A REVISION OF THE INDIAN SIPHONAPTERA.

PART I.—FAMILY PULICIDAE.

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INTRODUCTION.

This paper on the fleas of the family Pulicidae is the first part of a revision of the Indian fleas on which I have been engaged for some time. The collection of fleas of the other families of Siphonaptera at my disposal is unfortunately small; it represents only a few of the genera and species known from the Indian Region. I am, however, getting together collections of these forms and other papers in this series will appear as material becomes available.

The study of fleas of the family Pulicidae, owing to their importance as the vectors of the virus of bubonic plague between rat and rat and rat and man, has become very popular with parasitologists, but no comprehensive and up-to-date monograph on the group has been published so far. The published descriptions of the various Indian species are poor and incomplete, and are further scattered in not easily accessible journals published in different languages. In this paper I have redescribed all the species, as in most cases the previous descriptions, in view of the recent increase in the number of species and of our knowledge of this group, are of little value for separating the different species.

In my descriptions I have used the same terminology as is used by Jordan and Rothschild in their latest papers on fleas[1]. I have laid especial stress on characters which are of use for separating the different species, and have ignored others which are neither constant nor of any use in this connection. I attach a great importance to chaetotaxy, even though it is not especially valuable for systematic purposes; it has, however, been found very useful by several recent workers on this group for separating the different species. In giving the number of bristles in a row on a tergite or sternite I have counted the bristles on both sides of the plate, as the record of the number of bristles on only one side gives a wrong idea of the exact number of bristles on the plate.

The number of species belonging to this family recorded from a big country like India is rather small. This I believe is due to lack of interest in the collection of fleas both by the Indian entomologists and general collectors. When I started my work there were hardly more

[1] For accounts of the general structure of fleas and terminology employed by workers on fleas the accounts in Patton and Cragg's *A Textbook of Medical Entomology*, pp. 434-446, pls. liii-lv. (London, 1913), Fox's *Insects and Disease of Man*, pp. 112-130 (London, 1925), introduction to Jordan and Rothschild's papers published in *Parasitology* I, pp. 17-33 (1908) and in *The Thompson Yates and Johnston Laboratories Report* (n. s.) VII, pp. 19-41 (1906), may be consulted.

than a dozen tubes of fleas in the collection of the Indian Museum, and the collections which I received for examination from various Medical, Veterinary and Agricultural institutes of this country were also similarly poor. The greater portion of the collection on which I have worked was got together during 1927, through a circular letter sent at my request by Lt.-Col. R. B. Seymour Sewell, Director, Zoological Survey of India, to the heads of the Public Health and the Civil Veterinary Departments in the different provinces of India, requesting them to arrange for fleas to be especially collected for me. The results were not over encouraging as only about three hundred tubes of fleas, mostly from common animals such as the cat, dog, cattle, sheep, goat and rat from places sparsely scattered all over India and Burma were obtained.

I owe my best thanks to Mr. T. Bainbrigge Fletcher, Imperial Entomologist to the Government of India, who was kind enough to lend me his card-catalogue of the Indian fleas which has been of great use to me during my study of the group, and the collection of fleas in the Imperial Agricultural Research Institute, Pusa. I am thankful to Dr. C. Strickland, Professor of Medical Entomology, who lent me the identified and unidentified collections of the Calcutta School of Tropical Medicine and Hygiene for examination. The identified collection mostly consisted of specimens identified by the late Hon. N. Charles Rothschild, and has proved of great help in identifying other specimens. I am also obliged to the following gentlemen for sending me collections belonging to their respective institutions for examination :—Mr. M. A. Hussain, Entomologist to the Government of the Punjab, Lyallpur ; Mr. P. B. Richards, Entomologist to the Government of the United Provinces, Cawnpore ; Major H. E. Shortt, Director of the Kala-Azar Commission, Camp Gauhati, Assam ; Major H. H. King, Director, King Institute, Guindy ; Major S. S. Sokhey, Director, Haffkine Institute, Bombay ; the Director, Imperial Institute of Veterinary Research, Muktesar ; the Director, Central Research Institute, Kasauli.

The present work was undertaken at the suggestion of my chief Lt.-Col. R. B. Seymour Sewell, and I am obliged to him for the interest he has taken in my work. Dr. B. Prashad has kindly read through and revised my manuscript and made several valuable suggestions for which I am indebted to him.

The text-figures illustrating this paper are all camera-lucida drawings and were finished from my pencil sketches by Babu Subodh Mondul, one of the artists of the Zoological Survey of India.

PULICIDAE.

The family Pulicidae was up till recently considered separate from the Tungidae (=Sarcopsyllidae), but Jordan[1], in view of the similarities between the genera *Echidnophaga* Olliff and *Pulex* Linnaeus, has combined the two. Jordan divides the family into two subfamilies, *viz.*, Pulicinae and Spilopsyllinae. The subfamily Pulicinae is divided into

[1] Jordan, *III. Internationaler Entomologen-Kongress Zürich, Juli 1925*, II, pp. 601, 602 (Weimar, 1926).

two tribes—Tungicae [1] and Pulicicae—while the subfamily Spilopsyllinae consists of the three tribes—Archaeopsyllicae, Xenopsyllicae and Spilopsyllicae.

The family is represented in India by seven genera, thirteen species and one subspecies; of these, two species are described in this paper for the first time.

The following is a key to the Indian genera of the family Pulicidae :—

I. Mesopleura without internal rod-like incrassation from insertion of coxa upwards separating episternum from epimerum.

A. Antennal groove open; club of antenna elliptical, its first segment neither free nor foliaceous; falx absent; hind coxa without spinelets on inner side; antepygidial bristle absent; pygidium with eight grooves on each side; in male tergite VIII without manubrium and clasper with only two processes; in female anal stylet and stigmata on tergites I—III absent .. . . *Tunga.*

B. Antennal groove closed; club of antenna subglobular, its first segment free and foliaceous; falx present; hind coxa with a comb of spinelets on inner side; antepygidial bristle present; pygidium with fourteen grooves on each side; in male tergite VIII with manubrium and clasper with three processes; in female anal stylet and stigmata on tergites I—III present.

I. Frons angulate; labial palpus with one feebly chitinised segment; genal edge produced downwards into a triangular ventral lobe situated behind mouth-parts; without a row of short hairs along hinder margin of antennal groove; thoracic tergites together shorter than first abdominal tergite; mesosternite produced posteriorly into a small obtuse lobe; hind coxa produced into a prominent and truncate lobe at apex anteriorly .. .. *Echidnophaga.*

II. Frons not angulate; labial palpus with four strongly chitinised segments; genal edge not produced into a triangular lobe but usually provided with 1-3 short spines; with a row of short hairs along hinder margin of antennal groove; thoracic tergites together much longer than first abdominal tergite; mesosternite without any lobe; hind coxa without any apical lobe .. . .. *Pulex.*

II. Mesopleura with internal rod-like incrassation from insertion of coxa upwards separating episternum from epimerum.

A. Without pronotal and genal combs.

I. Anterior angle of genal margin with a large backwardly directed and pointed process; pronotum much longer than mesonotum . .. *Pariodontis.*

II. Genal margin of head without any such process; pronotum shorter than mesonotum.

A. Metepisternum fused with metasternum; apex of ejaculatory tube curved upwards . .. *Synosternus.*

B. Metepisternum separated from metasternum; apex of ejaculatory tube straight or curved downwards .. . . *Xenopsylla.*

B. With a pronotal and a genal comb running horizontally along lower border of gena .. .. *Ctenocephalus.*

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[1] I have adopted the name Tungicae in place of Jordan's Sarcopsyllicae as the latter name is not permissible according to the International Rules of Zoological Nomenclature, for the generic name *Sarcopsylla* Westwood had long ago been replaced by the older generic name *Tunga* Jarocki.

Genus **Tunga** Jarocki.

1838. *Tunga*, Jarocki, *Zoology, or General Description of Animals in accordance with the Latest System* VI, p. 50.
1906. *Dermatophilus*, Jordan and Rothschild, *Rept. Thompson Yates Labs* (n. s.) VII, pp. 18, 65-67.
1921. *Tunga*, Rothschild, *Ectoparasites* I, pp. 129, 130.
1925. *Tunga*, Fox, *Insects and Disease of Man*, p. 130.

Of the three known species of this genus only two are found in the Old World. *Tunga caecigena* [1] Jordan and Rothschild has been described from China and *T penetrans* (Linnaeus) has occasionally been recorded from the western ports of India.

Tunga penetrans (Linnaeus).

1758. *Pulex penetrans*, Linnaeus, *Systema Naturae* (X. ed.), pp. 614, 615.
1838. *Tunga penetrans*, Jarocki, *Zoology* VI, pp. 50-52, pl. ii, figs. 10-13.
1896. *Sarcopsylla penetrans*, Osborn, *Bull. U. S. Dept. Agric., Divis. Entom.* (n. s.) No. 5, pp. 142-144, text-fig. 77.
1906. *Dermatophilus penetrans*, Jordan and Rothschild, *Rept. Thompson Yates Labs.* (n. s.) VII, pp. 67-70, text-fig. *f*, pl. iv, fig. 28.
1910. *Dermatophilus penetrans*, Rothschild, *Bull. Entom. Res.* I, p. 90.
1913. *Dermatophilus penetrans*, Patton and Cragg, *A Textbook of Medical Entomology*, pp. 448, 449, pl. lvi, fig. 4.
1925. *Tunga penetrans*, Fox, *Insects and Disease of Man*, pp. 130, 131, text-fig. 58.

Head.—The rostrum is very long and reaches one-half to three-fourths the length of the fore femur. The fourth segment of the maxillary palp is nearly as long as the second. The oral edge is either as long or slightly longer than the genal edge. The frons is without any stout bristle but has a hair-like bristle in front of the eye. The eye is large and strongly pigmented. There are no bristles on the occiput, but there are 8 minute hairs representing the subapical row of bristles of other fleas.

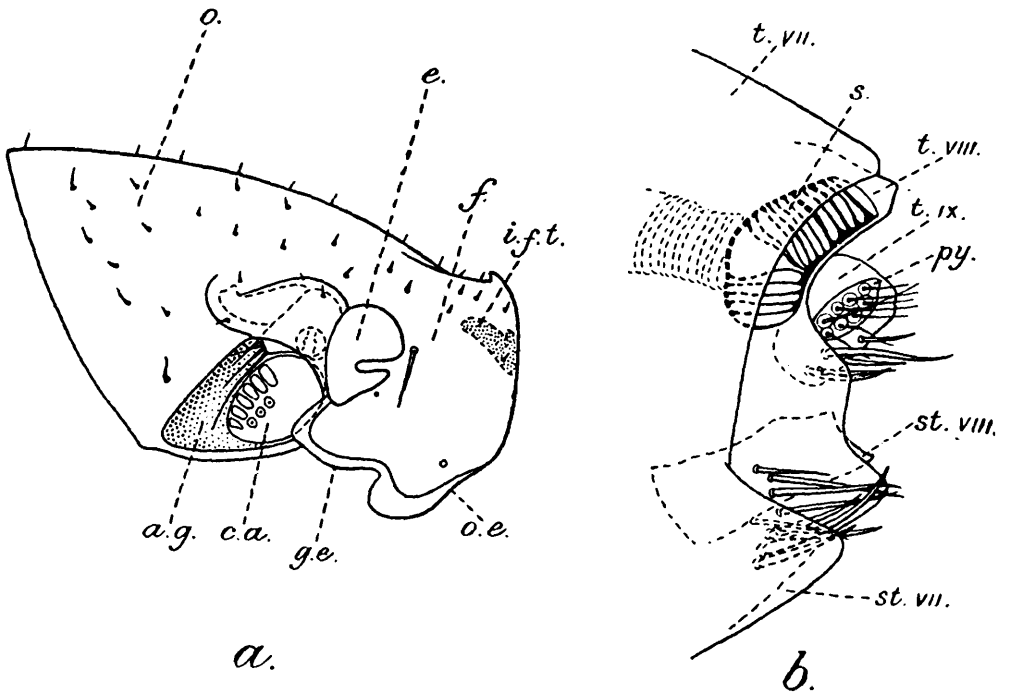
Thorax.—The bristles on the thorax are very minute and it is, therefore, difficult to determine their exact number on each sclerite. The pronotum bears 10-14 hair-like bristles in a row, the mesonotum and the metanotum have each 6-8 hair-like bristles in a row. Only the episternum of the metathorax possesses a slender bristle. The epimerum of the same segment is broad and is produced backwardly in the middle into a broadly rounded lobe. It bears 2 (rarely 3) bristles in a row, which represents the second row of other fleas.

Abdomen.—Tergite I has 2 bristles in a row. The other tergites also have each 2 bristles in a row, and each bristle is situated immediately above the stigmata of the same side. The bristles on the sternites are absent.

Legs.—The hind femur has a row of 7-9 bristles on the inner side and a single subapical ventral bristle on the outside. The hind tibia has no dorsal row of bristles on the outside but bears three notches including the apical. The longest bristle of the second segment of the hind tarsus extends beyond the tip of the fifth segment; the latter is of

[1] I have carefully compared Jordan and Rothschild's description [*Ectoparasites* I, pp. 131, 132, text-fig. 105 (1921)] of *Tunga caecigena* with Roubaud's description [*Bull. Soc. Path. Exotique* XVIII, pp. 399-405, text-figs. 4-6, pl. i (1925)] of *Dermatophilus lagranqei* and am of opinion that the latter is synonymous with the former.

uniform breadth throughout and is provided with 3 pairs of long and thin lateral bristles and 2 subapical ventral bristles.



TEXT-FIG. 1.—*Tunga penetrans*: (*a*) ♂, head, × 150; (*b*) ♀, terminal segments of the abodomen, × 150.

a. g. antennal groove; *c. a.* club of the antenna; *e.* eye; *f.* frons; *g. e.* genal edge; *i. f. t.* internal frontal tuber; *o.* occiput; *o. e.* oral edge; *py.* pygidium; *s.* stigmata; *st. vii., st. viii.* seventh and eighth sternites; *t. vii., t. viii., t. ix.* seventh, eighth and ninth tergites.

Modified Segments.—♂. The eighth sternite is deeply cleft on each side. The dorsal portion of tergite IX bearing the pygidium is almost separated from the clasper. The manubrium is long and club-shaped. The two processes of the clasper form a pair of pincers, the upper arm of which is fused with the main body of the clasper and the lower arm articulates with the upper by a suture. The ninth sternite when viewed from the side appears like an elongated triangle with its apex pointing backwards. The terminal portion of the ejaculatory tube is bent downwards, so as to form a hook, and has a short ventral process in front of it. ♀. The eighth tergite bears a broad lobe-like projection in the middle having a concavity above and below it. It bears 7-9 bristles on the outside; of these the three bristles near the ventral margin are well-developed. The spermatheca is spiniform and the head portion gradually passes into the slightly bent tail; its wall is very thin. The ductus receptaculi seminis is of uniform breadth and opens into a short bursa copulatrix.

