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ECTOPARASITES OF MAMMALS

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I

THE wingless permanent ectoparasites of mammals are chiefly of two groups, namely, the Mallophaga, or biting lice, which feed on the hair and dermal scales, and the Anoplura, or sucking lice, which feed on the blood. Certain mites and ticks, a few of the Pupipara (degenerate flies) and almost all of the fleas are also ectoparasites of the mammals, but the fleas, numerous and economically important as they may be, are not permanent parasites, for they live as larvæ not on the host of the adult, but in cracks and crevices in floors, or in the soil and elsewhere that the organic detritus used by them as food may be found. The adults, too, hop on and off their host, and often change from one host individual to another, and even from one host species to another. So that the problems of distribution and species-forming with which I am particularly concerned in my studies of the ectoparasites are not at all the same in such impermanent form as the fleas as in those truly permanent forms, the Mallophaga and Anoplura.

In these latter there occurs an extraordinary limitation of the parasite individuals and their immediate progeny and future generations to specific and even individual hosts (and *their* progeny and future generations), so that the Mallophagan and Anopluran fauna of any mammal usually represents a closely inbred family strain biologically iso-

lated from the rest of the individuals comprising the particular species represented by it. This brings about certain striking conditions of abundant small variation and subspecific (or intraspecific) distinction, which, however, because of the general similarity of habitat, food and habit, do not tend to grow rapidly into large (specific, generic, family) differences. The hundred or more species of Mallophaga so far recorded from mammals have, until very recently, all been ascribed to two genera, of which one included nearly nine tenths of the total number of kinds. There has been made a beginning—and not a particularly convincing one—at breaking up this inclusive genus (*Trichodectes*). It is a movement suggested more by the needs of convenience than the needs of expressing a biological situation. Similarly, although not representing so extreme a condition of likeness, the Anoplura, also including about a hundred parasite species (occurring only on mammals) have been, until recently, divided into but half a dozen genera, with the great majority of the species included in one. Certain aberrant forms found on man, the monkeys, the elephant, and on seals and walrus have always made necessary the recognition of four or five quite distinct genera. Attempts, however, are now being made to break up the unwieldy genus *Hæmatopinus*.

As this paper is, in effect, a continuation of my paper on "Distribution and Species-forming of Ecto-parasites" published in *THE AMERICAN NATURALIST* in March, 1913, which devoted itself to a consideration of the Mallophaga (some 1,400 species as so far known) found on birds, and to the problems presented by their conditions of life and their host and geographic distribution, I can dispense with any further account of the special biology of these parasites by referring the interested reader to this former paper. In it I have set out rather fully the special structural and habit features of the Mallophaga. Except that the Anoplura take blood, rather than feathers and hair, for food, and have specially modified

mouth parts to do it with, and are perhaps even more specialized in their physiological adaptations to their host than the biting lice, most of the general remarks made concerning the Mallophaga will apply to the sucking lice also.

In their peculiar special relations to their hosts as permanent ectoparasites on them, wingless, and reluctant to migrate even with opportunity, and so fitted physiologically to their parasitic life that they can not live for more than a few hours (or, at most, and exceptionally, days) off the bodies of their hosts, the Anoplura and Mallophaga are alike. And hence the conditions and problems of their distribution and species-forming are practically the same for the two groups.

The thesis that I have maintained, on a basis of the conditions presented by the bird-infesting Mallophaga, I now wish to test by the conditions presented by the mammal-infesting Mallophaga and Anoplura. This thesis is, in fewest words, that the host distribution of these wingless permanent ectoparasites is governed more by the genetic relationships of the hosts than by their geographic range, or by any other ecologic conditions. The fact, proved by abundant cases, that two host species of wholly distinct geographic range and with no possible opportunity for contact such as would permit of the migration of wingless parasites from one to the other, may have, nevertheless, one or more parasitic species common to them both, is associated almost always with the further fact that these common hosts are closely related genetically. They are most often of the same genus or of closely allied genera; they are almost certainly always of the same subfamily or family. The explanation for the possibility and the reality of this interesting host distribution I find in the hypothesis that the common parasite species has persisted unchanged from a common ancestor of the now divergent but allied host kinds.

Also, if it be true that genetic relationship is the deter-

mining factor in accounting for the host distribution of the parasites, then it is also true that the distribution of the parasites will indicate in some measure the genetic relationships of the hosts, and that occasional aid in determining the genetic affinities of birds and mammals of doubtful relationships may be had from a study of their parasitic fauna. In my paper already referred to I have pointed out some suggestive cases of this sort in connection with the birds and their parasites.

In examining the conditions existing among the mammals and their Mallophagan and Anopluran fauna, the first necessity was the compilation of a complete record or catalogue of mammalian hosts and their parasites, together with the record of the actual locality of each finding of parasites, together with a general record of the geographic range of all the various hosts. This catalogue, or set of records, I have now completed, and despite its meagerness compared with the similar catalogue of the bird hosts and their Mallophagan parasites from which the notes for the former paper were drawn, it contains enough records of interest to make worth while a preliminary report on the condition obtaining among the mammals and their parasites.

