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	<i>Page</i>
Observations on growth in certain Molluscs and on changes correlated with growth in the radula of <i>Pyrasmus palustris</i> (with a note on the radula by the late N. Annandale). <i>R. B. Seymour-Sewell</i> ...	529
The Oriental Species of the genus <i>Musca</i> Linnaeus. <i>W. S. Patton</i> and <i>R. Senior-White</i>	553
Notes on Fishes in the Indian Museum—	
VII. On a new genus of "Globe-fishes" (Fam. Tetraodontidae). <i>S. L. Hora</i>	579
Description of a new genus of Myrmecophilous Scarabeidae (Coleoptera) of India. <i>F. Silvestri</i>	583
Some Indian Spiders of the Family Lycosidae. <i>F. H. Gravely</i>	587
New Indian Psyllidae (with a list of the species recorded from India and Ceylon by T. V. Ramakrishna Ayyar). <i>D. L. Crawford</i>	615

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OBSERVATIONS ON GROWTH IN CERTAIN MOLLUSCS AND ON CHANGES CORRELATED WITH GROWTH IN THE RADULA OF *PYRAZUS PALUSTRIS*.

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During the past four years I have from time to time made notes on the rates of growth and other correlated changes in the structure and life-history of certain Indian molluscs, and in view of the little that is at present known regarding the bionomics of this group it has been thought advisable to publish the results that I have obtained, imperfect though they are. I have divided the paper into two portions, dealing respectively with (A) inhabitants of freshwater and (B) marine or brackish-water forms.

A. INHABITANTS OF FRESHWATER.

I have already (Annandale and Sewell, 1921) published the results of my researches on the life-history of *Vivipara bengalensis*, but during my investigations in 1919 and 1920 regarding the possibility of the more common species of freshwater molluscs in this country acting as hosts for the development of the cercariae of human-infecting schistosomes, I had occasion to keep a large number of examples of several other species in my experimental tanks, and during the progress of my work a number of young were born and continued to live. In several cases the dates on which the parent molluscs were introduced into and removed from these tanks is known, and also the date on which these young forms were subsequently examined and measured. In this way I have obtained a record of the rate of growth in early life and have been able to compare these young examples with adults of the same species obtained from other sources. It must be remembered that these young forms were living under somewhat artificial conditions, though I attempted to reproduce in my tanks a habitat as nearly as possible identical with their natural surroundings. Consequently the rates of growth observed may differ somewhat from those that pertain in the same species in the 'wild' state but at any rate they serve as a rough indication of the progress attained under normal conditions.

1. *Acrostoma variabile* (Benson).

The parent molluscs were introduced into my tanks between the 29th April and the 23rd May, 1919 : a number of young were produced and were subsequently examined and measured. The measurement taken was the maximum height of the shell, from the extreme apex to the furthest point on the margin of the peristome. The first batch of 33 examples were measured on 29th July, 1919, on which date they were between 68 and 92 days old. Their height measurements range from

6.0 mm. to 13.0 mm., the average for the group being 9.3 mm. On the same day a batch of 46 adults were taken from the tank in the Indian Museum and their measurement ranged from 27 mm. to 43 mm. On the 19th September, 1919, a further series of 42 young specimens from my experimental tanks were examined and measured, and it was found that the height measurement now ranged from 9.0 mm. to 16.0 mm., the average being 12.0 mm. These examples were between 110 and 144 days old.

The results of these measurements are plotted out in the accompanying text-figure (text-fig. 1).

