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STUDIES ON POPULATIONS OF HEADLICE
(*PEDICULUS HUMANUS CAPITIS*:
ANOPLURA). I

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FROM PARASITOLOGY, VOL. XXVIII, No. 1, 27 JANUARY, 1936



CAMBRIDGE
AT THE UNIVERSITY PRESS

PRINTED IN GREAT BRITAIN

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MANY biologists are at present interested in populations of animals, which are studied experimentally and also by more abstract mathematical methods, but it is frequently difficult to obtain facts about actual populations living under natural conditions unless they are studied by sampling, the accuracy of which cannot always be precisely defined. The method described in this paper tells us of the actual numbers of headlice in crops of hair on individual people. From it we may learn the proportion of people who are infested at different times or places, and the number of lice on different people: also the proportion of males, females and young in the louse population. The results with material from Woolwich and from Lagos are set out in this paper. Further work is now in progress on material received from several parts of the world: this material will be studied and the results published at a later date.

Available information on the prevalence of lice in human populations was summarised by Nuttall (1917 *b*). Most of it relates to body lice (*Pediculus humanus corporis*): with regard to this subspecies Nuttall gathered together a number of facts about the proportion of human beings who are infested in different parts of the world and in different social circumstances. He could find no actual enumerations of headlice, but published a single count made by himself.

I. METHODS

The general method is to obtain the crop of hair of a large number of individuals, to dissolve each sample separately in alkaline sodium sulphide, remove the lice and count them.

The method of collecting depends on local circumstances, but the purpose is to obtain the whole crop of hair of a number of individuals separately, removing it from the head with a razor if possible. In some places one can obtain material from the subjects of post-mortems, in others from prisoners on admission to jail or from the poorer members of the community who are willing to be completely shaved for a small sum. As the methods of collection are different, the figures from different countries are not strictly comparable,

but care has been taken to see that no selection is made of the infested or clean, and that as far as possible the details of collecting are standardised and adhered to in each country. In this matter much depends upon the person who is good enough to supervise the collecting. The hair from each individual, as soon as it has been taken off, is put into an envelope; on the outside of the envelope the necessary facts are written. They vary slightly with local conditions, but one should at least have name, sex, approximate age, race and date. It is essential that the work should be carried out throughout the year, and at present we are inclined to think that about thirty specimens per month are sufficient.

Batches of envelopes are posted to London, where the specimens of hair are weighed and transferred to beakers containing the sulphide solution, which are set in a bath of boiling water. We find that the following solution gives satisfactory results:

50 g. potassium hydroxide.
100 g. sodium sulphide.
1 litre tap water.

Half a litre of this solution is sufficient to dissolve 30 g. of hair, which is roughly the crop of a European man. The hair dissolves completely in two to three hours, forming a black solution in which the lice cannot be seen. But they can be easily removed by passing the solution through a funnel of stainless steel gauze, sixty meshes to the linear inch: we find that this mesh takes out even the newly hatched lice. Any material which has not dissolved in the solution and which is retained in the gauze funnel is washed back into a dish and the lice are searched for and counted. With a mechanical counter in the left hand and a pipette in the right, it is easy to count the males, females and young separately. The males are easily picked out by the aedeagus, and the females by the posterior lobes and the gonopods (Nuttall, 1917 *a*; Keilin and Nuttall, 1919). No attempt has been made to keep a separate record of the numbers of the three nymphal instars. All the data are recorded on cards, one for each man.

While this method was being developed and standardised, several others were tried. Tests were carried out with different concentrations of alkalis and sulphide, and with different volumes of solution. I understand that it is necessary to keep the pH at 11.0 or higher, but the empirical method described above appears to give good uniform results. Attempts were made to filter the solution, which appears to be colloidal, through very coarse filter paper and were abandoned when it was found that the wire gauze gives very clean, quick results. It was also discovered that the lice could be removed from the sulphide solution by differential flotation. If the solution of hair is shaken up with a considerable volume of liquid paraffin, some of the lice are wetted all over with the paraffin and float up into it when the vessel is allowed to stand. Others are partly wetted with the paraffin and accumulate in the layer separating the two liquids. The aqueous solution can be run off from below

and the lice counted, but the method is dirty and tedious and not to be compared in efficiency with the one that has been described.

Several general objections should be considered. It is clear that the results depend greatly on the person who supervises the collection of the material, and it is not easy for him to ensure that the barber and the clerk continue to carry out their work regularly and carefully. It is possible also that after the material has been collected some lice migrate away from the hair, but it seems that they nearly always continue to clasp a hair until death for we have never found them dead on the inside of the envelope or loose in it. There is also the possibility that some of the lice are carried off by ants in certain tropical countries; against this we cannot guard. Early in the investigation we feared that cast skins might be numerous in the hair and might readily be mistaken for lice, but they are easy to distinguish. For a short period all the cast skins, even fragments, were recorded; the proportion of them to lice varied greatly on individual heads, but on an average we found one cast skin for five lice.

It seems clear that the method here described could be used for many other types of experimental work. The solution dissolves not only hair and feathers but also skin: if the skin is removed from a mouse or canary, the lice on the animal can easily be counted. One might therefore investigate the spread of lice through a community of animals most of which had originally been clean, or the effect of nutrition upon infestation.

It is a pleasure to acknowledge the careful work of my assistant, Mr S. Smith, who has been responsible for the large amount of the routine work and counting, which is the basis of this paper.

