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SOME PECULIAR RELATIONSHIPS BETWEEN ECTOPARASITES AND THEIR HOSTS[1]

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A STUDY of the relationships of parasites to their hosts may be fruitful in a number of important ways. And in particular such a study is of value in judging relationships of the hosts themselves, their geographical distribution, their palaeogeography, and the phylogeny of both hosts and parasites. The reason why a study of the phylogeny of a parasitic group may throw much light upon the phylogeny of the hosts of the group is because parasites (especially fixed parasites) usually evolve with their hosts. Where they do, this type of evolution is termed "paralleled" phylogeny. But parasites do not always remain exclusively with the hosts of a single species, they may spread to other hosts which offer in or upon their bodies a similar "ecological habitat." Because of this ability of parasites occasionally to spread to new hosts their study is of great importance to that of geographical distribution and palaeogeography.

The object of this contribution is not to discuss the details, the scope, or the general results of the host-parasite method of study but to present certain new facts and to summarize and interpret certain old ones that have come to the writer's attention during recent years while studying ectoparasites. It is hoped that this contribution may have its justification in calling to the attention of biologists the opportunities for utilizing the host-parasite method of study, and in stimulating a desire for further cooperation on the part of students of the hosts and those who study their parasites.

HOST PREFERENCES

The sucking lice, or Anoplura, appear to have a high degree of host specificity. Yet recent experiments indi-

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cate that when impelled by hunger and the desire for warmth they will accept as host the mammal available.

In testing this point lice, *Pediculus* (*Parapediculus*) *atelophilus* Ewing, of the gray spider monkey, *Ateles geoffroyi,* were taken from their live host at the National Zoological Park, and offered a feeding upon the writer's arm. Far from being repelled by such a foreign host, they readily took to him, and two adult females fed to repletion. This they did in exactly the same manner as does the body louse of man, *Pediculus humanus corporis* Degeer. Following their engorgement they were kept in what appeared to be almost ideal conditions in a breeding cell next to the body, yet they both died in a few hours.

In another experiment lice, *Pedicinus* sp., from a sick baboonlike monkey, *Magus* sp., were transferred to the arm. These also readily took to the human host, and several began pricking the skin. Two of them, an adult female and a nymph, engorged to repletion. When these two were subsequently kept under what appeared to be good living conditions both died in a few hours.

Monkeys and man are primates belonging to the same order of mammals, and having, as is well known, blood and other physiological characteristics of a somewhat similar nature, yet when sucking lice are taken from hosts of other orders and placed on man, results similar to those just described may follow. Thus specimens of the sucking louse of the dog, *Linognathus piliferus* (Burmeister), taken from their canine host were placed on man, and out of 13 individuals used in two trials 3 fed within a short time. One of these, an adult female, fed for 45 minutes and then was removed to a breeding cell. She soon died, the blood appearing to be only partly digested.

These observations on the experimental transfer of sucking lice from their normal to a foreign host are not only of interest as appearing to indicate a lack of acuteness of the senses of smell and taste in these ectoparasites, but they are of significance in showing that sucking lice will accept foreign hosts. In nature they probably

at times make transfers upon contact of foreign with favored host species.

This tendency to accept foreign hosts may explain the presence in America on spider monkeys, species of *Ateles,* of lice that are so similar to the pediculid lice of man that for many years authorities believed that they were identical. All these monkey lice differ in a few minor characters from those found on man. Yet, knowing the tremendous gap in the natural affinities between man and spider monkeys, who would insist that the presence of these pediculid lice on the latter indicates a paralleled phylogeny of hosts and parasites? The only logical conclusion, from the phylogenetic standpoint, is that the spider monkeys obtained their lice for the first time following the arrival in tropical America of the American Indian. That the Indians were hosts of a *Pediculus* is shown by the presence of these lice on prehistoric Indian mummies.

Interpreting Host Phylogeny from a Study of the Relationships of Their Parasites

Professor V. L. Kellogg and the late Professor L. Harrison have been ardent students of the phylogeny of the biting lice and each has pointed out how the evidence obtained from a study of the relationships of the lice may affect, pro and con, the interpretations of the phylogeny of the hosts. Harrison (*2*), in addressing the Linnean Society of New South Wales, in 1928, said:

> The ostriches of Africa and the rheas or nandus of South America are commonly supposed by ornithologists to have arisen from quite distinct stocks. But their lice are so similar, and so different from all other bird-lice, that these must have evolved from a common ancestor, and so also must the birds themselves. Evidence derived from lice is confirmed by cestode and nematode parasites of the two groups of birds. Thus a phylogenetic relationship may be established by means of parasites. Equally, a supposed relationship may be refuted. Their lice prove that the penguins are in no way related to any northern group of aquatic birds, but belong in an ancient complex which includes the tinamous, fowls and pigeons; that the kiwis of New Zealand are modified rails, and not struthious birds at all; that the tropic-birds are not steganopodes but terns, and so on.