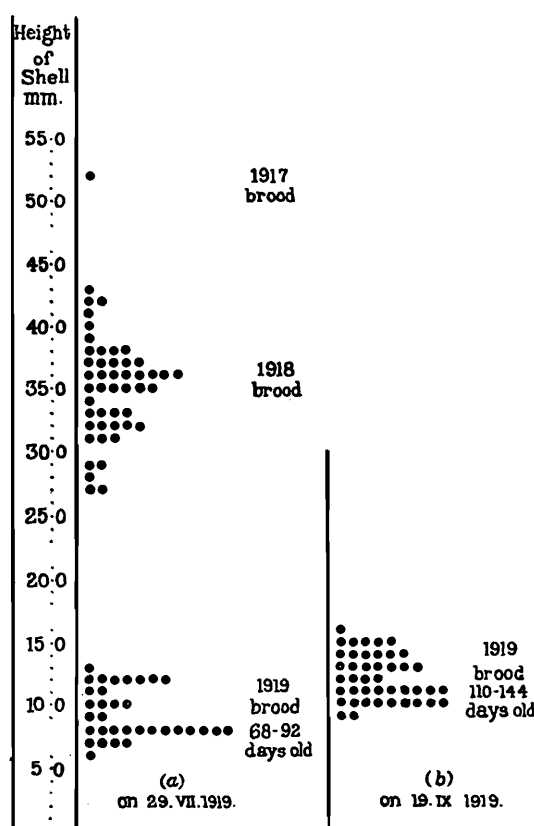


FIG. 1.—Growth stages of *Acrostoma variabile* (Benson).

The average rate of growth of the young of this species is thus seen to be to a height of 9.3 mm. in 92 days or less and to one of 12.0 mm. in 153 days or less.

The group of 46 adult examples taken from the Museum tank I believe to be composed of individuals who had completed a full year's growth and belonged to the 1918 brood. Larger specimens than this are rare, but a single example measuring 52 mm. in height was obtained at the same time and this I believe to be a survivor from the 1917 brood. If this be so then it would appear that the usual length of life of this species is but a little more than one year, and in only very exceptional cases does an individual survive for a second year.

2. *Melanoides lineatus* (Gray).

In the case of this species two series of examples were bred and examined. In series (1) the parents were introduced into my experi-

mental tanks between the 6th and 20th of May, 1919 (both dates inclusive), and they were removed from the tanks between the 22nd and 27th of July, 1919; all the young in this series must, therefore, have been born between these two dates, *viz.*, the 6th May and the 27th July. In series (2) the parents were introduced into tanks [different from those containing series (1)] on the 12th and 13th June, 1919, and were removed between the 1st and 6th of August, 1919. All the young examples in this series had therefore been born between the 12th of June and the 6th of August.

The young of both series were examined and measured on the 19th September, 1919, and the results are given in text-fig. 2.

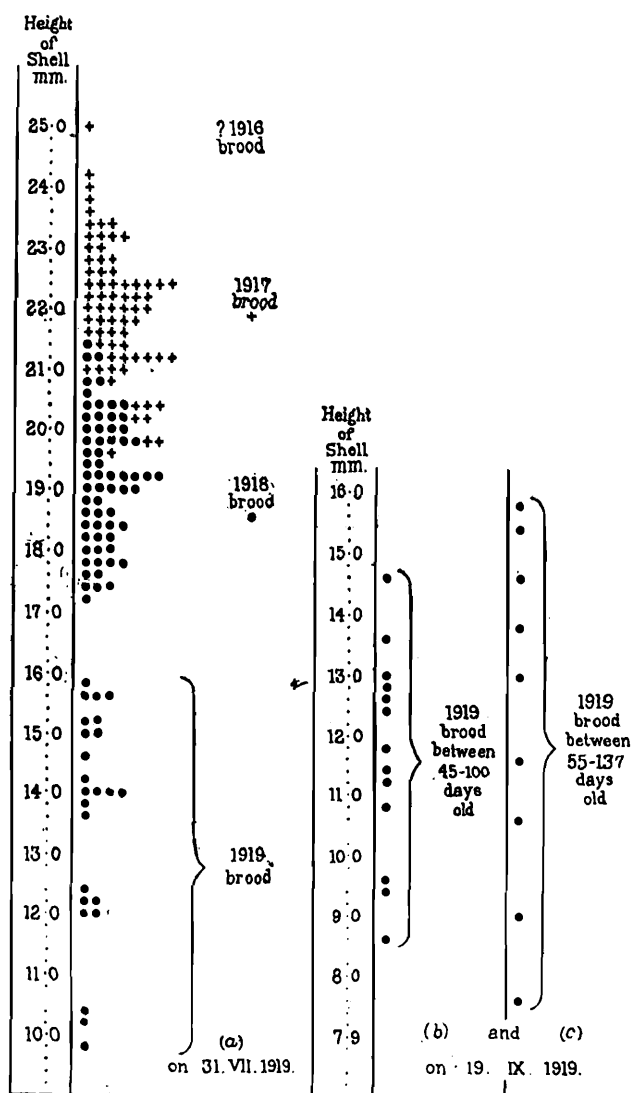


FIG. 2.—Growth stages of *Melanoides lineatus* (Gray).

