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Siphonaptera of New Zealand

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Abstract

FIFTEEN species of fleas have hitherto been recorded as occurring in the New Zealand subregion. In the present paper another five species, four of which are new to science, are added to the New Zealand list, and some notes are given on the origin of the flea-fauna of these islands.

INTRODUCTION

THE zoogeographical area dealt with in this paper is the New Zealand subregion of the Australian Region (Fig. 1), ranging from the Kermadec Islands in the north to Macquarie Island in the south and eastward to the Chatham Islands inclusive; Lord Howe Island, in the north-west, is excluded from this subregion.

Like the fauna of the host animals, the composition of the flea fauna of New Zealand is quite different from that of other regions of the world. About 95% of all fleas are parasites of mammals, 5% are associated with birds. However, the only native New Zealand mammals are two species of bats which share one species of endemic flea. Since about the middle of the 19th century a number of mammals has been introduced and acclimatised. These mammals brought with them nine different species of fleas, so at present ten species of mammal fleas are known to occur in New Zealand. At the moment the birds are host also to ten—more interesting—species of fleas, six of which are endemic, three more widespread in the subantarctic region, while one has been introduced from Europe.

It is well possible that a few more species of fleas will be found to belong to the fauna of New Zealand. This paper merely presents in a preliminary way all data concerning the subject which I have been able to gather during the last ten years.

The fleas of New Zealand are of considerable zoogeographical interest, their true centres of distribution being endemic, sub-antarctic, Australian or European, while seven are cosmopolitan species. The results of continued assiduous collecting should eventually help to clarify some problems of distribution which seem difficult to solve at present.

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Numerous birds' nests will have to be examined for fleas throughout the various islands (negative records should be carefully kept) before eventually a sound assessment of the New Zealand flea fauna can be made.

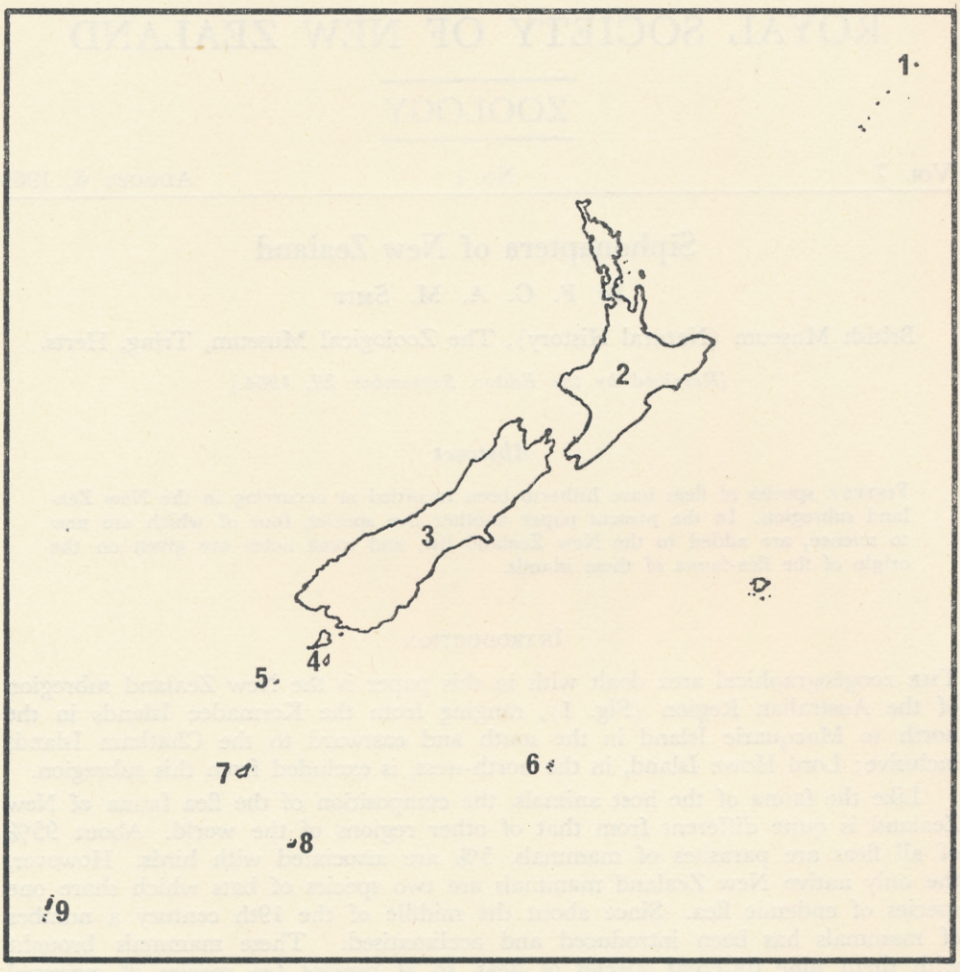


Fig. 1.—The islands of the New Zealand subregion where fleas have been collected: 1—Raoul I. (Kermadec Is.). 2—North I. 3—South I. 4—Stewart I. 5—Snares Is. 6—Antipodes Is. 7—Auckland Is. 8—Campbell I. 9—Macquarie I.

Chronological Review of Published Records

Early authors (Forster 1777, Nicholas 1817, Polack 1838, Dieffenbach 1843, White & Doubleday 1843, Angas 1847 and Hochstetter 1867) mentioned the occurrence of fleas in New Zealand but abstained from naming any particular species. Gillies (1878) refers to *Pulex irritans* as the flea which became a pest in Otago, but as in those days *P. irritans* was still the only well-known name for a flea it would seem that Gillies merely assumed the troublesome fleas to have belonged to that species. Hudson (1892: 64) states that "The Pulicina comprise the well-known fleas, which are probably identical with the European species". Actually, not more than a third of the New Zealand fleas are also found in Europe.

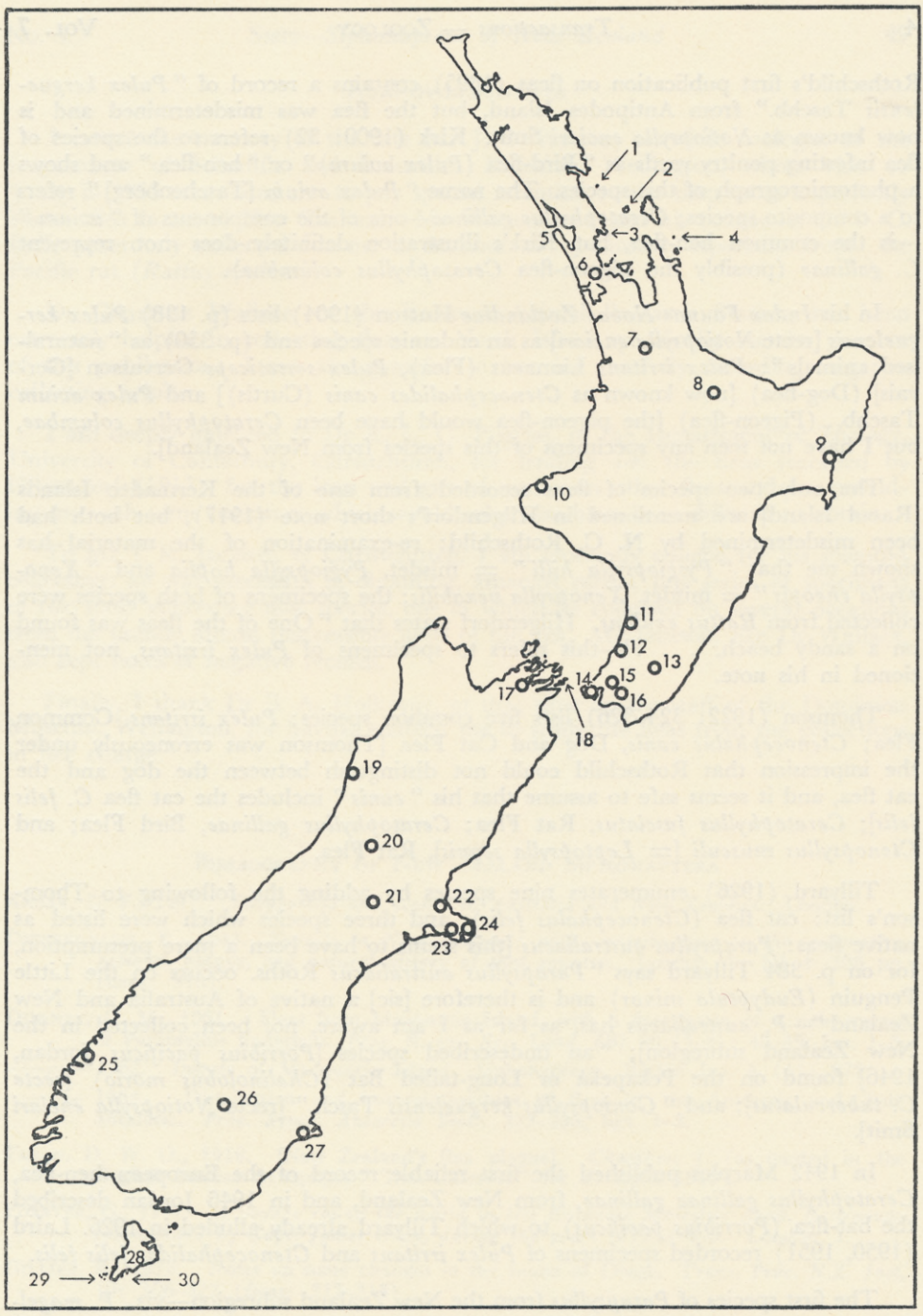


FIG. 2.—The localities on and around North and South Islands where fleas have been collected: 1—Hen I. 2—Little Barrier I. 3—Mahurangi Heads and Goat I. 4—Cuvier I. 5—Kaipara. 6—Auckland. 7—Motumaoho. 8—Mokoia I. 9—Taurau Valley. 10—New Plymouth. 11—Waitarere. 12—Waikanae. 13—Masterton. 14—Wellington, Kelburn, Porirua, Lower Hutt, Point Howard, Somes I., Days Bay, Lyall Bay, Petone. 15—Stokes Valley. 16—Lake Wairarapa. 17—Pelorus Valley. 18—Brother's I. 19—Perpendicular Point. 20—Arthur's Pass, Crow Valley, Mingha Valley. 21—Rakaia Gorge. 22—Christchurch, Tai Tapu, Sumner, Moat Knave, Lyttelton Harbour. 23—Banks Peninsula, on which: Lake Forsyth, Tumbledown Bay, Tokoroa Bay, Camp Bay, Akaroa, Murrays Mistake, Ohahoa Bay. 24—Hickory Bay and Crown I. 25—George Sound. 26—Roxburgh. 27—Dunedin. 28—Stewart I. 29—Solomon's I. 30—Kundy I.

Rothschild's first publication on fleas (1895) contains a record of "*Pulex kerguelensis* Taschb." from Antipodes Island, but the flea was misdetermined and is now known as *Notiopsylla enciari* Smit. Kirk (1900: 32) refers to the species of flea infesting poultry yards as "Bird-flea (*Pulex avium*)" or "hen-flea" and shows a photomicrograph of this species. The name "*Pulex avium* [Taschenberg]" refers to a composite species; *Ceratophyllus gallinae*—one of the components of "*avium*"—is the common hen-flea, but Kirk's illustration definitely does not represent *C. gallinae* (possibly the pigeon-flea *Ceratophyllus columbae*).

In his *Index Faunae Novae Zealandiae* Hutton (1904) lists (p. 138) *Pulex kerguelensis* [recte *Notiopsylla enciari*] as an endemic species and (p. 350) as "naturalised animals": *Pulex irritans* Linnaeus (Flea), *Pulex serraticeps* Gervasson [Gervais] (Dog-flea) [now known as *Ctenocephalides canis* (Curtis)] and *Pulex avium* Taschb. (Pigeon-flea) [the pigeon-flea would have been *Ceratophyllus columbae*, but I have not seen any specimens of this species from New Zealand].

The only two species of fleas recorded from one of the Kermadec Islands [Raoul Island] are mentioned in Hilgendorf's short note (1917), but both had been misdetermined by N. C. Rothschild: re-examination of the material has shown me that "*Pysgiopsylla hilli*" = misdet. *Pygiopsylla hoplia* and "*Xenopsylla cheopis*" = misdet. *Xenopsylla vexabilis*; the specimens of both species were collected from *Rattus exulans*. Hilgendorf states that "One of the fleas was found on a sandy beach, . . ."—this refers to specimens of *Pulex irritans*, not mentioned in his note.

Thomson (1922: 324–326) lists five common species: *Pulex irritans*, Common Flea; *Ctenocephalus canis*, Dog and Cat Flea [Thomson was erroneously under the impression that Rothschild could not distinguish between the dog and the cat flea, and it seems safe to assume that his "*canis*" includes the cat flea *C. felis felis*]; *Ceratophyllus fasciatus*, Rat Flea; *Ceratophyllus gallinae*, Bird Flea; and *Ctenopsyllus musculi* [= *Leptopsylla segnis*], Rat Flea.

Tillyard (1926) enumerates nine species by adding the following to Thomson's list: cat flea (*Ctenocephalus felis*), and three species which were listed as native fleas: *Parapsyllus australiacus* [this seems to have been a mere presumption, for on p. 384 Tillyard says "*Parapsyllus australiacus* Roths. occurs on the Little Penguin (*Eudyptula minor*) and is therefore [sic] a native of Australia and New Zealand"—*P. australiacus* has, as far as I am aware, not been collected in the New Zealand subregion]; "an undescribed species [*Porribius pacificus* Jordan, 1946] found on the Pekapeka or Long-tailed Bat (*Chalinolobus morio*) [*recte C. tuberculatus*]; and "*Goniopsyllus kerguelensis* Tasch." [recte *Notiopsylla enciari* Smit].

In 1942 Marples published the first reliable record of the European hen-flea, *Ceratophyllus gallinae gallinae*, from New Zealand, and in 1946 Jordan described the bat-flea (*Porribius pacificus*) to which Tillyard already alluded in 1926. Laird (1950, 1951) recorded specimens of *Pulex irritans* and *Ctenocephalides felis felis*.

The first species of *Parapsyllus* from the New Zealand subregion—viz., *P. magellanicus*, was recorded by de Meillon in 1952 from Macquarie Island; the second, *P. cardinis*, was added by Dunnet in 1961. Hopkins & Rothschild (1953) gave a few records of *Pulex irritans*, *Ctenocephalides canis* and *C. f. felis*.

In a most interesting paper on the history of plague in New Zealand, Maclean (1955) records the rat fleas *Nosopsyllus fasciatus*, *Ctenopsylla musculi* [= *Leptopsylla segnis*], *Xenopsylla cheopis* as well as *Ctenocephalides felis felis*.

Smit (1957) showed that *Pulex kerguelensis* from Antipodes Island, as recorded by Rothschild in 1895, had been misdetermined, and described the species as *Notiopsylla enciari.*

Finally, the fleas known from Macquarie Island were summarized by Dunnet (1961), which added *Notiopsylla kerguelensis* to the New Zealand list, and those from Campbell Island by Smit (1964), who showed that *Parapsyllus longicornis* is a common species in the New Zealand area.

LIST OF COLLECTING LOCALITIES

All localities where fleas have been collected, as recorded under each species, are listed below in alphabetical order per island. References to the maps (Figs. 1 and 2) are given for each island and for all localities on North and South Island; this will facilitate the tracing of any of the localities. The name of the relevant provincial district is given in brackets after the name of each locality on North and South Island. For detailed maps of New Zealand one should consult A. H. McLintock's *"A Descriptive Atlas of New Zealand"* (Government Printer, 1960).

ANTIPODES ISLANDS (Fig. 1, *6*)
- Antipodes Island

AUCKLAND ISLANDS (Fig. 1, *7*)
- Adams Island
- Enderby Island
- Ewing Island
- French Islet (off Port Ross)
- Ocean Island (in Port Ross inlet)

BROTHERS ISLAND (in Cook Strait) (Fig. 2, *18*)

CAMPBELL ISLAND (Fig. 1, *8*)
- Beeman
- Courrejolles Peninsula
- Courrejolles Point
- Mt. Dumas
- Smoothwater Bay

CUVIER ISLAND (Fig. 2, *4*)

GOAT ISLAND (just off and to the N.W. of Cape Rodney) (Fig. 2, *3*)

HEN ISLAND (Taranga Island) (Fig. 2, *1*)

KERMADEC ISLANDS (Fig. 1, *1*)
- Denham Bay, Raoul Island
- Raoul Island (= Sunday Island)

KUNDY ISLAND (south-east of Stewart Island) (Fig. 2, *30*)

LITTLE BARRIER ISLAND (Fig. 2, *2*)

MACQUARIE ISLAND (Fig. 1, *9*)
- ANARE Main Station
- Aurora Point
- Catch-me-cave
- Catch-me-corner
- Douglas Point
- Flat Creek
- Gadget Gully
- Garden Cove
- Mawson Point
- Mt Elder
- North Head
- North Head Cave
- Plateau
- Secluded Beach

North Island (Fig. 1, *2*)
Auckland (Auckland) (Fig. 2, *6*)
Days Bay (Port Nicholson inlet) (Wellington) (Fig. 2, *14*)
Kaipara Flats (Auckland) (Fig. 2, *5*)
Kelburn (a suburb of Wellington) (Wellington) (Fig. 2, *14*)
Lower Hutt (Wellington) (Fig. 2, *14*)
Lyall Bay (Wellington) (Fig. 2, *14*)
Mahurangi Heads (mouth of Warkworth River) (Auckland) (Fig. 2, *3*)
Masterton (Wellington) (Fig. 2, *13*)
Mokoia Island (in Lake Rotorua) (Auckland) (Fig. 2, *8*)
Motumaoho (between Hamilton and Morrinsville) (Auckland) (Fig. 2, *7*)
New Plymouth (Taranaki) (Fig. 2, *10*)
Petone (a suburb of Lower Hutt) (Wellington) (Fig. 2, *14*)
Point Howard (just south of Lower Hutt) (Wellington) (Fig. 2, *14*)
Porirua (Wellington) (Fig. 2, *14*)
Somes Island (in Port Nicholson inlet) (Wellington) (Fig. 2, *14*)
Stokes Valley (between Upper Hutt and Lower Hutt) (Wellington) (Fig. 2, *15*)
Taurau Valley (Poverty Bay) (Auckland) (Fig. 2, *9*)
Waikanae (Wellington) (Fig. 2, *12*)
Wairarapa (Lake) (Wellington) (Fig. 2, *16*)
Waitarere (near Levin) (Wellington) (Fig. 2, *11*)
Wellington (Wellington) (Fig. 2, *14*)
Whenuapai Airport (near Auckland) (Auckland) (Fig. 2, *6*)

Snares Islands (Fig. 1, *5*)

Solomon's Island (south-west of Stewart Island) (Fig. 2, *29*)

South Island (Fig. 1, *3*)
Akaroa (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Arthur's Pass (Canterbury) (Fig. 2, *20*)
Camp Bay (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Christchurch (Canterbury) (Fig. 2, *22*)
Crow Valley (Canterbury) (Fig. 2, *20*)
Crown Island, in Hickory Bay (Banks Peninsula) (Canterbury) (Fig. 2, *24*)
Dunedin (Otago) (Fig. 2, *27*)
George Sound (Fiordland National Park) (Otago) (Fig. 2, *25*)
Hickory Bay (= Waikerakikari Bay) (Banks Peninsula) (Canterbury) (Fig. 2, *24*)
Lake Forsyth (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Lyttelton Harbour (south of Christchurch) (Fig. 2, *22*)
Mingha Valley (near Arthur's Pass) (Canterbury) (Fig. 2, *20*)
Moat Knave (Governors Bay, just south of Christchurch) (Canterbury) (Fig. 2, *22*)
Murrays Mistake (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Ohahoa Bay (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Pelorus [River] Valley (Marlborough) (Fig. 2, *17*)
Perpendicular Point (north of Greymouth) (Nelson) (Fig. 2, *19*)
Port Levy (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Rakaia Gorge (Canterbury) (Fig. 2, *21*)
Roxburgh (Otago) (Fig. 2, *26*)
Sumner; Sumner Head (near Christchurch) (Canterbury) (Fig. 2, *22*)
Tai Tapu (just south of Christchurch) (Fig. 2, *22*)
Tokoroa Bay (Banks Peninsula) (Canterbury) (Fig. 2, *23*)
Tumbledown Bay (Banks Peninsula) (Canterbury) (Fig. 2, *23*)

Stewart Island (Fig. 1, *4*; 2, *28*)
Easy Cove (in the south-west of the island)

Records of New Zealand Siphonaptera

The records are listed per island. The islands, as well as the localities on North and South Island, are arranged from north to south. If a record has been previously published, a concise reference (author, date, page) concerning the relevant literature is given in brackets.

