

## THE SUCKING LICE OF AMERICAN MONKEYS

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## INTRODUCTION

Some years ago (1926) the writer published a revision of the American lice of the genus Pediculus which contained a synopsis of the species found on various American monkeys. Although the amount of material available from our monkeys at that time was small, yet it was sufficient to demonstrate that these lice were, in nearly all instances, distinct from those normally infesting man, and that more than one species was concerned. Up to that time much doubt had existed as to the specific distinctness of any of these lice found on American monkeys. Even no less an authority than G.H.F. Nuttall (1919, 1920) then Quick Professor of Biology at Cambridge University, England, asserted that such lice represented no more than a race of Pediculus humanus.

In recent years the writer has availed himself of every opportunity to acquire and study lice from American monkeys with the result that it is believed the National Museum collection of these forms can not be equaled elsewhere. The credit for bringing together such a collection should go largely to certain individuals who have either sent in material or notified the writer of its presence. Particularly is he under obligation to Dr. W. M. Mann, Director of the National Zoological Park, and to Gerrit S. Miller, Jr., Curator of the Division of Mammals, U.S. National Museum. Dr. Mann not only has helped the writer in various ways to obtain material but some years ago assigned to him a desk and laboratory space at the zoological park so that much work with lice could be done at the park grounds.

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Nuttall (1919, 1920) regarded all lice from American monkeys as

Pediculus humanus, yet when Ferris (1935) studied the Nuttall collection he came to a very different conclusion. Ferris (1935) regards them as different from P. humanus. However, like Professor Nuttall, to whom he dedicates his recent work, he decides that all of the true monkey-infesting forms are alike and places them in a single species. Unfortunately Professor Ferris did not examine the types of two of the four species, and does not go into the consideration of geographical races.

The confusion existing in regard to the identity and taxonomy of the sucking lice of American monkeys is the result of one or more of the following factors:

1. Inadequate technique in the preparation of material for study.
2. The utilization by nearly all workers of characters that do not really differentiate a species in this group.
3. The difficulty existing in getting preparations of the laterotergites so as to show them unstained, in lateral view and without distortion.
4. The omission of descriptions of the eggs, which possess valuable taxonomic characters.
5. The lack of knowledge as to the source of the louse material or the locality from which the host came.
6. The transfer of louse species to unnatural hosts in cages where monkeys of different species are mixed.
7. The large amount of temporary straggling on both live and dead hosts at zoological parks, institutions from which much of the material has come.
8. The lack of biological studies on the different forms, particularly in regard to the possible transfer to, and permanent infestation of, one host by lice from another, and in regard to possible hybridization between the different forms of lice.

The terminology employed in the present paper has been reviewed by R.E. Snodgrass of the Bureau of Entomology and Plant Quarantine. It is particularly important to note that for the first time the present writer (following Snodgrass) has introduced the term laterotergite to take the place of paratergal plate in the literature dealing with the Anoplura. The two terms are entirely equivalent.

#### THE TAXONOMIC VALUE OF EGG CHARACTERS IN THE GENUS Pediculus

The shape and size of the egg (Fig. 1) and of the cement cup which attaches the egg to a hair of the host have been used to a very limited degree in the differentiation of subgenera and species in the genus Pediculus (Ewing, 1933). The extent of individual variation of the egg itself, either in size or shape, is not great; however, the shape is modified considerably by the methods of treatment employed in mounting the

eggs on microscope slides. The importance of the shape of the cement cup as a specific character in Pediculus has been emphasized by Hinman (1931). Let us investigate its possibilities further.

In order properly to appraise the taxonomic value of the characters of the cement cup of the egg in Pediculus, it is very important to observe whether or not important changes occur in the shape of this cup when the eggs are attached to different types of hairs, and more particularly when eggs of one louse species are laid on hairs of different host species.

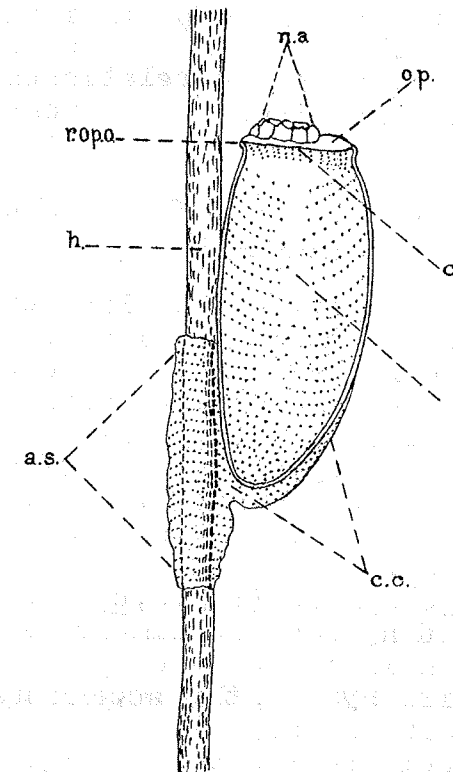


FIG. 1.--Egg of Pediculus humanus americanus, from scalp of Peruvian Indian mummy, x75; a.s., attachment sheath of cement cup; c., cellula; c.c., cement cup; e., egg; h., hair; n.a., nodular area; op., operculum; r.op.o., rim of operculum opening.

When an egg is attached to two or more hairs, or to the attachment sheath of another egg, or to the fabric of a garment, the attachment sheath of the cup is quite naturally abnormal. In the body louse of man the cement that would usually form a sheath about a hair may be so spread about when the egg is attached to the fabric of clothing that no real sheath is formed.

An examination of the eggs of P. atelophilus and of P. chapini on the hairs of an individual host shows that, in both species, variations in the

shape of the cement cup, particularly that of the attachment sheath, are independent of the size of the hair to which the eggs are attached. Eggs on hairs of the same size are found to have either long or short sheaths, but always within a certain range depending on the species of louse concerned. Further, the writer has observed that frequently almost the extreme range in the variation of length of the attachment sheath is to be found between adjacent eggs on a single hair! This fact alone indicates that most of the variation in the attachment sheath is independent of the size or shape of the hair to which it is attached. Thus it is possible to utilize the characters of the cement cup in identifying the eggs of a given species of Pediculus, regardless of the size or shape of the hairs to which they are attached. Also, the specific relationships of the cement cups usually can be determined, regardless of the host upon which the eggs are laid.

#### THE TAXONOMIC VALUE OF CERTAIN NYMPHAL CHARACTERS IN Pediculus

Only in one species of monkey-infesting lice of the genus Pediculus was the writer able to get a complete series of nymphs. This species was Pediculus atelophilus. The first nymph, or protonymph (Fig. 2, a), was reared from eggs obtained from an infested adult female spider monkey, Ateles geoffroyi, at the National Zoological Park. This monkey not only allowed the writer to pull out egg-bearing hairs from her furry coat, but appeared to enjoy the procedure immensely. She would press forward eagerly on the writer's approach to her cage and at once present herself for the hair-pulling process.