In series (1), containing examples whose length of life is known from the above dates to have been between 55 and 137 days, the height measurements range from 7.6 mm. to 16.8 mm., and we have an average rate of growth of 12.6 mm. in 96 days. In series (2) the height measurement ranges from 8.6 mm. to 14.6 mm. and the length of life of all these specimens must from the above dates have been between 45 and 100 days, or an average of 11.7 in 73 days.

A number of examples, 160 in all, of this species were obtained on 31st July, 1919, from a tank in the Zoological Gardens, Alipore; these were examined and the results of their measurements are given in text-fig. 2 (a). The smaller examples form a scattered group whose height measurement ranges from 9.8 to 15.8 mm., and a comparison with the examples reared in my tanks shows conclusively that these were members of the 1919 brood and were, if the height attained by individuals bred in captivity is any guide, from 2 to 4 months old. It would appear then that the breeding-season in this year began early in April and was still in full swing as late as August: this agrees very well with my observations on *Vivipara bengalensis* (vide Annandale and Sewell, 1921, p. 279), in which species I found that the breeding-season "commences early in the year and seems to extend throughout the whole of the hot-weather and monsoon periods up to and probably beyond September; but the period of most intense reproduction is from April to July." The larger examples of *Melanoides lineatus* were all adults and form, if we consider size alone, a somewhat scattered group whose height measurements range from 17.2 mm. to 25.0 mm. From this one might conclude that they were all examples of the 1918 brood. The shells, however, of certain individuals showed a marked difference from those of others; in some the shell was perfectly clean, whereas in others it was rough and thickly overgrown with algae. Examples with clean shells are represented in the figure by a circle O, and those with algae-incrusted shells by a cross +, and it is clear that they fall into two groups, the first having a height measurement ranging from 17.2 mm. to 21.4 mm. and having an average of 19.1 mm., and the second from 19.6 to 25.0 mm. with an average of 22.0 mm. These two groups, I believe, to be composed of individuals of the 1918 and 1917 broods respectively. Possibly the single example that had a length measurement of 25 mm. is a representative of the 1916 brood that has managed to survive.

It would seem probable that in this species the average period of life is as long as two years, and that occasionally an individual may survive even for a third year.

3. *Melanoides tuberculatus* (Müller).

In the case of this species my results are based on two series of observations. In series (1) the parent adults were introduced into my experimental tanks between the 14th and 18th May, 1919, and were removed between the 22nd and 27th July, 1919; while in series (2) the parents were introduced into different tanks on the 14th and 15th of June, 1919, and were removed between the 1st and 6th of August, 1919. All the young examples from both series were collected and measured on the 19th of September, 1919.

In the case of series (1) unfortunately only two examples survived. These measured respectively 15.8 mm. and 16.4 mm. in length. From the dates on which the parents were introduced and removed we know that the period of life of these two specimens was between 55 and 129 days. Series (2) was more successful and 33 examples were obtained and measured. The length measurement ranges from 6.2 mm. to

13.8 mm. the average length of the whole series being 10.8, while the length of life of these individuals lay between 44 and 98 days or an average of 71 days.

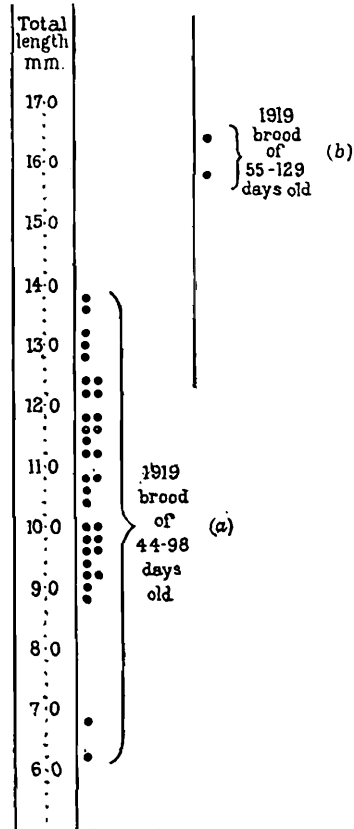


FIG. 3.—Growth stages of *Melanoides tuberculatus* (Müller).