It is unfortunate that, although there are nearly one fourth as many mammal species as bird kinds, only about one hundred mammals figure in the Mallophagan host list, while Mallophagan parasites have been taken from over eleven hundred bird species. Also, only one hundred different Mallophaga have been taken from mammals, while about fourteen hundred have been taken from birds. Of the Anoplura, which are found only on mammals, records have been made from about one hundred host species, these records referring to just about the same number of Anopluran kinds. Thus the mammalian host catalogue with its list of parasites is a short one; as far as it goes, however, it is thoroughly interesting and suggestive.

In working up the records I have used Trouessart's

"Catalogus Mammalium" as an authority for the synonymy of the hosts, and my own judgment, based on a considerable personal knowledge of the parasites and on a careful consideration of all the more intelligible literature of the two groups, as a last court for the synonymy of the Mallophaga and Anoplura species. The synonymy of the parasites I have, however, not pushed far.

With so much of introduction and explanation we may come to a swift résumé of the results of a scrutiny of these records, proceeding by sequence of the mammalian orders, and referring to either or both groups of parasites as they may happen to be represented in the parasite records of the successive host groups.

II

The Marsupialia are represented in the host list by half a dozen species of kangaroos and wallabies (family Macropidæ) all from Australia, and a wombat, *Phascalomys ursinus* (family Phalangeridæ), from Tasmania (also S. Australia?). From all of these hosts only Mallophaga are recorded, no Anoplura having yet been taken from a marsupial. The six species of kangaroos represent three genera (Macropus, Petrogale and Æprymnus), and their Mallophaga are of seven species, representing four genera. Four of the species belong to the genus Boopia, and I strongly suspect are not all different. In addition there is one Trichodectes, from *Petrogale penicillata*, one Latumcephalum, from "wallabies," and one Heterodoxus, which is recorded from *Macropus giganteus* in Australia as well as from the same host in the Jardin des Plantes, Paris. It is also recorded from an undetermined wallaby in Victoria and one in Queensland, as well as appearing in three other records from "kangaroo" or "wallaby" from Australia. The parasite of the wombat is a species of Boopia, and it has been twice recorded from the same host. It is interesting that the kangaroo in the Jardin des Plantes harbored, even after some period of captivity, only its own proper para-

sites without accepting new ones from its many, various and closely pressing neighbors.

Of the four Mallophagan genera found on the kangaroo, three, namely, *Boopia*, *Latumcephalum* and *Heterodoxus*¹ are peculiar to them. The third genus, *Trichodectes*, is represented by but a single species which has been recorded but once. This is the common Mallophagan genus of mammals generally. The record is perhaps a good one, but its lack of confirmation by being unrepeated either for the same species or for any other species of *Trichodectes*, is suggestive. *Heterodoxus*, *Latumcephalum* and *Boopia* are two-clawed genera; that is, they are Mallophagan forms which belong to a family all the other genera of which are confined to birds. The characteristic structural difference between the mammal-infesting Mallophaga and the bird-infesting species is the presence in the first group of a single claw on each tarsus, and in the second of two claws. This difference is plainly an adaptive one concerned with the fitting of the foot for the seizing of hairs and scrambling about among them, on the one hand, and the manipulation of feathers and moving about on them, on the other. In examining living specimens under the microscope the special use and fitness of the feet, in the one case adapted to hairs and in the other to feathers, is obvious. However, *Heterodoxus*, *Latumcephalum* and *Boopia*, and, in addition, perhaps one other doubtful genus, represented by one species, and perhaps two or three species of another two-clawed genus, constitute exceptions to the general rule. It is of decided interest to note that the only genera of two-clawed Mallophaga found exclusively on mammals are limited to the Marsupials. The antiquity and isolation of

¹ The single valid species of this genus—the two or three that have been named are undoubtedly all the same—has also been recorded from dogs! In fact specimens in my own collection were received with the record "from Japanese dog." And Enderlein has recorded it from a dog from China and Neumann from a dog from Formosa. Yet dogs ordinarily do not harbor this parasite, and kangaroos and wallabies do. It seems necessary to believe that the dog host records indicate cases of straggling from kangaroos in zoological gardens or menageries.

this host group strongly suggests that the one-clawed condition common to all other mammal-infesting Mallophaga is a derivative from the original two-clawed condition characteristic of the parasites of birds and of these ancient mammals. The two-clawed condition is, of course, the one common to insects generally and is characteristic of the Atropids, in whom I am inclined to see the ancestors, or near-ancestors, of the Mallophaga. All of the Anoplura, it may be added, which are exclusively mammal-infesting, are one-clawed.