The last, or third, stage nymphs (Fig. 2, c) were identified without rearing, by finding mounted nymphal specimens with adult individuals in the process of formation inside of the nymphal skins. Having determined the first and third nymphs, the second nymphs (Fig. 2, b) were identified by comparison with these two.

The major differences between the three nymphal instars of Pediculus atelophilus (described farther on under the heading, "Description of Species") are the same as those between the nymphal instars of Pediculus humanus Linnaeus (Keilin and Nuttall, 1930). Like P. humanus the first nymph is pale and poorly sclerotized; the last three antennal segments are indistinctly separated; the abdomen is relatively much smaller in proportion to the rest of the body than in later stages; the laterotergites are absent, and the chaetotaxy of the abdomen is characteristic. The chief differences between the three nymphal instars are to be found in the chaetotaxy of the abdomen and structure of the laterotergites.

Only in the case of third nymphs has the writer been able to get a series of the same nymphal stage for different species of Pediculus. Third nymphs are at hand for the following species and varieties:

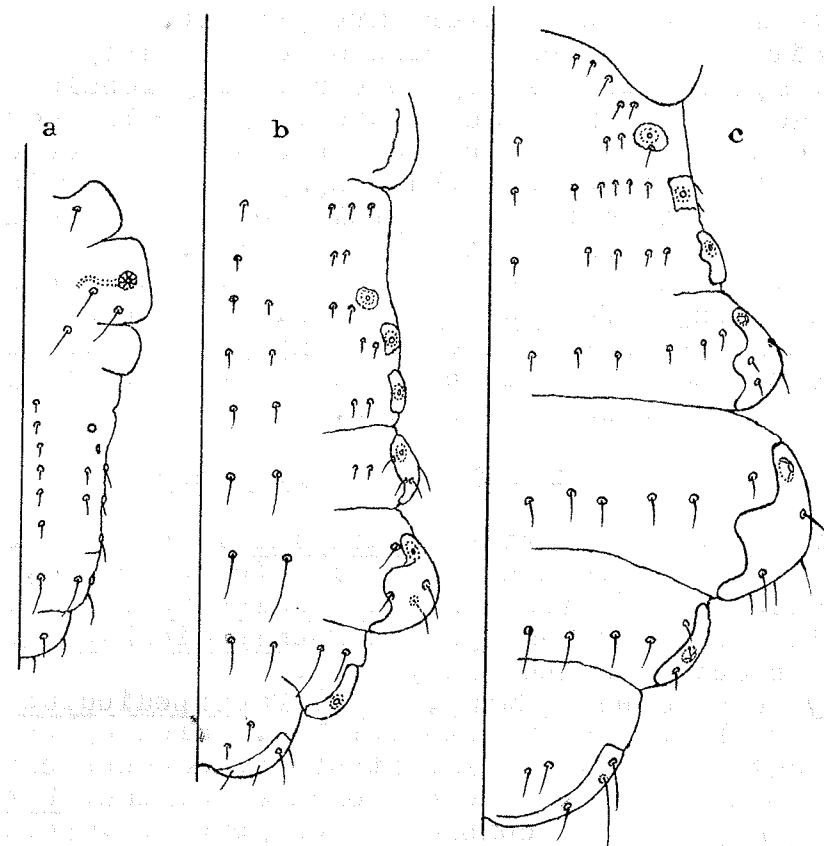


FIG. 2.--The three nymphs of Pediculus (Parapediculus) atelophilus Ewing; a, dorsal view of right half of body of first nymph; b, dorsal view of right half of abdomen of second nymph; c, dorsal view of right half of abdomen of third nymph. All drawings, x75.

Pediculus humanus capitus from man.

Pediculus humanus corporis from man.

Pediculus humanus americanus from pre-Columbian Indian mummies.

Pediculus pseudohumanus from two species of monkeys from the upper Amazon.

Pediculus atelophilus from a Guatemalan spider monkey.

Pediculus chapini from a South American spider monkey.

Pediculus lobatus from a Bolivian marmoset.

Pediculus simiae from a chimpanzee.

When the third nymph of each of these forms is compared with the adult of its own species the following basic differences are noted:

1. It is smaller.
2. The dorsal abdominal setae are fewer and are always arranged in a single transverse row on each segment.

3. The laterotergites are usually differently shaped and smaller.

4. No external sexual characters are present.

When the third nymph of one species or one variety is compared with that of another species or variety some striking results are obtained. In general if the adults of one species are very similar to the adults of another, the third nymphs will have about the same degree of similarity as these adults. But sometimes the third nymphs of two related species differ more from each other than the adults of these two species, and sometimes they are more similar than the adults.

The characters that have been used to distinguish one nymphal instar from another in a single Pediculus species, are the same ones that are most useful in differentiating the third nymphs of different Pediculus species. These characters have to do with the chaetotaxy of the abdomen and the structure of the laterotergites.

#### THE SUBGENERA OF Pediculus

The present writer has divided Pediculus into three subgenera: Pediculus, for the man-infesting varieties (or species), which are practically world-wide in distribution; Parapediculus (Ewing, 1926) for the New World species found on monkeys and Paenipediculus (Ewing, 1932) for the African species on the chimpanzee.

As already pointed out (Ewing, 1933) Paenipediculus differs sharply from Pediculus in the following stages: Egg, first nymph and adult. It is now apparent that equally important differences exist in the third nymphal stage. Such adult characters of the subgenus Paenipediculus as the following may well be considered of generic importance: anterior pair of legs distinctly longer than others; abdomen not distinctly demarcated from thorax and with sides subparallel anterior to segment VI; laterotergites I to III vestigial, ringlike; abdominal setae minute and arranged in transverse rows, there being typically a single row to an abdominal segment.

Further study may justify the raising of the subgenus Paenipediculus to the full status of a genus.

With Parapediculus conditions are different. The writer's study of Pediculus pseudohumanus indicates very strongly that this species so connects Parapediculus with Pediculus that there appears to be some justification for suppressing the former subgenus. Yet a study of the eggs and nymphal characters of all the species of the genus Pediculus indicates, in a way, a basic relationship of Parapediculus to the chimpanzee louse and Paenipediculus.

This relationship is indicated in the eggs of Parapediculus species which show a strong tendency to become constricted near the attachment end and for this constricted end to be curved toward the attached hair.

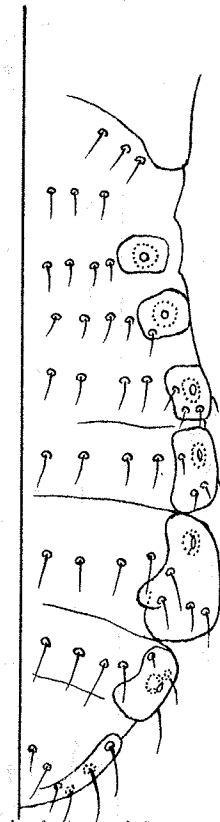


FIG.3--Dorsal view of right side of abdomen of third nymph of Pediculus (Parapediculus) pseudohumanus, new species, x75.