It is interesting to note that this rate of growth corresponds very closely with that found in *Melanoides lineatus* and it is possible that a particular rate of growth under similar conditions may be characteristic of a genus, rather than merely of a species. On the other hand the height of the shell in these two species at the end of the first year of life is so little different—16.5 mm. in the case of *M. tuberculatus* (*vide* Sewell, 1922, p. 14) and 19.1 mm. in *M. lineatus*—that one would expect to find a very similar rate of growth.

4. *Limnaea acuminata* (Lamarck) var. *gracilior* (v. Martens).

In the case of this species, the parent adults were introduced into my experimental tanks between the 4th and 14th of May, 1919, and were removed between the 22nd and 27th of July, 1919. The resulting progeny were collected and measured on the 19th of September, 1919; they were therefore between 54 and 139 days old.

The height of the shell exhibits a very considerable range of variation, the smallest measuring only 11.3 mm., while the largest measured as much as 27.3 mm., the average being 18.8. This rate of growth is obviously much more rapid than in the case of the different species we have so far been considering. Semper (1874) has, however, shown that though the rate of growth is affected by the amount of water in which the young are living, in *Limnaea stagnalis* individuals may attain

to a height of from 7.8 mm. to 26.0 mm. in 56—64 days or from 4.6 mm. to 21.0 mm. in 59—63 days. This agrees very closely with the results

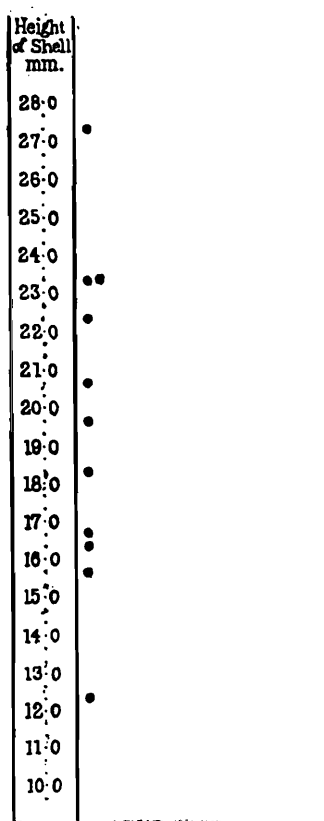


FIG. 4.—Height of shell in *Limnaea acuminata* var. *gracilior*, after 54 to 139 days growth.

given above, and it is possible that this rapid rate of growth may be characteristic of the genus.

5. *Indoplanorbis exustu* (Deshayes).

In the accompanying text-figure (Fig. 5) I have given the maximum breadth of the shell in a number of specimens of the above species that were collected in two tanks in Calcutta during the months June and July, 1919. The measurement taken was across the breadth of the spiral in the diameter at right angles to the mouth, as in this way one avoided any slight difference that might arise owing to damage or breakage of peristome.

At one end of the series are a few specimens measuring from 4.0 to 5.8 mm., these I believe to be individuals that had been born during the 1919 breeding-season, and the fact that not a single one was infected by Cercariae certainly indicates that they were less than three months old (*vide* Sewell, 1922, p. 14). Extending from 6.0 mm. to 8.8 mm. is a well-defined compact group that almost certainly belong to the 1918 brood and were therefore just over one year old. A number of individuals of considerably larger size, ranging from 9.2 mm. to 13.2 mm. form a less well-defined group that I believe represents the 1917 brood, and they were, therefore, just over two years of age. These larger specimens all came from the tank in the Indian Museum compound

and were collected during the month of June. During the early part of July, 1919 there was a very heavy mortality among the snails in this