The abbreviations in brackets following most records relate to the collection(s) in which the recorded specimens are preserved; the abbreviations are:

BM = British Museum (Natural History), The Zoological Museum, Tring, Herts.

BMH = B. P. Bishop Museum, Honolulu, Hawaii.

CM = Canterbury Museum, Christchurch, New Zealand.

CSIRO = Commonwealth Scientific and Industrial Research Organisation, Canberra, Australia.

CW = Dr Charlotte Wallace, Ruakura Animal Research Station, Hamilton, New Zealand.

DM = Dominion Museum, Wellington, New Zealand.

DSIR = Department of Scientific and Industrial Research, Lower Hutt, New Zealand.

UC = University of Canterbury, Christchurch, New Zealand.

Family RHOPALOPSYLLIDAE

Parapsyllus cardinis Dunnet, 1961 (Figs. 3–5)

AUCKLAND ISLANDS

French Islet, 29.XII.1962, nest of *Pterodroma lessoni,* leg. R. A. Falla: 1 ♀ (DM).

MACQUARIE ISLAND

Aurora Point, 16.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 2 ♂ 3 ♀ (Dunnet, 1961: 44); 17.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 2 ♂ 2 ♀ Dunnet, 1961: 44).

Flat Creek, 16.XII.1957, nest of *Pachyptila desolata,* leg. G. M. Dunnet; 1 ♂ 1 ♀ (Dunnet, 1961: 44); 16.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 1 ♀ (Dunnet, 1961: 44).

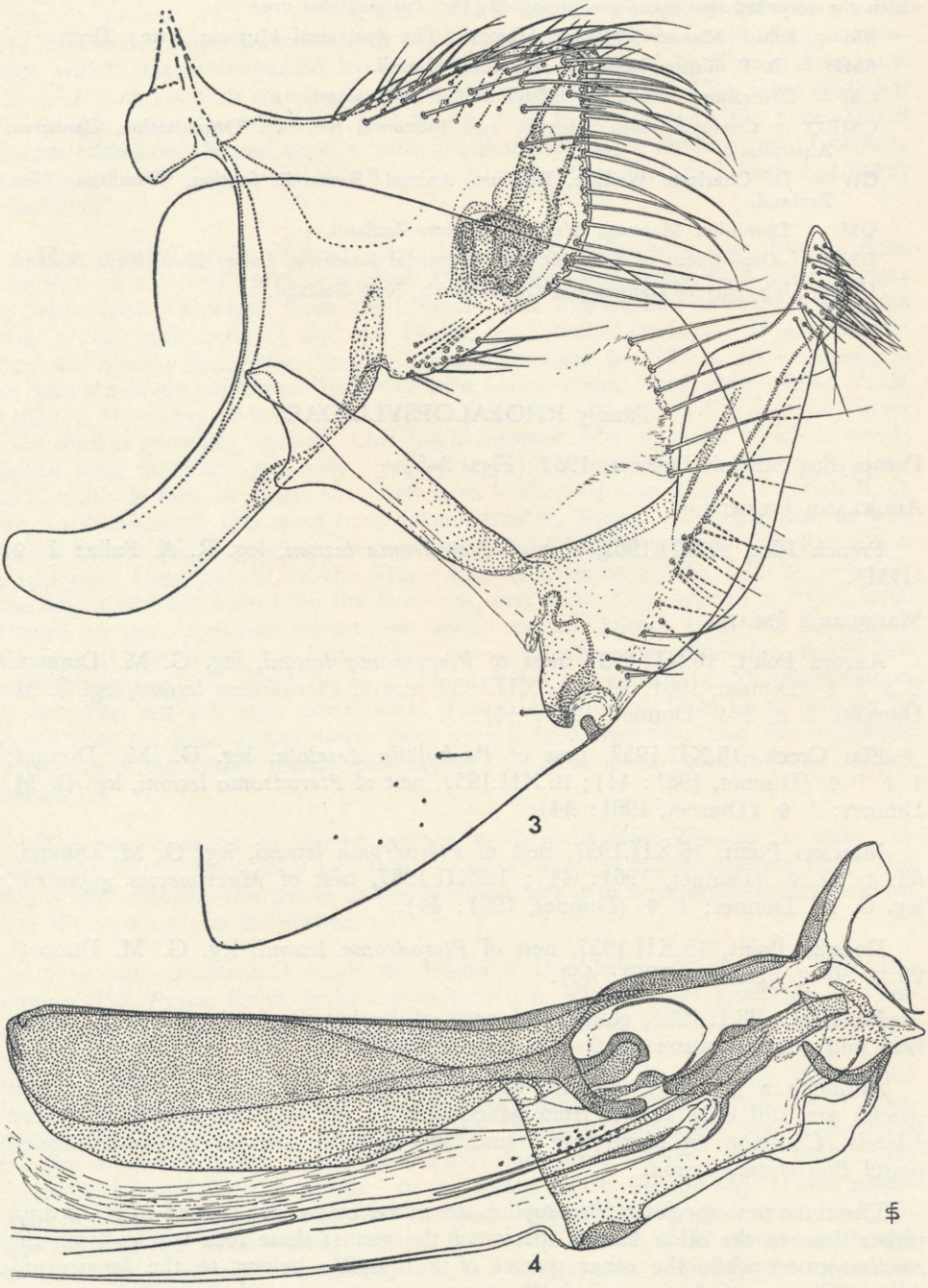
Mawson Point, 16.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 63 ♂ 59 ♀ (Dunnet, 1961: 44); 16.XII.1957, nest of *Macronectes giganteus,* leg. G. M. Dunnet: 1 ♀ (Dunnet, 1961: 44).

Douglas Point, 15.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 20 ♂ 30 ♀ (Dunnet, 1961: 44).

Mt Elder, 28.II.1961, chicks and nests of *Pachyptila desolata,* leg. T. Manefield and K. C. Watson: 2 ♀ (Dunnet, 1962: 972).

Although a flea of flying and widely dispersing sea-birds, members of this species are still only known from Macquarie Island and one of the Auckland Islands. Common on Macquarie Island, especially in nests of the white-headed petrel *Pterodroma lessoni.*

The three new species of *Parapsyllus,* described below, are related to *P. cardinis* rather than to the other known species of the genus; these four species form the *cardinis*-group while the other species of *Parapsyllus* belong to the *longicornis*-group. Figures of the taxonomically important structures of *P. cardinis* are reproduced here (Figs. 3–5) for comparison with the three species of the *cardinis*-group described below. Whereas the members of the *longicornis*-group of species occur on sea-birds throughout and to the north of the subantarctic (Smit, 1964), the species of the *cardinis*-group are only known from the New Zealand region.



FIGS. 3, 4.—*Parapsyllus cardinis* Dunnet, male: (3) sternum VIII and segment IX of holotype; (4) phallosome of paratype.

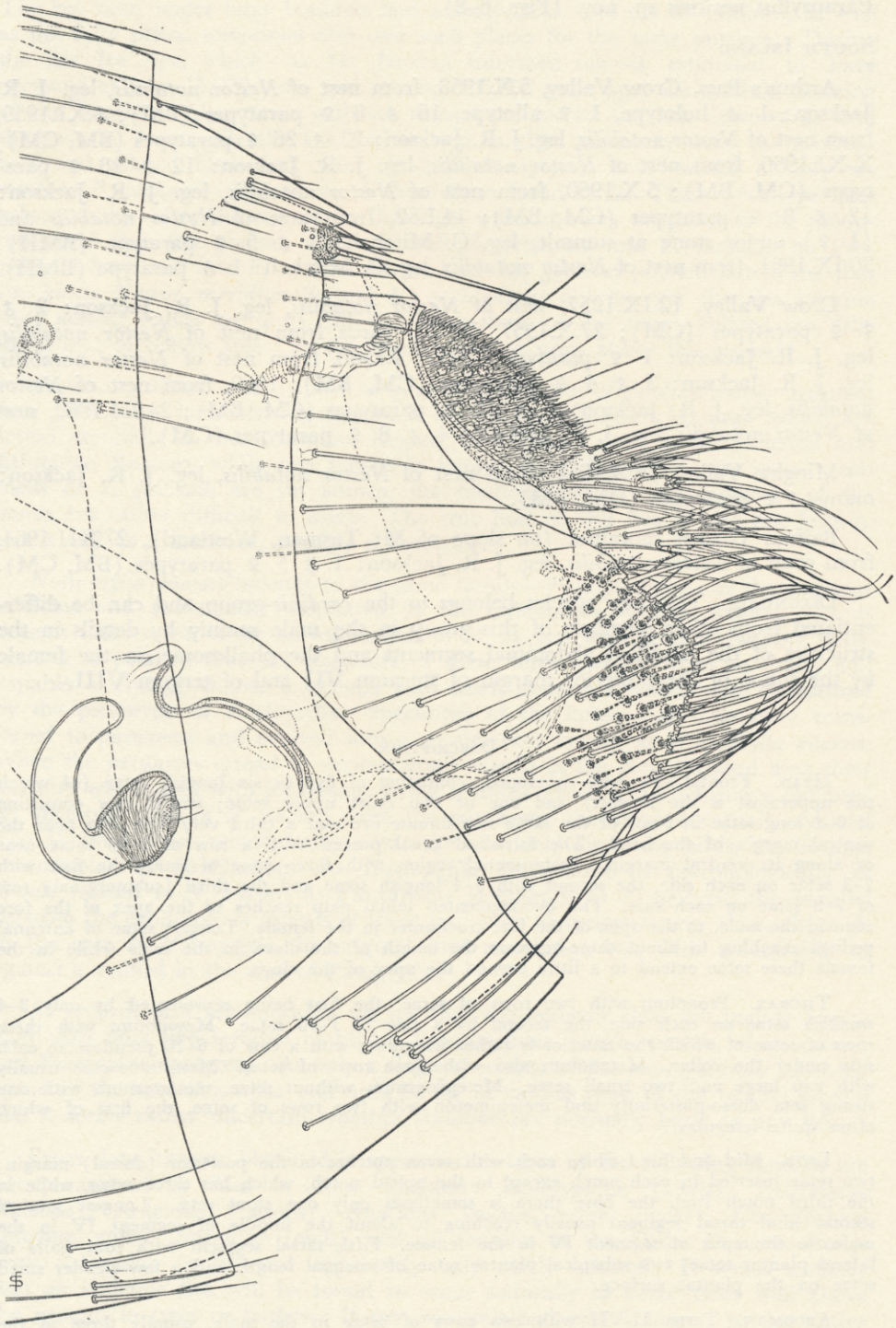


FIG. 5.—*Parapsyllus cardinis* Dunnet: terminalia of female allotype.

Parapsyllus nestoris sp. nov. (Figs. 6–8)

SOUTH ISLAND

Arthur's Pass, Crow Valley, 5.X.1958, from nest of *Nestor notabilis,* leg. J. R. Jackson: 1 ♂ holotype, 1 ♀ allotype, 16 ♂ 8 ♀ paratypes (BM); 8.XI.1959, from nest of *Nestor notabilis,* leg. J. R. Jackson: 23 ♂ 26 ♀ paratypes (BM, CM); X-XI.1960, from nest of *Nestor notabilis,* leg. J. R. Jackson: 12 ♂ 18 ♀ paratypes (CM, BM); 5.X.1960, from nest of *Nestor notabilis,* leg. J. R. Jackson: 12 ♂ 8 ♀ paratypes (CM, BM); 14.I.62, from nest of *Nestor notabilis* and (1 ♀) under stone at summit, leg. C. Mitchell: 3 ♂ 5 ♀ paratype (BMH); 30.IX.1961, from nest of *Nestor notabilis,* leg. C. Mitchell: 1 ♂ paratype (BMH).

Crow Valley, 12.IX.1957, nest of *Nestor notabilis,* leg. J. R. Jackson: 2 ♂ 4 ♀ paratypes (CM); 27.X.1957, 50–100 yards from nest of *Nestor notabilis,* leg. J. R. Jackson: 1 ♀ paratype (BM); I.1960, from nest of *Nestor notabilis,* leg. J. R. Jackson: 3 ♂ 4 ♀ paratypes (CM, BM); 1960, from nest of *Nestor notabilis,* leg. J. R. Jackson: 9 ♂ 12 ♀ paratypes (CM, BM); 24.III.1962, nest of *Nestor notabilis,* leg. J. R. Jackson: 4 ♂ 8 ♀ paratypes (CM).

Mingha Valley, 13.X.1962, from nest of *Nestor notabilis,* leg. J. R. Jackson: many ♂ ♀ paratypes (DM, BM).

Balfour Glacier moraines (on slope of Mt Tasman, Westland), 27.XII.1964, from roost of *Nestor notabilis,* leg. J. R. Jackson: 1 ♂ 3 ♀ paratypes (BM, CM).

DIAGNOSIS. This new species belongs to the *cardinis*-group and can be differentiated from other members of this group in the male mainly by details in the structure of the modified abdominal segments and the phallosome, in the female by the shape of the posterior margin of sternum VII and of tergum VIII.

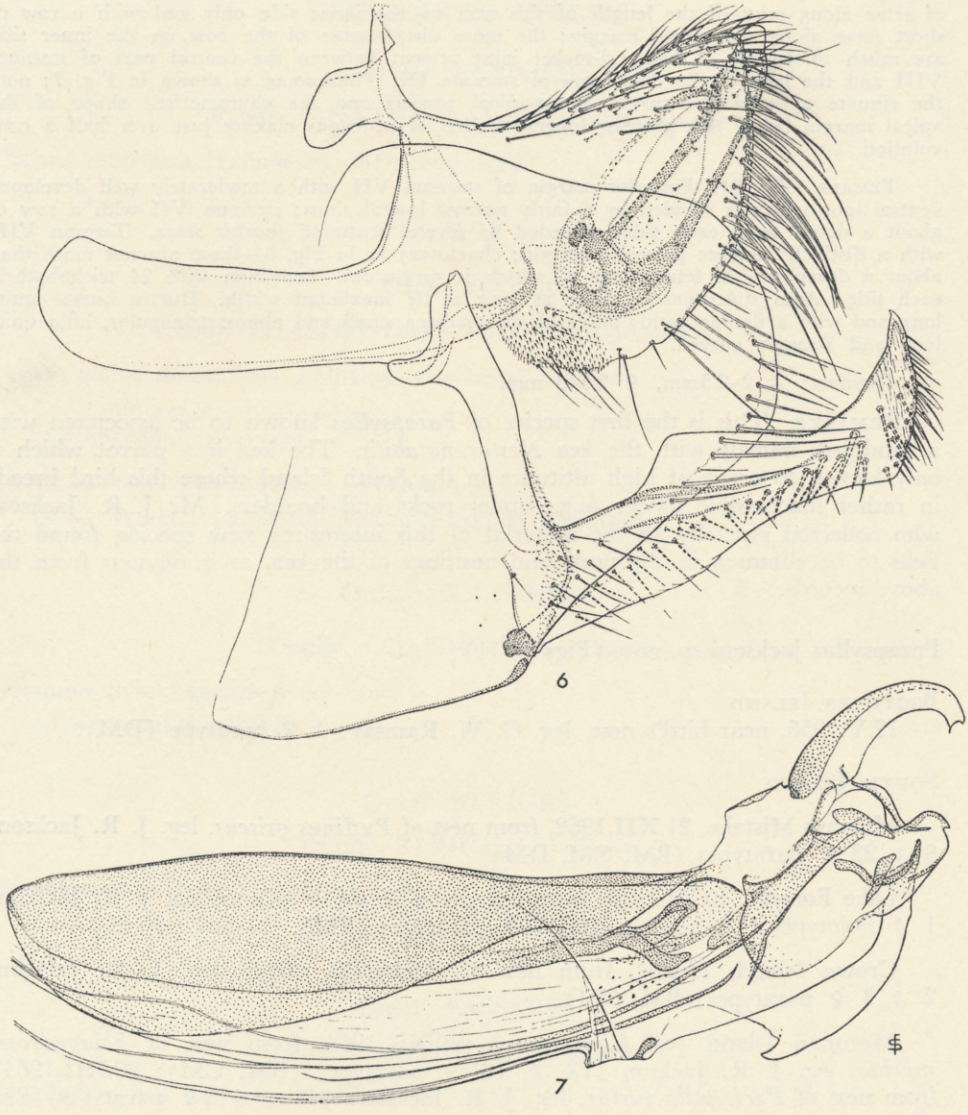
DESCRIPTION

HEAD. Frontal row well developed, consisting of five or six longish setae (of which the uppermost is the longest) and one or two short upper setae; ocular row consisting of 0–2 long setae in front of the large non-sinuate eye and a third very long seta near the ventral margin of the head. The fair-sized genal process with a row of 9–13 setae near or along its ventral margin. Postantennal region with three rows of setae, the first with 2–3 setae on each side, the second with 3–4 longish setae and the third (submarginal) row of 7–8 setae on each side. The five-segmented labial palp reaches to the apex of the fore coxa in the male, to the apex of the fore trochanter in the female. Longest setae of antennal pedicel reaching to about three-quarters the length of the clava in the male while in the female these setae extend to a little beyond the apex of the clava.