This tendency is particularly pronounced in the eggs of P.atelophilus (Fig.5,b). And the eggs of this species approach those of the chimpanzee louse, Pediculus simiae Ewing, in two other respects, the swollen condition of the egg near its middle and the reduction of the nodular area of the operculum.

A basic relationship of Parapediculus is further indicated in studying the third nymphs of all Pediculus species and varieties. In the third nymphs of the subgenus Pediculus the first three laterotergites are large and of about the same size as the fourth laterotergite; the fifth laterotergite is but slightly enlarged, slightly cupped, and usually is without lobes; the dorsal abdominal setae on the typical segments are almost subequal and are arranged in eight longitudinal rows and in transverse rows (one row to a segment). In the third nymph of Paenipediculus conditions are very different: The first three laterotergites are vestigial rings; the fifth laterotergite is greatly enlarged, extremely cupped and strongly lobed;

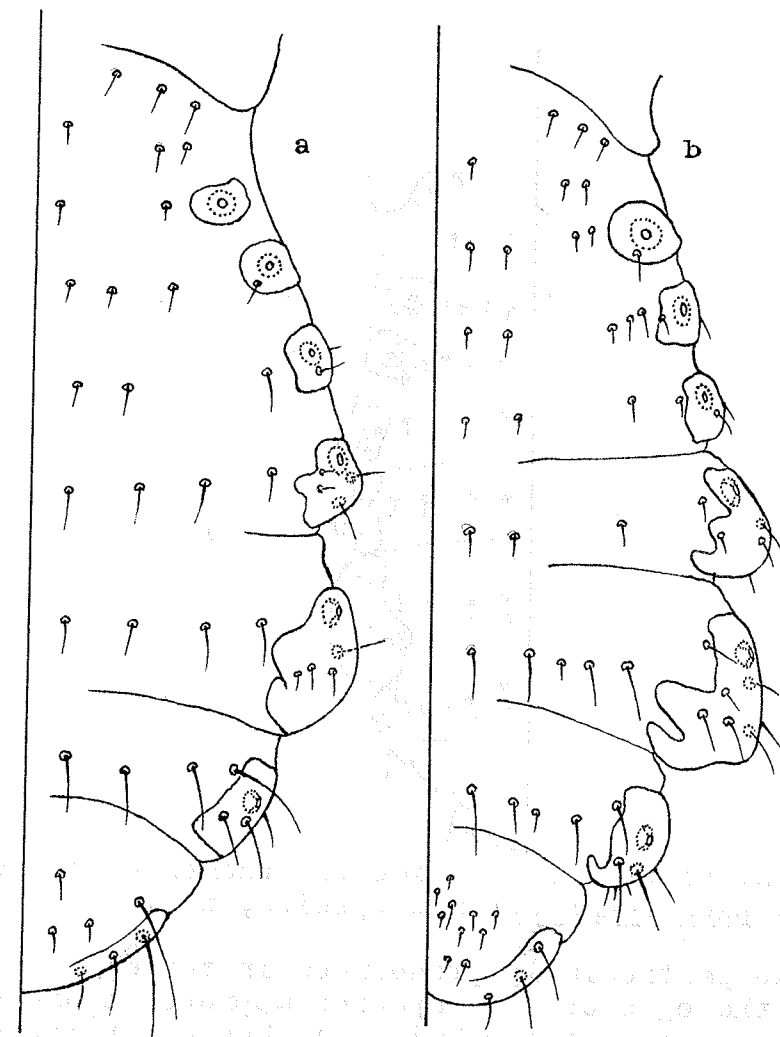


FIG. 4.--Dorsal views of right side of abdomen of third nymph of a, Pediculus (Parapediculus) chapini Ewing and b, Pediculus (Parapediculus) lobatus Fahrenholz. Both, X75.

the dorsal setae are absent from the first five abdominal segments, six and seven bear a single pair each, while the eighth segment has only six setae arranged in a transverse row.

When the third nymphs of Parapediculus species are compared with those of Pediculus and Paenipediculus in regard to the characters just given, it is noted that an intermediate condition exists in every species. The third nymph of pseudohumanus is very close to that of Pediculus humanus, while that of lobatus shows very strongly an approach to the



third nymph of Paenipediculus simiae in the reduction in size of the first three laterotergites, the increase in size and in degree of cupping of the lobes of the fifth laterotergite, and the reduction in size and number of the dorsal setae of the first six abdominal segments.

Finally it should be emphasized that while the egg and third nymph of Parapediculus lobatus very definitely approach those of Paenipediculus simiae in certain respects, there is a vast difference between the two species in the characters of the adults.

For the present it appears to the writer that Parapediculus should be retained as a subgenus, while there might be justification for the raising of Paenipediculus to the status of a genus.

#### THE STATUS OF Pediculus quadumanus (MURRAY) (1877)

Murray (1877) was the first to describe a Pediculus species from an American monkey, using the name Haematopinus quadumanus. Hence, if all the forms of this genus occurring on American monkeys are to be regarded as varieties of a single species, this species probably should take the name of Pediculus quadumanus (Murray). That Murray's quadumanus was a Pediculus is clear enough, but it may have been only one of the man-infesting varieties of Pediculus humanus occurring on a species of Ateles as a straggler. However, such cases of straggling on Ateles must be very rare. Out of a total of twenty-two different lots of specimens that the writer has taken from live or dead monkeys of the genus Ateles or from their skins he has found among them not one specimen of humanus.

#### THE Pediculus consobrinus OF PIAGET (1880)

Piaget (1880) questionably described as new, under the name of Pediculus consobrinus, a louse taken from a spider monkey, Ateles pentadactylus. He gave a good figure of this louse which indicates (but of course does not prove) that the specimen (or specimens) from which the figure was made was a true monkey louse. Ferris (1935), however, obtained a single female of Pediculus consobrinus (all that remained) from the old Piaget collection of lice, and has redescribed and figured it showing that this specimen evidently is only Pediculus humanus. It appears, therefore, since both Piaget and Ferris have given very good drawings that they must have figured specimens belonging to different species. In other words, Piaget apparently had specimens that belonged to two species, one being a true monkey-infesting louse and the other Pediculus humanus.

If the single remaining specimen from the old Piaget collection, which was described by Ferris, is to be regarded as the type of Piaget's species, Pediculus consobrinus becomes a synonym of Pediculus humanus.

Linnaeus. It is so regarded by Ferris. It is interesting to note in this connection that Piaget has figured the dorsal abdominal setae of his Pediculus consobrinus arranged correctly in transverse rows as they are in true monkey-infesting species, while Ferris (1935) does not represent them thus in his drawing of a monkey-infesting species, although these setae had been correctly figured by Hinman as late as 1931 for Pediculus atelophilus Ewing, an Ateles-infesting species.