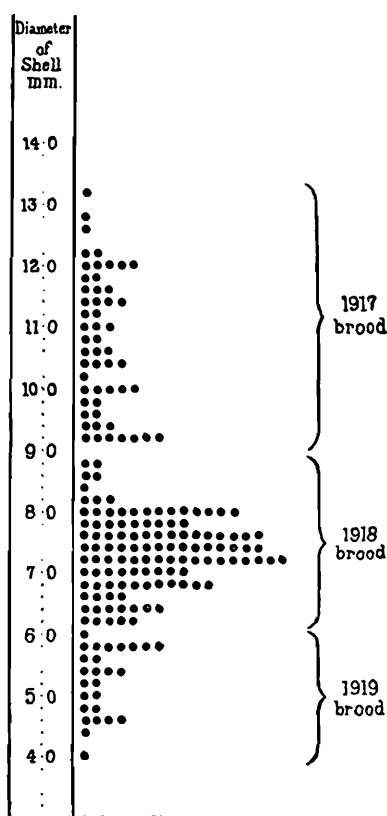


FIG. 5.—Growth stages of *Indoplanorbis exustus* (Deshayes).

tank and as I have already pointed out (Sewell, 1922, p. 13) this appears to be of universal occurrence and is due to the snails having reached their extreme limit of age. This mortality affected the examples of *Indoplanorbis exustus* equally with the other species, and during July only examples belonging to the middle group could be found—all those of the largest group having presumably died off.

This seems to us to indicate that the length of life of this species is two years, at the end of which period they die off.

B. MARINE AND BRACKISH-WATER FORMS.

During several survey seasons, from 1913-14 onwards, and at other times as the opportunity has occurred, I have made collections of certain marine molluscs and have examined and measured them with a view to determining, if possible, the rate of growth and average length of life attained by these species. Although much work has been done on these lines in temperate waters, particularly in connection with fishery work and regarding certain species that are of economic importance, little or nothing has, so far as I am aware, been done in tropical seas.

6. *Littorina scabra* (Linn.).

Large numbers of this species of *Littorina* were found in Nankauri Harbour, Nicobar Islands, living on the trunks and branches of trees

that had fallen along the beach or on an old wooden hulk that lies at the edge of the water in Spiteful Bay.

As Tattersall (1920, pp. 6, 7) has pointed out there is in the different species of *Littorina* a marked correlation between the habitat and the life-history ; thus *Littorina littorea* lives in the *Laminaria* and *Fucus* zones and is therefore only exposed at extreme low water spring tides and lays egg-capsules singly and unattached to weeds, while *L. obtusata* in its habitat is practically exposed at every low water and lays its egg-

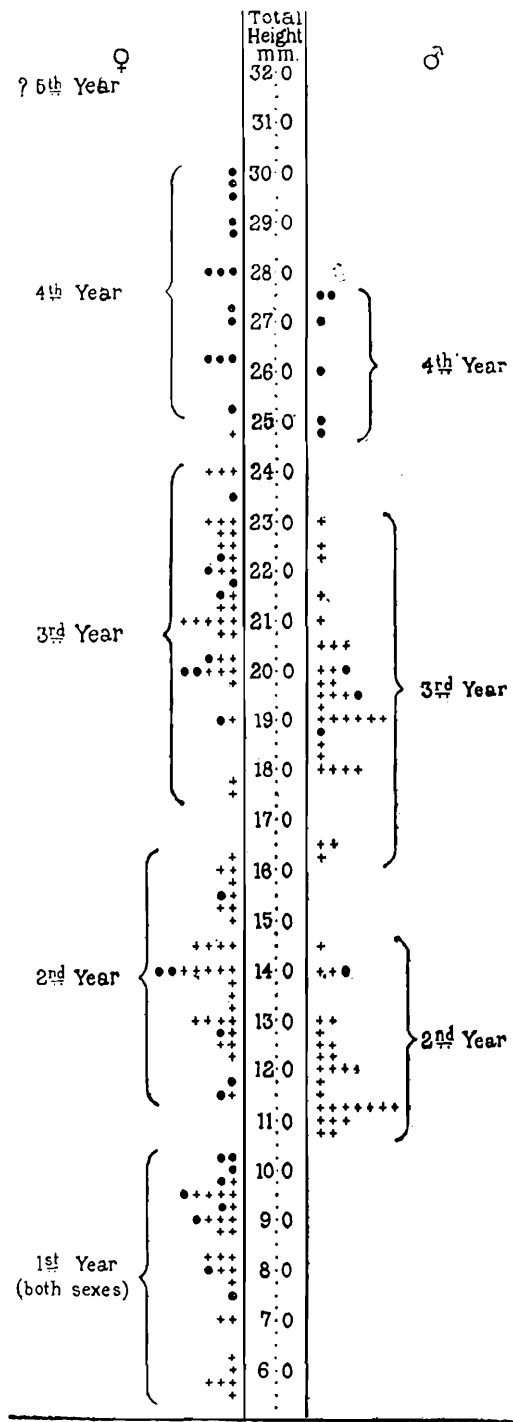


FIG. 6.—Growth stages of *Littorina scabra* (Linn.).
+ Specimens obtained in 1921.
O Specimens obtained in 1922.