THORAX. Pronotum with two rows of setae, the first being represented by only 3–4 smallish setae on each side, the second by a row of 7–10 setae. Mesonotum with three rows of setae of which the anterior is rather irregular; with a row of 6–10 pseudosetae each side under the collar. Metanotum also with three rows of setae. Mesosternosome usually with two large and two small setae. Metepisternum without setae, metasternum with one strong seta dorso-posteriorly and metepimeron with two rows of setae, the first of which often quite irregular.

LEGS. Mid and hind tibiae each with seven notches in the posterior (dorsal) margin; two setae inserted in each notch except in the apical notch, which has three setae, while in the third notch from the base there is sometimes only one stout seta. Longest seta of second hind tarsal segment usually reaching to about the middle of segment IV in the male, to the apex of segment IV in the female. Fifth tarsal segment with four pairs of lateral plantar setae, two subapical plantar setae of unequal length and a few slender small setae on the plantar surface.

ABDOMEN. Terga II-VII with two rows of setae in the male, usually three in the female; spiracular fossae rounded. Basal sternum with a lateral patch of 5–13 small setae in the male and of 15–25 in the female.



FIGS. 6, 7.—*Parapsyllus nestoris* sp. nov., male: (6) sternum VIII and segment IX of holotype; (7) phallosome of holotype.

MALE (Figs. 6, 7). Sternum VIII forming a blunt lobe posteriorly, with a submarginal row of medium-sized setae. Apodeme of tergum IX with an anterior downward pointing lobe which is about half the size of the sensilium in side-view. Manubrium three and a-half times as long as wide, its apex not strongly curved upwards. Corpus of clasper pyriform, with numerous setae at and near the dorsal and posterior margins as well as a ventral patch of setae (most of which are on the inner side of the clasper); the ventral area of the clasper, adjoining the base of the manubrium, is weakly sclerotized and spiculose; corpus of clasper (measured from the dorso-posterior angle to the spiculose ventral margin) as long as manubrium. Movable process elongate, with relatively few thin and small setae and with a bare and blunt hyaline apex; anterior margin with angular projection subapical. Subdorsal anterior extension of proximal arm of sternum IX relatively long and fairly narrow. Distal arm of sternum IX fairly broad and straight, with a triangular extension in the middle of the dorsal margin and a pointed upturned apex; a very irregular row

of setae along most of the length of this arm on the inner side only and with a row of short setae along the apical margin; the more distad setae of the row on the inner side are much thickened. A ball-and-socket joint present between the ventral part of sternum VIII and the base of the distal arm of sternum IX. Phallosome as shown in Fig. 7; note the sinuate apex of the curved dorso-apical process and the characteristic shape of the apical margin below this process; longest tendon of aedeagus making just over half a convolution.

FEMALE (Fig. 8). Posterior margin of sternum VII with a moderately well developed ventral lobe which is divided by a fairly narrow lateral sinus; sternum VII with a row of about a dozen setae each side, preceded by several scattered shorter setae. Tergum VIII with a distinctly sinuate posterior margin; chaetotaxy as in Fig. 8—there are not more than about a dozen genital setae, none of which is very stout. Sensilium with 24 trichobothria each side. Anal stylet nearly thrice as long as its maximum width. Ductus bursae quite long and with a double bend; bulga of spermatheca small and almost triangular, hilla quite long and strongly curved.

LENGTH: ♂ 2–2.5mm, ♀ 2.5–3 mm.

REMARKS. This is the first species of *Parapsyllus* known to be associated with a landbird, namely with the kea *Nestor notabilis*. The kea is a parrot which is only known to occur at high altitudes in the South Island where this bird breeds in rather inaccessible places—e.g., under rocks and boulders. Mr J. R. Jackson, who collected virtually all the material of this interesting new species, found the fleas to be common in the nests and nestlings of the kea, as is obvious from the above records.

Parapsyllus jacksoni sp. nov. (Figs. 9–11)

BROTHERS ISLAND

12.V.1956, near bird's nest, leg. G. W. Ramsay: 1 ♀ paratype (DM).

SOUTH ISLAND

Murrays Mistake, 21.XII.1962, from nest of *Puffinus griseus,* leg. J. R. Jackson: 8 ♂ 23 ♀ paratypes (BM, CM, DM).

Lake Forsyth, 30.XI.1958, from burrow of *Puffinus griseus,* leg. J. R. Jackson: 1 ♂ holotype, 1 ♀ allotype and 3 ♀ paratypes (BM).

Crown Island, 15.I.64, from nest of *Pachyptila turtur,* leg. J. R. Jackson: 2 ♂ 3 ♀ paratypes (BM, CM).

Motunau Island (off Canterbury), 20.XII.1964, from nest of *Pelagodroma marina*, leg. J. R. Jackson: 12 ♂ 10 ♀ paratypes (BM, CM); 20.XII.1964), from nest of *Pachyptila turtur,* leg. J. R. Jackson: 148 ♂ 170 ♀ paratypes (BM, CM).

STEWART ISLAND

Easy Cove, 26.I.1955, from *Eudyptula minor* (7 weeks old), leg. R. K. Dell: 1 ♂ 2 ♀ paratypes (DM, BM).

DIAGNOSIS. This new species, a member of the *cardinis*-group, is closely related to *Parapsyllus nestoris* (described above) and differs from the latter in the male by having a shorter movable process and a correspondingly smaller corpus of clasper, by a broader distal arm of sternum IX and by some minor differences in the aedeagus; as the female terminal abdominal segments and genitalia are very similar to those of *P. nestoris,* the best way to distinguish between the females of *P. jacksoni* and those of *P. nestoris* is to count the numbers of pairs of lateral plantar setae: three in the former and four in the latter species.

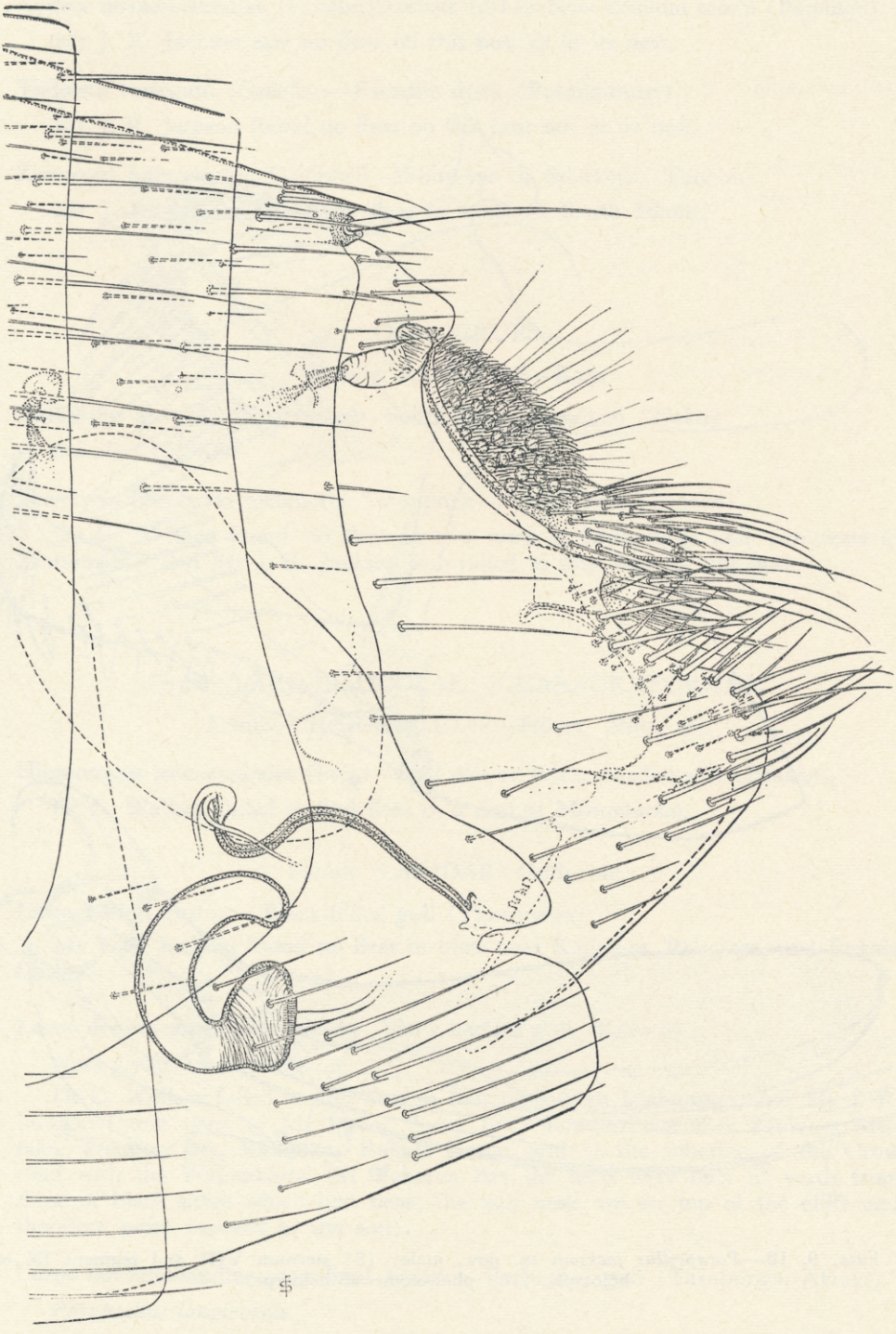
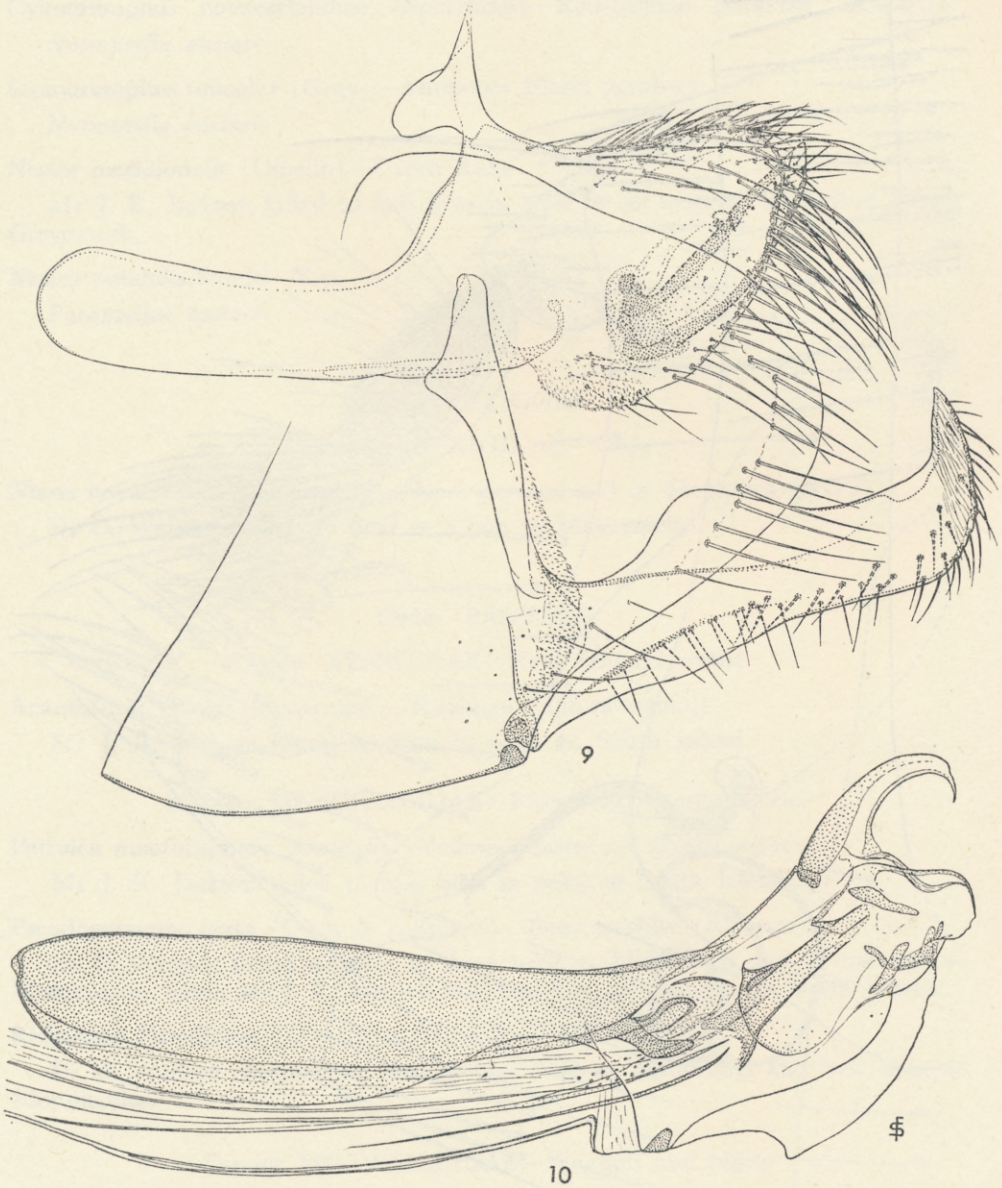


FIG. 8.—*Parapsyllus nestoris* sp. nov.: terminalia of female allotype.



FIGS. 9, 10.—*Parapsyllus jacksoni* sp. nov., male: (9) sternum VIII and segment IX of holotype; (10) phallosome of holotype.

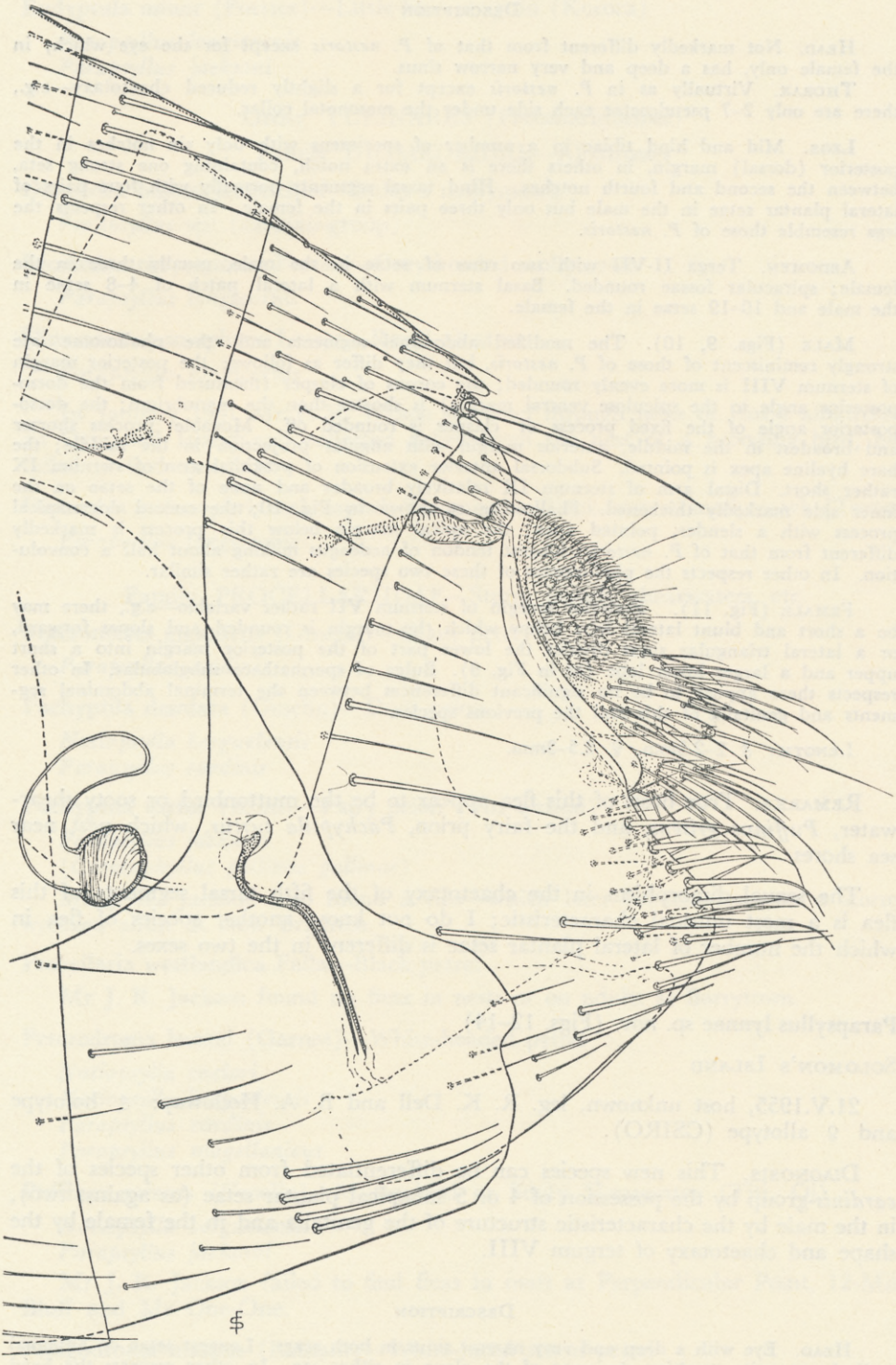


FIG. 11.—*Parapsyllus jacksoni* sp. nov.: terminalia of female allotype.

DESCRIPTION

HEAD. Not markedly different from that of *P. nestoris* except for the eye which, in the female only, has a deep and very narrow sinus.

THORAX. Virtually as in *P. nestoris* except for a slightly reduced chaetotaxy—e.g., there are only 2–7 pseudosetae each side under the mesonotal collar.

LEGS. Mid and hind tibiae in a number of specimens with only six notches in the posterior (dorsal) margin, in others there is an extra notch, containing one strong seta, between the second and fourth notches. Hind tarsal segments normally with four pairs of lateral plantar setae in the male but only three pairs in the female. In other respects the legs resemble those of *P. nestoris*.

ABDOMEN. Terga II-VII with two rows of setae in the male, usually three in the female; spiracular fossae rounded. Basal sternum with a lateral patch of 4–8 setae in the male and 10–19 setae in the female.

MALE (Figs. 9, 10). The modified abdominal segments and the phallosome are strongly reminiscent of those of *P. nestoris*, but they differ as follows: the posterior margin of sternum VIII is more evenly rounded; the corpus of clasper (measured from the dorso-posterior angle to the spiculose ventral margin) is shorter than the manubrium; the dorso-posterior angle of the fixed process of clasper is rounded off. Movable process shorter and broadest in the middle, anterior margin with angular projection in the middle; the bare hyaline apex is pointed. Subdorsal anterior extension of proximal arm of sternum IX rather short. Distal arm of sternum IX relatively broader and none of the setae on the inner side markedly thickened. Phallosome as shown in Fig. 10; the curved dorso-apical process with a slender, pointed apex; the apical margin below this process is markedly different from that of *P. nestoris*; longest tendon of aedeagus making about half a convolution. In other respects the phallosomes of these two species are rather similar.