#### THE Pediculus affinis OF MJÖBERG (1910)

Mjöberg (1910) described as Pediculus affinis a louse which was questionably taken from "Ateles ape" in a traveling menagerie. He considered it very close to Pediculus consobrinus Piaget but stated that it differed from Piaget's species especially in the length of the second antennal segment, the stronger lobing of the last abdominal segment, the shape of the genital plate and the gonopods. The writer has failed to find that these characters are of value in the differentiation of the species of Pediculus occurring on monkeys. Further, it is noted that Mjöberg's figure of the egg of P. affinis does not agree with any of the known forms occurring on species of Ateles. It does represent, however, very well the egg of Pediculus humanus. Also the drawing given of the last segment of the abdomen agrees very nicely with certain forms of Pediculus occurring on man. For these reasons P. affinis is regarded as only a variety of Pediculus humanus.

#### THE Pediculus mjobergi OF FERRIS (1916)

Ferris (1916) proposed a new name for Pediculus affinis Mjöberg, the name Pediculus affinis having been previously used by Burmeister for a louse now placed in the genus Polypax. Since Mjöberg's species is to be regarded as a variety of Pediculus humanus, as just shown, the Pediculus mjobergi of Ferris also takes the same status.

#### DESCRIPTION OF SPECIES

In presenting the descriptions of the different stages and the two sexes of the four species of Pediculus found on American monkeys the writer has attempted to confine his remarks strictly to those characters of value in taxonomic differentiation. In nearly all of the taxonomic literature dealing with the genus Pediculus there has been included an amazingly large amount of descriptive matter that can only confuse the taxonomists since it deals obviously with characters that have no taxonomic value. Some workers even up to the very present insist on befogging the whole problem by going into descriptive detail of characters that are plainly due to faulty technique, individual variation, hybridization or a state of repletion following feeding.

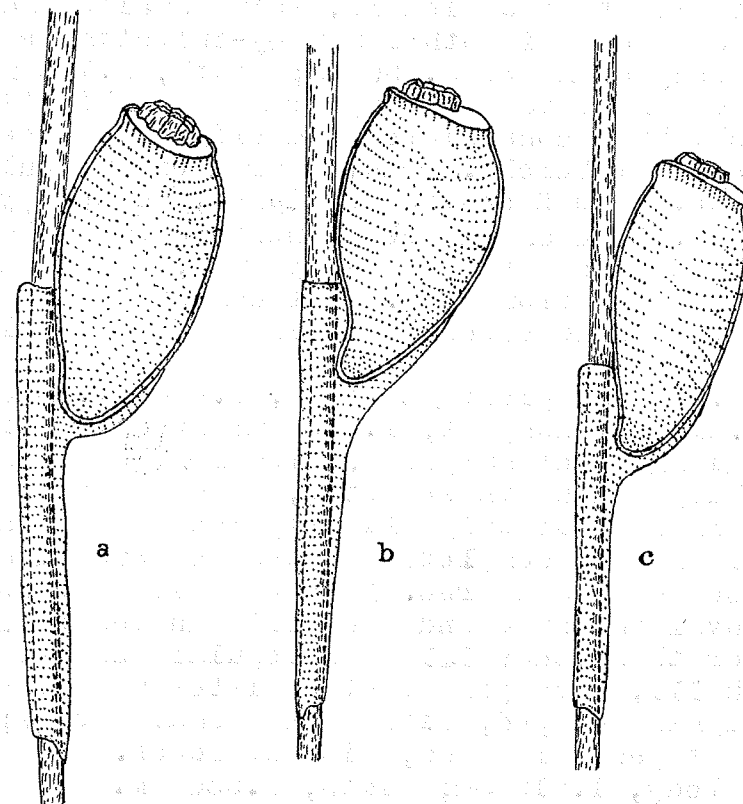


FIG. 5.--Eggs of three species of Pediculus (Parapediculus): a, of P. (P.) pseudohumanus, new species; b, of P. (P.) atelophilus Ewing; c, of P. (P.) chapini Ewing. All X 50

Pediculus (Parapediculus pseudohumanus n. sp.

(Fig. 3; Fig. 5, a; Fig. 6, a)

Female.-- Body setae slightly peglike. Dorsal setae of each typical abdominal segment arranged for the most part in three irregular transverse rows, the setae of the middle row being somewhat longer than those of the other two rows. Abdomen rarely greatly distended. Laterotergites long, well pigmented, and those of typical segments almost as long as laterotergal area. Laterotergites as follows: I subrectangular, broader than long, and occupying about one-half length of laterotergal area; II almost twice as long as I, but no broader; III much larger than II, nearly as long as laterotergal area and with small lateral lobes situated almost at posterolateral angles; IV similar to III but larger; V longest of all laterotergites, oval, without lobes, and with spiracle situated slightly in front of center; VI small, subrectangular, without lobes, about one-half as long as V, and occupying a little more than one-half length of laterotergal area. Setae on laterotergites rather numerous, there being about 20 on laterotergite V. Total length of body of female, 3.100 mm; width, 0.975 mm.

Male.--With the usual differences between male and female and in addition: Dorsal setae fewer and smaller in first and third transverse rows of typical abdominal segments, also differing from female in presence of small tergites and

sternites, each of which may be divided into two small transverse bars. Laterotergite I different from that of female, being smaller and very irregular in shape. Genital armature the same as in other monkey-infesting species of Pediculus.

Total length of body of male, 2.250 mm; width, 0.735 mm.

Egg.— Sides of egg next to and away from hair slightly and about equally rounded, base very slightly constricted and slightly turned toward hair, also frequently bearing a small tubercle. Modular area of operculum composed of 7 to 8 peripheral cellulae, 1 to 2 central cellulae, and occupying about two-thirds of diameter of operculum. Edge of egg shell next to opercular opening cupped inward. Wall of cement cup next to hair very thin, being much thinner than average thickness of wall away from hair. Attachment sheath thin-walled and with very long lower end, in some specimens this sheath greatly exceeds egg itself in length.

Length of egg, 0.905 mm; greatest width, 0.460 mm. Shortest attachment sheath measured, 1.110 mm; longest, 1.240 mm; average for 6, 1.165 mm.

Third Nymph.— Along front margin of abdomen, on each side, three subequal dorsal setae. Slightly behind these setae, on each side, three similar subequal setae. Dorsal abdominal setae only slightly increasing in size from second to eighth segment; arranged in complete transverse rows on segments III to VIII, there being eight setae in each row. Laterotergites as follows: I about equal to II, only slightly oval in shape and broader than long; II smaller than III, subrectangular, broader than long; III an irregular square with spiracle in middle; IV much larger than III, occupying most of laterotergal area; V largest of laterotergites, slightly cupped, with rather small lobes; VI about the same size as IV, much broadened at posterior end, without lobes.