Distribution and Hosts.—This originally South American species has been introduced into other tropical countries. In America it is common in all countries between Mexico and the northern parts of Argentina and the West Indies. It is believed that the species is also found in Southern Florida and parts of Texas neighbouring on Mexico. In Bermudas [1] it was common fifty years ago, but has now disappeared. In Africa,

[1] *Vide* Balfour, *Brit. Med. Journ.* I, No. 3506, p. 447 (1928).

where it has been introduced since 1872 [1], it has propagated with astonishing rapidity. In this continent it has been recorded from Tunis, Senegal, Liberia, Cameroons, Angola, Belgian Congo, Italian Somaliland[2], Uganda, Kenya Colony, Tanganyika Territory, Madagascar, Mahé Island[3] and Seychelles. In East Africa it is so common that during the Great War[4] it was a source of great annoyance to the British Army. According to Patton and Cragg " It has been introduced into Bombay and Karachi with infected sailors, but owing to the great care which has been taken to isolate affected persons, and probably also to the damp climate of these ports, it has not succeeded in gaining a footing" According to Gaspar Affonso [5] this species existed in the sixteenth century in India ; but it is doubtful whether the specimens he examined were those of *T penetrans* imported into the sea-ports of India trading with South America or of *Echidnophaga gallinaceus* (Westwood), a species common in Peninsular India. It is chiefly found on man and pig but it attacks other mammals as well.

I have examined specimens mounted on four slides prepared by the late Major F. W. Cragg from the collection of the Central Research Institute, Kasauli ; the provenance of the specimens is not indicated.

Genus **Echidnophaga** Olliff.

1886. *Echidnophaga,* Olliff, *Proc. Linn. Soc. N. S. Wales* (2) I, p. 172.
1906. *Echidnophaga,* Jordan and Rothschild, *Rept. Thompson Yates Labs.* (n. s.) VII, pp. 18, 43-45.
1911. *Echidnophaga,* Jordan and Rothschild, *Novitates Zoologicae,* XVIII, p. 61.
1913. *Echidnophaga,* Patton and Cragg, *A Textbook of Medical Entomology,* p. 450.
1925. *Echidnophaga,* Fox, *Insects and Disease of Man,* p. 131.

The two Indian species of this genus can be distinguished by the following key :—

I. Fifth hind tarsal segment provided on each side with one heavy subbasal bristle, a thinner median one and a minute postmedian hair ; anal stylet in female about three times as long as broad .. .. *liopus.*

II. Fifth hind tarsal segment provided on each side with three heavy bristles and a fourth slender bristle ; anal stylet in female nearly as long as broad .. *gallinaceus.*

Echidnophaga gallinaceus (Westwood).

1875. *Sarcopsyllus gallinaceus,* Westwood, *Entom. Month. Mag.* XI, p. 246.
1906. *Echidnophaga gallinaceus,* Jordan and Rothschild, *Rept. Thompson Yates Labs.* (n. s.) VII, pp. 52-54, pl. i, fig. 1 ; pl. ii, fig. 14 ; pl. iii, fig. 21 ; pl. iv, fig. 27.
1910. *Echidnophaga gallinaceus,* Rothschild, *Bull. Entom. Res.* I, p. 90, text-fig. 1.
1913. *Echidnophaga gallinaceus,* Patton and Cragg, *A Textbook of Medical Entomology,* p. 450, pl. liv. fig. 1 ; pl. lvi, fig. 3.

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[1] Blanchard says [*Bull. Soc. Zool. France* XIV, p. 98 (1889)] " C'est ainsi que, depuis 17 ans, elle se trouve en Afrique, où elle était jusqu' alors totalement inconnue : introduite au Gabon, en 1872, par l'équipage du navire anglais *Thomas Mitchel,* qui revenait du Brésil, elle s'est propagée avec une étonnante rapidité.

[2] *Vide* Zavattari, *Ann. Mus. Civ. Stor. Nat. Genova* (3) VI, p. 139 (1914).

[3] *Vide* Addison, *Ann. Rept. Med. Dept. year 1914,* 13pp. (Victoria, 1915).

[4] *Vide* Jolly, *Ind. Med. Gaz.* LXI, pp. 164, 165 (1926).

[5] *Vide* França, *Trans. Roy. Soc. Trop. Med. Hyg.* XV, p. 57 (1921).

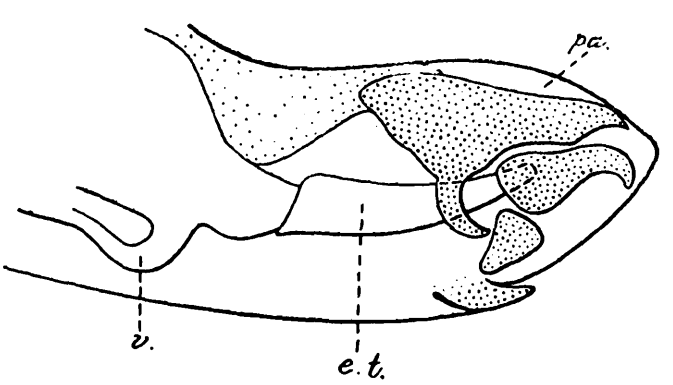
1914. *Echidnophaga gallinaceus*, Fletcher, *Some South Indian Insects*, pp. 365, 366, text-fig. 226 (Madras).
1915. *Echidnophaga gallinacea*, Bishopp, *Bull. U. S. Dept. Agric.* No. 248, pp. 19-21, text-figs.7, 8.
1925. *Echidnophaga gallinacea*, Fox, *Insects and Disease of Man*, p. 132, text-fig. 59.

Head.—The frons is strongly angulate [1] near the middle in both the sexes. The horizontal genal process is strongly chitinised and prominent in the female only. The occiput, which is nearly half the length of the frons, has 2 bristles behind the antennal groove. The hinder edge of the occiput of the female on each side is produced in the middle into a prominent lobe ; this is only feebly indicated in the male.

Thorax.—The pronotum bears 8-12 and the mesonotum 6-10 bristles. Only the pleurite of the mesosternum bears a single bristle, and the epimerum of the metathorax has a row of 4-6 bristles.

Abdomen.—The first tergite has 2 slender bristles in the first row and 2 or 3 strong bristles in the second row. Tergites II-VI have each 2 bristles, while tergite VII bears 4 bristles. As a rule only sternite VII has 2 or 3 bristles but in some cases sternite VI also bears 2 bristles.

Legs.—There are 14-25 spinelets on the inner side of the hind coxa. The hind femur has 4-6 hair-like bristles on the inner side. The hind tibia shows five notches including the apical one. The fifth hind tarsal segment has four pairs of bristles of which the fourth pair is not so well-developed as the remaining three pairs ; it also bears 2 subapical ventral bristles.



TEXT-FIG. 2.—*Echidnophaga gallinaceus* ♂ : terminal portion of the ejaculatory tube with paramere, × 350.

e. t. ejaculatory tube ; *pa.* paramere ; *v.* vesicle.

Modified Segments.—♂. The eighth sternite has 6 bristles in a vertical row and 2 bristles are found in front of this row. The upper process of the clasper has a long bristle near the apex on its ventral side. The broad distal portion of the lowest process of the clasper is longer than the narrow proximal portion. The terminal portion of the paramere is strengthened with sclerites ; its apical margin is dome-shaped and is provided with a ventral tooth-like process. The terminal portion of the ejaculatory tube, which is directed slightly upwards, narrows

[1] According to Jordan and Rothschild (*loc. cit.*) the frons is strongly angulate in the female and rotundate-angulate in the male ; but in all the specimens that I have examined it is nearly as angulate in the male as in the female.

gradually towards the apex. It is slightly constricted near the vesicle, and is unarmed. ♀. The broad portion of the eighth tergite is produced in the middle into a subtriangular lobe. It bears 3-6 bristles on its outer side, two of which come to lie near the ventral margin. There are 5-7 bristles on its inner side, the three upper ones of which are very strongly developed. The anal stylet is slightly longer than broad. The ductus obturatorius [1] is longer than the ductus receptaculi seminis and both these ducts join into a long common duct before opening into the bursa copulatrix.

Distribution and Hosts.—It is an Old World species but has been introduced into North America, where it has been recorded in the north up to Minnesota [2] and in the south to Panama[3] and Porto Rico[4]. According to Illingworth [2] it was not noticed by entomologists in Hawaii prior to 1913, and was probably introduced with poultry from California. In Africa it is found practically all over including Madagascar and the Mauritius Islands [5]. In Asia it has been recorded from Anatolia[6], Russian Armenia, Transcaspian provinces, Turkistan, India, Burma and Ceylon. It has also been reported from the Fiji Islands. It was first discovered in Western Australia in 1921[7], and has spread with so great rapidity that poultry imported from Western Australia into other parts of the Commonwealth is prohibited [8] unless accompanied by a certificate of freedom from *E. gallinaceus*. In spite of this measure it is spreading eastwards. Its chief host is poultry but it attacks other domestic animals as well. I have examined specimens from the following localities :—

Burma.—Natogyi (219/H6, ♀s, off dog ; 220/H6, ♀s, off cat), Myingyan district.

Madras Presidency.—Guindy (334/H6, ♀s, host ?), Madras district. Kilikarai (339/H6, ♂ ♀s, off poultry), Ramnad district. Kodaikanal (♀s, host ?), Madura district.

United Provinces.—Nawabganj, Cawnpore (337/H6, ♂ ♀s, off a young porcupine).

Bombay Presidency.—Belgaum (221/H6, ♀s, off Bandicoot ; 335/H6, ♂s ♀s, off cat). Mangalore (217/H6, ♂s ♀s, off hen), South Kanara district.

Mysore State.—Robertsonpet (338/H6, ♂♀, off cat), Kolar Gold Field district.

Travancore State.—Quilon (218/H6, ♀s, off dog).

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[1] For the diagram of spermatheca, bursa copulatrix and associated structures see Fox, *Treasury Dept. U. S. Publ. Heal. Serv., Hyg. Lab. Bull.* No. 97, pl. xvi, fig. 29 (1914).

[2] *Vide* Illingworth, *Hawaiian Forester and Agriculturist* XII, p. 130 (1915).

[3] *Vide* Dunn, *Amer. Journ. Trop. Med.* III, p. 340 (1923).

[4] *Vide* Cox, Carrion and Fox, *Publ. Hlth. Rept.* XLIII, pp. 611-616 (1928).

[5] *Vide* De Charmoy, *Mauritius Dept. Agric. Div. Entom.* 2 pp. (1914).

[6] *Vide* Vogel, *Centralbl. Bakt. Paras. Infekt.* (IIte Abt.) LXXI, pp. 313, 314 (1927).

[7] *Vide* Newman, *West. Australia Dept. Agric. Ann. Rept.* 1921-22, pp. 28-30 (1922).

[8] *Vide* Quarantine Proclamation, No. 153, *Commonw. Australia Gaz.* No. 3, 1 p. (1926).

Echidnophaga liopus Jordan and Rothschild.

1906. *Echidnophaga liopus*, Jordan and Rothschild, *Rept. Thompson Yates Labs.* (n. s.) VII, pp. 56, 57, pl. i, fig. 2 ; pl. iii, figs. 20, 26.
1910. *Echidnophaga liopus*, Rothschild, *Bull. Entom. Res.* I, p. 91, text-fig. 5.
1913. *Echidnophaga liopus*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 450.

This species was originally described from Western Australia where it is very common on *Echidna aculeata*. It has only once been recorded off rats from Agra in India. I have not seen any specimen of this species.

Genus **Pulex** Linnaeus.

1758. *Pulex* (*en partim*), Linnaeus, *Systema Naturae* (X. ed.), p. 614.
1832. *Pulex* (*en partim*), Dugès, *Ann. Sci. Nat.* XXVII, p. 163.
1835. *Pulex* (*en partim*), Bouché, *Nova Acta Physico-Medica Acad. Caes. Leop. Carol.* XVII, pp. 501-503.
1844. *Pulex* (*en partim*), Gervais in *Walckenaer's Histoire Naturelle des Insectes Aptères* III, pp. 362-365.
1907. *Pulex* (*en partim*), Tiraboschi, *Arch. Parasitol.* XI, p. 580.
1908. *Pulex*, Jordan and Rothschild, *Parasitology* I, pp. 5-7.
1911. *Pulex*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 62.
1913. *Pulex*, Patton and Cragg, *A Textbook of Medical Entomology*, pp. 452, 453.
1915. *Pulex*, Rothschild, *Entom. Month. Mag.* (3) I, pp. 55, 89.
1925. *Pulex*, Fox, *Insects and Disease of Man*, pp. 132, 133.

This the oldest of the Siphonapteran genera contains at present only two valid species. The genotype *Pulex irritans* Linnaeus has a world-wide distribution, while the other species *P. porcinus* was described by Jordan and Rothschild in 1923 [1] from Texas, United States of America. The other species, which were previously included in this genus, have been removed to other genera.

Pulex irritans Linnaeus.

1758. *Pulex irritans* (*en partim*), Linnaeus, *Systema Naturae* (X. ed.), p. 614.
1905. *Pulex irritans*, Liston, *Journ. Bombay Nat. Hist. Soc.* XVI, pp. 264, 265, pl. A, 1 fig. ; pl. B, 1 fig.
1908. *Pulex irritans*, Jordan and Rothschild, *Parasitology* I, pp. 7-12.
1910. *Pulex irritans*, Fox, in *The Rat and its Relation to the Public Health*, pp. 142, 143, pl. v. (Washington).
1915. *Pulex irritans*, Rothschild, *Entom. Month. Mag.* (3) I, pp. 55, 89, 90, pl. vii, fig. 2.
1915. *Pulex irritans*, Bishopp, *Bull. U. S. Dept. Agric.* No. 248, pp. 16-18, text-figs. 5, 6.
1916. *Pulex irritans*, Waterston, *British Mus. Econ. Ser.* No. 3, p. 18, 1 pl.

Head.—The rostrum extends to one-half to two-thirds the length of the fore coxa. There is one bristle (rarely 2) in front of the lower end of the eye and another bristle on the oral corner. The internal frontal tuber is absent. The antennal groove is short and broad. There is no sexual difference in the antenna of this species as is often the case in other species of the family ; it does not reach the vertex. The internal incrassation from the base of the antennal groove to the vertex is well-developed. Generally there is only one genal spine on each side. In both sexes there is a row of 7-14 short hairs behind the antennal groove.