FEMALE (Fig. 11). Posterior margin of sternum VII rather variable—e.g., there may be a short and blunt lateral lobe below which the margin is rounded and slopes forward, or a lateral triangular sinus divides the lower part of the posterior margin into a short upper and a larger lower lobe (as in Fig. 8). Bulga of spermatheca subglobular. In other respects there appear to be no significant differences between the terminal abdominal segments and genitalia of this and the previous species.

LENGTH: ♂ 2–2.5mm, ♀ 2.5–3mm.

REMARKS. True hosts of this flea appear to be the muttonbird or sooty shearwater, *Puffinus griseus*, and the fairy prion, *Pachyptila turtur*, which nest near sea shores.

The sexual dimorphism in the chaetotaxy of the fifth tarsal segments of this flea is a most unusual characteristic; I do not know another species of flea in which the number of lateral plantar setae is different in the two sexes.

Parapsyllus lynnae sp. nov. (Figs. 12–14)

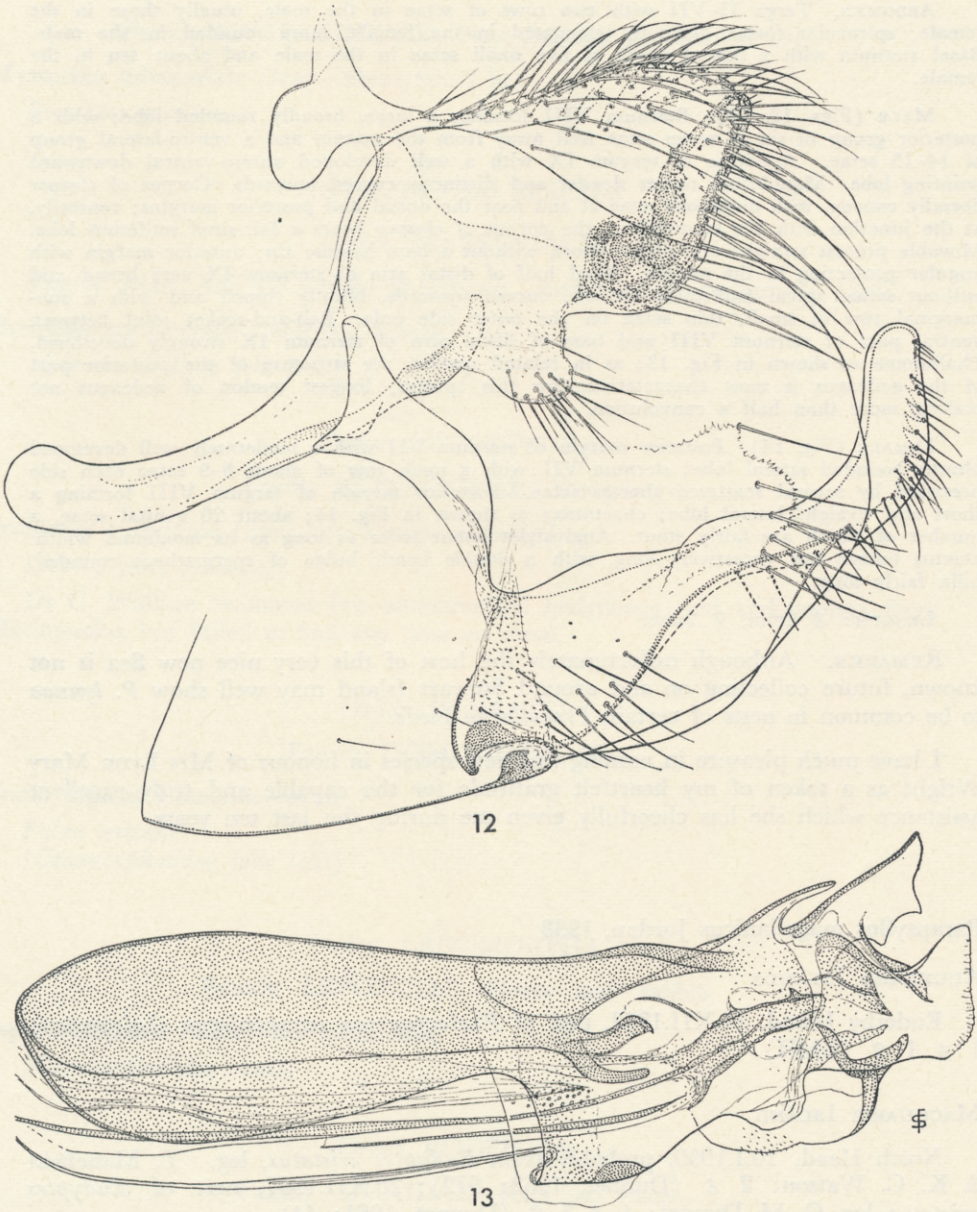
SOLOMON'S ISLAND

21.V.1955, host unknown, leg. R. K. Dell and B. A. Holloway: ♂ holotype and ♀ allotype (CSIRO).

DIAGNOSIS. This new species can be differentiated from other species of the *cardinis*-group by the possession of 4 or 5 subapical plantar setae (as against two), in the male by the characteristic structure of the genitalia and in the female by the shape and chaetotaxy of tergum VIII.

DESCRIPTION

HEAD. Eye with a deep and very narrow sinus in both sexes. Longest setae on antennal pedicel not quite reaching the apex of the clava in either sex. In other respects the head is very similar to that of the previous species.



FIGS. 12, 13.—*Parapsyllus lynnae* sp. nov., male: (12) sternum VIII and segment IX of holotype; (13) phallosome of holotype.

THORAX. Similar to that of preceding species but with the following exceptions: pronotum with only one row of setae in the female; only 1–3 pseudosetae each side under the mesonotal collar; metanotum with only two developed rows of setae; metepimeron with only one row of setae on the female (two rows in the male).

LEGS. Longest seta of second hind tarsal segment in both sexes reaching to the apex of segment IV or a little beyond. Fifth tarsal segments with four pairs of lateral plantar setae, four or five subapical plantar setae and only one or two small setae on the plantar surface.

ABDOMEN. Terga II–VII with two rows of setae in the male, usually three in the female; spiracular fossae distinctly elongated in the female, more rounded in the male. Basal sternum with a lateral patch of five small setae in the male and about ten in the female.

MALE (Figs. 12, 13). Sternum VIII forming a large, broadly rounded lobe; with a posterior group of six or seven setae well away from the margin and a ventro-lateral group of 14–15 setae. Apodeme of tergum IX with a well developed antero-ventral downward pointing lobe. Manubrium rather slender and distinctly curved upwards. Corpus of clasper dorsally convex, with numerous setae at and near the dorsal and posterior margins; ventrally, at the junction with the manubrium, the corpus of clasper bears a fair-sized setiferous lobe. Movable process straight and rather short, without a bare hyaline tip; anterior margin with angular projection in the middle. Basal half of distal arm of sternum IX very broad and without setae, apical half quite narrow, curved upwards, bluntly tipped and with a sub-marginal row of small, thin setae on the outer side only. Ball-and-socket joint between ventral part of sternum VIII and base of distal arm of sternum IX strongly developed. Phallosome as shown in Fig. 13; as in related species, the structure of the posterior part of the aedeagus is most characteristic for this species; longest tendon of aedeagus not making more than half a convolution.

FEMALE (Fig. 14). Posterior margin of sternum VII with a moderately well developed bluntly rounded lateral lobe; sternum VII with a main row of about 8–9 setae each side preceded by several scattered shorter setae. Posterior margin of tergum VIII forming a short and straight lateral lobe; chaetotaxy as shown in Fig. 14; about 20 genital setae, a number of which are fairly stout. Anal stylet about twice as long as its maximum width. Ductus bursae not excessively long, with a double bend; bulga of spermatheca rounded, hilla fairly long.

LENGTH: ♂ 2mm, ♀ 2mm.

REMARKS. Although unfortunately the host of this very nice new flea is not known, future collecting on and around Stewart Island may well show *P. lynnae* to be common in nests of certain *Procellariid* birds.

I have much pleasure in naming this new species in honour of Mrs Lynn Mary Wright as a token of my heartfelt gratitude for the capable and truly excellent assistance which she has cheerfully given me during the last ten years.

Parapsyllus magellanicus Jordan, 1938

AUCKLAND ISLANDS

Enderby Island, 31.XII.1962, nest of *Phalacrocorax carunculatus chalconotus*: 1 ♂ 1 ♀ (BMH).

MACQUARIE ISLAND

North Head, 10.I.1950, probably from *Eudyptes cristatus*, leg. T. Manefield & K. C. Watson: 2 ♂ (Dunnet, 1962: 972); 20.XII.1957, nest of *Eudyptes cristatus*, leg. G. M. Dunnet: 4 ♂ 3 ♀ (Dunnet, 1961: 44).

North Head Cave, 26.IX.1961, nest of *Eudyptes cristatus*, leg. T. Manefield & K. C. Watson: 1 ♀; 16.X.1961, nest of *Eudyptes cristatus*, leg. T. Manefield & K. C. Watson: 5 ♂ 4 ♀ 23.XI.1961, nest of *Eudyptes cristatus*, leg. T. Manefield and K. C. Watson: 114 ♂ 149 ♀ (Dunnet, 1962: 972).

Catch-me-corner, 19.XII.1957, nest of *Eudyptes cristatus*, leg. G. M. Dunnet: 137 ♂ 53 ♀ (Dunnet, 1961: 44).

Catch-me-cave, 27.XI.1961, nest of *Eudyptes cristatus*, leg. T. Manefield & K. C. Watson: 62 ♂ 139 ♀ (Dunnet, 1962: 972).

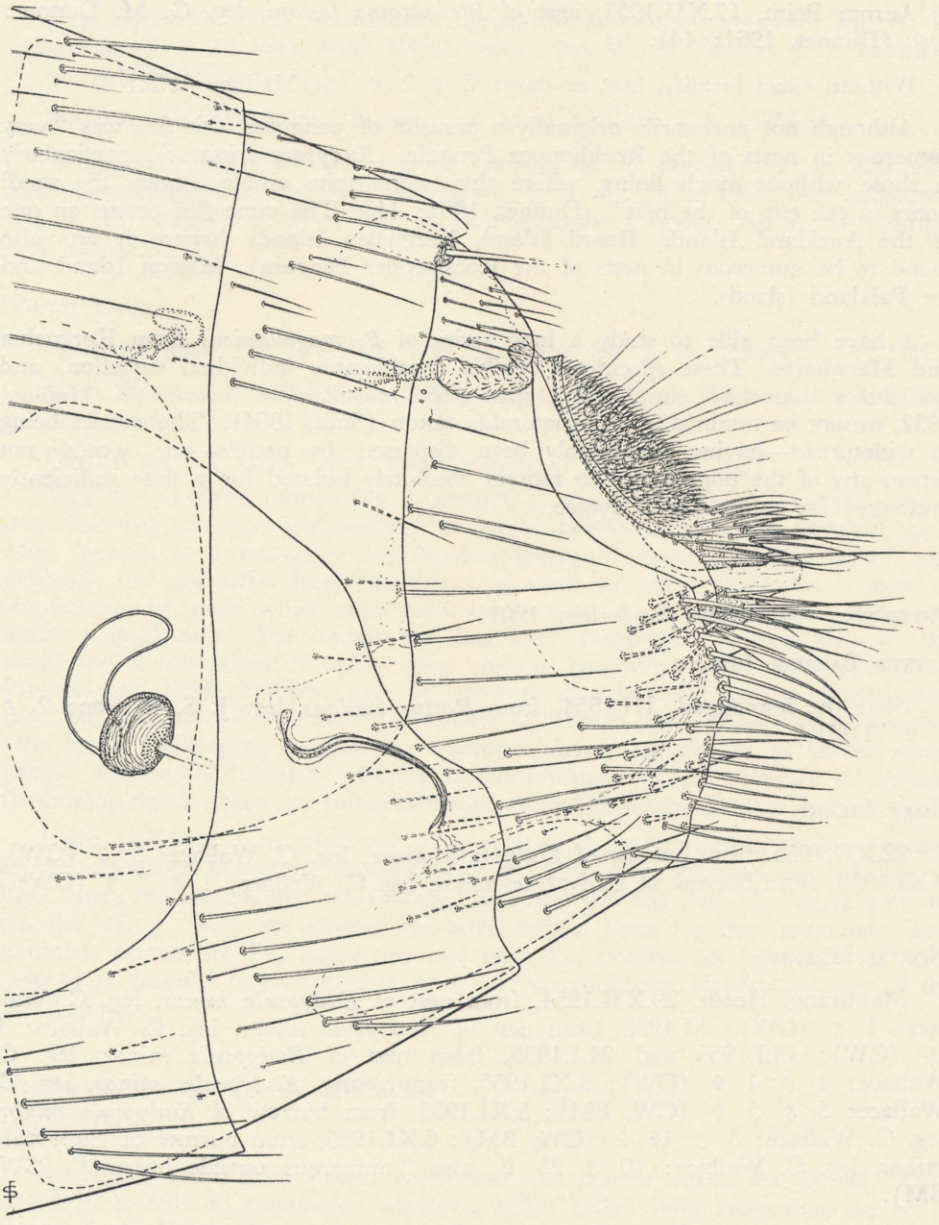


FIG. 14.—*Parapsyllus lynnae* sp. nov.: terminalia of female allotype.

Garden Cove, 6.XII.1949, probably from *Eudyptes cristatus,* leg. T. Manefield & K. C. Watson: 9 ♂ 9 ♀ (Dunnet, 1962: 972).

Douglas Point, 15.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 4 ♂ 2 ♀ (Dunnet, 1961: 44).

Mawson Point, 16.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 1 ♂ 4 ♀ (Dunnet, 1961: 44).

Aurora Point, 17.XII.1957, nest of *Pterodroma lessoni,* leg. G. M. Dunnet: 1 ♀ (Dunnet, 1961: 44).

Without exact locality, host or date: 2 ♂ 2 ♀ (de Meillon, 1952: 8).

Although not necessarily originally a parasite of penguins, this flea was "very numerous in nests of the Rockhopper Penguin (*Eudyptes cristatus*), particularly in those without much lining, where they were quite visible among the small stones in the cup of the nest" (Dunnet, 1961: 44). The same flea occurs on one of the Auckland Islands, Heard Island, Kerguelen Islands (where it was also found to be numerous in nests of the Rockhopper Penguin), Marion Island and the Falkland Islands.

I have been able to study a long series of *P. magellanicus* from Kerguelen and Macquarie. These specimens exhibit considerable individual variation, and this shows that these supposed subspecies *P. magellanicus heardi* de Meillon, 1952, cannot be retained as a recognisable taxon (Smit, 1964). The species being so widespread—having presumably been dispersed by petrels—one would not expect any of the populations to remain absolutely isolated for a time sufficiently prolonged for subspecies to evolve.

Parapsyllus longicornis (Enderlein, 1901)

LITTLE BARRIER ISLAND

Near the homestead, III.1954, from *Rattus exulans,* leg. J. S. Watson: 2 ♂ 1 ♀ (DSIR).

GOAT ISLAND

22.XII.1955, from burrow of *Eudyptula minor,* leg. C. Wallace: 3 ♀ (CW); 9.XI.1955, from burrow of *Eudyptula minor,* leg. C. Wallace: 1 ♂ 3 ♀ (CW).

NORTH ISLAND

Mahurangi Heads, 29.XII.1954, from nest of *Eudyptula minor,* leg. C. Wallace: 1 ♂ (CW); 2.I.1955, from nest of *Eudyptula minor,* leg. C. Wallace: 1 ♂ (CW); 13.I.1955 and 24.I.1955, from nest of *Eudyptula minor,* leg. C. Wallace: 1 ♂ 1 ♀ (CW); 5.XI.1955, from young *Eudyptula minor,* leg. C. Wallace: 5 ♂ 5 ♀ (CW, BM); 5.XI.1955, from burrow of *Eudyptula minor,* leg. C. Wallace: 3 ♂ 14 ♀ (CW, BM); 6.XI.1955, from burrow of *Eudyptula minor,* leg. C. Wallace: 10 ♂ 25 ♀, also "numerous outside burrow" (CW, BM).

Somes Island, 26.VII.1956, from body of *Eudyptula minor,* leg. F. C. Kinsky: 1 ♀ (DM); 10.XI.1956, from nest of *Eudyptula minor,* leg. F. C. Kinsky: 2 ♂ 6 ♀ (DM); 8.XII.1956, from nest of *Eudyptula minor,* leg. F. C. Kinsky: 1 ♂ 1 ♀ (DM).

Days Bay, 15.V.1952, from *Eudyptula minor*: 1 ♂ 3 ♀ (DM).

Lyall Bay, 9.III.1954, from *Diomedea epomophora* (cast up on beach), leg. R. A. Falla: 1 ♀ (DM).

Petone, 6.XI.1960, from *Eudyptula minor,* leg. R. A. Falla: 1 ♀ (DM).

SOUTH ISLAND

Perpendicular Point, 28.VIII.1957, from nest of *Phalacrocorax punctatus,* leg. J. R. Jackson & R. L. C. Pilgrim: 7 ♂ 11 ♀ (CM, BM); 10.II.1962, from nest of *Phalacrocorax punctatus,* leg. C. Mitchell: 1 ♂ 4 ♀ (BMH).

Rakaia Gorge, 21.IX.1963, from nests of *Phalacrocorax carbo,* leg. J. R. Jackson: 14 ♂ 7 ♀ (BM); 20.XII.1963, from nest of *Phalacrocorax carbo,* leg. J. R. Jackson: 7 ♂ 8 ♀ (CM).

Lyttelton Harbour, no date, from nest of *Eudyptula albosignata,* leg. E. Percival: 1 ♂ 2 ♀ (CM).

Sumner Head, 30.XI.1963, from nest of *Larus novaehollandiae scopulinus,* leg. J. R. Jackson: 1 ♀ (BM).

Lake Forsyth, 29.XII.1957, from nest of *Eudyptula albosignata,* leg. J. R. Jackson & R. L. C. Pilgrim: 10 ♂ 9 ♀ (CM); 29.XII.1957, from nest of *Phalacrocorax punctatus,* leg. J. R. Jackson & R. L. C. Pilgrim: 2 ♀ (CM).

Hickory Bay, 25.XII.1963 and 18.I.1964, from nest of *Eudyptula albosignata,* leg. J. R. Jackson: 1 ♂ 11 ♀; 26.XII.1963, from nest of *Phalacrocorax punctatus,* leg. J. R. Jackson: 23 ♂ 24 ♀ (BM, CM).

Tumbledown Bay, 10.XI.1957, from nest of *Phalacrocorax punctatus,* leg. J. R. Jackson and R. L. C. Pilgrim: 9 ♂ 6 ♀ (CM, BM); 10.XI.1957, from nest of *Eudyptula albosignata,* leg. J. R. Jackson & R. L. C. Pilgrim: 1 ♀ (CM).

Tokoroa Bay, 18.X.1959, and 6.II.1960, from nest of *Phalacrocorax carbo novaehollandiae,* leg. J. R. Jackson: 3 ♂ 15 ♀ (CM, BM).