capsules in masses attached to weeds. Finally *L. rudis* and *L. neritoides* live for the most part out of water and are viviparous. *L. scabra* also

has this latter type of existence, and appears to be exposed for days at a time, and have too we find the viviparous habit. The developing ova are small and are produced in enormous numbers: they form a brownish mass which partially fills the branchial chamber, occupying the dorsal and left hand portions of the cavity.

In all, I collected 192 examples. These were not all collected at one time, the dates and the numbers collected thereon being as follows:—

	Examples.
On October 27th and 28th, 1921	111
On November 5th, 1921	48
On October 19th, 1922	33

Each of these examples was carefully measured, the measurement taken being the maximum height from the apex of the shell to the margin of the peristome, and the results obtained are shown in the accompanying figure.

The specimens fall into a series of groups according to their size and, owing to the presence in this genus of a penis in the male, it was possible to determine the sex of a specimen in all but the very smallest examples.

The smallest examples form a somewhat scattered group whose height ranges from 5.50 mm. to 10.25 mm.

In the accompanying figure I have indicated the examples obtained in 1921 by a cross, and those taken in 1922 by a circle. It is interesting to note that examples of this group taken in 1922 were on the average somewhat larger than those of the previous year, although they were obtained at a slightly earlier date. The average length attained by this group in each year is as follows:—

In 1921	8.05 mm.
In 1922	9.28 mm.

The examples comprising this group I take to be individuals that had been born during the present breeding-season. Many of the individuals of the larger groups were taken in the act of copulation and still more adult females were ovigerous, so that there can be no doubt that a breeding-season was in progress. Tattersal (1920, p. 3) gives the breeding-season of *Littorina littorea* in English waters as "lasting from the middle of January to June, with a maximum in April and the early part of May." A comparison of the size of the individuals in the smallest group with the rate of growth of young examples in other species seems to me to indicate that these could not have been much older than two to three months, that is to say, they probably belong to a brood produced about August and September just after the close of the South-West monsoon season. I have already shown (Annandale and Sewell 1921, p. 279 and *vide supra*) that the breeding-season for fresh-water gastropods in India occurs during the hot weather and the early part of the South-West monsoon, from about March to September, with the most intense reproduction in April to July, and it is possible that *Littorina scabra* has a double breeding-season each year, namely, just before and

just after the South-West monsoon, but, if so, any distinction in size between the two broods appear to become obliterated by subsequent growth before the completion of the first year of growth.

In the next larger group, comprising 64 individuals, a study of anatomy showed that 35 examples were females and 29 were males. There is a marked disparity in the size of the two sexes: the females range in height from 11.50 mm. to 16.25 mm., and have an average of 13.9 mm., while the corresponding males measure only from 10.75 mm. to 14.50 mm., and have an average of only 12.04 mm. Although I cannot be certain on this point, I believe this group to be composed of individuals belonging to the 1920 brood in the case of specimens taken in 1921, and of the 1921 brood in those examples taken in 1922, *i.e.*, they are individuals who have commenced their second year of growth. Each succeeding group represents individuals of an additional year's growth.

The third group includes 73 examples, of which 42 are females and 34 males. Here again one finds the same disparity in size between the two sexes and I was inclined to think that both in this and the succeeding group I could detect a slight difference in the sexes in the breadth of the body-whorl, the female shell appearing to be slightly broader than the male, but I could not be certain of this. The females in the group have a height measurement varying from 17.50 mm. to 24.75 mm. and an average of 21.85 mm., while the males vary from 16.25 mm. to 23.0 mm. and have an average of 19.42 mm. In 1921 I obtained only one example larger than this, but in 1922 I succeeded in obtaining evidence of the existence of yet another group.

