Great tit ; (10) *Muscicapa striata* (Pallas)—Spotted flycatcher ; (11) *Phoenicurus ochrurus* (Gmelin)—Black redstart ; (12) *Phoenicurus phoenicurus* (L.)—Redstart ; (13) *Picus viridis* (L.)—Green woodpecker ; (14) *Dryobates major* (L.)—Great spotted woodpecker ; (15) *Jynx torquilla* L.—Wryneck ; (16) *Athene noctua* (Scopoli)—Little owl ; (17) *Strix aluco* L.—Tawny owl ; (18) *Tyto alba* (Scopoli)—Barn-owl ; (19) *Columba oenas* L.—Stock-dove.

Ceratophyllus fringillae—1 : E ; 2 : ES ; 3 : ES ; 5 : S ; 8 : E ; 9 : E ; 10 : S ; 17 : S.

Ceratophyllus gallinae gallinae—1 : ES ; 2 : ESI ; 3 : EWSI ; 4 : E ; 5 : ESI ; 6 : E ; 7 : E ; 8 : EWSI ; 9 : EWS ; 10 : ES ; 11 : E ; 12 : ES ; 13 : E ; 14 : E ; 15 : ES ; 16 : E ; 17 : ES ; 18 : E ; 19 : ES.

Ceratophyllus vagabundus insularis—1 : ES ; 10 : S ; 16 : E ; 17 : E.

Dasysyllus gallinulae gallinulae—1 : ES ; 2 : ESI ; 3 : EWS ; 4 : E ; 5 : ES ; 6 : E ; 7 : E ; 8 : ES ; 9 : ES ; 10 : ES ; 12 : ES ; 15 : S.

V. Nest in horizontal hole in sandpit or river bank.

Riparia riparia (L.)—Sand-martin.

Ceratophyllus styx ssp.—EWSI.

VI. Nest in hole in sandy soil, occupied by sea-birds.

(1) *Hydrobates pelagicus* (L.)—Storm-petrel ; (2) *Puffinus puffinus* (Brünnich)—Manx shearwater ; (3) *Fratercula arctica* (L.)—Puffin.

Ornithopsylla laetitiae—1 : EW ; 2 : EWI ; 3 : EWI.

VII. Nest on rocks, cliffs, under stones, in stone walls, all in vicinity of sea.

(1) *Corvus corax* L.—Raven. (2) *Anthus spinoletta* (Montagu)—Rock-pipit ; (3) *Motacilla alba* L.—White wagtail ; (4) *Motacilla cinerea* Tunstall—Grey wagtail ; (5) *Muscicapa hypoleuca* (Pallas)—Pied flycatcher ; (6) *Oenanthe oenanthe* (L.)—Wheatear ; (7) *Phoenicurus phoenicurus* (L.)—Redstart ; (8) *Falco peregrinus* Tunstall—Peregrine falcon ; (9) *Phalacrocorax aristotelis* (L.)—Shag ; (10) *Phalacrocorax carbo* (L.)—Cormorant ; (11) *Sula bassana* (L.)—Gannet ; (12) *Fulmarus glacialis* (L.)—Fulmar petrel ; (13) *Columba livia* Gmelin—Rock-dove ; (14) *Sterna macrura* Naumann—Arctic tern ; (15) *Larus argentatus* Pontoppidan—Herring-gull ; (16) *Rissa tridactyla* (L.)—Kittiwake.

Ceratophyllus borealis—2 : S ; 3 : S ; 4 : ES ; 5 : S ; 6 : EWSI ; 7 : S ; 11 : S ; 14 : S ; 15 : ES.

Ceratophyllus vagabundus insularis—1 : I ; 8 : E ; 9 : SI ; 10 : E ; 12 : S ; 13 : S ; 15 : SI ; 16 : SI.

VIII. Nest of house-martin *Delichon urbica* (L.).

Under eaves of buildings :

Ceratophyllus farreni farreni—EWSI.

Ceratophyllus hirundinis hirundinis—EWSI.

Ceratophyllus rusticus—ES.

On natural sites (against rocks and cliffs) :

Ceratophyllus farreni farreni—S.

Ceratophyllus rusticus—S.

Frontopsylla laeta—S.

Callopsylla waterstoni—S.

IX. Nest of pigeons.

(1) *Columba livia* Gmelin—Rock-dove ; (2) *Columba livia domestica* L.—Domestic pigeon ; (3) *Columba oenas* L.—Stock-dove ; (4) *Columba palumbus* L.—Wood-pigeon.

Ceratophyllus columbae—1 : ES ; 2 : E ; 4 : E.

Ceratophyllus gallinae gallinae—1 : ESI ; 3 : ES ; 4 : E.

REFERENCE.

SMIT, F. G. A. M., 1957, The recorded distribution and hosts of Siphonaptera in Britain. *Ent. Gaz.* 8 : (45-75)

This paper forms a supplement to this *Handbook* and contains the recorded hosts and county records per species and a bibliography of nearly 300 items. Reprints can be obtained from the Editor of the *Entomologist's Gazette*, 22 Harlington Road East, Feltham, Middlesex.

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