Port Levy, 10.X.1961, from nest of *Eudyptula albosignata,* leg. C. Mitchell: 5 ♂ 5 ♀ (BMH).

Akaroa, 30.VIII.1960, on footpath, leg. R. L. C. Pilgrim: 1 ♀ (CM).

Ohahoa Bay, 22.IX.1963, from nest of *Phalacrocorax carbo,* leg. J. R. Jackson: 1 ♀ (BM).

Camp Bay, 4.I.1961, near nest of *Phalacrocorax carbo,* leg. C. Mitchell: 1 ♀ (BMH).

CAMPBELL ISLAND

Courrejolles Point, 29.I.1961, from nest of *Diomedea melanophris impavida,* leg. P. R. Wilson: 3 ♂ 2 ♀ (BMH, BM).

Courrejolles Peninsula, 13.II.1963, from nest of *Diomedea melanophris,* leg. K. A. J. Wise: 2 ♀ (BMH); 14.XII.1961, from nest of *Diomedea melanophris impavida,* leg. J. L. Gressitt: 15 ♂ 16 ♀; from nest of *Diomedea melanophris,* leg. J. L. Gressitt: 7 ♂ 9 ♀; from nest of *Diomedea chrysostoma,* leg. J. L. Gressitt: 19 ♂ 33 ♀.

A strongly host-promiscuous flea: on North and Goat Islands common in nests of the little blue penguin *Eudyptula minor,* on South Island in nests of the shags *Phalacrocorax punctatus* and *P. carbo* as well as in those of the white-flippered penguin *Eudyptula albosignata,* and on Campbell Island in nests of petrels—viz., the mollymawks *Diomedea melanophris* and *D. chrysostoma.* Mr J. R. Jackson found no fleas in arboreal nests of shags on South Island. It seems quite certain that all species of *Parapsyllus* occur only in nests built on rock or soil.

Parapsyllus sp.

SNARES ISLANDS

30.I.1961, caught while handling a nesting *Diomedea bulleri*, leg. B. Stonehouse: 1 ♀ (CM).

At present this female specimen cannot be determined with any certainty. It is very closely related to *P. lynnae* and, when the individual variation of that species is known the specimen from the Snares may well prove to be identical with *P. lynnae* from the relatively nearby Solomon's Island.

Family PYGIOPSYLLIDAE

Notiopsylla kerguelensis (Taschenberg, 1880)

SNARES ISLANDS

30.I.1961, from burrow of *Puffinus griseus*, leg. I. Mannering: 1 ♀ (BM).

AUCKLAND ISLANDS

Ocean Island, 28.XII.1962, from nest of *Pterodroma lessoni*, leg. R. A. Falla: 1 ♂ 1 ♀ (DM); 29.XII.1962, from a burrow of *Pelecanoides urinatrix exsul*, leg. K. A. J. Wise: 2 ♀ (BMH); 29.XII.1962, from *Pterodroma lessoni*, leg. J. L. Gressitt: 11 ♂ 5 ♀ (BMH).

French Islet, 29.XII.1962, from *Pelecanoides urinatrix exsul*, leg. R. A. Falla: 2 ♂ 6 ♀ (DM).

Ewing Island, 5.I.1961, from nest of *Pelecanoides urinatrix exsul*, leg. K. A. J. Wise: 2 ♀ (BMH).

CAMPBELL ISLAND

Smoothwater Bay, 16.II.1963, from leaf mould of *Dracophyllum*, leg. K. A. J. Wise: 1 ♀ (BMH) (Smit, 1964).

South of Courrejolles Peninsula, ± 220m alt., 12.II.1963, from burrow of *Puffinus griseus*, leg. K. A. J. Wise: 2 ♀ (BMH) (Smit, 1964).

MACQUARIE ISLAND

Secluded Beach, 12.XII.1957, from nest of *Puffinus griseus*, leg. G. M. Dunnet: 3 ♂ 11 ♀ (Dunnet, 1961: 49).

Flat Creek, 16.XII.1957, from burrow of *Pachyptila desolata*, leg. G. M. Dunnet: 4 ♀ (Dunnet, 1961: 49).

Aurora Point, 17.XII.1957, from nest of *Pachyptila desolata*, leg. G. M. Dunnet: 6 ♂ 16 ♀ (Dunnet, 1961: 49).

North Head, 13.XII.1957, nest of *Larus dominicanus*, leg. G. M. Dunnet: 1 ♂ (Dunnet, 1961: 49).

Mt. Elder, 28.II.1961, from nests and chicks of *Pachyptila desolata*, leg. T. Manefield and K. C. Watson: 16 ♂ 7 ♀ (Dunnet, 1962: 972).

Gadget Gully, 7.III.1961, from *Puffinus griseus*, leg. T. Manefield and K. C. Watson: 1 ♂ 2 ♀ (Dunnet, 1962: 972).

A parasite of gulls and petrels and widely distributed throughout the subantarctic region, being known from New Zealand and from Heard Island (from the giant petrel *Macronectes giganteus*), Kerguelen Islands (from the grey petrel *Adamastor cinereus*, the blue petrel *Halobaena caerulea* and the Kerguelen diving petrel *Pelecanoides urinatrix exsul*) and South Georgia (from Bank's blue petrel *Prion banksi* and the Dominican gull *Larus dominicanus*). *Notiopsylla kerguelensis*, being a parasite of great travellers, is not likely to split up into different forms on different islands as long as it remains associated with petrels and gulls.

Notiopsylla enciari Smit, 1957

KUNDY ISLAND

21.V.1956, host unknown, leg. R. K. Dell: 1 ♂ (DM).

ANTIPODES ISLANDS

Antipodes Island, prior to 1895, from *Cyanoramphus unicolor*, leg. M. Dannefaerd: 1 ♂ (Rothschild, 1895: 66—as *Pulex kerguelensis*; Smit, 1957: 192); 9.XI.1950, from *Cyanoramphus unicolor*, leg. E. G. Turbott: 1 ♀ (Smit, 1957: 192).

AUCKLAND ISLANDS

French Islet, 5.XII.1943, from *Pterodroma lessoni*, leg. R. A. Falla: 1 ♀ (CM); 29.XII.1962, from nest of *Pterodroma lessoni*, leg. R. A. Falla: 1 ♂ 1 ♀ (DM).

Adams Island, 4.XI.1944, from *Cyanoramphus novaezelandiae*, leg. E. G. Turbott: 1 ♂ (CM).

MACQUARIE ISLAND

Aurora Point, 16.XII.1957, from nest of *Pterodroma lessoni*, leg. G. M. Dunnet: 10 ♂ 11 ♀ (Dunnet, 1961: 49); 17.XII.1957, from nest of *Pterodroma lessoni*, leg. G. M. Dunnet: 3 ♀ (Dunnet, 1961: 49).

Flat Creek, 16.XII.1957, from nest of *Pterodroma lessoni*, leg. G. M. Dunnet: 3 ♀ (Dunnet, 1961: 49).

Douglas Point, 15.XII.1957, from nest of *Pterodroma lessoni*, leg. G. M. Dunnet: 2 ♂ 8 ♀ (Dunnet, 1961: 49).

Mawson Point, 16.XII.1957, from nest of *Pterodroma lessoni*, leg. G. M. Dunnet: 1 ♂ (Dunnet, 1961: 49).

Plateau, 3.XII.1961, from burrow of *Pterodroma lessoni*, leg. T. Manefield & K. C. Watson: 3 ♂ 5 ♀; 22.III.1961, from nest of *Pterodroma lessoni*, leg. T. Manefield & K. C. Watson: 1 ♂ (Dunnet, 1962: 972).

This species is only known from small islands in the New Zealand region. Whereas on Antipodes Island and in the Auckland Islands parakeets of the genus *Cyanoramphus* have been recorded as hosts, the flea was found only in association with the white-headed petrel *Pterodroma lessoni* on Macquarie Island where, however, parakeets are now absent.

Stivalius galliralli sp. nov. (Figs. 15, 16)

SOUTH ISLAND

George Sound, 24.XI.1934, from *Gallirallus australis,* leg. R. A. Falla: 1 ♀ holotype (BM).

DIAGNOSIS. This new species agrees with *S. insolli* Traub, 1950, the only other bird-infesting species of the genus, in having a pronotal ctenidium composed of 28 spines but it differs markedly by numerous differences in the terminal abdominal segments and genitalia—e.g., tergum VII does not protrude between the two sets of antesensilial setae, the posterior margin of sternum VII is only ventrally sinuate, the anal sternum forms basally a coniform projection and the hilla of spermatheca does not protrude very deeply into the lumen of the bulga; the latter without a small dorsal outgrowth. Male unknown.

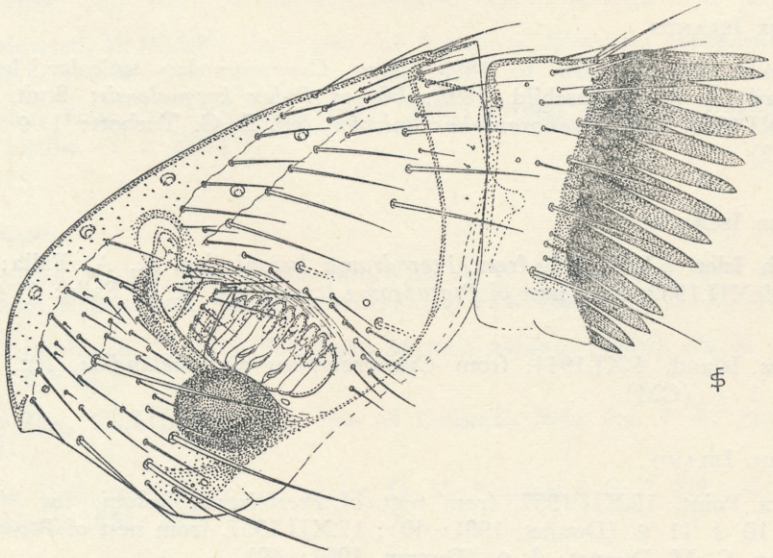


FIG. 15.—*Stivalius galliralli* sp. nov.: head and pronotum of female holotype.

DESCRIPTION

HEAD (Fig. 15). Fronto-clypeal margins smoothly rounded. Preoral tuber short and thin. Submarginal frontal row consisting of seven setae; between this row and the eye are numerous setae, three of which are quite long. Genal margin below the eye weakly divided into two lobes. Frontal area of micropores quite narrow. Eye strongly developed, ovoid and dark. Maxillary palps reaching to about two-thirds the length of the fore coxa; the first two segments of subequal length, while the third segment is the shortest of the four. The laciniae are smooth basally and finely serrated apically. The labial palp, reaching to about the apex of the fore coxa, consists of five segments. Scapus of antenna on the outer side of its widened portion with three thin setae; pedicel with six setae, the longest of which reaches to about two-thirds the length of the clava. Postantennal region of head with three rows of setae and a large seta about midway between the lowest seta of the second and third row; the first row consists of six setae each side, while the second row has about eight setae, and the third row contains seven setae. Bordering the antennal fossa posteriorly are 13–17 small setae.

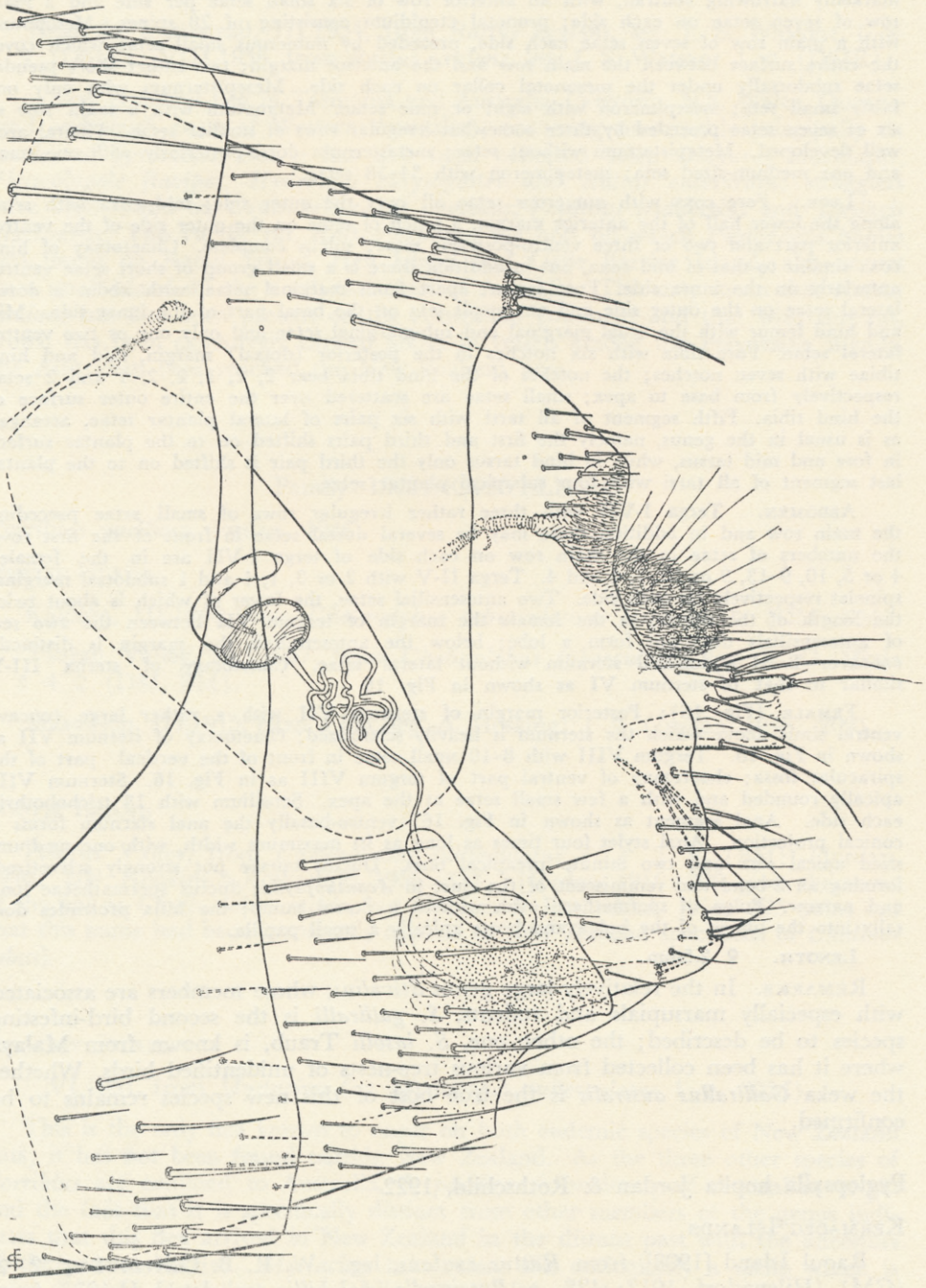


FIG. 16.—*Stivalius galliralli* sp. nov.: terminalia of female holotype.

THORAX. Pronotum (Fig. 15) dorsally as long as the dorsal-most pronotal spines but markedly narrowing ventrad, with an anterior row of six small setae per side and a main row of seven setae on each side; pronotal ctenidium consisting of 28 spines. Mesonotum with a main row of seven setae each side, preceded by numerous small setae which cover the entire surface between the main row and the anterior margin; two rather short pseudosetae subdorsally under the mesonotal collar on each side. Mesepisternum with only one fairly small seta; mesepimeron with eight or nine setae. Metanotum with a main row of six or seven setae preceded by three somewhat irregular rows of smaller setae. Pleural arch well developed. Metepisternum without setae; metasternum dorso-posteriorly with one small and one medium-sized seta; metepimeron with 34–38 setae.

LEGS. Fore coxa with numerous setae all over the outer side; mid coxa with setae along the lower half of the anterior margin, a patch of setae on the outer side of the ventro-anterior part and two or three ventro-posterior setae; sulcus complete. Chaetotaxy of hind coxa similar to that of mid coxa, but in addition there is a small group of short setae ventro-anteriorly on the inner side. Fore femur, apart from marginal setae, with about a dozen lateral setae on the outer side and one small seta on the basal part of the inner side. Mid and hind femur with the usual marginal and sub-marginal setae and only one or two ventro-lateral setae. Fore tibia with six notches in the posterior (dorsal) margin, mid and hind tibiae with seven notches; the notches of the hind tibia bear 2, 2, 1, 2, 2, 1 and 2 setae respectively from base to apex; small setae are scattered over the entire outer surface of the hind tibia. Fifth segment of all tarsi with six pairs of lateral plantar setae, arranged as is usual in the genus, namely the first and third pairs shifted on to the plantar surface in fore and mid tarsus, while in hind tarsus only the third pair is shifted on to the planta; last segment of all tarsi with four subapical plantar setae.

ABDOMEN. Terga I-VII with three rather irregular rows of small setae preceding the main row and in addition there may be several dorsal setae in front of the first row; the numbers of setae in the main row on each side of terga I-VII are in the female: 4 or 5, 10, 9–13, 9 or 10, 7, 4 and 4. Terga II-V with 2 or 3, 1, 1 and 1 subdorsal marginal spinelet respectively on each side. Two antesensilial setae, the lower of which is about twice the length of the upper; in the female the margin of tergum VII between the two sets of antesensilials does not form a lobe; below the antesensilials the margin is distinctly concave. Basal abdominal sternum without lateral setae. Chaetotaxy of sterna III-V similar to that of sternum VI as shown in Fig. 16.

FEMALE (Fig. 16): Posterior margin of sternum VII with a rather large concave ventral sinus above which the sternum is heavily sclerotized; chaetotaxy of sternum VII as shown in Fig. 16. Tergum VIII with 8–10 small setae in front of the vertical part of the spiracular fossa; chaetotaxy of ventral part of tergum VIII as in Fig. 16. Sternum VIII apically rounded and with a few small setae at the apex. Sensilium with 18 trichobothria each side. Anal segment as shown in Fig. 16; ventro-basally the anal sternum forms a conical projection. Anal stylet four times as long as its maximum width, with one medium-sized apical seta and two minute preapical ones. Ductus bursae not strongly sclerotized, forming an S-bend and reminiscent of the duct in *Acanthopsylla*; ductus spermathecae long and narrow. Bulga of spermatheca oval, without a dorsal hump; the hilla protrudes dorsally into the lumen of the bulga and bears apically a small papilla.

LENGTH. ♀ 2.5mm.

REMARKS. In the relatively large genus *Stivalius*, whose members are associated with especially marsupials and rodents, *S. galliralli* is the second bird-infesting species to be described; the other one, *S. insolli* Traub, is known from Malaya where it has been collected from various tree-nests of unidentified birds. Whether the weka *Gallirallus australis* is the true host of this new species remains to be confirmed.

Pygiopsylla hoplia Jordan & Rothschild, 1922

KERMADEC ISLANDS

Raoul Island [1908], from *Rattus exulans*, leg. W. R. B. Oliver: 1 ♂ 2 ♀ (CM) (Hilgendorf, 1917: 428—as *Pysgiosylla* [sic] *hilli;* err. det.); II.1957, from *Rattus norvegicus*, leg. J. S. Watson: 1 ♀ (DSIR).