In this connection the suggestiveness of the fact that in face of the examination of many specimens of half a dozen species of kangaroos and wallabies, no Anoplura have yet been found on the Marsupials, may be referred to. I am coming strongly to believe that there is no such wide ordinal separation of the Mallophaga and Anoplura as our clinging to the fetich of "biting and sucking mouth-parts" as basis for radical classificatory separation has led us to effect. I believe, with Mjöberg, that the two groups of parasites have a fairly near genealogical affinity, their differences, which are particularly those of mouth-parts, being adaptive rather than palingenetic in character. The Anoplura have gone on from the Psocid-Mallophagan condition to a more specialized parasitic habit, and are the extremes of a general line of ectoparasitic evolution. The absence of sucking lice from the kangaroos may mean that the Marsupials are older than the Anoplura! No other considerable group of mammals, except certain families of strong-smelling Carnivora, is free from the blood-sucking parasites.

There are but two Edentates in the host list, one, the Cape Ant bear, *Orycteropus afer* (family *Orycteropodidae*) of south and central Africa, harboring a sucking louse, of genus and species peculiar to it, and the other, the three-toed sloth, *Bradypus tridactylus* (family *Bradypodidae*) of eastern South America, harboring a Mallophagan of species peculiar to it but of the genus *Gyropus* which is the less scattered, although still rather catholic,

genus of the two large ones characteristic of the mammals.

The large order Ungulata, with its numerous domesticated and semi-domesticated species, is a favorite host group with both Mallophaga and Anoplura. Altogether² about thirty Anoplura and two dozen Mallophagan species are recorded from fifty host species representing nine Ungulate families.

The family Elephantidæ is represented by the African and Indian elephants, recognized as distinct species of distinct geographic range. They both harbor a common Anopluran species, *Hæmatomyzus elephantis*, of species, genus and family peculiar to the elephants. Fahrenholz has given the varietal name *sumatranus* to specimens of these sucking lice taken from an Indian elephant in Sumatra. Records show that the parasites have been taken from their elephant hosts not only in Africa and Asia, but in various zoological gardens, as Paris, Hamburg and Rotterdam.

The small family of Hyracidæ, or conies, is represented in the host list by two species and perhaps a third one, one of which, the Syrian coney of west and south Asia, harbors one Anopluran and one Mallophagan, while from the other, the Cape coney of South Africa, the same Anopluran species is recorded as well as another of the same genus. This record of a second species is from a coney in the London Zoological Gardens. From the possible third species of Hyrax (taken in the African Congo and perhaps, but not probably, also a Cape coney), a second Mallophagan species is recorded of the same genus, *Trichodectes*, to which that of the Syrian coney belongs.

In the family Equidæ three species, the horse, the donkey and Burchell's zebra, all suffer from the infestation of a common Anopluran species, *Hæmatopinus asini*. In addition, the horse and the zebra have a common

² The synonymy in the parasite records, and indeed in the host records as well, is a vicious tangle. I have done the best I can, for the present.

Mallophagan parasite, *Trichodectes parumpilosus*, while the horse and donkey have another common biting louse, *Trichodectes pilosus*. Two varieties of *Trichodectes parumpilosus* have been named by Piaget, one from the zebra and another from "little horses of Java."

The pigs (family Suidæ), of which three wild African species besides the familiar animal of the barnyard are found in the host list, are infested by two (perhaps three) species of Anoplura and one (a not too certain record) Mallophagan. *Hæmatopinus suis* is found on the domestic *Sus* all over the world, while *Hæmatopinus latus* of Neumann, *H. phoccochoeri* of Enderlein and *H. peristictus* of Kellogg and Paine, which are almost certainly all one species, are recorded from the wart hog, *Phacochærus athiopicus* from Nyasa-land, Africa, and probably also from another wart hog species from Africa, and the Red River hog, *Potamochoærus chæropotamus* from Nyasa-land, Africa. In addition *Potamochoærus demunis* (probably), from German east Africa, is credited by Stobbe with a Mallophagan parasite peculiar to it, *Trichodectes vosseleri* Stobbe.

The peccary, *Dicotyles tajacu* (family Dicotylidæ) of Central America and southwestern North America, has a Mallophagan species peculiar to it, belonging to the smaller of the two large Mallophagan genera, namely, *Gyropus*.

The dromedary, of north Africa and western Asia, and the bactrian camel, of central Asia, harbor a common sucking louse, *Hæmatopinus cameli*. A doubtful second species called *H. tuberculatus* (Neumann thinks it identical with *cameli*) has been recorded from a dromedary imported from India into Australia. The "South American camel," the llama, harbors an Anopluran species peculiar to it, and two Mallophagan species, *Trichodectes breviceps* Rudow and *T. inæqualemaculatus* Piaget. Although Rudow's species are often suspect, I have just had his *breviceps* from a llama of Peru (collector C. H.

T. Townsend). With these llama Mallophaga there is also a small Anopluran which I have not yet worked out.

The family Cervidæ is represented in the host list by about ten species. They are infested by three species of Anoplura, each peculiar to its host, and six species of Trichodectes (Mallophaga) of which *T. tibialis* is common to the roe deer of Europe and Asia Minor, an African *Capreolus*, and our own black-tailed deer of the western states. *Trichodectes longicornis* is common to the red deer of Europe and Asia Minor and the fallow deer of south Europe, Asia Minor and north Africa.

The giraffe (family Giraffidæ) harbors a sucking louse, *Linognathus brevicornis*, peculiar to it.