Total length of body, 1.515 mm; width, 0.530 mm.

The mounted nymphs of this species at hand are not engorged, and are slightly shriveled by the mounting medium. The drawing was made from such an unengorged specimen.

Type host.— Pithecia monachus.

Type locality.— Type specimens taken from a saki monkey that died at the National Zoological Park, Washington, District of Columbia. Original home of type host is the Upper Amazon.

Type slides.— U.S.N.M. No. 51451.

Remarks.— Material examined as follows: Many males and females and a few third nymphs and eggs from type host (U.S.N.M. 255542), at Washington, District of Columbia, August 29, 1930, by H.E. Ewing; many males and females and several eggs from a monkey, Cacajao rubicundus, coming from the Upper Amazon, that died at the National Zoological Park, Washington, September 10, 1930, by H.E. Ewing; three males, four females and one nymph from an Indian woman, Coban, Guatemala.

The specimens upon which this description is made were questionably identified (Ewing, 1934) as Pediculus humanus americanus Ewing. Their identity and possible relationships to other forms of Pediculus were discussed in a subsequent paper (Ewing, 1936) where the existence of two forms of Pediculus humanus americanus was reported.

This new species is close to Pediculus humanus americanus Ewing in its adult state, but differs from the types of americanus in having laterotergites III and IV regularly lobed and in the great length of laterotergite V.



The eggs are very different from those of americanus. Most of them possess a low, tubercle-like expansion at the base. But it is in the form of the attachment sheath that the eggs of pseudohumanus depart the farthest from those of humanus. In the egg of humanus (Fig. 1) this sheath is shorter than the egg in length, while in pseudohumanus (Fig. 5, a) it is much longer. One of the monkeys from which P. (P.) pseudohumanus was taken was a specimen of Cacajao ruficundus. In order to find out if a species of Cacajao might be infested in nature, skins of two adult individuals of Cacajao melanocephalus killed in nature at Rio Matutaca, Brazil, in November, 1930 by E. G. Holt were examined. They showed no evidence of infestation. It should be remembered, however, that negative evidence of this kind based on such a small number of skins means but little. The percentage of individual monkeys of any species that are infested in nature must be very small.

In the adult specimens taken from an Indian woman, laterotergites III and IV are very definitely lobed as in the specimens taken from the

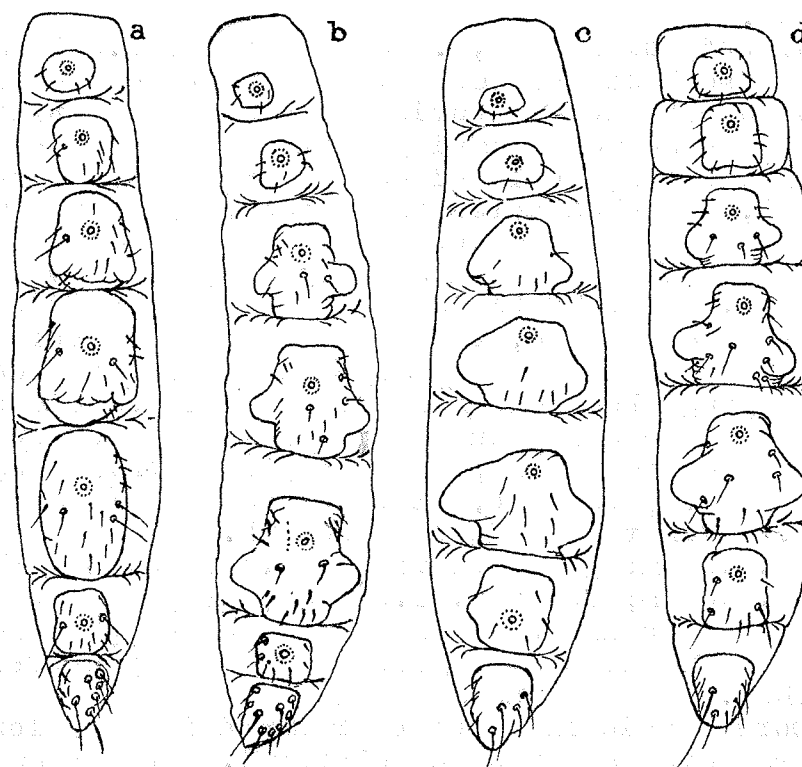


FIG. 6.--Lateral views of laterotergites on the right side of abdomen of a, Pediculus (Parapediculus) pseudohumanus, new species; b, P. (P.) atelophilus Ewing; c, P. (P.) chapini Ewing; d, P. (P.) lobatus Fahrenholz. All drawings  $\times 50$ .

monkeys, while laterotergite V shows a slight tendency toward lobe formation.

Pediculus (Parapediculus) atelophilus Ewing (1926)

(Fig. 2; Fig. 5, b; Fig. 6, b)

Female.—Abdomen capable of much distension. Dorsal setae of anterior and posterior transverse rows of a typical abdominal segment very short (easily overlooked), those of middle transverse row short but easily detected. Laterotergites as follows: I subrectangular, slightly broader than long; II similar in shape to I but slightly larger; III about twice as long and broad as II, with well-developed lobes the anterior margins of which do not merge into the anterior margin of laterotergite; IV very similar to III but slightly larger; V similar in shape to III and IV, the largest of all the laterotergites yet occupying only about the posterior three-fifths of the length of the laterotergal area; VI rectangular, in side view appearing as a square. Typical laterotergites each with several inconspicuous setae.

Total length of body of female, 2.985 mm; width, 1.325 mm.

Male.—With the usual differences between male and female and with special differences as follows: Abdomen provided with a few remnants of tergites and sternites, some of the segments having the tergite divided into an anterior and a posterior piece. Laterotergite I reduced to an irregular sclerotized ring and a very small, lateral, detached sclerotized piece; II about the same as in female; V with smaller lobes than in female.

Total length of body of male, 2.230 mm; width, 0.995 mm.

Egg.—Short, stout, considerably swollen on side away from hair, with conspicuous constriction near base, the constricted part being turned toward hair. Nodular area of operculum composed of 8 to 10 peripheral cellulae, 2 to 3 central cellulae, and occupying about one-half of diameter of operculum. Margin of egg shell next to opercular opening turned inward. Wall of cement cup next to hair much thickened toward middle; wall away from hair progressively increasing in thickness from top to base. Attachment sheath rather thick-walled except for lower portion, which varies much in length.

Length of egg, 0.915 mm; greatest width, 0.445 mm. Shortest attachment sheath measured, 0.810 mm; longest, 1.500 mm; average for 6, 1.094 mm.

The egg of this species has been previously described and well figured by Hinman, 1931. The description here given agrees very closely with characters given by this author.