HEN ISLAND

1963, from *Rattus exulans*, leg. P. C. Bull: 7 ♂ 4 ♀ (DSIR, BM).

LITTLE BARRIER ISLAND

Near the homestead, III.1954, from *Rattus exulans*, leg. J. S. Watson: 1 ♂ 1 ♀ (DSIR); VIII.1956, from *Rattus exulans*, leg. J. S. Watson: 1 ♀ (DSIR).

A very common flea in Tasmania and Australia (Victoria, N.S. Wales, Queensland and south coast of Western Australia), occurring presumably principally on species of *Perameles*, but it has also been collected from *Dasyurus maculatus, Phascologale flavipes, Hydromys chrysogaster* and *Rattus culmorum*; stragglers have been found on *Ornithorhynchus anatinus, Potorous tridactylus* and *Thylacis macrourus*. The Pacific rat, *Rattus exulans*, the host on which *Pygiopsylla hoplia* was found on Raoul Island, Hen Island and Little Barrier Island, also occurs on a small island off the north-east coast of Australia. This may mean that *Rattus exulans* has also been present on the Australian continent and that with this rat, which has been extensively carried about in vessels among the Polynesian islands, the Australian fleas reached the New Zealand area.

Family ISCHNOPSYLLIDAE

Porribius pacificus Jordan, 1946

NORTH ISLAND

Kaipara, III.1948, from *Chalinolobus tuberculatus*: 2 ♂ 10 ♀ (DM, BM).

Taurau Valley, 24.I.1947, from *Chalinolobus tuberculatus*, leg. R. G. Hini: 1 ♂ 4 ♀ (DM, BM).

Masterton, III.1915, from a bat, leg. A. Hosking: 1 ♀ (Jordan, 1946: 209).

SOUTH ISLAND

Pelorus Valley, from *Chalinolobus tuberculatus* 1 ♂ 2 ♀ (BM) (Jordan, 1946: 209; Hopkins & Rothschild, 1956: 373). [Jordan, 1946: 209, gives the name of the bat as *Chalinolobus morio*, but Hopkins & Rothschild, 1956: 373 point out that this name had been incorrectly applied to New Zealand specimens of *Chalinolobus*].

STEWART ISLAND

VI.1951, from *Mystacina* (= *Mystacops*) *tuberculata*: 1 ♀ (DM).

This is the only flea known to occur on both endemic species of New Zealand bats; it has not been found outside New Zealand. As the three other species of *Porribius* are confined to Australia, *P. pacificus* is evidently of Australian origin and the fact that it is specifically distinct from other members of the genus indicates that this flea arrived in New Zealand in the distant past with the ancestors of the present host(s). *Mystacina tuberculata* fills ecologically a niche which is quite different from that occupied by *Chalinolobus tuberculatus*, and one would expect it to have a flea of its own. However, it should be noted that only one female flea has so far been collected from this very rare host, and it is hoped that more specimens of *Mystacina tuberculata* can be examined for fleas before this bat becomes extinct.

Family LEPTOPSYLLIDAE

Leptopsylla segnis (Schönherr, 1811)

NORTH ISLAND

Probably Auckland, 1902, from rats, leg. J. M. Mason: 3 specimens (Maclean, 1955: 141).

Auckland, 1948, from *Rattus norvegicus* and *Rattus rattus,* leg. G. M. Wimsett & F. B. Sill: 1 specimen (Maclean, 1955: 142); 1950, from rats, leg. V. J. Enwright, C. Grieve-Dingwall & M. G. Goodey: 89 specimens (Maclean, 1955: 142).

Motumaoho, 1.VII.1955, from *Mus musculus,* leg. C. Wallace: 1 ♀ (CW).

Waitarere, 5.IV.1958, from nest of *Mus musculus,* leg. R. G. Ordish: 1 ♀ (DM).

Wellington, 23.III.1953, from *Mus musculus,* leg. P. C. Bull: 1 ♂ 1 ♀; from rats (Thomson, 1922: 326); 3.V.1956, from *Rattus norvegicus,* leg. R. G. Ordish: 1 ♀ (DM); 20.II.1956, from *Mus musculus,* leg. R. G. Ordish: 2 ♂ 3 ♀ (DM).

SOUTH ISLAND

Christchurch, III.1957, from *Mus musculus,* leg. R. L. C. Pilgrim: 1 ♂ 1 ♀ (UC); VI.1957, from *Mus musculus,* leg. R. L. C. Pilgrim: 3 ♀ (UC); V.1962, from *Mus musculus,* leg. R. L. C. Pilgrim: 4 ♂ 3 ♀.

This is the common cosmopolitan flea of the house mouse *Mus musculus,* also frequently encountered on rats.

Family CERATOPHYLLIDAE

Ceratophyllus gallinae gallinae (Schrank, 1803)

NORTH ISLAND

Motumaoho, all leg. C. Wallace: 25.XI.1954, from nest of *Passer domesticus*: many ♂ ♀; 20.IX.1955, in bed: 1 ♀ (CW); 4.V.1955, in bed: 1 ♀ (CW); 24.XI.1954, from nest of *Passer domesticus*: 1 ♂ 3 ♀ (CW); 26.II.1955 from nest of *Passer domesticus*: 3 ♂ 2 ♀ (CW); 13.III.1955, from nest of *Passer domesticus*: 2 ♂ 4 ♀ (CW); 15.III.1955, from nest of *Passer domesticus*: many ♂ ♀ (CW); 18.III.1955, from nest of *Passer domesticus*: many ♂ ♀ (CW); 11.IV.1955, from nest of *Passer domesticus*: 1 ♂ 1 ♀ (CW); 4.IV.1955, from nest of *Passer domesticus*: many ♂ ♀ (CW); 21.VI.1955, from nest of *Passer domesticus*: 1 ♂ (CW); 19.XII.1954, from nest of *Gallus gallus domesticus*: 2 ♀ (CW); 26.IX.1955, from nest of *Gallus gallus domesticus*: 3 ♀ (CW); 31.XII. 1955, from nest of *Gallus gallus domesticus*: 1 ♂ (CW).

Wellington, 8.I.1956, from nest of *Turdus merula,* leg. R. G. Ordish: 3 ♀ (DM); 9.I.1956, from nest of *Sturnus vulgaris,* leg. R. G. Ordish: 14 ♂ 15 ♀ (DM); 10.XI.1957, host unknown, leg. R. G. Ordish: 1 ♂ (DM).

Lower Hutt, 13.XII.1959, from nest of *Sturnus vulgaris* (in an old fowl house), leg. P. C. Bull: 8 ♂ 7 ♀ (DSIR, BM).

SOUTH ISLAND

Rakaia Gorge, 21.IX.1963, from nests of *Phalacrocorax carbo novaehollandiae,* leg. J. R. Jackson: 2 ♂ 2 ♀ (BM); 20.XII.1963, from nest of *Phalacrocorax carbo novaehollandiae,* leg. J. R. Jackson: 2 ♀ (CM).

Christchurch, 23.XII.1929, from *Sturnus vulgaris*: 1 ♂ (UC); 1.II.1965, from *Passer domesticus,* leg. J. R. Jackson: 2 ♂ (BM, CM).

Sumner, 1926, from *Gallus gallus domesticus*: 2 ♀ (CM, BM).

Dunedin, 1938, from *Athene noctua,* leg. B. J. Marples: 1 ♂ 3 ♀ (BM; Marples, 1942: 245).

Motunau Island (off Canterbury), 20.XII.1964, from nest of *Pachyptila turtur,* leg. J. R. Jackson: 2 ♀ (BM, CM).

The so-called European hen-flea is the commonest bird-flea throughout Europe (apart from New Zealand it has also been introduced into Australia (N.S. Wales) and North America), and has been recorded from a great many different bird-hosts. It prefers relatively dry nests in shrubs, trees and those in nesting-boxes. Since conditions in poultry-houses prove to be very agreeable to this species of flea, it has become a regular parasite of poultry and can be a real pest in hen-houses. The hen-flea bites man, as many other bird-fleas do.

Kirk (1900: 32) and Thomson (1922: 362) stated that the hen-flea was troublesome in many poultry-yards in New Zealand. Marples (1942: 237) found *C. gallinae* to be associated with the little owl *Athene noctua* in Dunedin and remarked that a number of these owls were imported from Germany.

Kirk (1900: 32) published a photograph of a mounted male "Flea (Pulex avium) from domestic fowl"—this is not a specimen of *C. gallinae,* but it seems to resemble the European pigeon-flea *Ceratophyllus columbae* (Gervais) more closely (the photograph does not show sufficient detail for an exact determination). Hutton (1904: 350) calls *Pulex avium* the "Pigeon flea", so it is well possible that *C. columbae* is also (or has been) present in New Zealand. *Pulex avium* Taschenberg, 1880, is a collective name and includes the hen-flea (*C. gallinae*) and the pigeon-flea (*C. columbae*).

Nosopsyllus fasciatus (Bosc, 1800)

HEN ISLAND

1963, from *Rattus exulans,* leg. P. C. Bull: 2 ♀ (DSIR).

LITTLE BARRIER ISLAND

III.1954, from *Rattus exulans,* leg. J. S. Watson: 1 ♂ (DSIR).

CUVIER ISLAND

21.VI.1960, from *Rattus exulans,* leg. P. R. Wilson: 5 ♂ 6 ♀ (DSIR, BM).

NORTH ISLAND

Probably Auckland, 1902, from rats, leg. J. M. Mason: 53 specimens (Maclean, 1955: 141).

Auckland, 1948, from *Rattus norvegicus* and *Rattus rattus*, leg. G. M. Wimsett and F. B. Sill: 53 specimens (Maclean, 1955: 142); 1950, from rats, leg. V. J. Enwright, C. Grieve-Dingwall and M. G. Goodey: 18 specimens (Maclean, 1955: 142).

Motumaoho, 18.III.1955, on stored blanket in a cupboard (there were traces of rats), leg. C. Wallace: 1 ♀ (CW).

Mokoia Island, 8.VI.1963, from *Rattus norvegicus*, leg. M. J. Daniel: 2 ♂ 3 ♀.

Waitarere, 5.IV.1958, from nest of *Mus musculus*, leg. R. G. Ordish: 1 ♂ (DM).

Waikanae, from *Mustela putorius*, leg. R. A. Falla: 1 ♀ (DM).

Stokes Valley, 31.V.1955, from *Rattus rattus*, leg. B. A. Holloway: 1 ♀ (DM).

Lower Hutt, 7.II.1955, from *Rattus norvegicus*, leg. P. C. Bull: 1 ♂ (DSIR).

Point Howard, 12.IX.1957, from nest (in hutch) of *Erinaceus europaeus*, leg. R. Brockie: 3 ♂ 9 ♀.

Wellington, from rats (Thomson, 1922: 325); X.1960, from *Canis familiaris*, leg. R. G. Ordish: 1 ♀ (DM).

South Island

Christchurch, X.1924, from *Rattus rattus*, leg. A. W. Parrott: 1 ♂ 4 ♀ (UC); 4.1.1950, from *Rattus rattus* (in grain stores), leg. F. S. Palmer: 1 ♂ (CM).

Near Christchurch, 25.VIII.1962, from *Mustela putorius* [ferret], leg. R. L. C. Pilgrim: 1 ♀ (UC).

Hickory Bay, 25.XII.1963, from nest of *Columba livia*, leg. J. R. Jackson: 1 ♀ (BM).

Dunedin, 1948, from *Rattus rattus*, leg. G. M. Wimsett & F. B. Sill: 40 specimens (Maclean, 1955: 142).

Stewart Island

I.1957, from *Mus musculus*, leg. R. Carrick: 1 ♀ (CSIRO).

Auckland Islands

Enderby Island, 31.XII.1962, from nest of *Phalacrocorax carunculatus chalconotus*: 2 ♂ (BMH).

Campbell Island

Beeman, 30.III.1962, from a rat (caught near a fowl run), leg. K. P. Rennell: 1 ♂ 11 ♀; 3, 6 and 9.IV.1962, from a rat (in a fowl house), leg. K. P. Rennell: 4 ♂ 3 ♀ (BMH).

Slope of Mt Dumas, 50m alt., 14.XII.1961, from *Rattus norvegicus*, leg. J. L. Gressitt: 3 ♀ (BMH).

Without exact locality, 4.I–8.I.1961, from *Rattus norvegicus*, leg. P. R. Wilson: 14 ♂ 17 ♀ (BMH, BM); ± 250m alt., 12.II.1963, from a dead albatross, leg. K. P. Rennell: 1 ♂ (BMH).

MACQUARIE ISLAND

ANARE main Station, 13.XII.1957, from *Rattus rattus*, leg. G. M. Dunnet: 1 ♀ (Dunnet, 1961: 49).

Camp area, 5.VII.1961, from nest of rat, leg. T. Manefield & K. C. Watson: 1 ♀; 9.XI.1961, from a rat, leg. T. Manefield & K. C. Watson: 1 ♀ (Dunnet, 1962: 972).

A very common rat flea, occurring principally on *Rattus* spp.; through the agency of ship rats (i.e., especially *Rattus rattus*) this species has become cosmopolitan (but it does not thrive in the tropics).

Nosopsyllus londiniensis londiniensis (Rothschild, 1903)

NORTH ISLAND

Stokes Valley, 31.V.1955, from *Rattus rattus*, leg. B. A. Holloway: 1 ♀ (DM).

Waitarere, 5.IV.1958, from nest of *Mus musculus*, leg. R. G. Ordish: 2 ♂ 10 ♀ (DM).

A more or less cosmopolitan flea, mainly associated with the house mouse *Mus musculus* and the black rat *Rattus rattus*; especially on the latter host this flea is carried all over the world by ships and it is therefore still often mainly found in ports or localities near ports.

Family PULICIDAE

Ctenocephalides felis felis (Bouché, 1835)

NORTH ISLAND

Motumaoho, 12.XI.1955, from a house, leg. C. Wallace: 3 ♀ (CW).

Kelburn, 25.VI.1948, from *Felis catus*: 9 specimens (Laird, 1950: 476). Wellington, 11.II.1944, from *Felis catus*: 1 ♀ (DM); XI.1953, from *Felis catus*, leg. V. Stout: 2 ♀ (DM); 29.III.1954, host unknown, leg. Health Dept.: 1 ♂ 4 ♀ (DM); IV.1957, from *Homo sapiens*, leg. L. S. McDowell: 1 ♂ 2 ♀ (UC).

SOUTH ISLAND

Roxburgh, from (captive) *Phascolarctos cinereus*, leg. B. Stonelake: many ♂ ♀ (Hopkins & Rothschild, 1953: 151).

Dunedin, 1948, from *Rattus rattus*, leg. G. M. Wimsett & F. B. Sill: 1 specimen (Maclean, 1955: 142).

The very common cosmopolitan cat flea which bites man readily and is now usually the species responsible for infestations of fleas in houses.

Laird (1950: 476) records the protozoon *Leptomonas ctenocephali* (Fantham), which is apparently normally found in the dog flea *Ctenocephalides canis*, from four out of nine specimens of *C. f. felis* from Kelburn (Wellington); the protozoons occurred in the hind gut, rectum and, more rarely, in the Malpighian tubules of the cat fleas.

Ctenocephalides canis (Curtis, 1826)

North Island

Auckland, XI.1884, from *Canis familiaris,* leg. T. Steel: many ♂ ♀ (Hopkins & Rothschild, 1953: 169).

Motumaoho, 2.IV.1955, from *Canis familiaris,* leg. C. Wallace: 1 ♂ 2 ♀ (CW); 4.IV.1955, from *Canis familiaris,* leg. C. Wallace: 1 ♀ (CW).

Wellington, 1958, from *Canis familiaris,* leg. R. Brockie: 2 ♀; 28.II.1961, from *Canis familiaris,* leg. R. G. Ordish: 1 ♂ (DM).

Lake Wairarapa, 28.I.1961, from *Lepus europaeus,* leg. R. G. Ordish: 1 ♀ (DM).

South Island

Christchurch, VIII.1956, from *Canis familiaris,* leg. R. L. C. Pilgrim: 2 ♂ 2 ♀ (UC).

Tai Tapu, VI.1926, from *Gallus gallus domesticus,* leg. A. W. Parrott: 2 ♀ (UC).

This is the dog flea (which in Europe also occurs on the fox); occurrence on cats is due to contamination, dogs and cats often living in close association. A very common species and more or less cosmopolitan. Thomson (1922: 325) called it a common species in New Zealand. Like the cat flea, to which it is closely related, the dog flea may become a pest in houses, attacking man without any reluctance.

Pulex irritans Linnaeus, 1758

Kermadec Islands

Denham Bay, Raoul Island, 1910, from sand, leg. W. R. B. Oliver: 2 ♂ 5 ♀ (CM).

Little Barrier Island

The homestead, III.1954, from a bed, leg. J. S. Watson: 2 ♂ 5 ♀ (DSIR).

North Island

Auckland, XI.1884, from *Canis familiaris,* leg. T. Steel: 4 ♀ (Hopkins & Rothschild, 1953: 113).

Whenuapai Airport, 1948, from a seat in an aeroplane arriving from North America: 2 specimens (Laird, 1951: 14, 15).

Motumaoho, 10.XII,1954, in bed, leg. C. Wallace: 1 ♂ 2 ♀ (CW); 23.II. 1955, from *Cairina moschata,* leg. C. Wallace: 1 ♂ (CW); 17.III.1955, in bed, leg. C. Wallace: 1 ♂ 1 ♀ (CW); 2.IV.1955, from *Canis familiaris,* leg. C. Wallace: 1 ♂ (CW); 4.IV.1955, in bed, leg. C. Wallace: 1 ♀ (CW); 15.IV.1955, in bed, leg. C. Wallace: 1 ♂ (CW); 9.V.1955, in clothing, leg. C. Wallace: 1 ♀ (CW).

New Plymouth, 1910, from *Rattus norvegicus* and *Canis familiaris*, leg. W. W. Smith: many ♂ ♀; 1912, from *Rattus rattus*, leg. W. W. Smith: 1 ♀ (Hopkins & Rothschild, 1953: 113).

Porirua, 5.X.1959, from a factory, leg. M. A. Ordish: 1 ♀ (DM).

Wellington, 14.X.1954, from *Homo sapiens*, leg. E. Munster: 2 ♀; XII.1954, from *Canis familiaris*, leg. A. Rawnsley: 1 ♂ 3 ♀; 18.XI.1960, host unknown, leg. R. G. Ordish: 1 ♀ (DM); 26.II.1961, from a house, leg. R. G. Ordish: 1 ♀ (DM).

SOUTH ISLAND

Westland prov. dist., IV.1916, host unknown, leg. J. W. Hende: 1 ♀ (UC).

Moat Knave, 1911-1912, from *Homo sapiens*, leg. R. P. Cormack: 1 ♀ (Hopkins & Rothschild, 1953: 113).

Christchurch, II.1957, from *Homo sapiens*: 1 ♂ 2 ♀ (UC).