II. DATA FROM WOOLWICH, ENGLAND

I have found great difficulty in obtaining suitable material from Great Britain, but owing to the kindness of the Director-General of Medical Services at the War Office it was arranged that Major F. C. Tibbs, R.A.M.C., should send me a regular supply of clippings from recruits admitted into the Woolwich Dépôt. The hair of these men is removed with scissors to a standard degree of shortness, but is not cut very close to the scalp; as it is known that lice when they are present are generally found close to the skin, the figures are not comparable with those which would be obtained by shaving the whole scalp. Altogether 235 specimens have been received during all the months of the year ending April 1935. No lice were found in any of the specimens. For the reason just given, we cannot feel certain that the insects are entirely absent from all these individuals, but it seems clearly indicated that if any infestations occur in young men of this class they are rare and light.

III. DATA FROM LAGOS, WEST AFRICA

Material. The material was collected from dead bodies, subjects of post-mortem examinations in Lagos, from February 1934 to February 1935. The hair of the whole scalp was removed with a razor; no selection of clean or lousy people was made, though I believe that the hair was not removed from everybody which came up for examination. All the people whose hair was examined were African by race. I am very much obliged to Dr J. Cauchi, who obtained and forwarded the specimens.

Crude figures. The crude figures are shown in Table I. It will be observed that of the heads examined, almost exactly 20 per cent. harboured lice. Moreover, the frequency distribution among those found infested is very peculiar, the number of lice ranging from one to 1286.

Table I. Showing the prevalence of lice in Lagos, in the heads of people of many African races, and both sexes

Month	Total heads	No. lice per head			
		Nil	1-10	11-100	101 and over
1934 Feb.	3	2	—	1	—
Mar.	16	12	1	2	1 (263)
Apr.	12	10	1	1	—
May	14	10	1	3	—
June	9	7	1	1	—
July	10	9	—	—	1 (131)
Aug.	10	8	—	—	2 (368, 130)
Sept.	8	5	2	1	—
Oct.	5	4	—	—	1 (1286)
Nov.	6	6	—	—	—
Dec.	3	3	—	—	—
1935 Jan.	5	4	1	—	—
Feb.	1	1	—	—	—
Total	102	81	7	9	5

Sex of human being. In tabulating the material it was observed that women were more frequently and more heavily infested than men. This is shown very clearly in Table II: "all races" include people from many parts of Nigeria (several Hausas), also Liberians and men from Togoland, Sierra Leone, etc. "South Nigerians" are Yoruba, Ijaw, Sobo, etc., also people from Warri, Benin, Calabar.

Table II. Showing the prevalence of infestation in the heads of men and women separately

Race	Sex	Total heads	No. lice per head		
			Nil	1-100	101 and over
All races	♂	77	67	7	3
"	♀	25	14	9	2
South Nigerians	♂	46	40	5	1
"	♀	22	12	9	1

The difference between men and women is considerable, and the appropriate statistical test (χ^2) shows that it is significant; for the differences recorded between males and females (both in all races and in South Nigerians) would occur less than one time in a hundred if they were due to chance. It seems probable that the greater lousiness of the women is due to their elaborate and rather permanent head-dressing. But it is possible that the women are more infested than the men because their hair is longer: the difference is considerable, for the average weight of a man's hair is 6-7 g., of a woman's 24 g. But in spite of a considerable amount of work, I have not established any statistical relation between the weight of a crop of hair and its infestation.

Race. It is generally held in Nigeria that Hausas and men from the north are more heavily infested than men from the south (at least with body lice). But so far as Hausas resident in Lagos are concerned, I have the following figures:

Race	Sex	Total heads	No. lice per head		
			Nil	1-100	101 and over
South Nigerian	♂	46	40	5	1
Hausa	♂	18	14	2	2

Inspection seems to show that there is no great difference in the rate of infestation in the two samples. If the difference is tested statistically (by χ^2), it can be shown that it is not significant, *i.e.* the above difference might frequently be obtained if there was no difference between the races and if one examined a number of samples of that size. It will, of course, be realised that these Hausas had perhaps lived long in Lagos: they give no indication of what might be found on Hausas in their own country.

Season. The climate of Lagos is equable and of the equatorial type. The seasonal differences in temperature are very slight indeed. The means (half the sum of the maximum and minimum) of the hottest and the coldest months in 1934 were 83.1 and 78.9° F. (28.4 and 26.1° C.) respectively: it is therefore unlikely that there is any effective change in temperature on the surface of the human head since the atmospheric temperature is so equable. The humidity also is high and constant: the monthly means for 1934 (obtained by averaging the readings at 9 and 15 hours) run from 73 to 85 per cent. But the rainfall shows much more definite seasonal changes, the winter months being nearly dry and the summer months very wet. In the thirteen months under review, from February 1934 to February 1935, the monthly totals exceeded 5 in. in the five months from April to August and were below 5 in. in the other months except that 13.45 in. was registered in October. In the crude figures given in Table I it appears that lice are rarer in the dry season than in the summer, but differences due to sex are so considerable that the crude figures must be disregarded. I have therefore brought together the figures for all males, which are as follows:

Period	Total heads	No. lice per head		
		Nil	1-100	101 and over
Apr.-Aug. inclusive	41	35	5	1
Other months	36	32	2	2

One may conclude from this that there is no significant difference between the two seasons. I have also considered the figures for South Nigeria, males only, a smaller but more homogeneous group of people. Here again no significant difference is discoverable. We may conclude that there is no evidence in our figures of any seasonal distribution in infestation at Lagos. This is not unexpected, because the climatic conditions are so equable.

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(*MS. received for publication 26. vi. 1935.—Ed.*)