The great family Bovidæ, with its many buffalo, buck, sheep, goat and antelope kinds, is represented in the host list by five or six species of Bos, four African bucks, three or four sheep, the ibex, chamois and two or three goats, and five or six antelopes, or gazelles. The domestic ox, *Bos taurus*, harbors three species of Anoplura and one Mallophagan. Curiously, none of these species is recorded from any other Bos. On the other hand, the zebu, the Indian buffalo, and the American bison all have the same Anopluran species (and no other, nor any Mallophagan), while the yak of central Asia and the Kaffir buffalo each have an Anopluran peculiar to it. The four species of African reedbucks and duikerboks have, according to the records, each a peculiar species of sucking louse. These records need scrutiny. One of them is my own, but I had to describe the species without seeing the types of the others. The domestic sheep carries two Anopluran species and one Mallophagan. The latter occurs also on at least two wild species of Ovis, one of west Africa and the other of north Africa. The fat-tailed sheep has a record from German southwest Africa of a Trichodectes of its own.

The domestic goat harbors one Anopluran and at least one Mallophagan, the latter being common also to the Angora goat, the chamois, and a wild (?) goat of Guinea,

and a wild (?) goat of Java. A recent description of a second Mallophagan species from the domestic goat is not convincing. The chamois has also an Anopluran, but one, so far, peculiar to it. Three species of Gazella (or Antelope) have three species of Trichodectes, of which one is common to two host species, one of Arabia and Syria and the other of north Africa and southwest Asia generally. This same Trichodectes is also recorded from the roan antelope, *Hippotragus equinus*, of east central and south Africa. One species of Gazella carries an Anopluran peculiar to it, as does also *Tragelaphus gratus* of west Africa.

The order Carnivora is represented in the host list by eight families and a total of fifty-four species. Only one species of Anopluran, the common sucking louse of the dog (not found yet even on the wolf or fox, both of which have other records) is recorded from a Carnivore, outside of the two families Trichechidæ (walruses) and Phocidæ (seals and sea-lions). From these two families, on the other hand, only Anoplura are recorded.

The family Felidæ is represented by three species, the domestic cat, the California lynx and the tiger. The cat and lynx have a common Mallophagan parasite, *Trichodectes subrostratus* (and no other), while the tiger has a biting louse presumably peculiar to it. The description of this parasite is, however, very brief and unsatisfactory.

The family Viverridæ, mongooses, ichneumons and genets, is represented in the host-list by eight species, of which five are of the genus *Herpestes*. Two of these *Herpestes* species, one of southern Spain, north Africa and Asia Minor, the other of west, east and south Africa, harbor a common Mallophagan parasite. A record of the finding of *Trichodectes subrostratus*, the familiar biting louse of the cat, on *Herpestes pluto*, comes from the Kamerons (Africa). It is probably a case of straggling, the mongooses being common enough in gardens, and some of them fairly domesticated.

Of the family Canidæ there are records from eleven

species, including the domestic dog, a wild dog of South America, two wild dogs of Asia, two foxes, and a wolf. The domestic dog has a familiar sucking louse and is also credited with that problematical normal or straggling biting louse of a peculiar genus which I have referred to in my account of the parasites of the kangaroos *Trichodectes latus*, the common biting louse of the domestic dog, is also common to the wolf, *Canis lupus*, of Europe and Asia, and to the raccoon-like wild dog, *Nyctereutes procyonoides*, of Asia and Japan. The record of this last came, it must be noted, from the Berlin Zoological Gardens. There is no other record of commonness of parasite to two hosts in the family. The English fox has a single Mallophagan species, and the California fox has another. The dhole, a wild dog of the Himalayas, has a Mallophagan species, and the Magellan wolf of Patagonia has another.

The family Procyonidæ is represented in the host-list by two raccoons, the California ring-tailed cat, and two coatis of Central and South America, respectively. The two raccoons, *Procyon lotor* of North America and *Procyon psora* of California, harbor a common Mallophagan parasite. In addition a German record (from a zoological garden?) credits *Procyon lotor* with carrying also a Mallophagan which is the characteristic parasite of the badger. On the California ring-tailed cat, *Bassariscus astuta*, have been found two Mallophagan species, one of which is the characteristic parasite of the skunks of North and South America. The two coatis, *Nasua narica* and *Nasua rufa*, one of southwestern United States, Mexico and Central America, and the other of South America from the equator south, both harbor a common Mallophagan species.