This, the so-called human-flea, is actually a parasite of mammals which live in large burrows (e.g., fox and badger) or bigger dwellings (man and domestic pig). Man belongs to a homeless and flea-less group of mammals (Primates) and evidently did not suffer from *Pulex irritans* until he began to occupy a more or less permanent home which must have been—and actually still is—not altogether unlike a large hole. The human flea has been transported by man all over the world and is only absent in areas where climatic conditions are entirely unsuitable. Pig-sties and fields fertilised with pig manure may become heavily infested with this flea, and several instances are known of human fleas swarming on beaches (the larvae developing in decaying seaweeds above tide line or at places where people undress for bathing). Owing to improvement of the standard of hygiene the human flea is much less frequently encountered in urban districts than formerly.

Laird (1951: 21) reported that canine filariasis, or heartworm of dogs, caused by the nematode *Dirofilaria immitis*, is absent from New Zealand but common in Fiji. Since the human flea (*P. irritans*) and also the dog flea (*C. canis*) and the cat flea (*C. f. felis*) are among the intermediate hosts for this nematode and doubtless present in Fiji, Laird surmised that it is possible for fleas infected with cysts of *D. immitis* to be imported by means of aeroplanes arriving by way of the Fiji Islands.

Xenopsylla cheopis (Rothschild, 1903)

NORTH ISLAND

Auckland, 1948, from *Rattus norvegicus* and *Rattus rattus*, leg. G. M. Wimsett & F. B. Sill: 43 specimens (Maclean, 1955: 142); 1950, from rats, leg. V. J. Enwright, C. Grieve-Dingwall and M. G. Goodey: 79 specimens (Maclean, 1955: 142).

This rat-flea, the well-known vector of bubonic plague, is cosmopolitan. It is carried all over the world by ship rats (chiefly *Rattus rattus*) and is therefore often found in ports.

Maclean (1955) published a valuable paper on the history of plague, the threat of which brought about the establishment of the Department of Health, in New Zealand. Between 1900 and 1911 there were 21 human cases of the disease, 9 of which were fatal; 17 of the 21 cases occurred in Auckland, 3 in

Onehunga and 1 in Lyttelton. The author points out (p. 142) that "whatever the conditions may have been earlier in the century, *X. cheopis* is certainly to be found in Auckland today. There is so far no evidence that it has spread south of Auckland. This is as would be expected as *cheopis* is unlikely to become established unless a minimum temperature of about 60° F. is maintained. In fact, this species of rat flea will only breed freely at temperatures between 68° and 78° F."

I have not seen any specimens of *X. cheopis* from New Zealand myself.

Xenopsylla vexabilis Jordan, 1925

KERMADEC ISLANDS

Raoul Island, X.1908, from *Rattus exulans*, leg. W. R. B. Oliver: 2 ♀ (CM) (Hilgendorf, 1917: 428—as *Xenopsylla cheopis*; err. det.); II.1957, from *Rattus norvegicus*, leg. J. S. Watson: 1 ♂ 8 ♀ (DSIR, BM).

HEN ISLAND

V.1950, from *Rattus exulans*, leg. J. S. Watson: 2 ♀ (DSIR); 1963, from *Rattus exulans*, leg. P. C. Bull: 9 ♂ 13 ♀ (DSIR, BM).

LITTLE BARRIER ISLAND

Near the homestead, III.1954, from *Rattus exulans*, leg. J. S. Watson: 8 ♂ 8 ♀ (DSIR, BM); VIII.1956, from *Rattus exulans*, leg. J. S. Watson: 10 ♂ 17 ♀ (DSIR, BM).

This Australian species has also been introduced into the Hawaiian Isles. A pair of specimens from Franklin I., South Australia, served for the original description of the species; specimens from Queensland were described as subspecies *vexabilis meseris* Jordan, 1936, and specimens from Hawaii as *vexabilis hawaiiensis* Jordan, 1932. A study of the New Zealand specimens and of additional material from Hawaii has shown me that the supposed differences between the three subspecies do not hold good, and I therefore place *X. vexabilis hawaiiensis* Jordan, 1932, and *X. vexabilis meseris* Jordan, 1936, as synonyms of *X. vexabilis* Jordan, 1925 (*Syn. nov.*). In New Zealand *X. vexabilis*, like *Pygiopsylla hoplia*, is mainly found in association with the Pacific rat *Rattus exulans*.

HOST-FLEA INDEX

Under each host species the species of fleas are listed which have been found in association with that host in New Zealand; negative data are also given. In parenthesis are the names of those fleas which occur accidentally on the host concerned.

The suprageneric classification followed for listing the birds is that suggested by Mayr & Amadon, 1951, *Amer. Mus. Novit.* (1496).

MAMMALS

ENDEMIC SPECIES

Order CHIROPTERA

Family VESPERTILIONIDAE—Earlet Bats

Chalinolobus tuberculatus (Forster)—Long-tailed bat

Porribius pacificus

Family MYSTACINIDAE—New Zealand short-tailed bat

Mystacina tuberculata Gray—Short-tailed bat

Porribius pacificus

INTRODUCED SPECIES

Order MARSUPIALIA

Family PHALANGERIDAE—Phalangers, Australian "opossums", koala.

Phascolarctos cinereus Goldfuss—Koala

(*Ctenocephalides felis felis*)

Order INSECTIVORA

Family ERINACEIDAE—Hedgehogs

Erinaceus europaeus Linnaeus—European hedgehog

(*Nosopsyllus fasciatus*)

Dr C. Wallace examined five anaesthetized hedgehogs (old and young) from Motumaoho, but failed to find any fleas on them.

Order PRIMATES

Family HOMINIDAE—Men

Homo sapiens Linnaeus—Man

Pulex irritans
(*Ctenocephalides felis felis*)

Order LAGOMORPHA

Family LEPORIDAE—Hares and rabbits

Lepus europaeus Pallas—European hare

(*Ctenocephalides canis*)

Order RODENTIA

Family MURIDAE—Rats and mice

Mus musculus Linnaeus—House mouse

Leptopsylla segnis
Nosopsyllus londiniensis londiniensis
Nosopsyllus fasciatus

Rattus exulans (Peale)—Pacific rat (Kiore)

Pygiopsylla hoplia
Xenopsylla vexabilis
(*Nosopsyllus fasciatus*)
(*Parapsyllus longicornis*)

Rattus norvegicus (Berkenhout)—Brown rat

Nosopsyllus fasciatus
Xenopsylla cheopis
Leptopsylla segnis
(*Pulex irritans*)
(*Pygiopsylla hoplia*)
(*Xenopsylla vexabilis*)

Rattus rattus (Linnaeus)—Black rat

Xenopsylla cheopis
Nosopsyllus fasciatus
Nosopsyllus londiniensis londiniensis
Leptopsylla segnis
(*Pulex irritans*)
(*Ctenocephalides felis felis*)

Order CARNIVORA

Family CANIDAE—Dogs, Wolves, Foxes

Canis familiaris Linnaeus—Domestic dog

Ctenocephalides canis
(*Pulex irritans*)
(*Nosopsyllus fasciatus*)

Family MUSTELIDAE—Stoats, Weasels, Polecats, etc.

Mustela putorius Linnaeus—Polecat or ferret

(*Nosopsyllus fasciatus*)

Family FELIDAE—Cats, Lions, Tigers, etc.

Felis catus Linnaeus—Domestic cat

Ctenocephalides felis felis

BIRDS

ENDEMIC SPECIES

Order APTERYGES

Family APTERYGIDAE—Kiwis

Apteryx haasti Potts—Large grey kiwi (Roa)

Mr J. R. Jackson found no fleas in a nest at Edwards River (half a mile from Arthur's Pass).

Order SPHENISCI

Family SPHENISCIDAE—Penguins

Eudyptes cristatus (Miller)—Rockhopper penguin or Victoria penguin

Parapsyllus magellanicus

Eudyptula albosignata Finsch—White-flippered penguin

Parapsyllus longicornis

Eudyptula minor (Forster)—Little blue penguin (Korora)

Parapsyllus longicornis
Parapsyllus jacksoni

Order TUBINARES (Procellariiformes)

Family DIOMEDEIDAE—Albatrosses

Diomedea bulleri Rothschild—Buller's mollymawk

Parapsyllus sp. (*cardinis*-group)

Diomedea chrysostoma Forster—Grey-headed mollymawk

Parapsyllus longicornis

Diomedea epomophora Lesson—Royal albatross

Parapsyllus longicornis

In January 1961 Mr P. R. Wilson searched through nests of Royal albatrosses on Campbell Island and collected debris from the nest of a brooding bird, but failed to find any fleas.

Diomedea melanophris melanophris Temminck—Black-browed mollymawk (Toroa)

Parapsyllus longicornis

Family PROCELLARIIDAE—Storm petrels, shearwaters, etc.

Macronectes giganteus (Gmelin)—Giant petrel

Parapsyllus cardinis

Pachyptila desolata (Gmelin)—Dove prion

Notiopsylla kerguelensis
Parapsyllus cardinis

Pachyptila turtur (Kuhl)—Fairy prion (Titi wainui)

Parapsyllus jacksoni
(*Ceratophyllus gallinae gallinae*)

Mr J. R. Jackson also found a flea—which later became lost—on a storm-wrecked adult at New Brighton.

Procellaria westlandica Falla—Black petrel

Mr J. R. Jackson found no fleas in nests or on adults at Barrytown.

Peterodroma lessoni (Garnot)—White-headed petrel

Notiopsylla enciari
Notiopsylla kerguelensis
Parapsyllus cardinis
Parapsyllus magellanicus

Puffinus griseus (Gmelin)—Muttonbird or Sooty Shearwater (Titi, Oi)

Notiopsylla kerguelensis
Parapsyllus jacksoni

Mr J. R. Jackson failed to find fleas in nests at Perpendicular Point, 12-Mile Bluff and Mr One-One.

Pelagodroma marina (Latham)—White-faced storm petrel

Parapsyllus jacksoni

Family PELECANOIDIDAE—Diving petrels

Pelecanoides urinatrix exsul (Salvin)—Kerguelen diving petrel
Notiopsylla kerguelensis

Order STEGANOPODES (Pelecaniformes)

Family PHALACROCORACIDAE—Cormorants

Phalacrocorax carbo novaehollandiae Stephens—Black shag (Kawau)
Parapsyllus longicornis
(*Ceratophyllus gallinae gallinae*)
Mr J. R. Jackson found fleas in cliff-nests at Tokoroa Bay but not in tree-nests at Motukarara.

Phalacrocorax carunculatus chalconotus (Gray)—Gray's shag
(*Parapsyllus magellanicus*)
(*Nosopsyllus fasciatus*)

Phalacrocorax melanoleucos brevirostris Gould—White-throated shag (Kawau-paka)
Mr J. R. Jackson found no fleas in tree-nests at Coe's Ford.

Phalacrocorax punctatus (Sparrman)—Spotted shag (Parekareka)
Parapsyllus longicornis

Order FALCONES (ACCIPITRES)

Family FALCONIDAE—Falcons, etc.

Falco novaeseelandiae Gmelin—New Zealand falcon or Bushhawk (Karearea)
Mr J. R. Jackson found no fleas in a nest at Arthur's Pass.

Order GRESSORES (Ciconiiformes)

Family ARDEIDAE—Herons, etc.

Demigretta sacra (Gmelin)—Blue heron or Reef heron (Matuku-moana)
Dr C. Wallace found no fleas in two nests on Goat Island.

Egretta alba modesta (Gray)—White egret (Kotuku)
Mr J. R. Jackson found no fleas in a nest on South Island.

Notophoyx novaehollandiae (Latham)—White-faced heron (Matuku-moana)
Mr J. R. Jackson failed to find fleas in tree-nests at McCormack's Bay.

Order ANSERES

Family ANATIDAE—Swans, Geese, Ducks

Anas superciliosa Gmelin—Grey duck (Parera)
Mr J. R. Jackson found no fleas in several nests from the neighbourhood of Christchurch, and he also never saw fleas on ducks from Lake Wairarapa when plucking them. Large numbers are shot in the open season (May), but no shooter is known to have observed fleas on the ducks.

Aythye novaeseelandiae (Gmelin)—Black teal or New Zealand scaup (Papango)

Mr J. R. Jackson saw no fleas on this host or in its nest.

Tadorna variegata (Gmelin)—Paradise duck (Putangitangi)

Mr J. R. Jackson found no fleas on this host nor in its nest.

Zosterops halmaturina Campbell—White-eye or Silvereye (Tauhou)

Mr J. R. Jackson found no fleas in nests on South Island.

Order GRUES

Family RALLIDAE—Rails

Gallirallus australis (Sparrman)—South Island woodhen (Weka)

Stivalius galliralli

Porphyrio porphyrio melanotus Temminck—Swamp hen (Pukeko)

Dr C. Wallace found no fleas in two nests at Mahurangi and two nests at Motumaoho, and Mr J. R. Jackson also failed to find fleas on this host.

Order LARO-LIMICOLAE (CHARADRIIFORMES)

Family CHARADRIIDAE—Plover, Stilts, etc.

Himantopus leucocephalus Gould—Pied stilt or White-headed stilt (Poaka)

Dr C. Wallace failed to find fleas in a nest at Motumaoho.

Family LARIDAE—Gulls, etc.

Larus bulleri Hutton—Black-billed gull (Tarapunga)

Mr J. R. Jackson found no fleas in nests near Kaikoura, Rangiora, and Rakaia Gorge.

Larus dominicanus Lichtenstein—Black-backed gull (Karoro)

Notiopsylla kerguelensis

Dr C. Wallace failed to find fleas in four nests from Mahurangi, and Mr J. R. Jackson found none at Mt Davey, Long Bay, Tumbledown Bay, Murrays Mistake, Tokoroa Bay, Rangiora, Rakaia Gorge, and at the junction of the Crow river with the Waimakariri (at Tokoroa Bay the nests were only 25 yards from those of black shags which had fleas; the gull nests are on top of the cliffs and therefore more exposed to the sun).

Larus novaehollandiae scopulinus Forster—Red-billed gull (Tarapunga, Akiaki)

Parapsyllus longicornis

Mr J. R. Jackson found no fleas in nests at Okarito, Kaikoura and Murrays Mistake, and a single specimen, only, in a nest at Sumner Head.

Order PSITTACI

Family PSITTACIDAE—Parrots

Cyanoramphus novaezelandiae (Sparrman)—Red-fronted parakeet (Kakariki)

Notiopsylla enciari

Cyanoramphus unicolor (Gray)—Antipodes Island parakeet

Notiopsylla enciari

Nestor meridionalis (Gmelin)—Green Kaka

Mr J. R. Jackson failed to find fleas in nests or on nestlings at Nelson Creek, Greymouth.

Nestor notabilis Gould—Kea

Parapsyllus nestoris

Order STRIGES

Family STRIGIDAE—Owls

Ninox novaeseelandiae (Gmelin)—New Zealand owl or Morepork (Ruru)

Dr C. Wallace found no fleas in a nest at Motumaoho.

Order PASSERES

Family XENICIDAE—New Zealand wrens

Acanthisitta chloris (Sparrman)—Rifleman (Titi-pounamu)

Mr J. R. Jackson found no fleas in nests on South Island.

Family MUSCICAPIDAE—Flycatchers, Fantails, etc.

Petroica macrocephala (Gmelin)—Yellow-breasted tit (Ngiru-ngiru)

Mr J. R. Jackson failed to find fleas in nests on South Island.

Pseudogerygone igata (Quoy & Gaimard)—Grey warbler (Riroriro)

Dr C. Wallace found no fleas in three nests at Mahurangi and in one nest at Motumaoho, while Mr J. R. Jackson failed to find any in nests on South Island.

Rhipidura flabellifera (Gmelin)—Pied fantail (Piwakawaka)

Dr C. Wallace observed no fleas in four nests at Mahurangi and four nests at Motumaoho.

Family MOTACILLIDAE—Wagtails and pipits

Anthus novaeseelandiae (Gmelin)—New Zealand pipit (Pihoihoi)

Mr J. R. Jackson found no fleas in nests on South Island.

Family MELIPHAGIDAE—Honeyeaters

Prosthemadera novaeseelandiae (Gmelin)—Tui

Dr C. Wallace found no fleas in a nest on Goat Island

INTRODUCED SPECIES

Order ANSERES

Family ANATIDAE—Swans, Geese, Ducks

Cairina moschata (Linnaeus)—Muscovy duck

(*Pulex irritans*)

Order GALLI

Family PHASIANIDAE—Pheasants, Guineafowl, etc.

Gallus gallus domesticus Linnaeus—Domestic fowl

Ceratophyllus gallinae gallinae
(*Ctenocephalides canis*)

Phasianus colchicus Linnaeus—Pheasant

Dr C. Wallace found no fleas in a nest at Mahurangi.

Order COLUMBAE

Family COLUMBIDAE—Pigeons

Columba livia Gmelin—Rock-dove

(*Nosopsyllus fasciatus*)

Order STRIGES

Family STRIGIDAE—Owls

Athene noctua (Scopoli)—Little owl

Ceratophyllus gallinae gallinae

Order PASSERES

Family ALAUDIDAE—Larks

Alauda arvensis Linnaeus—Skylark

Dr C. Wallace found no fleas in a nest at Motumaoho, nor in nests at Mimiwhangata (near Whangarei, Auckland) and at Ruakura (near Hamilton, Auckland).

Family MUSCICAPIDAE—Flycatchers, Warblers, Thrushes, etc.

Turdus ericetorum Turton—Song-thrush

Dr C. Wallace failed to find fleas in seven nests at Motumaoho and in one at Mahurangi.

Turdus merula Linnaeus—Blackbird

Ceratophyllus gallinae gallinae

Dr C. Wallace found no fleas in six nests at Motumaoho.

Family FRINGILLIDAE—Typical Finches

Fringilla coelebs Linnaeus—Chaffinch

Dr C. Wallace observed no fleas in four nests from Motumaoho.

Passer domesticus (Linnaeus)—House sparrow

Ceratophyllus gallinae gallinae

Family STURNIDAE—Starlings

Acrodotheres tristis (Linnaeus)—Indian mynah

Dr C. Wallace found no fleas in two nests at Motumaoho.

Sturnus vulgaris Linnaeus—Starling

Ceratophyllus gallinae gallinae

Notes on Zoogeography

A third of the fleas known at present to occur in New Zealand can be said to belong to the native fauna, another third is made up of introduced cosmopolitan species, while the remainder contains introduced forms with a Subantarctic, Australian or European distribution.

The distribution per island of the species of fleas in New Zealand is shown in Table I. It will be seen that apart from the European "chicken-flea", all introduced species are mammal fleas and that these are commoner on and around North Island than on and around South Island where, however, the endemic species occur.

Endemic Species

The only endemic mammal-flea is the bat-flea *Porribius pacificus,* associated with *Chalinolobus tuberculatus* and perhaps also with the very rare bat *Mystacina tuberculata.* This flea, like the host, must have originated from an Australian ancestor which arrived in New Zealand in the distant past.