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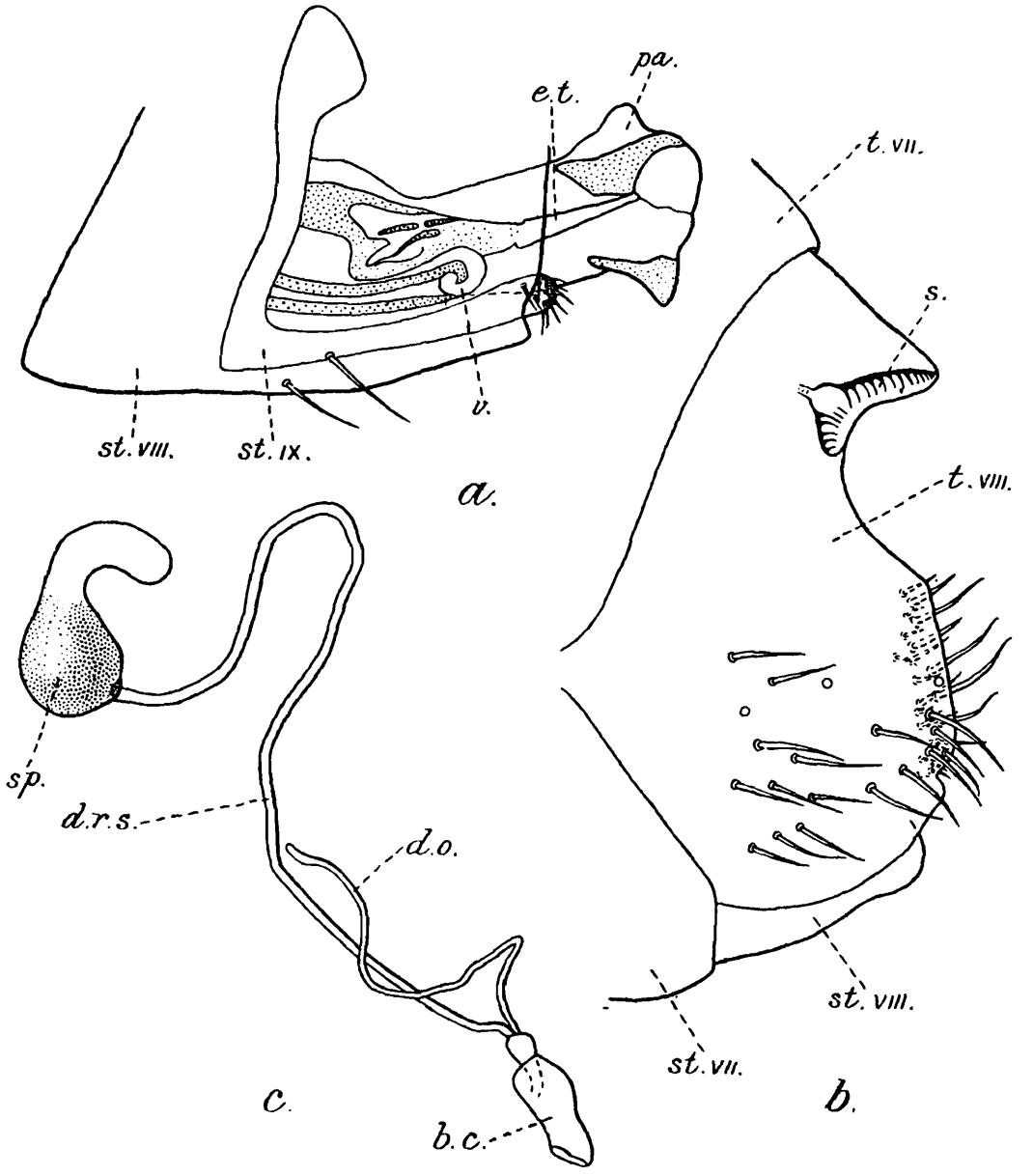
[1] Jordan and Rothschild, *Ectoparasites* I, pp. 312-314 (1923).

The occiput on each side bears a single bristle, which represents the lowest bristle of the subapical row.

Thorax.—The number of bristles on the pronotum varies from 12 to 15, on the mesonotum from 12 to 15 and on the metanotum from 11 to 14. The mesosternite bears 1-3 (generally 2) bristles. The sternum of the metathorax bears one bristle and the episternum of the same segment 2 or 3 bristles. The metepimerum has 5-7 bristles in the first row and 4-7 bristles in the second row.



TEXT-FIG. 3.—*Pulex irritans*: (*a*) ♂, lower portion of the terminal genital segments, × 100; (*b*) ♀, eighth abdominal segment, × 83; (*c*) ♀, spermatheca, bursa copulatrix and associated structures, × 150.

b. c. bursa copulatrix; *d. o.* ductus obturatorius; *d. r. s.* ductus receptaculi seminis; *e. t.* ejaculatory tube; *pa.* paramere; *s.* stigmata; *sp.* spermatheca; *st. vii.*, *st. viii.*, *st. ix.* seventh, eighth and ninth sternites; *t. vii.*, *t. viii.* seventh and eighth tergites; *v.* vesicle.

Abdomen.—The first row on the first tergite consists of 3 or 4 bristles and the second row of 4-6 bristles. The numbers of bristles on the other tergites are as follows:—ii. ♂ 8-11, ♀ 9-12; iii. ♂ 8-10, ♀ 9-11; iv. ♂ 8-10, ♀ 9-12; v. ♂ 8-9, ♀ 9-11; vi. ♂ 6-9, ♀ 8-11; vii. ♂ 6-9, ♀ 6-10. The bristles on tergite VII are unusually small and weak. The bristles on the sternites are as follows:—ii. ♂ 0-2, ♀ 2; iii. ♂ 5-7, ♀ 9-11; iv.

♂ 4-7, ♀ 8-10 ; v. ♂ 4-7, ♀ 7-11 ; vi. ♂ 4-6, ♀ 7-11 ; vii. ♂ 4-7, ♀ 9-12. The abdominal stigmata are large and each of them is situated below the lowest bristle of the corresponding tergite.

Legs.—The comb on the hind coxa consists of 6-20 spinelets. The hind femur has a lateral row of 7-14 bristles on the inside and 2 subapical ventral bristles on the outside. The hind tibia shows 6 deep notches including the apical one, but in some cases an additional notch is present between the second and the third notch from the proximal end. The dorsal row of the hind tibia contains 4-8 bristles. The fifth hind tarsal segment widens considerably towards the apex and has very stout lateral bristles. The distance between the third and the fourth lateral bristles is double that between the second and the third. The fifth tarsal segment of the hind leg as also of the other legs have each two [1] unequal and long subapical ventral bristles.

Modified Segments.—♂. The eighth sternite bears on each side 4 slender bristles along the apical margin, 1-3 bristles in the middle and 3-6 bristles in the proximal row. The eighth tergite is provided with a manubrium on each side. The clasper has three separate processes ; the upper process is large, sub-semicircular in shape and hairy ; while the other two processes form a pair of very strong pincers below the upper process. The manubrium is broad and curved upwards. The paramere is strengthened by a dorsal and a ventral sclerite ; its apical margin is convex. The terminal portion of the ejaculatory tube, which is directed slightly upwards, gradually narrows towards the apex ; it is somewhat constricted near the vesicle and is unarmed. The spiral of the penis is very much coiled. ♀. The eighth tergite bears 2-5 bristles along the apical margin, 16-22 bristles arranged in 2 or 3 irregular rows on the inside and 8-15 bristles usually arranged in 2 or 3 vertical rows laterally. The anal stylet is short, being only about twice as long as broad. The spermatheca is inverted comma-shaped, with the head portion about one-half the length of the slender tail. The ductus receptaculi seminis and the ductus obturatorius open into a club-shaped sac, which in its turn opens into the small bursa copulatrix.

Distribution and Hosts.—This species has come to have an almost cosmopolitan distribution as a result of the increased modes of intercommunication between the different countries. Originally an Old World form it has spread from the North Temperate Region to various parts of both the Old and the New World with man, its chief host. Its absence from the Sahara and Haussa countries in Africa and other very hot regions is due to the fact that this flea cannot stand a constant temperature of over 85°F.[2] In India it is found mostly in the hilly regions, but is rare in the plains. It has previously been recorded from Lhassia and Ukhrul in the Manipur district in Assam, Darjeeling, Coonoor and Bombay. In addition to its chief host it attacks wild and domestic

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[1] In Wagner's diagram of the fifth segment of the hind tarsus of *P. irritans* [*Horae Soc. Entom. Ross.* XXXI, pl. viii, fig. 8 (1898)] three subapical ventral bristles are shown. In a few of the specimens, which I have examined, there are three subapical ventral bristles but in the majority the number is two.

[2] According to Lethem [*Journ. State Med.* XXXI, pp. 508-511 (1923)] this species dies at a temperature of over 85°F

animals. I have examined specimens of this species from the following localities :—

Burma.—Lomira (306/H6, ♂s ♀, off dog) and Takaw (312/H6, ♂ ♀, off dog), Southern Shan States.

Assam.—Shillong (♀, in a house). Ukhrul (336/H6, ♂s ♀s, in a house), Manipur district.

Bengal.—Darjeeling (1489/16, ♀, off dog) and Singla (477/H6, ♀s, host ?), Darjeeling district.

Bihar.—Jogidih (307/H6, ♀s, off *Canis pallipes* Sykes), Hazaribagh district.

Central Provinces.—Jubbulpore (303/H6, ♀, off rat).

Madras Presidency.—Pamban (314/H6, ♂ ♀s, found on the floor of a house and in sand), Mandapam (313/H6, ♂s ♀s, host ?) and Duripatam (310/H6, ♀, among crevices in the floor of a house), Ramnad district. Kodaikanal (308/H6, ♀s, host ?), Madura district.

United Provinces.—Muktesar (304/H6, ♀, off fox), Naini Tal district. Almorah (305/H6, ♀s, host ?). Chakrata (309/H6, ♀, off dog), Dehra Dun district.

Kashmir State.—Kashmir (♂, host ?).

North-West Frontier Province.—Bannu town (311/H6, ♂, off dog), Razmak (469/H6, ♀s, host ?), Bannu district.

Bombay Presidency.—Ahmednagar (♀, host ?).

Genus **Pariodontis** Jordan and Rothschild.

1908. *Pariodontis*, Jordan and Rothschild, *Parasitology* I, pp. 13, 14.
1911. *Pariodontis*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 65.
1926. *Pariodontis*, Jordan, *III. Internat. Entom.-Kongress*, II, p. 603.

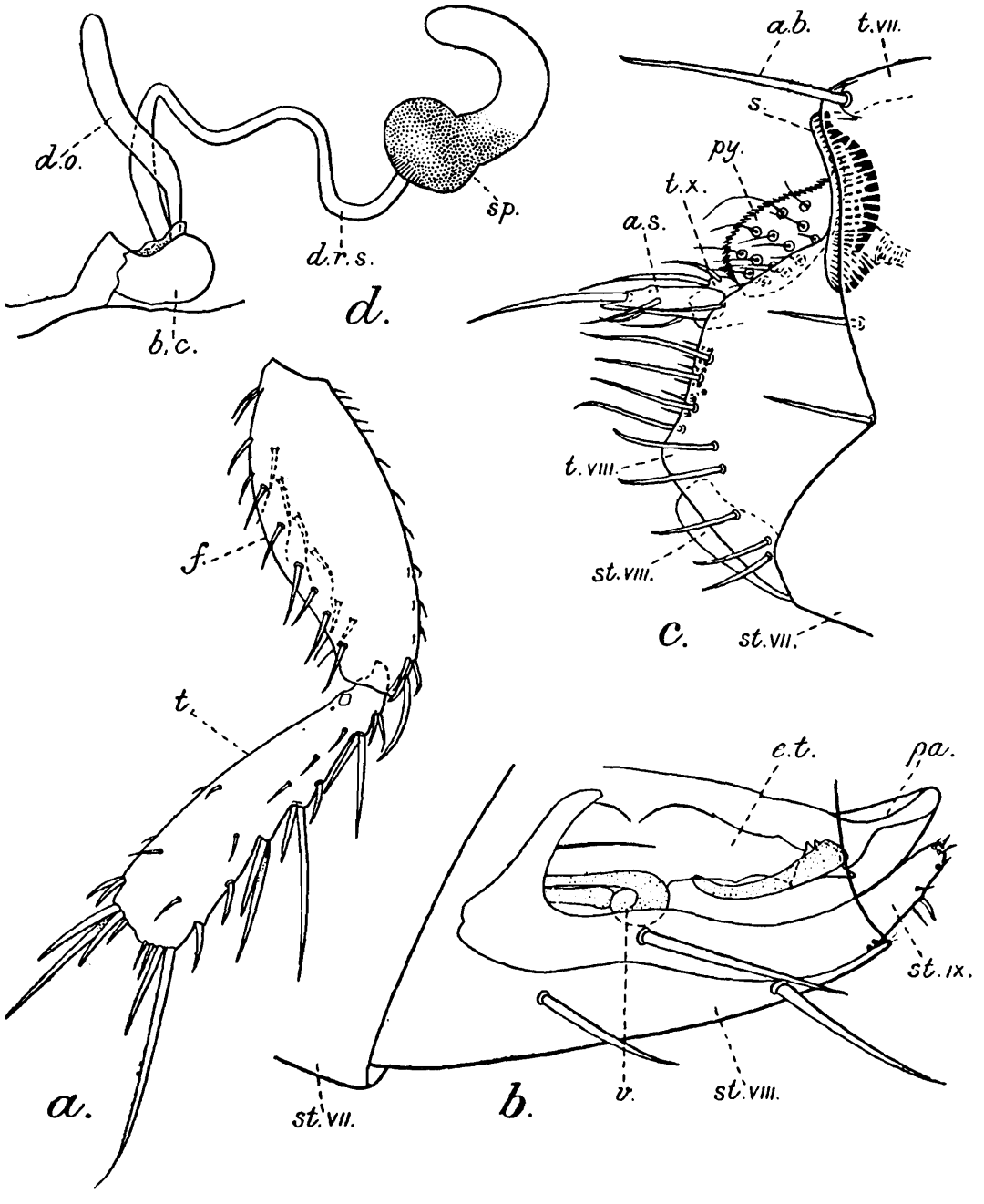
Of the two species of this genus only the genotype *P. riggenbachi* (Rothschild) has been reported from India. The other species *P. subjugis* Jordan, which was described in 1925 from the Malay Peninsula, differs from *P. riggenbachi* in having the end segment of the labial palpus slightly longer than the penultimate one.

Pariodontis riggenbachi (Rothschild).

1904. *Pulex riggenbachi*, Rothschild, *Novitates Zoologicae*, XI, pp. 611, 612, pl. viii, figs. 19, 20 ; pl. ix, fig. 24.
1908. *Pariodontis riggenbachi*, Jordan and Rothschild, *Parasitology* I, p. 14, pl. ii, fig. 1.
1911. *Pariodontis riggenbachi*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 65.
1917. *Pulex ruptoris*, Weiss, *Bull. Soc. Hist. Nat. Afriq. Nord.* VIII, pp. 55-62, text-figs. 1-3.
1926. *Pariodontis riggenbachi*, Jordan, *III. Internat. Entom.-Kongress*, II, pp. 603, 604.

Head.—The rostrum extends beyond the apex of the fore coxa and its end segment is about twice as long as the penultimate segment. There are 15-22 stout hairs arranged in a row along the posterior margin of the antennal groove in the male, which are absent in the female. The occiput possesses two unequally long bristles behind the antennal groove, one near the base and the second almost in the middle. The subapical row of bristles of the occiput consists of 6-8 bristles.

Thorax.—The number of bristles on the pronotum is 8-12, on the mesonotum 8-10, and on the metanotum 8. The mesosternite bears 3 (rarely 4) bristles on the hinder margin of the epimerum and one bristle on the incrassation separating the epimerum and the episternum. The episternum and the sternum of the metathorax have each a single stout bristle. The first and the second rows on the metepimerum consist



TEXT-FIG. 4.—*Pariodontis riggenbachi* : (*a*) ♀, femur and tibia of the hind leg, ×43 ; (*b*) ♂, lower portion of the terminal genital segments, × 120 ; (*c*) ♀, terminal segments of the abdomen, × 60 ; (*d*) spermatheca, bursa copulatrix and associated structures, × 120.

a. b. antepygidial bristle ; *a. s.* anal stylet ; *b. c.* bursa copulatrix ; *d. o.* ductus obturatorius ; *d. r. s.* ductus receptaculi seminis ; *e. t.* ejaculatory tube ; *f.* femur ; *pa.* paramere ; *py.* pygidium ; *s.* stigmata ; *sp.* spermatheca ; *st. vii.*, *st. viii.*, *st. ix.* seventh, eighth and ninth sternites ; *t.* tibia ; *t. vii.*, *t. viii.*, *t. x.* seventh, eighth and tenth tergites ; *v.* vesicle.

of 3-7 and 5-9 bristles respectively. Two to four lower bristles of the second row are generally placed close to one another.