This additional group, that I believe is composed of individuals who have survived to a fourth year of life, includes 15 females and 6 males. At this age the height of the females varies from 25.25 mm. to 31.75 mm. and gives an average of 28.10 mm., while the males vary from 24.75 mm. to 27.50 mm. and have an average of 26.29 mm.

A single example, a female, was obtained in 1921, that had a height measurement as long as 40.00 mm. I have on account of its disparity in size excluded it from the group that I believe is composed of individuals in their fourth year of life, and it seems probable that it is an example of a survivor who has managed to exceed the usual span of life and has attained to the age of a fifth year. It is interesting to note that this individual was ovigerous and that the larger size was therefore not due to parasitisation.

A study of the proportions of the sexes in each of these groups reveals several interesting features. In the group corresponding to the first year of growth, sexual maturity has not yet been attained, and it appears probable that sexual maturity is not usually attained much before the end of the first year of life.

In the group corresponding to the second year of growth, the proportions of the sexes are very similar: in every 100 examples we should, judging from the figures I have given above, find 45 males and 55 females, but my examination of the individuals captured in 1921 and 1922 seems to indicate that these figures are liable to very considerable variation,

and in the Table below I give the percentages as calculated from my examination :—

	1921		1922	
	♂	♀	♂	♀
	Per cent	Per cent	Per cent	Per cent
2nd year	48	52	14	85
3rd year	46	54	33	67
4th year	...	...	29	71
5th year	...	100	...	...

Examples that were in their second year in 1921 were in their third year in 1922 and it is extremely interesting to note the way in which the number of males becomes reduced in proportion to the females. I have shown that an exactly similar state of affairs is found in *Vivipara bengalensis* and it is probably of universal occurrence among Mollusca in tropical regions. During the period of life between the third and fourth year this disparity in the proportion of the sexes becomes even more marked, and the sole example in what I believe to have been the fifth year of life was a female.

A further indication of the greater susceptibility of the males to adverse conditions is to be found in the proportions of the two sexes that exhibit a ' varix ' across the shell. This ' varix ' I consider is produced by a period of arrested growth followed by a subsequent recovery and growth in size of the individual, and I think one is justified in assuming that the arrest of growth is caused by some adverse condition that has affected the snail in a greater or less degree. The subsequent growth shows that, whatever the cause, the individual has survived. Out of a total of 10 examples that possessed a ' varix ' 8 were in their second year and of these five were females and three males, or a proportion of 71 : 29 ; and in the case of the two examples in the third year of life that showed a ' varix ' both were females, which indicates that far fewer males than females survive after being affected by adverse conditions.

It is possible that this increased susceptibility of the male to adverse conditions is correlated with the time of life at which sexual maturity is attained. I have no evidence of its being the case, but in view of what occurs in other molluscs it seems reasonable to conclude that the males become mature at the end of the first year of life. A study of the numbers of females that were found to be producing ova seems to indicate that in this sex the onset of sexual maturity may be delayed, and I give the actual figures below :—

Out of 24 females in the	2nd year of life	7 were ovigerous	= 29 per cent
„ 40	„ 3rd	„ 23	„ = 57 „
„ 11	„ 4th	„ 9	„ = 82 „
„ 1	„ 5th	„ 1	„ =100 „

The height of the shell in the females varies from 11.0 mm. to 13.5 mm. and the average is 12.38 mm., whereas in the males the height is from 9.0 mm. to 12.0 mm., the average being 10.95 mm. The members of this group I believe to be in the second year of life, and it is interesting to note that eight individuals, seven females and one male, possessed a well marked 'varix' close to the margin of the peristome.

In the third group, corresponding to individuals in their third year of life, the disproportion between the two sexes has become much more marked; out of a total of 48 examples, 35 were females and only 13 were males. The height of the shell in the females varies from 14.00 mm. to 18.00 mm., the average being 15.57 mm., whereas in the males, which are much smaller, the height ranges from 13.00 mm. to 15.00 mm., with an average of only 13.85 mm. In this group 19 individuals exhibited a well-marked varix of which 14 were females and only 5 were males. In seven females and 3 males the 'varix' was situated close to the margin of the peristome and had only recently been formed, probably during the preceding South-West monsoon season (1921). In the remaining seven females and two males the varix was at some distance from the peristome and had probably been produced at the end of the first year of life, that is to say during the South-West monsoon of 1920.