First Nymph.—Dorsal abdominal setae arranged in four longitudinal rows; two rows being paramedian and two dorsolateral. Each paramedian row consisting of seven or eight setae, there being typically one seta in such a row for each abdominal segment. All paramedian setae very minute except the last, which is conspicuous, being about as long as last abdominal segment. Dorsolateral setae less numerous than paramedian; all minute except the last seta, which is about three-fourths as long as last paramedian seta. A lateral row of setae is present, consisting of a single seta to each paratergal area. These lateral setae are larger than the dorsal setae. Laterotergites absent. First two pairs of abdominal stigmata distinctly dorsal in position.

Length of newly hatched first nymph, 0.925 mm; width, 0.380 mm.

This nymph has already been described and figured by Hinman, 1931. Hinman notes its close resemblance to that of the first nymph of humanus and states that it is doubtful if the two species can be separated with any degree of certainty in this stage. The chief difference is to be found in the chaetotaxy of the abdomen. In the first nymph of humanus there is no striking difference in size between the dorsal abdominal setae of the first seven segments and those of the eighth segment, while in atelophilus the setae of the eighth segment are strikingly

Second Nymph.—In the second nymph the seventh abdominal segment becomes distinctly broader than the others and the laterotergites appear for the first time. Dorsal abdominal setae about twice as numerous as in first nymph and for the first time arranged in definite transverse rows, a single row being present on each abdominal segment. Dorsal setae also arranged more or less in eight longitudinal rows. Lateral setae more numerous than in first nymph and no longer arranged in a longitudinal row on each side of body. Laterotergites very unequal in size; I and II smaller than the others and slightly dorsal in position; III larger than II, quadrangular, without lobes; IV much larger, and more strongly sclerotized than III, also cupped and usually with minute lobes; V much the largest, thickest, most pigmented and most cupped of all the laterotergites and provided with conspicuous lobes; VI similar to IV in size, shape and sclerotization.

Length of second nymph, 1.515 mm; width, 0.675 mm.

Third Nymph.—The third nymph differs from the second in being larger, in having larger and somewhat differently shaped laterotergites and in the chaetotaxy of the abdomen. The dorsal abdominal setae have lost their arrangement in longitudinal rows and are now arranged only in transverse rows, one row to a segment. These rows are incomplete on segments I to VI inclusive, and the setae increase progressively in size from the first to last abdominal segment. Laterotergites I and II much smaller than the others, about equal in size, I being distinctly dorsal and II laterodorsal; III to V heavily sclerotized, strongly cupped and with conspicuous lobes; VI about the size of III but without lobes. No external sexual characters observed in third nymph.

Length of fully engorged third nymph, 1.520 mm; width, 0.905 mm.

Type host.—*Ateles geoffroyi*.

Type locality.—Holotype from skin of type host individual which was kept at the National Zoological Park, Washington, District of Columbia.

Type slide.—U.S.N.M. No. 28105.

Remarks.—Material examined as follows:

From *Ateles geoffroyi*: two eggs from skin (U.S.N.M. 12138) of individual taken in nature, Talamanca, Costa Rica, by W.M.Gabb; many eggs (about rump) from skin (U.S.N.M. 12150) taken in nature, same place, same collector; several eggs from skin (U.S.N.M. 12151) taken in nature, same place, same collector; three eggs from skin (U.S.N.M. 154223) of individual that died in National Zoological Park, May 7, 1909; several eggs from skin (U.S.N.M. 61209) of individual taken in Costa Rica; eggs and male (holotype) from skin (U.S.N.M. 155393) of individual that died at National Zoological Park, September 11, 1909; eggs and first nymphs from skin (U.S.N.M. 154223), without other data; two males and four females collected by E.H.Hinman from young female host brought to this country from the Coto Region, Northern Panama, by E.C.Faust, September, 1930; two males and three females, Ancon, Canal Zone, by L.H.Dunn (received in 1930); one male, nymphs and eggs, from a two-thirds-grown female at the National Zoological Park, October 7, 1933, by H.E.Ewing (female host was one of several individuals taken earlier in the year in the Coto Region of western Panama by C.R.Carpenter and kept in an out-of-doors cage); adults, nymphs and eggs, from a host individual with same data except that lice

were collected October 14; several eggs from live, one-half-grown, dark brown female, November 8 (other data as before); several eggs from two-thirds-grown female, November 28 (other data as before); reared first nymph, from egg taken on large, live, female host, October 31 (other data as before).

From Ateles panama: a single female not yet emerged from her nymphal skin, many nymphs and eggs from skin (U.S.N.M. 61284) from Guatemala. (These specimens were wrongly identified by the writer (Ewing, 1926) as P. (P.) lobatus Fahrenholz.)

From Ateles dariensis: two males, two females and two nymphs, Ancon, Canal Zone, L.H. Dunn (received in 1930).

From Ateles hybridus: a second nymph and eggs from adult female, National Zoological Park, February 15, 1934, by H.E. Ewing.

Among the specimens of the seventeen lots here regarded as P. (P.) atelophilus Ewing there is considerable variation. Some of this is possibly due to hybridization. The species is particularly characterized by the shape of the lobes of the laterotergites and by the fact that the typical laterotergites occupy only from one-half to three-fifths of the length of the laterotergal areas.

#### Pediculus (Parapediculus) chapini Ewing (1926)

(Fig. 4, a; Fig. 5, c; Fig. 6, c)

Female.—Body setae very small, most of them minute. Abdomen easily distended by imbibed blood. Laterotergites short, broad, not occupying very much of anterior part of laterotergal areas. Laterotergites as follows: I greatly reduced and varying in shape, considerably broader than long, occupying about one-third length of laterotergal area; II about twice as large as I and with anterior and posterior margins almost straight; III large, three-fourths as long as laterotergal area, with spiracle almost contiguous with anterior margin and with very large lateral lobes, the dorsal one being continuous along its anterior margin with anterior margin of laterotergite; IV very similar to III, but slightly larger; V largest of all laterotergites, but only occupying about three-fourths length of laterotergal area, frequently not so strongly lobed as IV; VI subrectangular, slightly longer than broad, slightly lobed dorsally, and with spiracle situated slightly behind middle of laterotergite. Setae on laterotergites small; largest number on any one laterotergite about ten.

Total length of body of female, 2.800 mm; width, 1.445 mm.

Male.—With the usual differences between male and female and in addition: Provided with a few tergites and sternites which are never large and may be divided so that some of them are represented by two small transverse bars. Laterotergites I and II different from those of female; I a crescent or circle of chitin, partly or completely surrounding first spiracle; II irregularly subrectangular, longer than broad, with spiracle almost contiguous with front margin.

Total length of body of male, 2.250 mm; width, 0.925 mm.