Abdomen.—The first row of bristles on the first tergite consists of 2 bristles in the male, but it is absent in the female. The second row on the same tergite has 4 (rarely 3 or 5) bristles in both the sexes. Tergites II—VI have each 10 (rarely 8) stout bristles in a row. The seventh tergite bears 8 (rarely 7) bristles. The numbers of bristles on the sternites are as follows:—

♂. ii. 0-2 ; iii. 2 ; iv. 2 ; v. 4 (rarely 3) ; vi. 4-6 ; vii. 6-8.
♀. ii. 0-2 ; iii. 2 ; iv. 4-6 ; v. 6-8 ; vi. 6-9 ; vii. 8-12.

The stigmata are large, and each is situated above the lowest bristle of the tergite in the male, while in the female each lies above the two lowest bristles of the tergites of segments III—VI.

Legs.—The comb of the hind coxa consists of 6-15 spinelets. The hind femur bears a row of 5-7 bristles on the inner side and a row of 4-7 bristles along the ventral margin on the outer side. There are 8 dorsal notches including the apical one on the hind tibia, and a row of 3-9 bristles on the outer surface. The fifth tarsal segment of all the legs has two equally strong subapical bristles on the ventral surface.

Modified Segments.—♂. The eighth sternite bears 3 long bristles on each side, of which two are along the ventral margin, while the third arises a little higher up between them. The manubrium of the clasper is much shorter than the distance from its base to the apex of the longest process of the clasper. The uppermost process of the clasper is the longest and subcylindrical. It bears 3-5 long and stout and 1 or 2 slender bristles at the apex ; it also has 2 slender bristles on its external surface. The middle process bears a few short bristles near the apex. The lowest process is broadly fused with the clasper and generally bears 7 slender bristles along its ventral margin. The apical margin of the paramere is oblique and its dorsal corner is produced into a broad lobe-like process. The apical portion of the ejaculatory tube is provided with two closely placed dorsal teeth and a third obsolete one further away from them. There is a forcep-like brown sclerite near the terminal portion of the ejaculatory tube. ♀. The eighth tergite bears 8-11 (generally 10) long bristles in the apical row, 7-9 (usually 8) short ones on the inner side and two well separated long bristles on the lateral surface. The anal stylet is very long, being three to four times as long as broad. It is produced apically into a prominent process. The spermatheca is inverted comma-shaped. The ductus obturatorius is much wider than the ductus receptaculi seminis and opens independently into the small bursa copulatrix.

I have not seen the specimen which was named *Pulex ruptoris* by Weiss but from his defective description of this species I have little doubt that his species is based on a female specimen of *Pariodontis riggenbachi.*

Distribution and Hosts.—The species has so far been recorded from Morocco, Tunis, Angola, Kenya Colony, Tanganyika Territory and Cape Colony in Africa, and in India. Its host is the porcupine (*Hystrix cristata* Linnaeus in Africa and *H. leucura* Sykes in India). I have examined specimens (299/H6, ♂ ♀s, off porcupine) from Pashok in the Darjeeling district, Bengal and two lots (300/H6, 301/H6, ♂s ♀s, off porcupine) from Cawnpore in the United Provinces.

Genus **Synosternus** Jordan.

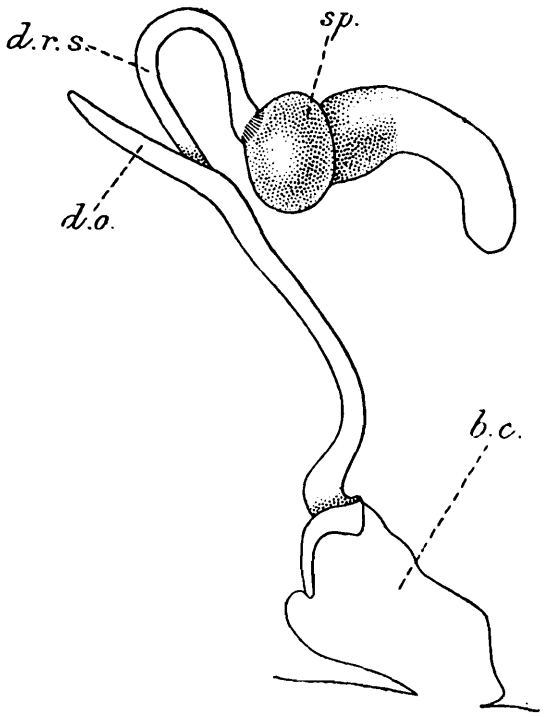
1880. *Pulex (en partim)*, Taschenberg, *Die Flöhe*, p. 64.
1908. *Loemopsylla (en partim)*, Jordan and Rothschild, *Parasitology* I, pp. 15, 16.
1909. *Xenopsylla (en partim)*, Rothschild, *Novitates Zoologicae*, XVI, p. 132.
1925. *Synosternus*, Jordan, *Novitates Zoologicae*, XXXII, p. 103.
1926. *Synosternus*, Jordan, *III. Internat. Entom.-Kongress*, II, p. 606.

It is predominantly an African genus but is represented in India by the genotype *S. pallidus* (Taschenberg).

Synosternus pallidus (Taschenberg).

1880. *Pulex pallidus*, Taschenberg, *Die Flöhe*, pp. 65, 66, pl. i, fig. 9.
1904. *Pulex pallidus*, Baker, *Proc. U. S. Nat. Mus.* XXVII, p. 437.
1908. *Loemopsylla pallidus*, Jordan and Rothschild, *Parasitology* I, pp. 35-37, pl. iii, fig. 4 ; pl. iv, fig. 9 ; pl. v, fig. 8.
1911. *Xenopsylla pallidus*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 63.
1926. *Synosternus pallidus*, Jordan, *III. Internat. Entom.-Kongress*, II, p. 607.

Head.—The rostrum either reaches to or extends beyond the apex of the fore coxa. In the male there are about 14 small hairs behind the antennal groove, but there is no trace of these in the female. The subapical row of the occiput has 5 or 6 bristles ; the lowermost bristle of each side is separated by a fair space from the one above it.



TEXT-FIG. 5.—*Synosternus pallidus* ♀ : spermatheca, bursa copulatrix and associated structures, × 175.

b. c. bursa copulatrix ; *d. o.* ductus obturatorius ; *d. r. s.* ductus receptaculi seminis ; *sp.* spermatheca.

Thorax.—The pronotum bears 11 or 12, the mesonotum 9-11 and the metanotum 8-10 bristles. The number of bristles in the first row of the metepimerum is 3 in the male and 4 or 5 in the female ; in the second row there are 4 bristles in the male and 4 or 5 in the female.

Abdomen.—The first tergite bears two rows usually of 4 bristles in each. The numbers of bristles on the remaining tergites are as follows :— ii. 8-10 ; iii. 10 ; iv. 8-10 ; v. 8-9 ; vi. 8 ; vii. 6-8. Sternite II has one or two bristles on the ventral margin and sternites III—VII have each 4 bristles.

Legs.—The comb on the hind coxa has 8-12 spinelets. The hind femur, which possesses a distinct subbasal tooth, has a row of 7-15 bristles on the inside and a subapical ventral bristle on the outside. The hind tibia shows six notches including the apical one and a lateral row of 6-12 bristles along its dorsal margin. The fourth hind tarsal segment is nearly as long as broad. The fifth tarsal segment of all legs, in addition to the minute hairs on the ventral side, bears 2 slender subapical bristles of unequal size.

Modified Segments.—♂. The eighth sternite bears 5-7 short bristles on each side. The clasper has three processes of which the upper and outer is the longest. The ninth sternite is bent apically into a short hook-shaped structure. The brush-like structure below the apex of the ejaculatory tube is very prominent. The apical margin of the paramere is oblique and the apex of the paramere is produced into a narrow dorsal process. The terminal portion of the ejaculatory tube is strongly bent upwards ; its surface is minutely denticulated and it has a strongly developed process on its dorsal surface. ♀. The apical edge of the eighth tergite is almost straight and bears 6-8 bristles in the apical row, 12-15 short bristles on the inside and 3-6 bristles on the lateral surface. The head of the spermatheca is broader than the basal portion of the tail. The ductus obturatorius is short, it is as broad as the ductus receptaculi seminis.

Distribution and Hosts.—This species has so far been recorded from certain parts of Africa (excepting the south, south-east and the north), Mesopotamia, Transcaspia and India. It has been recorded only once from Rio de Janerio in Brazil[1] where probably it had been imported. In India it has been recorded from Cutch (off *Vulpes* sp.) and Karachi (7488/16, ♂ ♀s, off *Erinaceus collaris* Gray and Hardwicke). The latter specimens are in the Indian Museum.

Genus **Xenopsylla** Glinkiewicz.

1907. *Xenopsylla*, Glinkiewicz, *Sitzungsb. Math.-Natur. Klas. K. Akad. Wiss Wien*, CXVI, p. 385.
1908. *Loemopsylla* (*en partim*), Jordan and Rothschild, *Parasitology* I, pp. 15, 16.
1909. *Xenopsylla* (*en partim*), Rothschild, *Novitates Zoologicae*, XVI, p. 132.
1911. *Xenopsylla* (*en partim*), Jordan and Rothschild, *ibid.* XVIII, p. 63.
1913. *Xenopsylla* (*en partim*), Patton and Cragg, *A Textbook of Medical Entomology*, p. 453.
1915. *Xenopsylla* (*en partim*), Rothschild, *Entom. Month. Mag.* (3) I, pp. 54, 89.
1926. *Xenopsylla*, Jordan, *III. Internat. Entom.-Kongress*, II, p. 609.

This genus is represented in India by two new and three previously described species, *viz.*, *X. cheopis* (Rothschild), *X. astia* Rothschild and *X. brasiliensis* (Baker). The distribution of the three previously known species in this country is of great importance from the epidemiological

[1] *vide* Pinto, *Bull. Soc. Path. Exotique*, XXI, p. 106 (1928).

point of view, since *X. cheopis* is the most important vector of plague. A determination of the exact proportion of the three species for a place at different seasons of a year is, therefore, of great value for the control of outbreaks of plague.

For previous detailed records of the three species in this country the papers by Cragg[1], Hirst[2], Mital and Dunn[3], and Goyle [4] may be consulted.

The Indian species of this genus can be separated with the help of the following key :—

I. Male.
- A. Antepygidial bristle situated on a marginal cone; bristles on P^1. of clasper stout, one of them being elbowed or twisted, P^2. curved upwards at tip .. *brasiliensis.*
- B. Antepygidial bristle submarginal in position and not situated on a marginal cone ; bristles on P^1. of clasper not stout, none of them twisted or elbowed, P^2. straight or slightly curved down at apex.
  - *I.* Horizontal portion of sternite IX club-shaped ; occipital groove less deep, its outline regular ; 6-8 bristles on central abdominal sternites .. *cheopis.*
  - *II.* Horizontal portion of sternite IX ribbon-shaped, very thin and transparent laterally and dorsally ; occipital groove deep, its outline more or less wavy ; 10 or more bristles on central abdominal sternites.
    - *A.* Paramere slanting with a separate dorsal process ; manubrium one and a half times as long as the distance from its junction with the clasper to the longer process .. . *astia.*
    - *B.* Paramere subtriangular, its apex produced into a long spout-like process, no separate dorsal process ; manubrium only as long as the distance from its junction with the clasper to the longer process .. .. .. *hussaini*, sp. nov.

II. Female.
- A. Head of spermatheca wider than base of tail.
  - *I.* Head of spermatheca much wider than base of tail, pigmentation only confined to its dilated base ; 13 or 14 bristles on central abdominal tergites and 7-9 bristles on central abdominal sternites ; 2 ventral subapical bristles on fifth segment of pro and mid tarsus ; about 17 bristles on outer surface of tergite VIII .. .. .. *brasiliensis.*
  - *II.* Head of spermatheca slightly wider than base of tail, pigmentation extends beyond dilated portion of tail ; 15-18 bristles on the central abdominal tergites and 13-16 bristles on central abdominal sternites ; 3 ventral subapical bristles on fifth segment of pro and mid tarsus ; about 30 bristles on outer surface of tergite VIII .. .. *sewelli.* sp. nov.
- B. Head of spermatheca not wider than base of tail.
  - *I.* Base of tail of spermatheca much wider than head ; 10 or more bristles on central abdominal sternites.. *astia.*
  - *II.* Base of tail of spermatheca nearly as wide as head ; 6-8 bristles on central abdominal sternites *cheopis.*

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[1] Cragg, *Ind. Journ. Med. Res. Special Ind. Sci. Congr.* No. 1920, pp. 29-34 (1920) ; *Ind. Journ. Med. Res.* IX, pp. 374-398 (1921) and X, pp. 953-961 (1923).

[2] Hirst, *Ceylon Journ. Sci. (Sect. D.)* I, pp. 155-271, pl. xxvi (1926) ; and pp. 277-455, charts 1-4, 5 maps (1927).

[3] Mital and Dunn, *Report on the geographical distribution and seasonal prevalence of rats and rat-fleas in the United Provinces*, pp. 1-9, 4 maps, 14 g. charts (Lucknow, 1926).

[4] Goyle *Ind. Journ. Med. Res.* XV, pp. 837-860 (1928).

Xenopsylla cheopis (Rothschild).

1903. *Pulex cheopis*, Rothschild, *Entom. Month. Mag.* (2) XIV, pp. 85, 86, pl. i, figs. 3, 9 ; pl. ii, figs. 12, 19.
1905. *Pulex cheopis*, Liston, *Journ. Bombay Nat. Hist. Soc.* XVI, p. 265, pl. A, 1 fig. ; pl. B, 1 fig.
1908. *Loemopsylla cheopis* (*en partim*), Jordan and Rothschild, *Parasitology* I, pp. 42-45, pl. i ; pl. ii, fig. 8 ; pl. iv, fig. 8 ; pl. vi, fig. 1.
1910. *Loemopsylla cheopis*, Fox in *The Rat and its Relation to the Public Health*, pp. 138-140, pl. iii.
1910. *Xenopsylla cheopis*, Rothschild, *Bull. Entom. Res.* I, p. 92, text-figs. 9,11.
1911. *Xenopsylla cheopis*, Jordan and Rothschild, *Novitates, Zoologicae*, XVIII, p. 63.
1913. *Xenopsylla cheopis*, Patton and Cragg, *A Textbook of Medical Entomology*, p. 455, pl. lv, figs. 2, 3, 5, 7 ; pl. lvi, fig. 6.
1914. *Xenopsylla cheopis*, Fletcher, *Some South Indian Insects*, p. 366, text-fig. 227.
1914. *Xenopsylla cheopis*, Rothschild, *Bull. Entom. Res.* V, pp. 84, 85, text-figs. 2, 5.
1915. *Xenopsylla cheopis*, Rothschild, *Entom. Month. Mag.* (3) I, pp. 54, 89, pl. vii, figs. 1, 9, 12.
1916. *Xenopsylla cheopis*, Waterston, *Brit. Mus. Economic Ser.* No. 3, p. 7, text-figs. 1, 5, 6.
1925. *Xenopsylla cheopis*, Sinton, *Ind. Journ. Med. Res.* XII, pp. 473, 474, pl. xxxv, fig. 4 ; pl. xxxvi, figs. 11, 14.
1926. *Xenopsylla cheopis*, Jordan, *III. Internat. Entom.-Kongress*, II, pp. 614, 615, pl. xix, fig. 60 ; pl. xx, fig. 71.

Head.—In the male only there is a row of 10-17 short stout hairs along the hinder margin of the antennal groove. The subapical row on the occiput in both the sexes consists of 11-13 bristles.

Thorax.—There are 12-15 bristles in a row on the pronotum, 12-14 bristles on the mesonotum and 11-13 bristles on the metanotum. The epimerum of the metathorax has two rows of 5-7 bristles in each row.