Without wishing to endorse all these conclusions of Harrison the writer would like to add that the ostriches of Africa and the rheas of South America have the same mite parasite, *Eupterolichus bicaudatus* (Gervais), and that this mite is not known from any other birds.

THE LICE OF COWBIRDS

The differences between related species of biting lice, or Mallophaga, are believed to have arisen largely because of isolation on certain very similar hosts. Such isolation prevents interbreeding of varieties of species or other closely related forms, and allows them to accumulate minute inheritable increments in any direction.

But what are the factors that support this isolation of species and under what conditions are they rendered inoperative? Kellogg (*4*), as long ago as 1896, emphasized particularly the fact that in the case of non-gregarious wild birds few contacts are made even between individuals of the same host species and are seldom made between individuals of different species. Among individuals of a single species contact is brought about between adults chiefly during mating, and between parents and young during the nesting period, and between young individuals while in the same nest. To what degree this lack of contact operates to restrict a species might be tested by transferring specimens of a louse species from their natural host or hosts to those of other species. This has already been done in a very limited way, yet with the lice of certain birds it is hardly necessary, for in nature we find the experiment being constantly performed for us and under conditions even better than man can devise and on a scale his ambition would hardly lead him to attempt. In nature this experiment is performed by many birds of parasitic habits when they lay their eggs in the nests of other birds. Here the eggs hatch and the young alien finds himself squeezed in the nest amongst nestlings of a different species. He is reared under the optimum conditions for the transfer of para-

sites. Thus these birds, the cuckoos and the cowbirds and some others, are exposed at the very beginning of life to infestations of many diverse sorts.

But what are the results of this experiment of nature? Have the cowbirds, for example, acquired a diverse assortment of lice? In order to answer this question a special study has been made of the lice of the common cowbird, *Molothrus ater,* this host having the parasitic habit best developed of any of the cowbirds. Dr. Herbert Friedmann (*1, p. 189*) in speaking of this species in his book, "The Cowbirds," has stated that it lays its eggs in the nests of no less than 158 species of birds. These belong to 8 orders, 25 families and 103 genera. Many scores of skins of this cowbird were carefully searched by the writer for the presence of lice. Of this large number only 13 were found to possess any. Eight of these were infested with a species of *Philopterus* of the type already reported from icterid hosts, being in fact only slightly different, yet specifically distinct, from two species found on our blackbirds. Of the other five skins, two were infested with a species of *Degeeriella* of a type quite characteristic of icterids, being very similar, yet distinct, from our blackbird-infesting species and even more distinct from our species found on the meadowlark. One was infested with a species of *Myrsidea,* probably *M. bonariensis* Malcomson, found on a South American cowbird. A specimen of *Goniocotes,* evidently a straggler, was taken from another skin. The remaining skin had on it a specimen of *Degeeriella* and a nymph of *Myrsidea.*

Thus it is seen that our common cowbird is only moderately parasitized, and that its lice are those characteristic of the group of birds to which it belongs.[2] This is certainly a most remarkable condition considering the

[2] Kellogg (3, pp. 478–480, pl. liv, fig. 6) has described from our cowbird a species, (*Docophorus*) *Philopterus transpositus,* which apparently belongs to a group found only on parrots. I was unable to take this species from the skins examined. It must be one of rare occurrence on cowbirds.

fact that their young do not have the usual contacts with their parents during the nesting period, but with the young, as well as the adults, of many diverse species. This experiment of nature has given the entomologists and parasitologists a crucial test of the host-group specificity of certain types of biting lice. It does not follow, however, that all other groups have such a tenacious attachment for their original hosts.

THE KANGAROO-DOG LOUSE

It has been stated that parasites may occasionally leave their natural hosts and transfer to others of a quite different sort, provided that in so doing they find a similar "ecological environment." An outstanding example of this kind is found in the kangaroo-dog louse, *Heterodoxus longitarsus* (Piaget). This louse not only is a native of Australia and an original parasite of the kangaroo, but all of the members of its subfamily, the Boopinae, belong exclusively to Australian marsupials. Following the introduction of kangaroos into this country for zoological gardens and circuses this louse has spread to dogs and is now found on these domestic hosts in many parts of the warmer regions of the world. And where it occurs on dogs, frequently it is much more abundant than the original biting louse of the dog, *Trichodectes canis* Degeer.