The family Mustelidæ, comprising the badgers, weasels, martens, and skunks, an ill-smelling crew, offers no attraction to blood-sucking parasites, but is represented in the host-list by nearly twenty species from which Mallophaga have been taken. The Old World badger has

a characteristic species, *Trichodectes crassus*. The martens, weasels and ermine have also a characteristic species, *Trichodectes retusus*, which is recorded from the pine marten of Europe and northern Asia, the beech marten of the same range, still another Old World marten, the weasel of Europe and Asia, the ermine of north Europe, Asia and America, and the weasel and mink of North America, in all six or seven species of *Mustela* and *Putorius* of very wide geographic range. The skunks of North and South America have also a characteristic Mallophagan species, *Trichodectes nephitidis*, described by Osborn from the common North American skunk, *Mephitis mephitis*, taken in Nebraska. I have found this parasite on the western skunk, *M. occidentalis*, in California, and on *M. macrura* of Arizona. It has also been recorded from the spotted skunk, *Spilogale interupta*, of the southern United States, Mexico and Central America, and I have examples from a "skunk" of Bolivia. It is also recorded from a Chilean Mustelid, *Galictis quiqui*, which ranges over South America from the River Plate south, and from another species of *Galictis* in Brazil. Finally, examples of this ubiquitous pest are recorded from *Helictis everetti* from North Borneo! The last record comes from Neumann, a very careful and well-informed student of the parasites, but his specimens were taken from a skin in the Museum of Natural History of Paris. The Old World otter, *Lutra lutra*, has a *Trichodectes* of its own, as has also an African otter, *L. matschiei*, and the North African *Zorilla lybica*. Mjöberg records a species of *Boopis* (typical kangaroo parasite genus) from *Lutra pruneri* of India. As the record is an extraordinary one, being the only case of a *Boopis* found outside of Australia or on a mammal other than a Marsupial, it is well to note the exact circumstances of the record. The parasites (several examples) were got by Mjöberg from the Hamburg Zoological Museum where they were ticketed as having been taken from a "soeben frisch angekommenes Thier" of the species *Lutra pruneri*, the animal having been received

from India. There are to be considered in connection with this extraordinary record, first, the possibility of an exchange of labels in the course of the several handlings of the Mallophagan specimens, and, second, the possibility of a favorable answer to the question: Is *Lutra prumeri*, which does not appear in Trouessart at all, only *Lutra lutra*, the common Old World otter, and was the specimen from which the Mallophagan came a resident in a zoological garden in which kangaroos or wallabies also lived, affording a bare chance of straggling? The similar aberrant records from dogs of the kangaroo parasite *Heterodoxus* have already been referred to.

The bears (family Ursidæ) have, so far, but one parasite record to present, a Mallophagan species, *Trichodectes pinguis*, having been described from the Thibetan bear, *Ursus thibetanus*, a century ago.

The walrus (family Trichechidæ) harbors a strange Anopluran parasite of species, genus and family peculiar to its host, as, indeed, might be expected of any ectoparasite daring enough to brave comrade life with walruses. Examples of the parasite have been taken from walruses from Spitzbergen, Frobisher Bay (Davis Straits), the Hamburg Zoological Garden, and I have recently had them from a "Pacific walrus" from "south-east of Siberia."

The family Phocidæ is represented in the host-list by at least five species of seals and sea-lions carrying an equal number of Anopluran species representing three different genera, all of them peculiar to the seals. A single parasite species, *Echinopthirius phocæ* has been repeatedly taken from the fur seal, *Proca vitulina*, from both Old World and New World shores. The harp seal of the Arctic is credited with the same parasite, as well as another. Hooker's seal of New Zealand and the Auckland Islands carries an Anopluran, *Antarctopthirius macrochir*, of species and genus peculiar to it, while the elephant seal of the south Pacific has another parasite also of genus and species peculiar to it.

The large order Rodentia is well represented in the

host-list, representatives of thirteen families, summing about sixty species, being listed. Both Mallophaga and Anoplura infest the rodents, but certain families are parasitized almost or quite exclusively by Anoplura, while Mallophaga are the only parasites of others.

The Sciuridæ (squirrels and spermophiles), for example, with a dozen host species, are parasitized by a dozen species of Anoplura with only a single Mallophagan record; and a single record under such circumstances is always suspect. There is little commonness of parasite species to two or more host species in this family. Osborn's *Polyplax montana* is recorded from the eastern and western North American gray squirrels, and his *P. suturalis* has been taken from two Spermophile species, both, however, of the same general range. The well-differentiated parasite genus *Acanthopinus* is represented by one species from the common Old World squirrel, *Sciurus vulgaris*, and another from the eastern gray squirrel of North America. These species, though close together, really seem to be different. In addition I have just found the *Acanthopinus* species of the eastern gray squirrel on Douglas's squirrel in California, and another (new) species on a California chipmunk. The only Mallophagan species recorded from a Sciurid is *Gyropus turbinatus* from the marmot, *Arctomys marmotta*, of the mountains of southern Europe.

From the beaver (family Castoridæ) a characteristic Mallophagan species, *Trichodectes castoris*, has been taken in America. The beaver, it may be noted, is the host of the only beetle (*Platypsylla castoris*) that has become a specialized permanent ectoparasite, passing its whole life on the body of its host.

The Old World dormouse (family Gliridæ or Myoxidæ) harbors a sucking louse, *Polyplax pleurophæa*.