Egg.—Rather slender, side away from hair not swollen, base turned somewhat toward hair. Nodular area of operculum composed of 6 to 9 peripheral cellulae, 1 to 3 central cellulae, and occupying about one-half diameter of operculum. Margin of eggshell next to opercular opening turned inward. Wall of cement cup next to hair very thin at top but considerably thickened toward base;



wall away from hair progressively increasing in thickness from top to base. Attachment sheath with rather thick walls at top, but becoming very thin toward bottom.

Length of egg, 0.825 mm; greatest width, 0.340 mm. Shortest attachment sheath measured, 0.835 mm; longest, 1.470 mm; average for 7, 1.038 mm.

Third Nymph.—Three subequal dorsal setae on each side of abdomen along front margin, indicating fusion of first abdominal segment with second; behind these three setae, on either side, two or three smaller setae indicating presence of fused second abdominal segment. Dorsal abdominal setae increasing in size from second to eighth segment; arranged in incomplete transverse rows on segments I to V, but forming a complete row of eight setae on segments VI to VIII. Laterotergites: I smaller than others, variously shaped, usually more or less oval; II larger than I, subquadrangular, without lobes; III larger than II, sometimes slightly lobed; IV larger than III, cupped, with rather small, but distinct lobes, and occupying about posterior half of laterotergal area; V largest of all laterotergites, strongly cupped, strongly lobed, with spiracle near anterior margin, and occupying about posterior two-thirds of laterotergal area; VI subrectangular, about as large as V.

Total length of body, 1.95 mm; width 0.755 mm.

Type host.—*Ateles ater*.

Type locality.—Type specimens taken from host individual that died at the National Zoological Park, Washington, District of Columbia.

Type slide.—U.S.N.M. No. 28106.

Remarks.—Descriptions based on material as follows: Many males, females and some nymphs in lot material including types taken by E.A. Chapin from host individual, *Ateles ater*, which died at the National Zoological Park in 1921; several eggs from skin of *Ateles ater* (U.S.N.M. 200153) by H.E. Ewing; a few eggs from skin of young male of *Ateles ater*, received from Brazil, which died July 24, 1915.

Material considered as representing stragglers as follows: One male, one female, and one third nymph taken alive from living spider monkey, *Ateles geoffroyi*, at the National Zoological Park, October 23, 1928, by R.W. Wells, H.S. Peters, and H.E. Ewing; adult male, female and several nymphs from *Cebus capucinus imitator*, Ancon, Canal Zone, by L.H. Dunn.

Typical specimens of *Pediculus* (*Parapediculus*) *chapini* are easily distinguished from the other forms occurring on American monkeys by the shortness of the laterotergites, the extreme reduction in size of laterotergite I (particularly in the male), and the reduction in size and number of the abdominal setae. Unfortunately all specimens at hand of this species were taken from captive animals. Since three lots came from the South American spider monkey, *Ateles ater*, it is believed that this species constitutes a natural host for the louse.

*Pediculus* (*Parapediculus*) *lobatus* Fahrenholz (1916)

(Fig. 4, b; Fig. 6, d)

Female.—Abdomen may be much distended after feeding. Dorsal setae of anterior and posterior transverse rows of a typical abdominal segment greatly

reduced or absent, but those of middle transverse row present and of moderate length. Laterotergites as follows: I subrectangular, broader than long; II subrectangular, about as broad as I but longer, with spiracle situated in front of middle; III well lobed, considerably larger than II; IV similar to III but larger; V similar to IV, but the largest of all laterotergites; VI without lobes, similar to II except for being more cupped. Each laterotergite has several setae of varying lengths, those on IV and V being more conspicuous.

Total length of body of female, 2.55 mm; width, 1.200 mm.

Male.—Smaller than female and with usual sexual differences found in species of Pediculus, with special variations noted as follows: Abdomen provided with a few small tergites and sternites; tergites each typically divided, or almost divided, into two small transverse strips of pigmented chitin. Laterotergite I slightly smaller than in female, varying greatly in shape; II similar to that of female; V apparently less conspicuously lobed than in female.

Total length of body of male, 2.35 mm; width, 0.960 mm.

Egg.—The egg of P. lobatus is of the same type as that of P. atelophilus. I have failed to find a good character for separating the two.

Third nymph.—Subequal dorsal setae present on each side of abdomen along its front margin; behind these setae, on each side, three small setae. Dorsal abdominal setae increasing in size from second to seventh segment; arranged in incomplete transverse rows on segments I to VI, but forming a complete row of ten setae on segments VII and VIII. Laterotergites as follow: I subequal to II, irregularly rounded; II subrectangular; III slightly larger than II, with small lobes; IV much larger than III, conspicuously lobed, strongly cupped, occupying about four-fifths of laterotergal area; V much the largest of all the laterotergites, most strongly lobed, very strongly cupped, occupying about four-fifths of laterotergal area; VI about same size as IV, slightly lobed, strongly cupped, occupying about two-thirds of laterotergal area.

Total length of body, 1.80 mm; width, 0.870 mm.

Type host.—Ateles pan.

Type locality.—(?)

Remarks.—Material examined as follows: Many males, females, and eggs and some third nymphs from one (U.S.N.M.238254) of two infested red-faced spider monkeys, Ateles paniscus, which died in 1922, at the National Zoological Park, Washington, District of Columbia. These specimens were collected by the writer at the time of the death of the host. Dr. W.M. Mann obtained these monkeys from some Indians at Beni, Bolivia. The monkeys were pets of the Indians. Just how the Indians came into possession of them is not known, but since they were living within the natural range of the host species, it is highly probable that the monkeys did not come into their hands from exotic sources or through an animal dealer. The lice evidently could not have been stragglers from the Indians themselves.

Specimens regarded as stragglers, examined as follows: Adults, nymphs and eggs from one (U.S.N.M.238258) of two infested brown-hipped marmosets, Lentocellus nigricollis, which died at the National Zoological Park in 1922. These lice were taken by Dr. E.A. Chapin and the writer from the host, a male, that was collected by Dr. W.M. Mann, at Tumu Pasa, Bolivia. The two infested marmosets were brought back from South America in close proximity to the heavily infested red-faced

spider monkeys and evidently obtained their lice from the latter. I have found no evidence indicating that marmosets are infested in nature with any species of sucking lice. It is important to note that the infestation on these marmosets was not heavy.

There is some doubt in regard to the identification of this species with Fahrenholz's lobatus. It certainly exhibits strikingly the characters he mentions, yet comes from a different host.

The name Pediculus lobatus Fahrenholz was proposed in 1913, but the species was not described until 1916. The type host was given as Ateles rellerosus, which is now regarded as Schlegel's spider monkey, Ateles pan. In the writer's revision of the American lice of the genus Pediculus (1926) he referred to Pediculus lobatus a single female that had not yet emerged from her nymphal skin, together with some nymphs and eggs. In this he may have been mistaken.