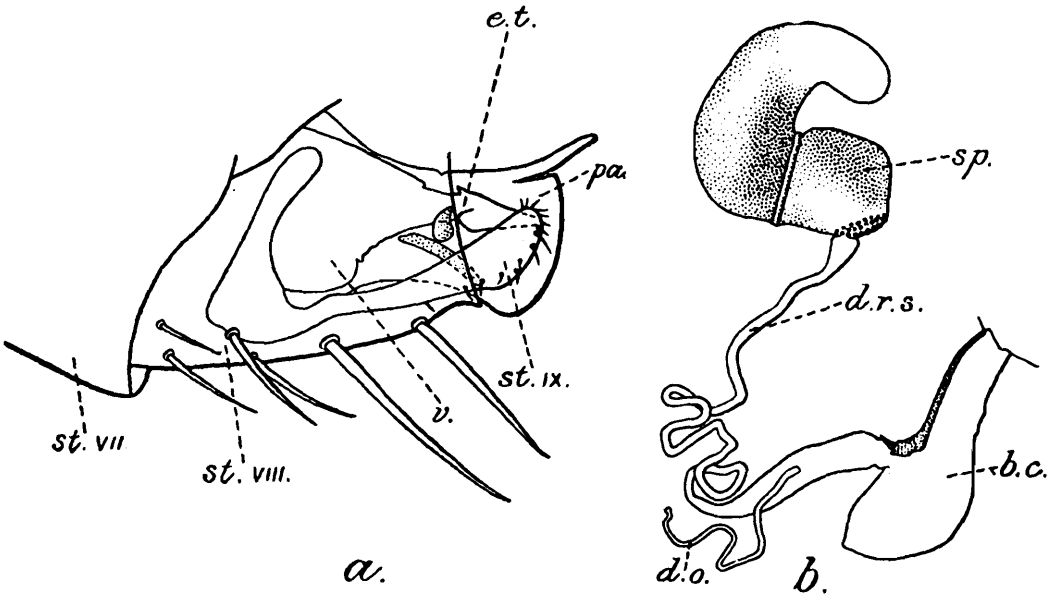
Abdomen.—The chaetotaxy as given by Jordan and Rothschild (1908) for this species shows a considerable range of variation ; this, however, is not the case in the very large series from India examined by me. In the specimens that I have examined I found the following range of variation.

The first row on the first tergite has 5-8 bristles and the second row 6 or 7 bristles. Tergites II—V have each a row of 13-16 bristles and tergites VI, VII have each a row of 12-15 bristles. Sternite II has 2 bristles and sternites III—VII have each a row of 6-8 bristles (generally 6 in ♂ and 8 in ♀). The seventh sternite has in addition 2-5 slender bristles in front of the row.

Legs.—The comb on the hind coxa has 4-10 spinelets. The hind femur bears a row of 5-9 bristles on the inner surface and 2 (rarely 3) subapical ventral bristles on the outer surface. The hind tibia has 6 notches including the apical one. There are 6-9 bristles in a row on its outer side and a row of 2 or 3 bristles between it and the dorsal margin. The fifth segment of the fore and mid tarsus has 3 subapical bristles in addition to the several minute hairs on its ventral surface ; these are long and slender in the female and short and spiniform in the male. The fifth segment of the hind tarsus has only 2 unequal and slender subapical bristles on its ventral surface in both the sexes.

Modified Segments.—♂. The eighth sternite bears on each side a row of 4 or 5 bristles along the ventral margin ; the two posterior ones of these are very strong and the last one is slightly farther from the apex

than from the preceding one, and 3-6 bristles on its lateral surface. The manubrium is narrow and is as long as or shorter than the distance from its junction with the clasper to the tip of the longer process ($P^{2\cdot}$).



TEXT-FIG. 6.—*Xenopsylla cheopis*: (*a*) ♂, lower portion of the terminal genital segments, × 150; (*b*) ♀, spermatheca, bursa copulatrix and associated structures, × 150.

b. c. bursa copulatrix; *d.o.* ductus obturatorius; *d. r. s.* ductus receptaculi seminis; *e. t.* ejaculatory tube; *pa.* paramere; *sp.* spermatheca; *st. vii.*, *st. viii.*, *st. ix.* seventh, eighth and ninth sternites; *v.* vesicle.

The outer process of the clasper ($P^{1\cdot}$) is short and sole-shaped and bears 9-12 moderately strong bristles on its dorsal and apical margins. The horizontal portion of sternite IX widens gradually towards the apex so as to look like a club. Its dorsal and ventral margins are equally chitinised, and its apex is not distinctly curved upwards. The paramere possesses a separate long pointed dorsal process, and its apical margin is evenly rounded. The apical portion of the ejaculatory tube, which is straight, is provided with a dorsal tooth and a small blunt ventral lobe. It possesses a small V-shaped brown sclerite on its ventral side. ♀. The eighth tergite bears 9-13 bristles along the apical margin and 6-8 short ones on the inner side. The lateral row contains 6-9 bristles and besides there are 2-5 bristles between the lateral row and the apical. The anal stylet is short and is almost twice as long as broad. The head of the spermatheca is nearly as large as the base of the tail, which is long and widens gradually towards its base. About one-half of the tail portion is pigmented. The ductus obturatorius opens in the middle of the dilated portion of the ductus receptaculi seminis.

Distribution and Hosts.—It is predominantly an Indo-African species, but has also been recorded from some places all over the world between 40° N. and 40° S. Its wide distribution is due to the fact that its chief host—the rat—can transfer itself with ease from ship to shore and *vice versa*. This flea in various stages of its development has as a result been carried from place to place amongst grain and with other forms of merchandise. It has been introduced into America but is not common. It has been recorded there from certain places between Boston in the north and Buenos Aires in the south, where the species has become established only in the port towns and in a few cases in the interior.

It has also been introduced into the West Indies. In Europe it has only been recorded from port towns and only in a few cases from large towns which carry on trade in grain with Africa and the Oriental Region. It is common all over Africa. In Asia it is very common in all countries below 40° N. In Japan it has only been recorded from port towns and has not penetrated into the interior. In Australia it has established itself only along the coast and is not found in the interior.

In India, where it is now very common, the species has, in my opinion, been introduced. Before 1896 there is no record of plague in India and this, owing to *X. cheopis* being the chief vector of plague, naturally leads one to believe that this species was very scarce or not found in India before the advent of plague. According to Hirst [1] it was absent from Ceylon before 1914 when plague first made its appearance in Ceylon. At present it is very common all over India, but is comparatively rare in places where the climate is warm and moist, especially along the coast of the Bay of Bengal. It has been suggested [2] that it is comparatively rare in the plains of Bengal and Madras Presidencies, Burma and the Bundelkhand division. In the hilly regions of Northern India it is the only rat-flea of the genus *Xenopsylla*, but in the hilly regions of Central and Peninsular India it is, along with *X. brasiliensis*, the common parasite of the rat.

Cragg's [3] statement " while *astia* is the predominant species in those areas which have remained free from the disease or have suffered only lightly " has to be accepted with some caution as in most of the hilly regions *X. cheopis* [4] is the only rat-flea, and still there is no plague in those regions.

Probably the original home of this species is the Nile Valley and its vicinity, and from this area it has spread into the Mediterranean Subregion and the Oriental Region.

I have examined about 80 lots from all over India and a few specimens from Basra in Mesopotamia.

Xenopsylla astia Rothschild.

1911. *Xenopsylla astia*, Rothschild, *Novitates Zoologicae*, XVIII, pp. 117, 118, text-fig. 1.
1914. *Xenopsylla astia*, Rothschild, *Bull. Entom. Res.* V, pp. 84, 85, text-figs. 3, 6.
1925. *Xenopsylla astia*, Sinton, *Ind. Journ. Med. Res.* XII, p. 474, pl. xxxvi, figs. 12, 15.
1926. *Xenopsylla astia*, Jordan, *III. Internat. Entom.-Kongress*, II, p. 618, pl. xix, fig. 54 ; pl. xx, fig. 64.

Head.—The occipital groove in the male is deeper than that in *X. cheopis* and its outline is more or less undulate. There are 17-20 short

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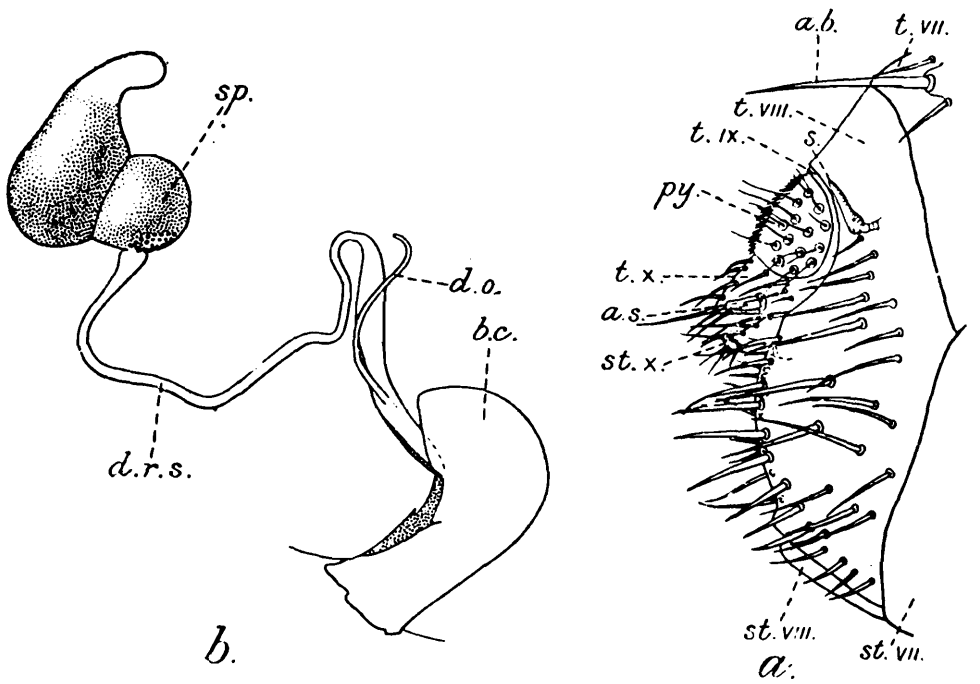
[1] Hirst, *Ceylon Journ. Sci.* (*Sect. D.*) I, p. 160 (1926).
[2] *Vide* Hirst, *Ceylon Journ. Sci.* (*Sect. D.*) I, p. 316 (1927).
[3] Cragg, *Ind. Journ. Med. Res.* IX, p. 394 (1921).
[4] According to Barraud [*Ind. Journ. Med. Res.* XV, pp. 519-521 (1927)] the only rat-flea which is found at Gauhati and Shillong in Assam is *X. cheopis* but no indigenous cases of plague have been recorded during the past few years from these places. According to Goyle [*Ind. Journ. Med. Res.* XV, p. 856 (1928)] *X. cheopis* also forms the bulk of the rat-flea at Naini Tal and Almora and the population does not suffer from plague epidemics. So it appears that hilly regions in India are free from plague even though *X. cheopis* greatly predominates over other species in these regions.

stout hairs along the hinder margin of the antennal groove in the male. The subapical row of the occiput contains 12-16 bristles in both sexes.

Thorax.—The pronotum and mesonotum possess each a row of 14-16 bristles and the metanotum has a row of 12-16 bristles. The epimerum of the metathorax has 6-9 bristles in the first row and 4-7 in the second row.

Abdomen.—The first row of the first tergite has 5-8 and the second 6-9 bristles. The numbers of bristles on the other tergites in both sexes are as follows :—ii. 16-20 ; iii. 16-21 ; iv. 16-18 ; v. 15-18; vi. 15-18 ; vii. 14-16. The numbers of bristles on the sternites are as follows :— ii. 2 ; iii. 10-13 ; iv. 10-15 ; v. 10-16 ; vi. 10-16 ; vii. 10-16. There is an additional row of 3 or 4 slender bristles in front of the postmedian row on sternite VII.

Legs.—As in *X. cheopis.*



TEXT-FIG. 7.—*Xenopsylla astia* ♀: (*a*) terminal segments of the abdomen, × 90 ; (*b*) spermatheca, bursa copulatrix and associated structures, × 150.

a. b. antepygidial bristle ; *a. s.* anal stylet ; *b. c.* bursa copulatrix ; *d. o.* ductus obturatorius ; *d. r. s.* ductus receptaculi seminis ; *py.* pygidium ; *s.* stigmata ; *sp.* spermatheca ; *st. vii.*, *st. viii.*, *st. x.* seventh, eighth and tenth sternities ; *t. vii.*, *t. viii.*, *t. ix.*, *t. x.* seventh, eighth, ninth and tenth tergities.

Modified Segments.—♂. The eighth sternite bears on each side a row of 7-9 bristles along the ventral margin ; of these the posterior 3 or 4 bristles are very strong and the distalmost is shorter than the two preceding it. There are 8-12 bristles on the lateral surface. The manubrium is very long and narrow and is about one and a half times as long as the distance from its junction with the clasper to the longer process (P^{2}·) of the clasper. The outer process (P^{1}·) is comparatively smaller than that of *X. cheopis* and bears 6-9 bristles on its dorsal side ; one of these bristles is longer than the others. The horizontal portion of sternite IX is only strongly chitinised on the ventral side and therefore has the appearance of a ribbon presenting only its edge to the eye. The penal plate resembles that of *X. cheopis*, but is broader and its anterodorsal angle is not so pointed. The paramere has a separate dorsal

process and its apical margin is slanting. The apical portion of the ejaculatory tube is bent downwards and is provided with two dorsal teeth and a strong ventral hook. Above this tube there is a U-shaped brown sclerite with its limbs hanging on either side of the tube. The lower ends of these limbs are serrated. ♀. The eighth tergite bears 11-16 bristles along the apical margin and 7-10 short ones on the inner side. There is an irregular vertical row of 8-10 bristles along its anterior margin and another irregular row of 6-9 bristles between it and the apical row. The head of the spermatheca is much smaller than the dilated basal portion of the tail. The lower greater half of the tail is pigmented. The ductus obturatorius opens behind the dilated portion of the ductus receptaculi seminis.

Distribution and Hosts.—This species has so far been recorded from Indo-China[1], Singapore[2], Burma, India, Ceylon, Mesopotamia, and the Arabian peninsula[3] and certain East African ports—Mombasa, Dar-es-Salaam—where it has been introduced recently. According to Jordan its record from Accra, Gold Coast by Evans[4] is based on wrong identification of specimens of *X. nubicus* (Rothschild) which closely resembles *X. astia.*

According to Hirst[5] its original home was Indo-China from where it has migrated into the low plains of India, but in my opinion it is predominantly a species of the Ceylonese Subregion and has spread along the coast of the Bay of Bengal to Burma and from there into other parts of the Indo-Chinese Subregion. It is found all over India but is absent in the hilly regions. It is evidently a species of the plains and flourishes well in warm and moist areas.

It may be noted here that the specimens recorded by Rothschild as *X. nesiotes* in *Rec. Ind. Mus.* VI, p. 43 (1911) belong to this species. I have examined about sixty lots of this species from the plains all over India.

Xenopsylla brasiliensis (Baker).