The large family Muridæ, including the rats, mice, voles and lemmings, is represented by twenty host species well scattered over the world. There are twenty-two Anopluran species and two Mallophagan species in the parasite list for the group. Both of these Mallophagan

records are my own. One is a new species of Colpocephalum (exclusively a bird-infesting genus) from a "spotted rat," Uganda, Africa, sent me by Sjoestedt in a collection made by the Swedish Zoological Expedition to Kilimandjaro-Meru, Africa, in 1905-1906. It is undoubtedly a straggler from some bird taken at the same time. The other is a poor specimen of Trichodectes from *Mus rattus*, Canal Zone, Panama, sent me by Dr. Jennings. It may be a good record—or it may be a deceiving one. Both record and specimen need further scrutiny. It is, perhaps, important to note that two specimens of a wingless Psocid (Atropidæ) were sent with the lot labeled "parasites from *Mus rattus*." It would be very interesting if we could know that these Atropids were really living on the rats, feeding on their hair or dermal scales. I have found Atropids in rats' nests and birds' nests living undoubtedly on the loose hairs, feathers and dermal exuvia. It is my belief, based primarily on certain striking facts of morphology, that the Mallophaga are degenerate descendants of the Rsocidæ.³ Of the murid Anoplura, two or three are common to several hosts, as the well-known *Polyplax spinulosa*, recorded from all over the world from the now cosmopolitan *Mus rattus* and *Mus decumanus*, as well as from *Mus sylvaticus* of Europe and north Asia, and *Mus alexandrinus* of south Europe and Asia Minor (perhaps only a variety of *Mus rattus*), and *Polyplax affinis* (perhaps only a variety of *P. spinulosa*) recorded from *Mus agrarius* of eastern Europe, and *Mus sylvaticus* of Europe and north Asia. *Polyplax (Hoplopleura) acanthopus*, the common sucking louse of the mouse has been taken from the now cosmopolitan *Mus musculus*, and also from *Lemmus torquatus*, the lemming of Arctic Europe, Asia and America, *Microtus agrestis*, the field vole of Europe, *Microtus arvalis*, another common vole of Europe and Asia, and *Microtus* sp. from Iowa, U. S. A. The water rat, *Hydromys chrysogaster*, of Australia, has a *Polyplax* species of its own as has also *Otomys bisulcatus* of south and central

³ See *Psyche*, Vol. 9, 339, pp. 1902.

Africa, *Hesperomys leucopus* of North America, *Epimys aurifer* of the Malay Peninsula, *Gerbellus indicus* of northern India and Afghanistan, and *Holochilus sciureus* of Brazil and Peru. The common Old World mouse, *Mus minutus*, harbors three Anopluran species, while *Mus musculus* has but two. The Old World water vole, *Microtus terrestris*, has a parasite differing from the two infesting respectively the two Old World land species of *Microtus*.

In connection with this résumé of the Murid parasites, I may say that I have now in process of working over some two hundred vials of material collected last summer from California mammals, which is going to add many records to the Murid list of both hosts and parasites. It will also add numerous records for the squirrels and spermophiles (Sciuridæ).

The family Geomyidæ, gophers, is represented in the host list by three North American and one Central American species. The Mallophagan species *Trichodectes geomydis* occurs on all of these hosts. The North American hosts are *Geomys bursarius* (Iowa), *Thomomys bottæ* (California), *Thomomys bulbivorous* (California), and the one Central American host is *Macrotomys heterodus* (Costa Rica). *T. bulbivorous* may be a synonym of *T. bottæ*. In addition, *Geomys bursarius* has yielded an Anopluran species of genus and species peculiar to it.

The pocket rats, family Heteromyidæ, are represented by a species of *Perognathus* (Baja California), and *Dipodomys merriami* (Arizona). From both are recorded the same Mallophagan species, *Trichodectes californicus*.

The jerboa, *Dipus* sp., is the sole representative of the family Dipodidæ. From it is recorded an Anopluran species taken in Tunis.

The Octodontidæ are represented by three species parasitized by one Anopluran and three different Mallophaga. The three hosts are of three different genera, one with an African range, the other two of South America. The parasite species on each is peculiar to it. A third

record, crediting the characteristic *Trichodectes pilosus* of the horse to a coypou of South America (in the menagerie of the Jardin des Plantes in Paris), is certainly either a false record or one of rather extraordinary straggling. The two Mallophagan species from these South American tuco-tucos belong to the genus *Gyropus*, which is the Mallophagan genus especially characteristic of the related South American families, the Caviidæ (guinea-pigs), the Dasyproctidæ (agoutis), and the Chinchillidæ (chinchillas and vizcachas) (see following paragraphs).