The P. (P.) lobatus of Fahrenholz has very large laterotergites, the typical ones covering about the posterior three-fourths of the length of the laterotergal area; the lobes are well developed on III and IV but do not extend forward so as to become continuous with the anterior margin of the laterotergites. These characteristics identify Fahrenholz's species with the species which the writer considered as Pediculus consobrinus Piaget (Ewing, 1926). If Piaget's consobrinus is to be regarded as only humanus, as claimed by Ferris (1935), Fahrenholz's name Pediculus lobatus apparently should be applied to this Bolivian species. The louse very probably would live on any spider monkey, since it maintained itself for days on a marmoset.

#### THE POSSIBLE ORIGIN AND PHYLOGENETIC RELATIONSHIPS OF SUCKING LICE OF AMERICAN MONKEYS

The occurrence on American monkeys of lice very closely related to those found on man and the absence of such closely related lice on the apes and monkeys of the Old World presents an interesting problem in evolution. The writer (Ewing, 1924) advanced the suggestion that the pediculid lice of American monkeys were derived from American Indians, when the latter reached the tropical regions of the New World in their southward migrations. If this hypothesis had been the correct one, we should have expected further studies to show (1) new intergrading characters between the lice of man and the lice of American monkeys and (2) a variational change in the members of the genus correlated with geographical distribution.

Has further study produced such evidence? It certainly has. In regard to the first point, a study of the species described in this paper as new under the name of pseudohumanus shows that here we have what might rightly be considered a connecting link between the previously

known monkey-infesting species and those infesting man. Further, there is the evidence that this species parasitizes both monkeys and man. In regard to the second point, a comparison of the louse specimens in the large collection of the United States National Museum indicates that the development of the lobes on the laterotergites is directly correlated with the distribution of Pediculus species as far as Asia and America are concerned. In some of the man-infesting forms of eastern Asia there is a very slight lobing of the laterotergites; in the lice of prehistoric Indians this lobing is somewhat increased; on P. (P.) pseudohumanus the lobes, though very small, occur on all specimens; finally, in P. (P.) chapini, a Brazilian species on Ateles ater, the lobes (Fig. 6, c) reach their greatest development.

The writer (Ewing, 1924) also suggested that in the genus Pediculus we may have a generalized type that that is to an unusual degree free from the influences of its environment. If this hypothesis had been the correct one, we should have expected that further studies possibly would show that the group is (1) a very old one and (2) that it now occurs on widely diversified hosts. In regard to the first point, the antiquity of the genus, the studies here made give but little, if any, evidence. At first thought it appears that the presence of well-developed laterotergites on most of the abdominal segments, and of three transverse rows of dorsal setae on the typical abdominal segments in some of the forms of Pediculus, stamps the genus as an old and generalized one. Yet when the lice of the Old World monkeys are examined it is noted that the laterotergites are much reduced in size and number. And as for the presence of three transverse rows of dorsal setae to a typical abdominal segment is concerned, such a condition is not found in any of the other monkey-, or ape-infesting lice, or in the lice of lemurs. However, in the genus Hoplopleura and related genera, admittedly very old and generalized forms in many respects, there are three transverse rows of dorsal setae for each typical abdominal segment.

In regard to the second point, the possible occurrence of Pediculus on widely diversified hosts, the evidence accumulated so far has been negative. The present writer has examined many live and dead monkeys from the Old and New Worlds and the entire collection of ape, monkey and lemur skins of the United States National Museum without finding any records other than those mentioned in this paper. The presence of Pediculus on gibbons has been reported by Fahrenholz (1913, 1916, 1919), and their presence on apes other than the chimpanzee has been surmised. Yet the present writer has examined all of the gibbon skins in the United States National Museum and many from other sources without finding as much as a single nit of any sucking louse. He also has examined several live orangs and many skins of this ape with the



same negative results. The negative evidence, while not in the least conclusive, is entirely against the thesis that Pediculus is widely distributed among primate hosts.

In conclusion it can be stated that the evidence brought forth in this paper further supports the writer's previously stated hypothesis that the sucking lice of American monkeys were derived originally from those of American Indians. On the other hand, there is little evidence produced to support the hypothesis that the genus Pediculus is a generalized one whose species are to an unusual degree free from the influences of host environment.

# BIBLIOGRAPHY

- EWING, H.E. 1924 Lice from human mummies. *Science* 40:389-390.  
 -----1926 A revision of the American lice of the genus Pediculus, together with a consideration of the significance of their geographical and host distribution. *Proc.U.S.Nat Mus.* 48: 1-30.  
 -----1932 A new sucking louse from the chimpanzee. *Proc.Biol.Soc.Wash.* 45: 117-118.  
 -----1933 The taxonomy of the Anopluran genus Pediculus Linnaeus. *Proc. Biol.Soc.Wash.* 46:167-174.  
 -----1934 The identity and origin of the sucking lice of American monkeys. *Proc.Helm.Soc.Wash.* 1: 21.  
 -----1936 The identity and variation of Pediculus humanus americanus. *Proc.Helm.Soc.Wash.* 3: 36-37.  
 FAHRENHOLZ, VON H. 1913 Ektoparasiten und Abstammungslehre. *Zool.Anz.* 41: 371-374.  
 -----1916 Weitere Beiträge zur Kenntnis der Anopluren. *Arch. Naturg.*, Jahrb. 81 (Pt.A, fasc.11): 34 pp.  
 -----1919-1921 Bemerkungen zu der Arbeit G. Schwalbe's "Über die Bedeutung der äusseren Parasiten für die Phylogenie der Säugetiere und des Menschen." *Z.Morph.u.Anthrop.* 21:361-364.  
 FERRIS, G.F. 1916 A catalogue and host list of the Anoplura. *Proc.Calif. Acad.Sc.*, ser.4. 6:129-213.  
 -----1935 Contributions toward a monograph of the sucking lice, Pt. 8. *Stanford Univ.Pub.*, Univ. Ser., *Biol.Sc.* 2: 529-634.  
 HIRMAN, E.H. 1931 Pediculus (Parapediculus) atelopphilus Ewing 1926 from the red spider monkey, Ateles geoffroyi. *Parasitology* 23: 488-491.  
 KEILIN, D. AND NUTTALL, G.H.F. 1930 Iconographic studies of Pediculus humanus. *Parasitology* 22: 1-10.  
 MEYERBERG, E. 1910 Studien über Mallophagen und Anopluren. *Ark.Zool.* 6: 296 pp.  
 MURRAY, A. 1877 Economic Entomology--Aptera. South Kensington Museum Science Handbook. London: Chapman and Hall. 433 pp.  
 NUTTALL, G.H.F. 1919 The systematic position, synonymy and iconography of Pediculus humanus and Phthirus pubis. *Parasitology* 11: 329-346.  
 -----1920 On Fahrenholz's purported new species, subspecies and varieties of Pediculus. *Parasitology* 12: 136-153.  
 PIAGET, E. 1880 Les Pediculines. Leide. E.J.Brill. 714 p..