The ancestral stocks of the endemic bird-fleas came from two directions: (a) the species of *Parapsyllus* have their roots in the Neotropical Region, (b) *Stivalius* and *Notiopsylla* are genera of Pygiopsyllidae, a family which is concentrated in the Australian Region. The four endemic species of *Parapsyllus* form a species-group (*cardinis*-group) which—as far as is known—is confined to the New Zealand subregion; they are morphologically more strongly modified that the members of the other group (*longicornis*-group) and are associated with flying seabirds, with the exception of *P. nestoris,* the only species of *Parapsyllus* entirely parasitic on a typical land bird (the kea). The history of this transition may possibly have been as follows: *Parapsyllus nestoris,* the flea of the kea *Nestor notabilis,* is very closely related to *P. jacksoni,* a parasite of the muttonbird or sooty shearwater *Puffinus griseus* and of the fairy prion *Pachyptila turtur. Parapsyllus jacksoni* in turn is nearest related to *P. cardinis,* a flea of the white-headed petrel *Pterodroma lessoni* (*P. lynnae* is morphologically more distanciated from those three species and its true host not yet known, though this will very likely be a Procellariid bird).

The kea nests under large boulders and among rocks, and the muttonbird, as well as the fairy prion, sometimes also uses such places for the same purpose. During the last Ice Age, which—as Mr Jackson informed me—is estimated to have occurred at least 15,000 years and at most 100,000 years ago, the gradual covering of the Southern Alps range with ice must have forced the kea downwards and shorewards. Eventually the kea had to nest in close proximity with the muttonbird and related birds and thus obtained *Parapsyllus* fleas—which already resembled *P. jacksoni*—from nests of these Procellariid birds. These prototype fleas subsequently—after the end of the Ice Age, when the kea retreated to the mountains and thus lost contact with the seabirds—evolved into *P. jacksoni* on Procellariid hosts and into *P. nestoris* on the kea. Mr Jackson pointed out to me that the kakas *Nestor meridionalis* and *N. occidentalis* did not get the flea because their nesting habits are quite different from those of the closely related kea (the kakas nest in hollow trees; no *Parapsyllus* lives in nests above the ground).

Stivalius galliralli is a member of quite a large genus of predominantly mammal fleas (one other bird-infesting species is known, namely from Malaya) which are found especially in the Australian Region, to a lesser extent in the Oriental and Ethiopian Regions, while one species is known from Japan. As no male specimens of *S. galliralli* are yet known, the relationships to other members of the genus are rather difficult to assess. The true host of this flea is also not known, but it will be a landbird, possibly a Passerine.

Notiopsylla enciari belongs to the same family—Pygiopsyllidae—as the previous bird-flea and presumably originated in the Oriental/Australian Region. As at present there seems to be an association of *N. enciari* with ground-dwelling parakeets it is possible that the ancestors of these birds (which were no doubt still capable of flying) shared a biotope with small mammals which were parasitized by the prototype of *Notiopsylla*. Specimens of the latter may then have transferred to parakeets and evolved into a species now known as *Notiopsylla enciari*. When the parakeets spread to various small islands in the New Zealand area their territory was shared with long-range flying seabirds which seemed to have obtained an ancestral form of *N. enciari* from the parakeets; this form eventually evolved into *N. kerguelensis* which, being a parasite of widely dispersing birds, has become circumpolar in distribution. As *Notiopsylla kerguelensis* is morphologically as closely related to *N. enciari* as *Parapsyllus jacksoni* is to *P. nestoris*, the parallel between the evolutionary aspects of these two pairs of species is very close, although in the case of *Notiopsylla* the original host association was with a landbird, as against a seabird in the case of *Parapsyllus*.

As regards host relationships, we see that the endemic fleas are mainly associated with only two families of birds: Procellariidae (storm petrels, shearwaters) and Psittacidae (parrots). As only a single specimen of *Stivalius galliralli* has been found in the nest of a weka and none so far in various nests of the related swamp hen it seems rather uncertain whether Rallidae are normally hosts to any flea.

From data hitherto obtained it appears that birds of the following families are not parasitized by fleas in New Zealand: Apterygidae (kiwis), Falconidae (falcons), Ardeidae (herons), Anatidae (swans, geese, ducks), Charadriidae (plovers, stilts), Strigidae (owls) and all families of the Order Passeres (songbirds); Laridae (gulls) are apparently only rarely infested. It seems unlikely that an endemic flea will be found to occur naturally in birds' nests well above the ground in trees or bushes. If tree squirrels had ever belonged to the native fauna, a squirrel-flea might have had a chance to transfer to birds nesting also in trees and could then have evolved into a true bird-flea.

Subantarctic Species

As has been remarked above, *Notiopsylla kerguelensis* is probably an offshoot from the prototype of *N. enciari* and would therefore have had its origin in the Australian Region. However, its distribution is now markedly circumpolar, and this species should be classed as a Subantarctic insect. The same applies to the two species of *Parapsyllus* of the *longicornis*-group, *P. longicornis* and *P. magellanicus,* which are doubtless of South American origin but are now also circumpolar in distribution.

The three species of fleas belonging to this category are associated with five families of birds: Spheniscidae (penguins), Diomedeidae (albatrosses), Phalacrocoracidae (shags), Procellariidae (storm petrels, shearwaters) and Pelicanoididae (diving petrels).

Australian Species

Two species are to be considered here: *Pygiopsylla hoplia,* a flea of small mammals (marsupials and rodents) occurring in Australia and Tasmania, and *Xenopsylla vexabilis,* a parasite of rats in Australia and introduced into the Hawaiian Islands. In New Zealand these two fleas are wholly associated with the Pacific rat *Rattus exulans* (virtually the same applies to *X. vexabilis* in Hawaii) and both fleas have been found on Raoul Island (Kermadecs), Hen Island and Little Barrier Island; on Raoul Island, where *Rattus norvegicus* is replacing *R. exulans,* both species of flea have also been collected from *R. norvegicus.* The presence of *P. hoplia* and *X. vexabilis* in New Zealand would seem to have been simply the result of the introduction of *Rattus exulans* for which the Maoris are held responsible. However, *R. exulans* is not known from Australia (apart from what is regarded as a recent introduction on the small island off the N.E. coast and N.W. coast—if these records are at all reliable) and the Pacific rat can therefore not be considered as the original true host of these fleas; moreover, there has apparently been very little Maori traffic between Australia and New Zealand, the Maoris having arrived in New Zealand from Polynesia. Somehow the fleas must somewhere have come in contact with a species of rat which carried them to a stronghold of *Rattus exulans* (presumably to the north of Australia) whither they spread within Polynesia through the agency of Maori traffic. This truly intriguing problem of zoogeography is at present most difficult to explain satisfactorily.

European Species

Here only belongs the European "chicken-flea" *Ceratophyllus gallinae gallinae,* which may have been introduced on several occasions with—e.g., chickens or with various European birds. These birds must have travelled in cages which contained "nesting material" or some such detritus in which fleas could breed during the long sea journey; the fleas would never have stayed on the birds themselves for so long.

As domestic fowl were first introduced by Captain Cook two centuries ago, the chicken-flea has presumably been present in New Zealand for that period. During that time this flea has been very successful in obtaining a strong foothold on North and South Island, but it is noteworthy that it has not been found on any members of the endemic genera of New Zealand birds.

The European rabbit and hedgehog are without their specific fleas (*Spilopsyllus cuniculi* and *Archaeopsylla erinacei* respectively) in New Zealand.

COSMOPOLITAN SPECIES

The seven cosmopolitan mammal-fleas must have arrived in New Zealand as stowaways in ships especially from Europe. Four of the species are rat-fleas: *Nosopsyllus fasciatus, Nosopsyllus londiniensis, Xenopsylla cheopis* and *Leptopsylla segnis* (the latter is also a specific house-mouse flea). As specimens of these species are regularly present (or certainly used to be) on ship rats (*Rattus rattus* and—to a much lesser degree—*R. norvegicus*) anywhere in the world it is impossible to indicate from which direction these fleas were imported by white men. Soon after Cook's visits came other navigators, especially from France, Spain, Russia and America. At the end of the 18th century came sealers, whalers and trading schooners. English missionaries, headed by Samuel Marsden, landed in 1814.

It is also difficult to find an explanation for the presence on *Rattus exulans* of *Nosopsyllus fasciatus,* a flea of *Rattus norvegicus* and *Rattus rattus,* on Hen Island and Little Barrier Island where the latter rats do not occur (and apparently have never been present; the first of these two small islands is uninhabited and there is therefore little traffic between it and the North Island, where *N. fasciatus* does occur. Little Barrier Island has had resident caretakers since 1897.)

In contrast with the rat-fleas, the three other species may have made their presence truly felt because they are associates of man and of his favourite carnivorous pets—namely the human flea *Pulex irritans,* the dog flea *Ctenocephalides canis* and the cat flea *Ctenocephalides felis felis.* It is difficult—if not impossible—to establish by whom and when exactly these fleas were added to the New Zealand fauna. As the spread overseas of these fleas is entirely governed by the movements of man, it is relevant to review concisely the history of man's population of New Zealand. One should distinguish between the arrival of the Polynesian Maoris and of the " white man ". It seems to be generally accepted that by the 14th century A.D. Polynesian canoemen had reached the northern shores of North Island and that by 1642 they had spread to South Island. On 13 December of that year the great Dutch navigator Abel Janszoon Tasman, sailing in the Heemskerck, and accompanied by the Zeehaen, discovered a large island in the south seas and named it Staten landt, later to be renamed Nieuw Zeeland (New Zealand). Tasman did not go ashore because of the hostile attitude of the natives (Maoris) experienced in the Moordenaers Baai (Massacre Bay or Golden Bay, in the north of the South Island). It has been suggested that Spanish explorers already knew about the existence of New Zealand before Tasman sighted it and that as usual they kept such a discovery a secret.

As far as we know, the first Europeans to set foot on New Zealand were Captain James Cook and his party, who were on their first voyage around the world in H.M.S. Endeavour (1768-1771). They landed in Poverty Bay (east coast of North Island) on 8 October 1769, and thence made several other landings on North Island. Among Cook's party was Sir Joseph Banks, whose Journal of the voyage was eventually published by Hooker in 1896. On p. 224 of Banks's Journal we read that " On every occasion when we landed in this country, we have seen, I had almost said, no quadrupeds originally natives of it. Dogs and rats, indeed, there are, the former as in other countries companions of the men, and the latter probably brought hither by the men; especially as they are so scarce that I myself have not had opportunity of seeing even one." On p. 225 Banks states that " Neither are insects in greater plenty than birds; a few butterflies and beetles, flesh-flies very like those in Europe, mosquitos and sand-flies, perhaps exactly the same as those of North America, make up the whole list."

The first mention of the presence of fleas in New Zealand is found in Johann Forster's Journal (1777) of Captain Cook's second voyage round the world (1772-1775). Forster travelled with Cook in His Britannic Majesty's sloop Resolution, which was accompanied by the Adventure, captained by Tobias Furneaux. On p. 201 of Forster's travelogue we read that on 20.V.1773 " We were told that the people from the Adventure had found them [native huts in the area around Queen Charlotte's Sound on the north of South Island] exceeding full of vermin, and particularly fleas, from which it should seem that they had been but lately inhabited."

The question arises whether these fleas in the native huts were human fleas, dog fleas or cat fleas. Members of all three species will attack man when hungry or when freshly emerged from the cocoon. The Maoris had brought with them only a dog (now extinct) and the Pacific rat (*Rattus exulans*). If we consider that the human flea (*Pulex irritans*) was *e.g.* found in 1938 in New Guinea in an area where no white man had ever been before (Smit, 1953, *Amer. Mus. Novit.* (1638): 3) it may well be that this flea has been widespread for a much longer time than is generally realised. One might suppose that an insect which is closely linked with man has relatively recently been distributed by him from A direct to Z, while in fact the insect may well have worked its way from A through B, C, etc. to Z, although this must have taken infinitely longer. The dog flea, as well as the human flea, has an aversion to tropical conditions, and the only flea which might have been present on the Maori dogs is *Ctenocephalides felis orientis*, but the dog would not have been the true host, and while *C. f. orientis* is found from Ceylon to the Admiralty Islands, no specimens are known from the Australian Region. If the Pacific rat had had fleas—presumably they did—they would not have been noticed by Cook's sailors. The cat flea can be left out of consideration as cats had not yet been introduced. There seems to be little or no reason to doubt that the fleas in the native huts were indeed true fleas and the specimens that caused the heavy infestations appear to have been human fleas (*Pulex irritans*).

The next mention of the occurrence of fleas in New Zealand is given by Nicholas (1817: 338), who says that "A white man = Packhaha [pakeha]. The flea is also called by this name, as the Maoris assert it to have been first introduced into their country by Europeans ".

A similar statement is made by White & Doubleday (1843: 291): "Aphaniptera. 137. *Pulex*. Keha, or flea. Polack l.c.i, p. 321. Tuiau. Dieffenbach. The natives say that fleas were introduced by the Europeans, and for that reason call them sometimes 'he pakea nohinohi', the little stranger.—Dieffenbach." Dieffenbach (1843: 318), in an essay on the language of the Maoris, quotes the following sentence: " E riri ana ahau ki enei purui e mungea noku ", *i.e.*, " I am angry with these fleas, they make me itch." Tuiau is the second Maori name for the flea we see in print, purui (or puruhi) the third. Miller (1949, 1952) adds " mororohu " and " kutu-porenga " to the Maori names for the flea. These names were in use in various parts of New Zealand. Miller (1949) dealt with the question whether the Maoris knew of fleas before the arrival of Europeans; although he based his conclusions partly on what are now known to be incorrect data, he correctly surmises that the ancient Maori should have noticed—if only just—the fleas of the bats and of the penguins. Whether the human flea arrived in New Zealand before the Europeans or not may remain argumentative. In any case the " common flea " soon became too common in many districts, as is evident from the following excerpts.

Angas (1847: 20) relates that "Here we pitched our tent, overlooking the broad surface of the Waikato [a river on North Island], at about half a dozen yards from its brink. The fear of too many visitations from that active parasite, the flea (cleverly styled e pakea nohinohi, or 'the little stranger', by the natives, who say that it was first introduced by the Europeans), prevented our encamping within the enclosure of the pah [a native fortified camp]."

A vivid description of the numerosity of fleas in the Otago district (South Island) in the early days of the settlement is given by Gillies (1878: 312–313). He remarked that fleas (which he supposed to be *Pulex irritans*) were more numerous in those early days than at the time of his writing in 1877. "The Maoris, with their pigs and their dogs, in other parts of New Zealand, account for a great deal of what was in those days, *the special characteristic of New Zealand,* . . . ." But Gillies then states that there were never many Maoris in Otago and that they did not live near settlements. "And yet, go where you liked, in town or country, the fleas were masters of the situation, and were more talked about than even the Crimean war." The whole face of the country was at that time densely covered with herbage, fern, tutu [a small bush] and flax especially, and before this was burned down "you could not lie down or go amongst it anywhere without being covered with fleas. Great differences of opinion used to exist as to whether these fleas were the true genuine flea (*Pulex irritans*), and there is no doubt that they were not so active nor so bloodthirsty and irritating as their brethren [*P. irritans*], which infested all domiciles alike." After the rough herbage, especially fern, was burned once or twice this insect pest almost disappeared.

When settling on Ruapuke Island, in the Foveaux Strait, in 1844, missionary Wohlers (1882: 125) occupied a native hut and wrote: "In order to keep the house free from fleas, which my visitors brought me in great abundance, I procured some planks and made a floor. I also partitioned off a sleeping place, to keep the visitors with their fleas away from my bed. The house being now a little refined, visitors were no longer allowed to go to sleep in it, nor to stay over long. When a set of them left I took the broom and swept the fleas out after them". Ruapuke Island was frequently visited by the dispersed population in the Straits; whaling and sealing vessels had called there and some 40 of the sailors had remained on the island and lived among the Maoris. (The place-name Te Awatuiau on Ruapuke Island means flea-channel; it is not known when this name was given. There is also a Flea Bay in Banks Peninsula.)

Finally, there is Fagan's (1916) delightful but doubtless much exaggerated story about New Zealand's flea plagues of the past: "Years ago it fell to the writer's lot to experience something of the horror of one of these flea plagues. Circumstances, in my case, permitted an early flight from the infested area; but the memory of these two tormentful days and anguished nights has lost nothing of its vividness. It was not so much the horrid discomfort of the time. It was, I think, the feeling of utter and absolute helplessness in the face of present misery that made it so distressing.

"It was in a little coastal town not far [to the north] from Dunedin, in the South Island. Waikouaiti at the time was an important little place. Untouched by the railway that now carries holiday folk past its doors, it had developed into a seaside resort of the well-to-do from its bigger neighbour. The streets of the town were wide and well-planned; each house stood separate from its neighbour,

on its own allotment. There was no insanitary crowding of dwellings. For nine months of the year the place was swept by the south-east trades that blew in from the sea, and during the remaining period it was scoured clean by winter rains. This stressing of the point of cleanliness is necessary in the light of what follows.

"The first intimation of coming woe arrived by way of a school picnic, and a panic ensued. The fleas were upon us—millions of them! You could hear them patter, patter, patter as they hopped by in armies. The ground seemed covered by a brown spray as they passed. I had read of ant armies on the march in Africa; but never in my wildest dreams could I have conceived anything like the actuality of the fleas. Dogs rolled in the dust and howled. Cats took to the bush and were seen no more. The fleas invaded the houses. Floors and walls literally swarmed with them. They got into the food and every utensil. Sleep was quite impossible. The town came within an ace of madness from protracted insomnia.

"But Providence intervened. The visitation lasted only three weeks. Night fell on the twenty-first day, and the town was one huge dolorous scratch. In the morning not a single flea remained."

	Kermadec Is.	North I.	Goat I.	Hen (Taranga) I.	Little Barrier I.	Cuvier I.	Brothers I.	South I.	Stewart I.	Solomon's I.	Kundy I.	Snares Is.	Antipodes Is.	Auckland Is.	Campbell I.	Macquarie I.
ENDEMIC SPP.																
P. pacificus		+						+	+							
P. cardinis								×						×		×
nestoris								×								
jacksoni							×	×	×							
lynnae										×		(×)				
N. enciari											×		×	×		×
S. galliralli								×								
SUBANTARCTIC SPP.																
P. magellanicus														×		×
longicornis		×	×		×			×							×	
N. kerguelensis												×		×	×	×
AUSTRALIAN SPP.																
P. hoplia	●			●	●											
X. vexabilis	●			●	●											
EUROPEAN SPP.																
C. g. gallinae		×						×								
COSMOPOLITAN SPP.																
L. segnis		●						●								
N. fasciatus		●		●	●	●		●	●					●	●	●
l. londiniensis		●														
C. f. felis		●						●								
canis		●						●								
P. irritans	●	●			●			●								
X. cheopis		●														

TABLE I.—Distribution per island of fleas in New Zealand. × = bird-fleas; + = bat-flea; ● = mammal-flea other than bat-flea.

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