The guinea-pigs and mocos (family Caviidæ) are represented by three species, and are strongly parasitized by Mallophaga. They have no Anoplura. The domesticated form, which is variously held to be a species distinct from any wild one now known, or a variety of the wild species, *Cavia cutleri*, harbors two well-known species of Gyropus, namely *G. ovalis* and *G. gracilis* (this latter is held by some students to be of distinct genus). In addition, Piaget has described a species of Menopon (bird-infesting genus) from it, and Paine and I have described another Menopon from it from collections we have had from Peru and Panama. We have also found this latter species on the wild guinea-pig, *Cavia cutleri*, from Peru, and from this host Paine has described a species of Gyropus peculiar to this host. From the Brazilian moco, *Kerodon moco*, has been recorded a variety of *Gyropus gracilis*, one of the familiar species of the domestic guinea-pig, as well as another species of Gyropus peculiar to the moco. Recently Cummings has described a new Mallophagan taken at Villa Rica, Paraguay, from the wild guinea-pig, *Cavia aperea*. For this new species he established a new genus called Trimenopon. As a matter of fact the species is so much like Kellogg and Paine's *Menopon jenningsi*, except for its markedly larger size, that I am not at all sure it should be added as a fourth guinea-pig parasite.

A single agouti, *Dasyprocta aguti*, from Brazil, represents the family Dasyproctidæ. From it have been described two species of Gyropus peculiar to it.

The chinchillas and vizcachas (family Chinchillidæ, or Lagostomidæ) are represented in the host list by two species, to which I can add another (perhaps two others) on the basis of material recently received from Dr. C. H. T. Townsend, of Peru. From *Lagidium peruanum* Gay long ago described a peculiar Gyropus, and I have specimens of a Gyropus which may or may not be different from Gay's species. His description is very meager. In addition I am about to describe, under the name *Philandria townsendi*, another species, representing also a new genus, specimens of which have been sent me by Dr. Townsend from the same host. Also in this Townsend sending are specimens of a small Polyplax species (Anopluran) from the same host.

The Cercolabidæ or Coendidæ, American porcupines, are represented in the host lists by five species, three of Central and South America and two of North America. They harbor no Anoplura, but are parasitized by two Mallophagan species, of which one, *Trichodectes setosus*, occurs on all the host species in the list. The second Mallophagan is a *Trichodectes* recently described by Stobbe from *Cercolabes nova-hispaniæ* of Mexico and Central America. The other South American host porcupines are *Coendu* (*Cercolabes*) *prehensilis* (northern South America) and *C. villosus* (Brazil). The North American hosts are *Erethizon epixanthum* (California) and *E. dorsatum* (Nebraska).

Finally the family Leporidæ, hares and rabbits, appears in the host list with six (perhaps only five) representatives, of which four, namely, *Lepus timidus*, of circumpolar arctic regions, *Lepus cuniculus*, native to Europe and north Africa but introduced over the whole world, *Lepus europæus* of Europe and *Lepus campestris* of western Canada and United States, harbor the same species of sucking louse, representing a genus peculiar to hares and rabbits. I must note that this species, *Hæmatopinus ventricosus* Denny, is commonly referred to as two species, of which one, *H. ventricosus*, is recorded from the American host species and *L. cuniculus*, while

the other, called *H. lyriocephalus*, is recorded from *L. timidus* and *L. europæus*. But Neumann, an exceptionally experienced student of the Anoplura, holds that the two species are one. A deer-infesting Mallophagan, *Trichodectes tibialis*, certainly a straggler, has been recorded from *Lepus europæus*, and another *Trichodectes* (a very old and uncertain record) from *Lepus cannabinus*.

The order Insectivora is represented by but two species, the mole, *Scalops argentatus*, of North America, and the shrew, *Sorex araneus* of Europe and Asia. Each harbors an Anopluran species, that of the mole being a curiously modified form and of species and genus peculiar to its host, while that of the shrew is of a species not found on other hosts.

The order Prosimiæ, the lemurs, presents a single record, that of a species of Mallophagan, *Trichodectes mjobergi* Stobbe, described from the North Bornean *Nycticebus borneanus* (family Nycticebidæ).

The order Primates is represented in the host list by four families, the Cebidæ of the New World, the Cercopithecidæ, the single family of apes, Simiidæ, of the Old World, and the family of man, Hominidæ. The distribution of the ectoparasites of these groups is of unusual interest to the special student and will likely prove equally so to more general students.

The Cebidæ, platyrrhine, tailed, New World monkeys, are represented by two species, the spider monkey and one of the howling monkeys of Brazil, members of different genera, each with a *Trichodectes* species peculiar to it. In addition three species of *Ateles*, one of Mexico and Central America, another of Guiana and Brazil, and the third an undetermined species of the genus represented by a specimen in a traveling menagerie in Europe, have yielded three species of the Anopluran genus *Pediculus*, otherwise characteristic of man and the anthropoid apes. These three *Pediculus* species have been recorded and described by three different students of the group, all careful workers, and there can be no doubt of the generic reference. But it is to be noted that the specimens of all three

parasite species were obtained either from host skins in a museum (in one case the Zoological Museum of Hamburg, in another, the Berlin Museum) or from a live host in a menagerie. In no case, therefore, is the possibility of a straggling record wholly excluded, but the coincidence of three discoveries makes the records practically safe. Finally, in this connection it is to be noted (as I have already pointed out in a brief paper¹), that, although *Ateles* is a tailed New World genus and presumably widely separated genetically from the anthropoids, Friedenthal has affirmed, on a basis of blood and hair comparison, that *Ateles* shows unmistakable differences from other tailed monkeys, and resemblances with the anthropoids, and he suggests that in *Ateles* we should see monkeys, which, in a certain sense, replace, in the New World, the anthropoids of the Old. It is, in any event, a strange thing that *Ateles* differs from the other Cebidæ and from the Cercopithecidæ as well, in not harboring the Anopluran genus *Pedecinus* to which all monkey-infesting Anoplura, except those of the simians, belong, but in actually harboring parasite species of the genus found elsewhere only on the simians and man.