1904. *Pulex brasiliensis*, Baker, *Proc. U. S. Nat. Mus.* XXVII, pp. 379, 380.
1909. *Loemopsylla vigetus*, Rothschild, *Novitates Zoologicae*, XVI, p. 53, pl. viii, figs. 3, 4.
1909. *Xenopsylla brasiliensis*, *id. ibid.* p. 332.
1910. *Xenopsylla brasiliensis*, Rothschild, *Bull. Entom. Res.* I, p. 92, text-figs. 8, 10.
1911. *Xenopsylla brasiliensis*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 65, text-fig. 4.
1914. *Xenopsylla brasiliensis*, Rothschild, *Bull. Entom. Res.* V, pp. 84, 85, text-figs. 1, 4.
1925. *Xenopsylla brasiliensis*, Sinton, *Ind. Journ. Med. Res.* XII, pp. 473, 474, pl. xxxvi, figs. 10, 13.
1926. *Xenopsylla brasiliensis*, Jordan, *III. Internat. Entom.-Kongress*, II, p. 611, pl. xviii, fig. 42 ; pl. xix, fig. 57.

Head.—There are 9-13 short and stout hairs along the posterior margin of the antennal groove of the male only and 10-12 bristles in the subapical row on the occiput in both the sexes.

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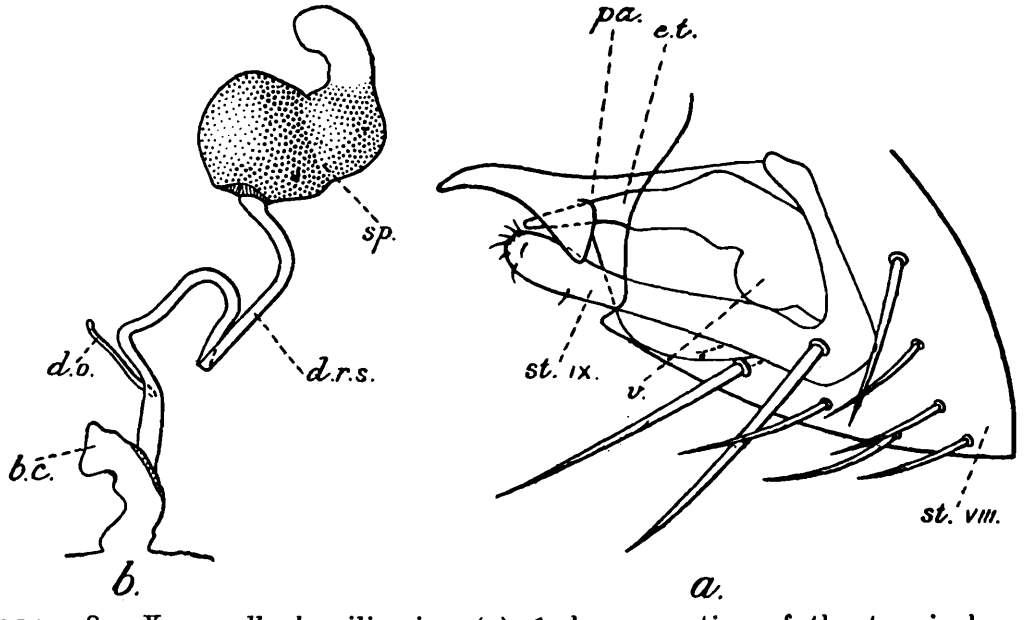
[1] *Vide* Hirst, *Ceylon Journ. Sci.* (*Sect. D.*) I, p. 340 (1927).
[2] Only a single specimen of this species has been recorded from Singapore and it is just possible that it might have been a recently imported specimen.
[3] *Vide* Hirst, *Ceylon Journ. Seci.* (*Sect. D.*) I, p. 162 (1926).
[4] Evans, *Ann. Trop. Med. Parasitol.* XVI, p. 449 (1922).
[5] Hirst, *Ceylon Journ. Sci.* (*Sect. D.*) I, p. 325 (1927).

Thorax.—There are 13-16 bristles on the pronotum, 12-14 bristles on the mesonotum and 10-13 bristles on the metanotum. The epimerum of the metathorax possesses 4-7 bristles in the first row and 4-6 in the second row.

Abdomen.—The first row on the first tergite has 4-7 bristles and the second 5 or 6 bristles. Tergites II-VI have each 13 or 14 bristles and the seventh tergite has 10-12 bristles. Sternite II has only 2 bristles in both sexes. Sternites III-VII in the male have each 4-6 bristles. In the female the numbers of bristles on the remaining sternites are as follows :—iii. 8-9 ; iv. 8-9 ; v. 7 or 8 ; vi. 7 ; vii. 10-14. The seventh sternite in the female possesses in addition to the postmedian row a row of 2-5 slender bristles in front of it. The antepygidial bristle is situated on a conical projection in the male, while it is submarginal in the female.

Legs.—The comb on the hind coxa has 4-6 spinelets. On the inner side of the hind femur there is a row of 4-6 bristles, while there are 2 subapical ventral bristles on its outer side. The hind tibia has six notches including the apical one. The fifth tarsal segment in all legs of the female has 2 slender, unequal, ventral, subapical bristles ; but in the male the fifth segment of the fore and mid tarsus has 3 short and spiniform bristles and the fifth hind tarsal segment, as in the female, bears only 2 bristles. In other respects the legs are as in *X. cheopis.*



Text-fig. 8.—*Xenopsylla brasiliensis :* (*a*) ♂, lower portion of the terminal genital regments, × 188 ; (*b*) ♀, spermatheca, bursa copulatrix and associated structures, × 150.

b. c. bursa copulatrix ; *d. o.* ductus obturatorius ; *d. r. s.* ductus receptaculi seminis ; *e. t.* ejaculatory tube ; *pa.* paramere ; *sp.* spermatheca ; *st. viii., st. ix.* eighth and ninth sternites ; *v.* vesicle.

Modified Segments.—♂. The eighth sternite bears on each side a vertical row of 3 bristles along the anterior margin and 4 or 5 bristles along the ventral margin ; of these the distalmost is the largest and best developed ; there is in addition a strong bristle in between these two rows. The manubrium, which is short and slender, is shorter than the distance from its junction with the clasper to the tip of the longer process (P^{2}·) of the clasper. The outer process (P^{1}·) of the clasper is subcylindrical and bears 7 or 8 strong bristles on the dorsal side ; of these

the third from the base is the strongest, the fourth is the longest and is curved like a boomerang; the two distal bristles are very slender. The inner process (P^2) is narrower and longer than the outer and its distal end is curved upwards. The horizontal portion of sternite IX is club-shaped. Its tip is distinctly widened and rounded and its ventral surface has only a few hairs. The penal plate is as in *X. cheopis* but its proximal narrow portion passes gradually into the broad distal portion. The apical margin of the paramere is oblique and is provided with a big subtriangular dorsal process partially fused with the paramere. The apical portion of the ejaculatory tube, which bends downwards, is unarmed. ♀. The eighth tergite has 8-10 bristles along the apical margin and 6-9 short ones on the inner side. The lateral row contains 4-6 bristles and 2 or 3 bristles between it and the apical row. The anal stylet is comparatively longer than that in *X. cheopis* or *X. astia*. The head portion of the spermatheca is much larger than the base of the tail and only the swollen portion of the tail is pigmented. The ductus obturatorius is short and opens in front of the slightly dilated portion of the ductus receptaculi seminis.

Distribution and Hosts.—This species has, so far, been recorded from West, Central and South Africa, Comoro Islands and Mauritius [1] and the southern uplands of the Indian Peninsula, but is not found in the lowlands of the Madras Presidency. In the Punjab it has been recorded from Chiniot in the Jhang district, Karnal, Jullunder and Lyallpur: only a single specimen of this species has been recorded from each of the above mentioned places and Balipara Frontier Tract in Assam. These records are probably based upon recently and accidently introduced specimens of this species. It has been introduced into Brazil from where it was first described. One specimen of this species has been recorded from England.

I have examined specimens from the following places:—

Assam.—Balipara Frontier Tract (231/H6, ♂, off dog), Tezpur district.

Central Provinces.—Jubbulpore (357/H6, 226/H6, ♂s ♀s, off rat). Pachmarhi (227/H6, 280/H6, ♂s, off rat and 298/H6, ♀, off squirrel), Hoshangabad district.

Bombay Presidency.—Nasik (222/H6, 343/H6, ♂s♀s, off rat). Bombay (361/H6, ♂s ♀s, off rat). Belgaum (350/H6, ♂s ♀s, off rat).

Mysore State.—Mysore City (230/H6, ♂ ♀, off rat).

Xenopsylla hussaini, sp. nov.

Head.—The rostrum does not quite reach the tip of the fore coxa. There is a row of 22 short hairs along the hinder margin of the antennal groove. The subapical row of the occiput contains 13 bristles. The occipital groove is as deep as in *Xenopsylla astia* and its outline is almost similar.

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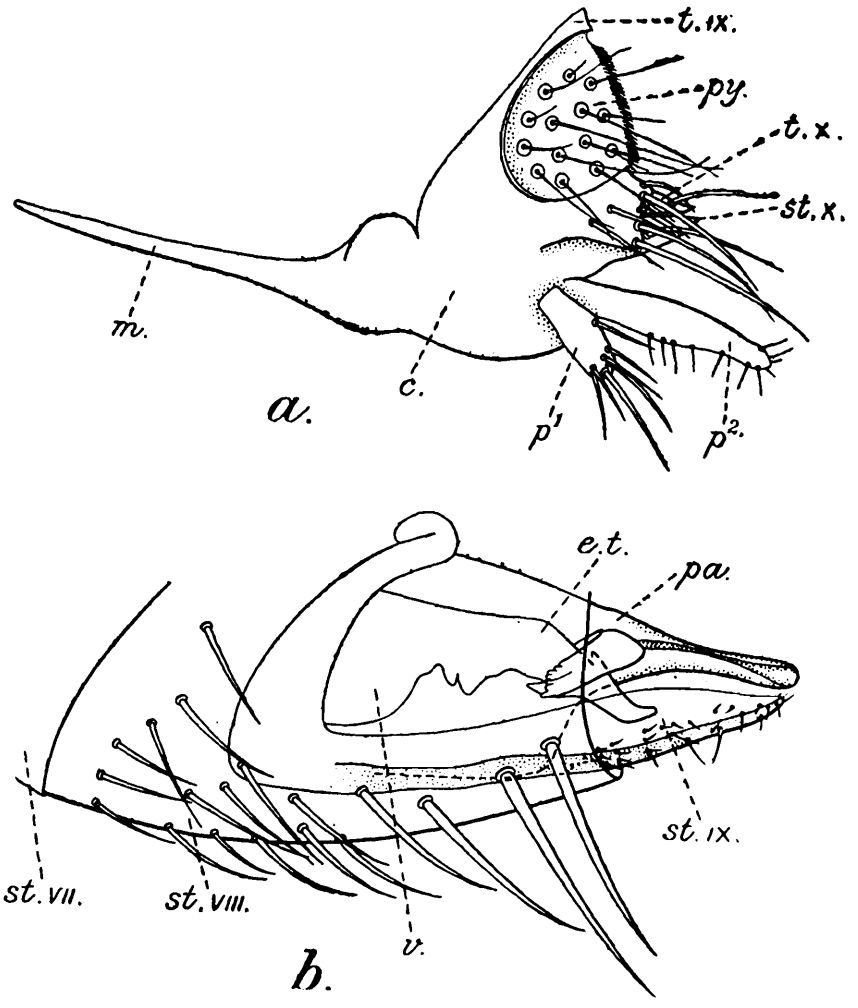
[1] *Vide* Hirst, *Ceylon Journ. Sci.* (*Sect. D.*) I, p. 283 (1927).

Thorax.—There are 16 bristles on the pronotum, 17 bristles on the mesonotum and 15 bristles on the metanotum. The metepimerum has 6 or 7 bristles in the first row and 5 in the second row.

Abdomen.—The two rows on the first tergite have each 8 bristles. The numbers of bristles on the other tergites are as follows :—ii. 17 ; iii. 18 ; iv. 16 ; v. 17 ; vi. 17 ; vii. 16. Sternite II has 2 bristles and sternites III—VII have each 11 bristles.

Legs.—The comb on the hind coxa has 6 or 7 spinelets. The hind femur has a row of 8 bristles on the inner side and 3 subapical ventral bristles on the outer side. The hind tibia shows 6 dorsal notches bearing stout bristles. There is a row of 9 bristles on its outer side and 3 bristles between this row and the dorsal margin. Otherwise the legs are as in the male of *Xenopsylla cheopis*.



TEXT-FIG. 9.—*Xenopsylla hussaini* ♂ : (*a*) upper portion of the terminal genital segments, × 150 ; (*b*) lower portion of the terminal genital segments, × 150.

c. clasper ; *e. t.* ejaculatory tube ; *m.* manubrium ; p^1. p^2. first and second processes of the clasper ; *pa.* paramere ; *py.* pygidium ; *st. vii., st. viii., st. ix., st. x.* seventh, eighth, ninth and tenth sternites ; *t. ix., t. x.* ninth and tenth tergites ; *v.* vesicle.

Modified Segments.—♂. The eighth sternite bears on each side a row of 10 bristles along the ventral margin ; of these the first and third from the distal end are almost equally strong. On the lateral surface there are 19 bristles. The manubrium is shorter than that of *X. astia* and is as long as the distance from its junction with the clasper to the longer process ($P^{2\cdot}$) of the clasper, which is longer than that of *X. astia*. The

horizontal portion of sternite IX is as in *X. astia*, but its lateral surfaces are more chitinised and not so transparent as in that species. The paramere is subtriangular and its apical portion forms a very long spout-like process which is longer than that of *X. nesiotes* (Jordan and Rothschild). The terminal portion of the ejaculatory tube first bends downwards and then becomes straight. It is provided with a dorsal tooth and a strong ventral hook. Above this tube is a brown U-shaped sclerite of almost the same form but comparatively longer than that of *X. astia*. The female of this species is unknown.

This species resembles *X. astia* in several characters, but the genitalia is quite different and resembles that of *X. nesiotes* (Jordan and Rothschild).

I have great pleasure in associating this species with the name of my friend Mr. M. A. Hussain, Entomologist to the Government of the Punjab, who presented to the Indian Museum the only specimen upon which the description of this species is based. The type-specimen (480/H6), which was collected from a field-rat—*Gerbillus indicus* (Hardwicke)—at Tundla in the Ambala district, is deposited in the Indian Museum.

Xenopsylla sewelli, sp. nov.

Head.—The rostrum extends up to the middle of the fore trochanter. The subapical row of the occiput contains 11 bristles.

Thorax.—There are 18 bristles on the pronotum, 16 bristles on the mesonotum and 15 bristles on the metanotum. The metepimerum has 6 bristles in the first row and 5 bristles in the second row.

Abdomen.—The first row on the first tergite has 6 bristles and the second row has 7 bristles. The numbers of bristles on the other tergites are as follows :—ii. 17 ; iii. 18 ; iv. 17 ; v. 16 ; vi. 17 ; vii. 15. Unlike other species of this genus there are 2 bristles below the stigmata on tergites II—VI. The bristles on the sternites are as follows :—ii. 2 ; iii. 13 ; iv. 16 ; v. 14 ; vi. 14 ; vii. 15. The seventh sternite has a row of 11[1] hair-like bristles in front of the post-median row.