The possession, in this instance, by the dog and the kangaroo of an identical species indicates the contact of these two diverse types of hosts. But in the case of both host species the "distribution" which brought about the contact was effected through the agencies of man. Had it happened in ancient geological times it would have implied an overlapping in the natural range of the dog and of the kangaroo, an implication which would mean the lack at that time of any natural barrier. Thus the absence of any large body of water, or of a mountain chain, or of an extensive desert, may have been indicated as the conditions should demand.

The Crab Lice

As an example of implied relationship between hosts of closely related parasites there is here cited for the first time the case of the crab louse, genus *Phthirus*. The crab louse of man, *Phthirus pubis* (Linnaeus), which infests the body of its host, favoring particularly the inguinal region, is a most unusual species in which the first five segments of the abdomen are ankylosed, and the abdominal segments are produced laterally into large tubercles. Because of these profound morphological changes it has been placed in a family (Phthiridae) by itself.

The writer a few years ago was most surprised to find a second species of crab louse, which infests the gorilla. This species, *Phthirus gorillae* Ewing, is known only from the egg and nymphal instar. Until adults are taken the full significance of its relationship to the crab louse of man remains in doubt. Yet it is most surprising to learn that these two congeneric species—one from man, the other from the gorilla—should constitute a family distinct and apart from all the other sucking lice. To the writer this is one more fact indicating not only the natural relationship of man to the gorilla but also the great antiquity of both man and the great apes. If the crab lice have evolved upon the great apes and man, as apparently they have done, then this evolutionary period must have been long enough to develop family characters in these louse species.

Our Common Chigger and Its Hosts

For years the writer has been conducting surveys in different sections of the eastern part of the United States so as to establish the host distribution of the common chigger, *Trombicula irritans* (Riley). This is the mite that in its larval stage is so very annoying to man in certain sections of the country during the hot summer months. As a result of this survey, which has included

the examination of many scores of species and hundreds of individuals of land vertebrates, it is believed that a fair picture of the host distribution of this mite has been obtained. Briefly summarized it is as follows:

The common chigger occurs in nature on certain vertebrate groups, in certain or all stages of the life history of the hosts. It parasitizes four of the five classes of vertebrates—Amphibia, Reptilia, Aves, and Mammalia. Yet the most remarkable thing about this distribution is not the occurrence of the parasite upon so many unrelated hosts but its absence from so many of the host species in all of these four classes.

Of the amphibians only young toads were found infested. Of the snakes only certain land species were infested, while all water snakes and all venomous snakes were without the mites. Of the turtles only one species, *Terrapene carolina,* the common box-turtle, was found infested, yet this one turtle host species proved to be a very important source of supply for the chiggers in nature. Of the birds several species were found to harbor chiggers, yet the vast majority of the mites were obtained from a few ground-frequenting land birds such as the Carolina wren and the towhee. Of the mammals the rabbit was found to be the only important host, and nearly all other wild species were without chiggers.

In many instances the absence of the chiggers on certain groups of hosts was easily explained because the habits of the hosts did not expose them to attack. Unattached chiggers occur only in ground litter where there is sufficient depth of the same to insure moisture in the bottom layers for most of the year. Chiggers are probably absent from most amphibians, from water snakes, water turtles, water birds, and other water species because these hosts do not frequent the particular places where the mite larvae are. Birds that feed in the air and build nests above the ground, as well as those that nest and feed exclusively in trees, would not come in contact with chiggers. On the other hand certain game

birds, such as the bob-white, that feed on the ground, nest on the ground, and roost on the ground, are found to be heavily parasitized with chiggers. Young toads are infested with chiggers, but the adults are not. The absence of the mites from the adult toads may be explained by the presence of repellent glands. Similarly the absence of chiggers from many, if not the most, of the mammals may be explained. Chiggers are easily repelled, as has been shown repeatedly, by any oil or other liquid with a moderate to strong odor. Persons who are largely immune to chigger attack frequently may owe this immunity to a body odor.

In casting about to find an analogous case to that of our common chigger in its host distribution a somewhat similar one has been found. It is that of our rabbit-bird tick, *Haemaphysalis leporis-palustris* Packard. This tick, which does not attack man or most of the other mammals, is very abundant on rabbits. Most birds are not attacked by it, but many birds that feed, nest or roost on the ground are parasitized. In addition to not being found on man, the rabbit-bird tick also differs in its host relationships from those of the chigger in not being reported on cold-blooded vertebrates. Thus, up to date the host distribution of our common chigger appears to be the most unusual in its "spotted" diversity of that of any ectoparasitic species yet studied.

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