The family Cercopithecidæ, catarrhine, Old World monkeys, is represented in the host list by a dozen species, from which one Mallophagan species, viz., my *Trichodectes colobi* from a guereza monkey, *Colobus guereza* var. *caudatus* (East Africa), and ten Anopluran species have been recorded. Of the Anoplura nine species belong to the genus *Pedecinus*, long recognized as the characteristic genus of the lower monkeys, as contrasted with the genus *Pediculus* characteristic of the anthropoid apes and man. For the tenth species, Fahrenholz establishes the new genus *Pthirpedecinus*, just as for one of the man-infesting species the separate genus *Phthirus* had to be established. There are several cases of the commonness of a single *Pedecinus* species to two or three hosts. *P. breviceps* Piaget is recorded from *Macacus silenus* of

¹ "Ectoparasites of the Monkeys, Apes and Man," *Science*, N. S., Vol. 38, pp. 601-602, 1913.

India, *Cercopithecus mona* of west Africa, and a third *Cercopithecus* skin in the Zoological Museum at Hamburg. *P. longiceps* Piaget is recorded from *Macacus cyclopis* of Formosa, *Semnopithecus maurus* var. *cris-tatus* of Borneo, and *Macacus cynomolgus* of the Malay-sian region. *P. eurygaster* Gervais has been recorded from *Macacus sinicus* of India and on a macaque in the Zoological Garden at Sydney, and another in the Zoolog-ical Garden at Melbourne. A hamadryad (*Paphio* sp.) of north Africa has a *Pedecinus* species peculiar to it, as has a *trachypithecus*, of Malaysia, and the Barbary ape, *Macacus inuus*, of northern Africa and Gibraltar. The common *Macacus rhesus* carries one species of *Pedecinus* peculiar to it, and that single species of *Phthirpedecinus* already referred to. *Macacus silenus* also has recorded from it two species both belonging to *Pedecinus*.

The family Simiidae, anthropoid apes, is represented in the host list by three species, namely, the chimpanzee and two gibbons. One of these gibbons is *Hylobates syndactylus* of Sumatra; the other is *H. leuciscus* of Borneo. A single species of *Pediculus* is common to them both, and is not elsewhere recorded. The chimpanzee has also a single species of *Pediculus* which is pecul-iar to it. No *Pedecinus* has been taken from a Simian.

Finally man, representing the fourth Primate family, Hominidae, is the host of three notorious Anopluran species, two of which are species of *Pediculus* and the third the only species so far known of another genus, *Pthirus*. Neumann is inclined to see in *Pediculus corporis* only a variety of *Pediculus capitis*. All of these parasites are found on man in all parts of the world. Some curious variations among the parasite individuals are shown, perhaps the most curious being a plain tendency to a darker coloration of the individuals occurring on the bodies of men of the dark-skinned races. In my brief dis-cussion elsewhere, already referred to, I have noted the interesting significance of this possession by man and the anthropoid apes of a common genus of Anopluran para-sites, while the parasites of the lower monkeys belong to

a well-distinguished other genus. There is no doubt that the close physiological fitting of parasites to host makes their host distribution significant of genetic or "blood" relationship, and this commonness of one type of parasite to man and the apes, and its limitation to these hosts, and replacement on the lower monkeys by another parasitic type, is an added indication of the actual blood-likeness of the Simians and man, a likeness apparently greater than that between the Simians and the lower monkeys.

III

In the light of the plain statement in part I of this paper of my belief gained from a study of the distribu-tion of the bird-infesting Mallophaga, to the effect that the host distribution of the permanent wingless ecto-parasites of birds is determined more by the genetic rela-tionships of these hosts than by geographic relationships or any ecological condition, and the corollary of this, which is that the distribution of the parasites may there-fore often have a valuable significance as to the genetic relationships of animals whose genealogic affinities are in process of ascertainment, and in the light of the facts of distribution for the mammal-infesting Mallophaga and Anoplura as just set out in part II of this paper, I hardly need to do more, in conclusion, than to point out that the distribution conditions exhibited by the mammal parasites, even in the face of the meager knowledge that we yet have of the mammal-infesting forms, clearly, on the whole, confirm this thesis. In fact, considering how few mammal-infesting parasite species we yet know, it is surprising how repeatedly the commonness of parasite species to two or more related, although geographically well separated, host species, is illustrated. All through the order from Marsupials to Quadrumana this condition is again and again exemplified. I am then, naturally, made more certain of the essential truth of the thesis, and can the more strongly recommend the attention of sys-tematic zoologists to that practical application of it, which I have stated in the form of a corollary.