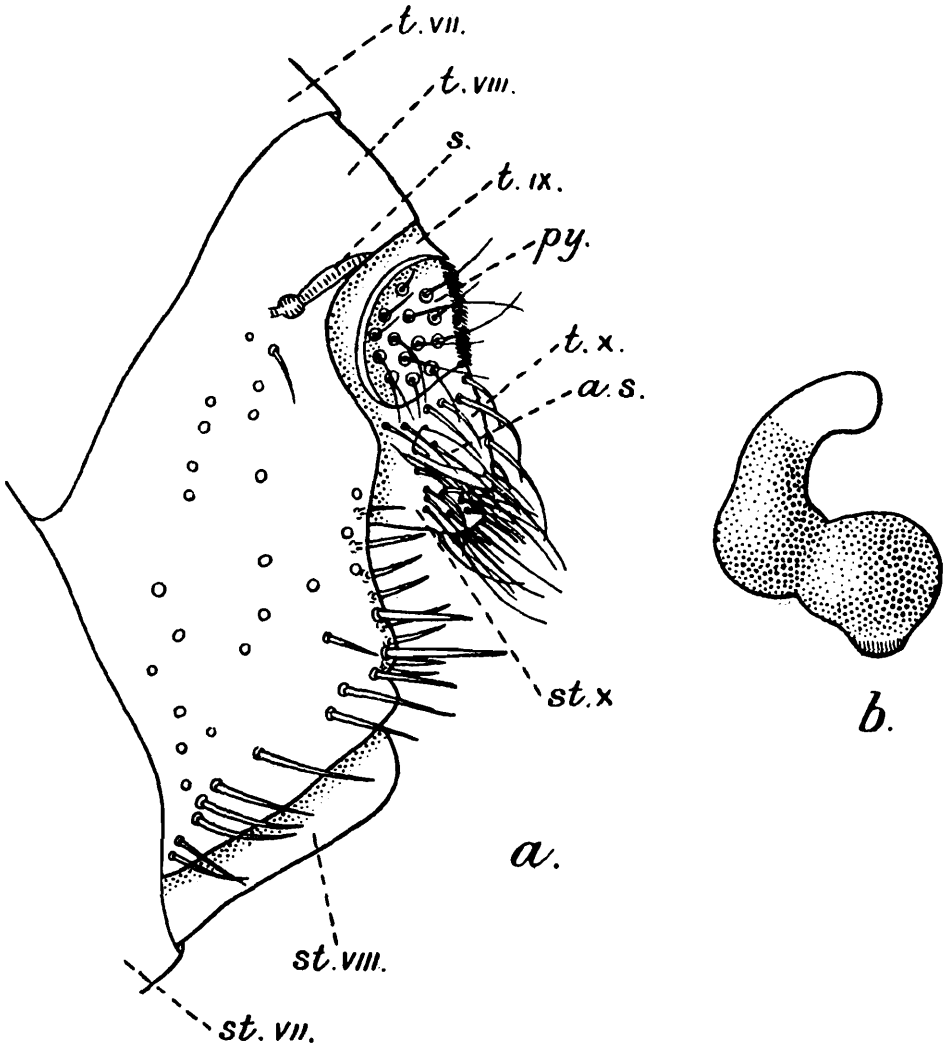
Legs.—The comb on the hind coxa and the arrangement of the bristles on the hind femur and on the hind tibia are similar to those of *X. hussaini*. The fifth tarsal segments of all legs are as in the female of *X. cheopis*.

Modified Segments.—♀. The eighth tergite has 14 bristles along the apical margin and 9 stout bristles on the inner side. There is an irregular vertical row of 10 bristles near its anterior margin and another irregular vertical row of 8 bristles in between the anterior and the apical rows. The head of the spermatheca is broader than the dilated portion of the tail whose proximal greater half is pigmented.

This species is described from a single specimen (type-specimen, 481/H6) taken from *Gerbillus indicus* (Hardwicke) at Tundla in the Ambala district. The specimen came from the same lot as *X. hussaini*. At first I considered it to be the female of *X. hussaini*, but the shape of the spermatheca of this species is of the type of the *brasiliensis* subgroup of

[1] The places of insertion of the bristles are to be clearly seen though the bristles have dropped off in the type-specimen.

species, while *X. hussaini* undoubtedly belongs to the *cheopis* subgroup of species, and I have, therefore, no hesitation in considering the two



TEXT-FIG. 10.—*Xenopsylla sewelli* ♀: (*a*) terminal segments of the abdomen, × 106; (*b*) spermatheca, × 200.

a. s. anal stylet; *py.* pygidium; *s.* stigmata; *st. vii., st. viii., st. x.* seventh, eighth and tenth sternites; *t. vii., t. viii., t. ix., t. x.* seventh, eighth, ninth and tenth tergites.

specimens as distinct. The type-specimen is deposited in the Indian Museum.

Genus **Ctenocephalus** Kolenati.

1758. *Pulex (en partim)*, Linnaeus, *Systema Naturae* (X. ed.), p. 614.
1859. *Ctenocephalus*, Kolenati, *Jahresh. Nat. Sect. Mähr. Schles. Ges.* 1858, p. 65.
1863. *Ctenocephalus*, Kolenati, *Horae Soc. Entom. Ross.* II, pp. 44, 45.
1880. *Pulex (en partim)*, Taschenberg, *Die Flöhe*, p. 64.
1904. *Ctenocephalus (en partim)*, Baker, *Proc. U. S. Nat. Mus.* XXVII, p. 384.
1904. *Ctenocephalus (en partim)*, Tiraboschi, *Arch. Parasitol.* VIII, pp. 253, 254.
1907. *Ctenocephalus*, Tiraboschi, *Arch. Parasitol.* XI, p. 588.
1911. *Ctenocephalus*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 66.
1915. *Ctenocephalus*, Rothschild, *Entom. Month. Mag.* (3) I, pp. 56, 91.
1925. *Ctenocephalus*, Fox, *Insects and Disease of Man*, p. 135.

In India this genus is represented by *C. canis* (Curtis), *C. felis* (Bouché) and *C. felis* subsp. *orientis* Jordan. These three forms are very closely related to one another, and the subspecies *orientis* is undoubtedly intermediate between *C. felis* and *C. canis*.

Key to the Indian species and subspecies of the genus *Ctenocephalus*.

I. Anteriormost genal spines much smaller than those behind; metepisternum usually with three or more bristles and metepimerum with 7-14 bristles in the first and 7-9 bristles in the second row; hind tibia with eight dorsal notches; male with moveable finger of clasper broadly rounded at the apex, its proximal three-fourths along ventral margin strongly chitinised and devoid of hairs; anal stylet of female one and a half times as long as broad .. .. *canis*.

II. Anteriormost genal spines nearly as strong as those behind; metepisternum usually with two bristles and metepimerum with 4-8 bristles in both rows; hind tibia with either six or seven dorsal notches; male with moveable finger of clasper somewhat pointed apically, its proximal half along ventral margin strongly chitinised and devoid of hairs; anal stylet of female nearly three times as long as broad.

A. Frons elongate and pointed at the anterior end; female without a row of short hairs behind antennal groove; hind tibia with six dorsal notches; manubrium not widened apically.. .. .. *felis* forma *typica*.

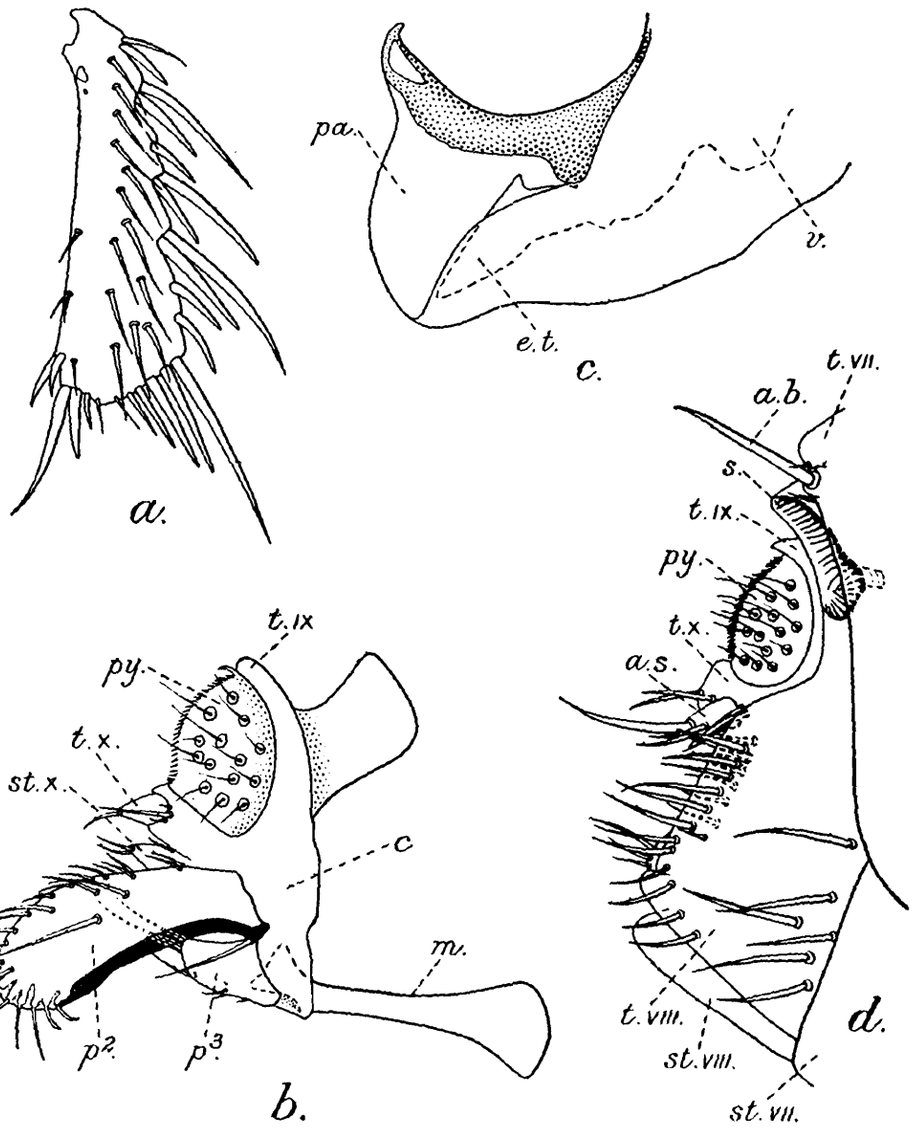
B. Frons short and broadly rounded anteriorly; female with a row of 1-8 short hairs behind antennal groove; hind tibia with seven dorsal notches; manubrium widened apically.. .. .. .. *felis* subsp. *orientis*.

Ctenocephalus canis (Curtis).

1826. *Pulex canis*, Curtis, *Brit. Entom.* III, No. 114, figs. A-E, 8.
1832. *Pulex canis* (*en partim*), Dugès, *Ann. Sci. Nat.* XXVII, pp. 157-160, 163, pl. iv, figs. 2, 5, 7, 8.
1844. *Pulex canis*, Gervais in *Walckenaer's Histoire Naturelle des Insectes Aptères* III, p. 372.
1904. *Ctenocephalus serraticeps*, Tiraboschi, *Arch. Parasitol.* VIII, pp. 254-259.
1904. *Ctenocephalus canis* (*en partim*), Baker, *Proc. U. S. Nat. Mus.* XXVII, pp. 384, 385, 438.
1905. *Ctenocephalus canis* (*en partim*), Baker, *Proc. U. S. Nat. Mus.* XXIX, pp. 131, 145.
1907. *Ctenocephalus canis*, Tiraboschi, *Arch. Parasitol.* XI, pp. 591, 592, text-figs. 11A, 11A'.
1910. *Ctenocephalus canis*, Fox, in *The Rat and its Relation to the Public Health*, pp. 143, 144, pl. vi.
1911. *Ctenocephalus canis*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, p. 67.
1915. *Ctenocephalus canis*, Rothschild, *Entom. Month. Mag.* (3) I, pp. 56, 91, 92, pl. vii, figs. 4, 10.
1925. *Ctenocephalus canis*, Fox, *Insects and Disease of Man*, pp. 135, 136, text-fig. 63.

Head.—In both sexes the frons is broadly rounded at the anterior end and the perpendicular distance between the falx and the anterior oral corner is equal to the distance between the base of the posteriormost genal spine and the apex of the falx. The genal comb has 16 spines (rarely 14 or 15), the two anteriormost being about half as small as those behind. The labial palpi reach two-thirds to three-fourths the length of the fore coxa. The internal frontal tuber is comparatively short and its proximal half is near the anterior edge of the frons. The occiput has 2 bristles behind the antennal groove, one near the base and the other near the middle. In some cases there is a row of 2 bristles in the middle. The subapical row of the occiput has 10-12 bristles. The male has two or three rows, each consisting of about 8 short stout hairs behind the antennal groove; they are altogether absent in the female.

Thorax.—The pronotal comb contains 14-17 spines in the male and 16-18 in the female. The number of bristles in the row on the pronotum is 12-14, on the mesonotum 12-16 and on the metanotum 10-13. The mesothorax bears a single bristle (rarely 2 or more) on the episternum and 4-7 bristles on the epimerum. The metathorax has a single bristle (rarely 2 or more) on the sternum and 3-5 (rarely 2) on the episternum and two rows of 7-14 and 7-9 bristles on the epimerum. The bristles of the first row are not regularly arranged and in some specimens are seen to be arranged in two rows, thus making the number of rows on the metepimerum three.



TEXT-FIG. 11.—*Ctenocephalus canis:* (*a*) ♂, hind tarsus, × 82; (*b*) ♂, upper portion of the terminal genital segments, × 133; (*c*) ♂, terminal portion of the ejaculatory tube and paramere, × 240; (*d*) ♀, terminal segments of the abdomen, × 80.

a. b. antepygidial bristle; *a. s.* anal stylet; *c.* clasper; *e. t.* ejaculatory tube; *m.* manubrium; p^2. p^3. second and third processes of the clasper; *pa.* paramere; *py.* pygidium; *s.* stigmata; *st. vii., st. viii., st. x.* seventh, eighth and tenth sternites; *t. vii., t. viii., t. ix., t. x.* seventh, eighth, ninth and tenth tergites; *v.* vesicle.

Abdomen.—The two rows on the first tergite have each 4 (sometimes 5-7) bristles. Tergites II—V have each 11-15 bristles and tergites VI and VII have each 10-12 bristles. The second sternite has 2 bristles

and sternites III—VI have each 4-6 bristles. Sternite VII bears 4-8 bristles. The abdonimal stigmata are large in size.

Legs.—The fore coxa is strongly hairy and usually bears 30 stout bristles on the outer surface. The comb on the hind coxa has 8-11 spinelets. The fore femur has 6-11 bristles on the outer surface and 1 or 2 subapical ventral bristles. The hind femur bears a row of 7-13 bristles on the inner side and 3 (rarely 2 or 4) subapical ventral bristles on the outer side. There are 9-13 bristles on the outer surface of the hind tibia and it also possesses 8 dorsal notches including the apical one. The third, sixth and seventh usually possess each a single bristle. In some specimens there is an additional notch after the third notch from the proximal end. The fifth tarsal segment of all the legs has 2 ventral subapical bristles of unequal length.

Modified Segments.—♂. The eighth sternite bears a vertical row of 10-14 bristles and one or two rows of 2 bristles in front of the row. The clasper has a sole-shaped moveable finger (P^2·), beneath which there is a small triangular process (P^3·). The moveable finger is broadly rounded at the apex and its proximal three-fourths along the ventral margin, which is strongly chitinised, is devoid of hairs. The manubrium is straight and narrow at its origin, but is considerably widened at the apex to form a spatula-like structure. The apical margin of the paramere is slightly convex and is produced dorsally into a hook-like process. The apical portion of the ejaculatory tube, which is bent downwards, has only a backwardly directed dorsal tooth. ♀. The eighth tergite bears 8-12 bristles in the apical row, 2 or 3 bristles on the apical margin and 5-8 bristles on the inner side. There are 4-9 bristles sometimes arranged in two rows on the lateral surface. The anal stylet is nearly one and a half times as long as broad, and bears 2 strong apical bristles of unequal length. The head of the spermatheca is subrectangular in shape, and the two ducts are subequal in length; they open into a common broad duct before opening into the bursa copulatrix.

Distribution and Hosts.—This species has hitherto been confused with *C. felis* and its subspecies, and it is, therefore, very difficult to form a correct idea of its exact distribution. According to Rothschild it is found only in Europe, Africa and Asia. There are, however, records of its occurrence in other areas, but these appear to be based on wrongly identified specimens as the species is not indigenous in other continents. There is the possibility that it may have been introduced into these parts, but in such cases it would be confined only to certain trade centres and could not already have become widely distributed. According to Jordan [1] it has been introduced into South and East Africa where *C. felis strongylus* Jordan is the indigenous flea. In my opinion it is predominantly a flea of the Palaearctic Region and has spread with its main host—the dog—all over the world. It is a flea of cold regions and cannot flourish in hot climates. Its chief hosts are the dog and the cat, but it occasionally attacks other animals and man.

The previous records from India are mostly based on wrongly identified specimens of *C. felis* subsp. *orientis*. In this country it is only confined to the hilly regions and is very scarce in the plains. I have ex-

[1] Jordan, *Novitates Zoologicae*, XXXII, p. 98 (1925).

amined a fairly large number of specimens of the genus *Ctenocephalus* from all over India but only a few lots from places mentioned below belong to this species.

Madras Presidency.—Kodaikanal (454/H6, ♂s ♀s, host ?), Madura district.

United Provinces.—Muktesar (122/H6, ♂ ♀s, off fox and 121/H6, ♂ ♀s, off dog), Naini Tal district. Almora city (166/H0, ♂s ♀s, off dog). Chakrata (208/H6, ♂s ♀s, off dog), Dehra Dun district.

Punjab.—Hissar (462/H6, ♀, off wild boar). Sohawa (453/H6, ♂s ♀s, off dog), Jhelum district.

Ctenocephalus felis (Bouché).

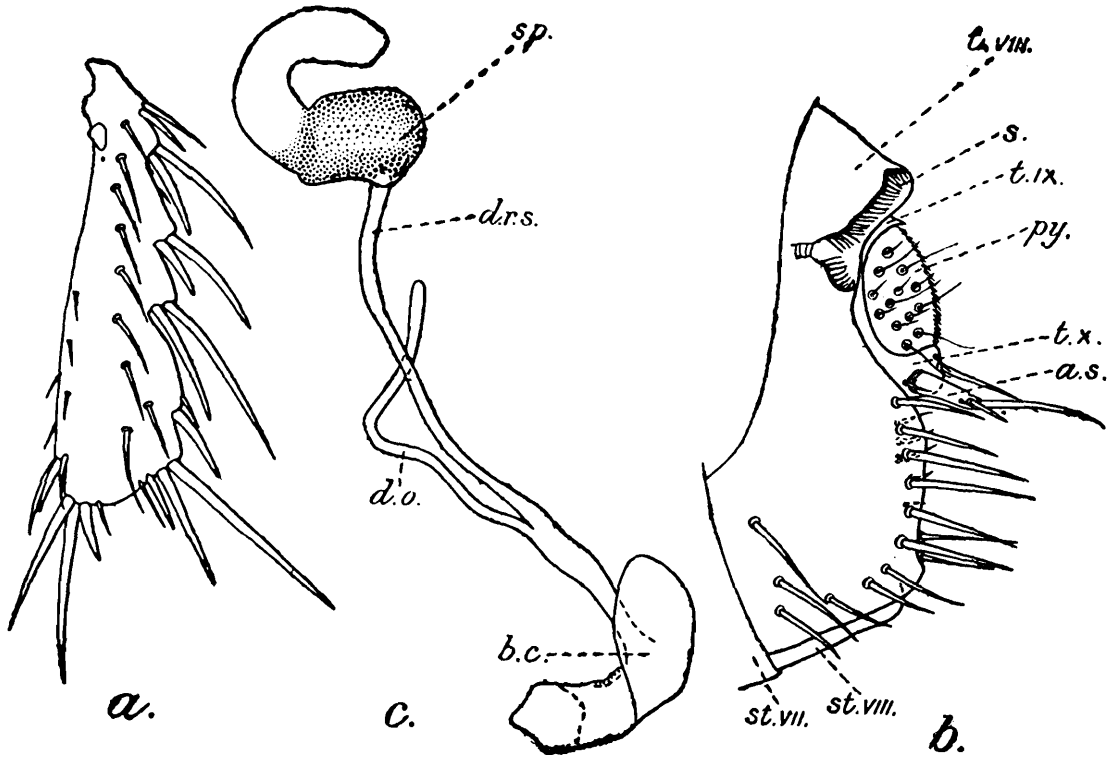
1832. *Pulex canis* (*en partim*), Dugès, *Ann. Sci. Nat.* XXVII, pp. 157-160, 163, pl. iv, figs. 2, 5, 7, 8.
1835. *Pulex felis*, Bouché, *Nova Acta Physico-Medica Acad. Caes. Leop. Carol.* XVII, pp. 505, 506.
1896. *Pulex serraticeps* (*en partim*), Howard, *Bull. U. S. Dept. Agric., Divis. Entom.* (n. s.) No. 4, pp. 24-31, text-figs. 5, 6.
1896. *Pulex serraticeps* (*en partim*), Osborn, *Bull. U. S. Dept. Agric., Divis. Entom.* (n. s.) No. 5, pp. 150-152, text-fig. 83.
1905. *Pulex felis*, Liston, *Journ. Bombay Nat. Hist. Soc.* XVI, p. 264, pl. A, 1 fig. ; pl. B, 1 fig.
1905. *Ctenocephalus canis* var. *felis*, Baker, *Proc. U. S. Nat. Mus.* XXIX, p. 131.
1907. *Ctenocephalus felis*, Tiraboschi, *Arch. Parasitol.* XI, pp. 592, 593, text-figs. 11B, 11B′.
1911. *Ctenocephalus felis*, Jordan and Rothschild, *Novitates Zoologicae*, XVIII, pp. 67, 68.
1915. *Ctenocephalus felis*, Rothschild, *Entom. Month. Mag.* (3) I, pp. 56, 57, 92, 93, pl. vii, figs. 5, 11.

Head.—The frons is longer and more pointed at the anterior end than in *C. canis*, especially so in the female. The two bristles on the frons are weaker than those in *C. canis*, especially the one at the anterior oral corner. The genal comb has 16 spines (rarely 15) ; the two anteriormost and the one situated at the apex of the genal lobe are longer and stronger than those in *C. canis* : the former are approximately as strong as those behind them. The internal frontal tuber is longer than that in *C. canis*. The occiput has only 2 bristles behind the antennal groove and its subapical row consists of 10 bristles (rarely 8 or 9). The male has two rows, each consisting of 8 short and stout hairs behind the antennal groove, while they are absent in the female.

Thorax.—The pronotal comb contains 14-17 spines in the male and 15-18 spines in the female. The number of bristles in the row on the pronotum is 10-13, on the mesonotum 11-13 and on the metanotum 9-12 (generally 10). The mesothorax bears a single bristle on the episternum and 4 bristles on the epimerum. The metathorax has one bristle on the sternum and 2 (rarely 3) on the episternum and two rows of 4-7 and 5-8 bristles on the epimerum.

Abdomen.—The first row on the first tergite has 2-4 bristles (rarely 5 or 6) and the second row has 4 bristles (rarely 5 or 6). Tergites II—VI have each 10 or 11 (rarely 12 or 13) bristles and tergite VII possesses 10 (sometimes 8 or 9) bristles. Sternite II possesses only 2 bristles, while sternites III—VII have each 2-4 bristles (always 4 in ♀). The stigmata are much smaller than in *C. canis*.

Legs.—The fore coxa is less hairy than in *C. canis* and bears about 20 comparatively less stout bristles on the outer surface. The comb of the hind coxa has 6-12 spinelets. The fore femur has 3-7 bristles on the outside and a single subapical ventral bristle. The hind femur has 6-9 bristles on the inner side and 2 subapical ventral bristles on the outer side. There are 7-11 bristles on the outer side of the hind-tibia : it also bears 6 dorsal notches including the apical one, of these only the fifth notch has a single bristle. The mid tarsus is more slender than that in *C. canis*, especially its second segment.



TEXT-FIG. 12.—*Ctenocephalus felis* ♀ : (*a*) hind tarsus, × 82 ; (*b*) terminal segments of the abdomen, × 82 ; (*c*) spermatheca, bursa copulatrix and associated structures, × 150.

a. s. anal stylet ; *b. c.* bursa copulatrix ; *d. o.* ductus obturatorius ; *d. r. s.* ductus receptaculi seminis ; *py.* pygidium ; *s.* stigmata ; *sp.* spermatheca ; *st. vii., st. viii.*, seventh and eighth sternites ; *t. viii., t. ix., t. x.* eighth, ninth and tenth tergites.

Modified Segments.—♂. The eighth sternite bears a vertical row of 6 bristles and 2 bristles are present in front of the row. The moveable finger ($P^{2'}$) is somewhat pointed at the distal end; its greater proximal half along the ventral margin, which is strongly chitinised, is devoid of hairs. The breadth of the manubrium is practically uniform throughout. The dorsal tooth on the ejaculatory tube is either absent or poorly indicated. ♀. The eighth tergite bears 7-10 bristles in the apical row, 2 (rarely 3) bristles on the apical margin and 4 or 5 bristles on the inner side. There are 3 or 4 bristles in the lateral row. The anal stylet is about three times as long as broad. The spermatheca and bursa copulatrix are as in *C. canis*, but the ductus obturatorius and the ductus receptaculi seminis are longer than in that species.

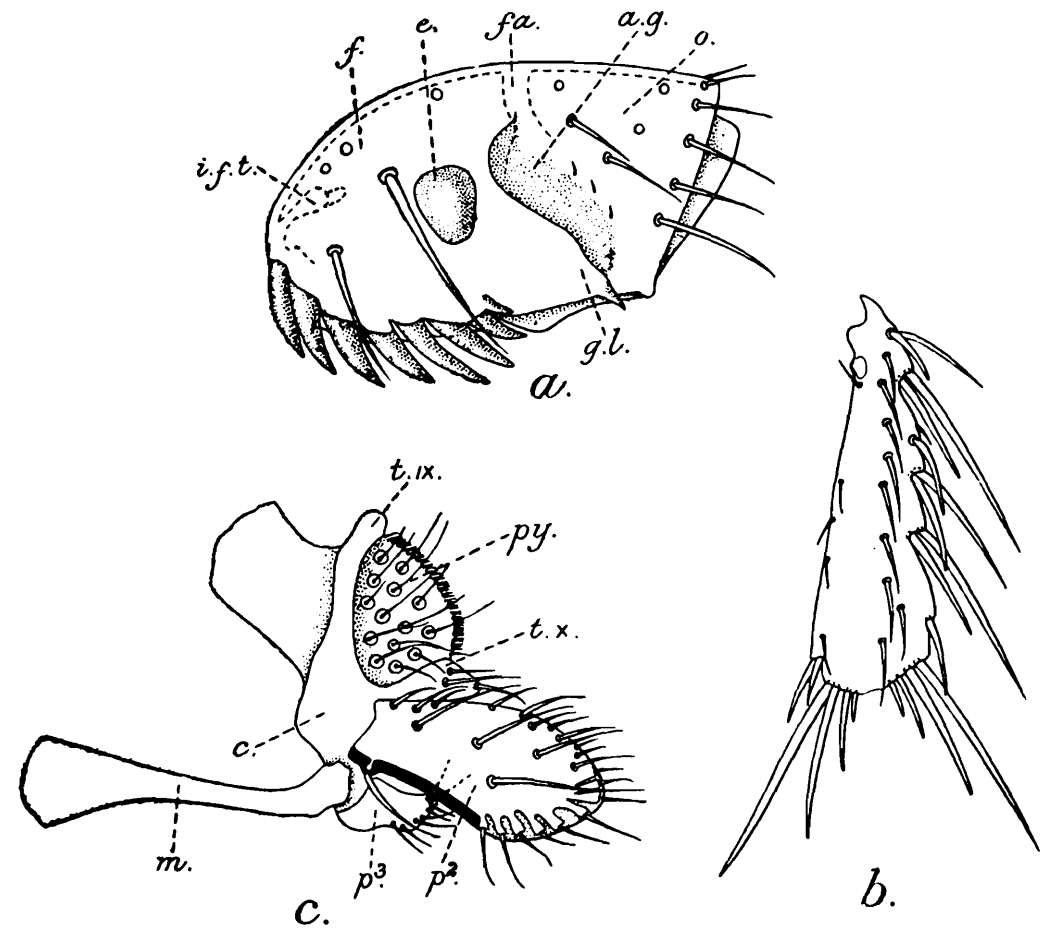
Distribution and Hosts.—This species is cosmopolitan in its distribution and appears to be the most widely distributed flea. It is found in all climes but flourishes best in tropical countries. Its chief host is the cat, but it is also found on other carnivores and occasionally attacks man and rodents. It is found all over India but appears to be less

common than its subspecies *orientis*. I have examined about one hundred lots from places all over India, Burma and the Andamans.

Subsp. **orientis** Jordan.

1925. *Ctenocephalus felis orientis*, Jordan, *Novitates Zoologicae*, XXXII, p. 99.

This subspecies is intermediate between *C. canis* and *C. felis* as it possesses certain characters in common with *C. canis* and others with *C. felis*. It differs from the typical form in the following points. The frons is more broadly rounded ; it is nearly as short and rounded as in *C. canis*. The anteriormost genal spines and the one at the apex of the genal lobe are as strong as in the *forma typica*. The female has a row of 1-8 short stout hairs behind the antennal groove. The abdominal stigmata are larger in size than those in the typical form, but not so large as in *C. canis*. The hind tibia possesses seven dorsal notches including the apical one and the third and sixth notches only bear each a bristle.



TEXT-FIG. 13.—*Ctenocephalus felis* subsp. *orientis* : (*a*) ♀, head, × 82 ; (*b*) ♂, hind tarsus, × 82 ; (*c*) ♂, upper portion of the terminal genital segments, × 133.

a. g. antennal groove ; *c.* clasper ; *e.* eye ; *f.* frons ; *fa.* falx ; *g. l.* genal lobe ; *i. f. t.* internal frontal tuber ; *m.* manubrium ; *o.* occiput ; p^2., p^3. second and third processes of the clasper ; *py.* pygidium ; *t. ix.*, *t. x.* ninth and tenth tergites.

Modified Segments.—♂. The eighth sternite bears a vertical row of 8 bristles (rarely 6 or 7) with 1 or 2 bristles in front of the row. The manubrium is widened at its apex into a spatula-like structure as in *C. canis*. ♀. The eighth tergite bears 7-11 bristles in the apical row and 4-7 bristles on the inner side. There are 3 (sometimes 4) bristles

in the lateral row. The spermatheca, bursa copulatrix and associated structures are more like those of *C. canis* than of *C. felis*.

Distribution and Hosts.—This subspecies has been recorded from the Admiralty Islands and Rook Island of the Bismarck Archipelago, the Philippine Islands, Sumatra, Pulo Bali (off west coast of Sumatra), Malay Peninsula, Burma, India and Ceylon. In India it appears to be the commonest flea of the genus *Ctenocephalus* and replaces *C. canis*. Its chief hosts are the dog, the goat and cattle, but it is sometimes found on the cat, sheep, the rat and the squirrel.

I have examined about 160 lots from all over India, Burma and the Andamans.