The fourth group, which I believe to consist of individuals in their fourth year of life, is only very poorly represented in my collection, and contains two females, both of 19.00 mm. in height, and four males, whose height ranges from 16.25 mm. to 17.50 mm., with an average of 16.87 mm.

It appears then the maximum length of life in *Littorina obesa* is about four years, but that the majority of specimens perish after three years. We again find, as in *Vivipara bengalensis* and *Littorina scabra*, a tendency for the proportions between the two sexes to vary as age progresses; thus—

	♂	♀
In the 2nd year of life the proportion is	52	48
In the 3rd year of life the proportion is	27	73

In this species, however, there seems to be a tendency towards an equalisation of the proportions again in the fourth year. The proportion between the sexes in my collection in examples of this length of life was 67 ♂ to 33 ♀, but as I only obtained seven specimens in all one cannot place much reliance on these figures. As in *Littorina scabra* we get an indication of the greater susceptibility of the male to adverse conditions in the comparatively few males in proportion to females, viz., 6 : 21, that survive a period of adverse condition and so live to form a varix in the shell, and in view of the possible tendency to equalisation of the sexes in the later years of life it is interesting to note that the proportion of males to females with a varix in the second year of life is only 21.4 : 78.6, whereas in the third year of life it has risen to 42.9 to 57.1, so that at the end of their second year a much greater number of males are able to survive the ill-effects of a period of adverse circumstances and so live to form a varix in their shells than do so in examples that are affected at the end of their first year.

8. *Pyrasmus palustr* (Linn.).

On the western side of Mayo Point in Nankauri Harbour, Nicobar Islands and close to the village of Innanga is a small low-lying area separated from the beach by a thin fringe of trees. The southern portion of this area is swampy and is connected by a narrow channel with the waters of the bay which flow in and out with the rise and fall of the tide. At high water most of the area is submerged but as the tide recedes a large part becomes exposed while only here and there isolated pools of water are left behind.

Living in this swamp were enormous numbers of the mollusc *Pyrasmus palustris* and associated with them were also a few examples of *Telescopium telescopium*. The examples of *Pyrasmus palustris* varied enormously in size and a number of examples, 212 in all, were collected between the 27th November and 10th December, 1921.

These were subsequently measured, the measurement taken being the extreme height of the shell from the apex to the margin of the peristome. In Fig. 8 I give the results of this measurement and it is seen that individuals fall into four quite distinct groups, of which the two of smaller size are compact, while the other two groups comprising the larger specimens are somewhat scattered and tend to be subdivided.

The first group, comprising examples having a maximum height of shell that varies from 9.0 mm. to 19.0 mm., I believe to include those individuals that were in the first year of life.

The second group includes those individuals whose height ranges from 24.0 mm. to 38.0 mm. and in my opinion corresponds to the second year of life.

The third group is a somewhat scattered one and includes specimens whose height of shell varies from 58.0 mm. to 91.0 mm. In this group we appear to get a quite distinct tendency towards a sub-division into (a) examples that are grouped round an average of about 72 mm. in length and (b) those that tend to have an average of about 95 mm. This tendency towards sub-division, which would, I think, become clearer if more specimens had been obtained and measured I attribute to a dimorphism between the two sexes. I have already shown that males appear in all species examined to be smaller than females of the same age, and although none of the examples examined by me appeared to be sexually mature, and I was unable to determine their sex, I believe that the smaller sub-group includes the males and the larger the females in the third year of life. If this be so then the proportion of males to females appears to be 57.7 : 42.3.

The fourth group is again a scattered one with a tendency towards sub-division into a smaller sub-group having an average length of about 109 mm. and a larger sub-group having an average of about 120 mm., which I again attribute to sexual dimorphism. In this case, if my assumption is correct, the proportion of males to females has now dropped to 36.6 : 63.2, which agrees very well with the tendency that we have seen in other species for the proportions of males to females to diminish as age advances.

Associated with this gradual increase in size is a very remarkable change in the character of the radula. So marked is the difference

between the smallest and the largest specimens that one might reasonably doubt whether they were individuals of the same species. I have, therefore, submitted all my examples to Dr. N. Annandale who agrees with me that they are specifically identical and, moreover, a study of their internal anatomy reveals no difference other than that noted above in the character of the radula.

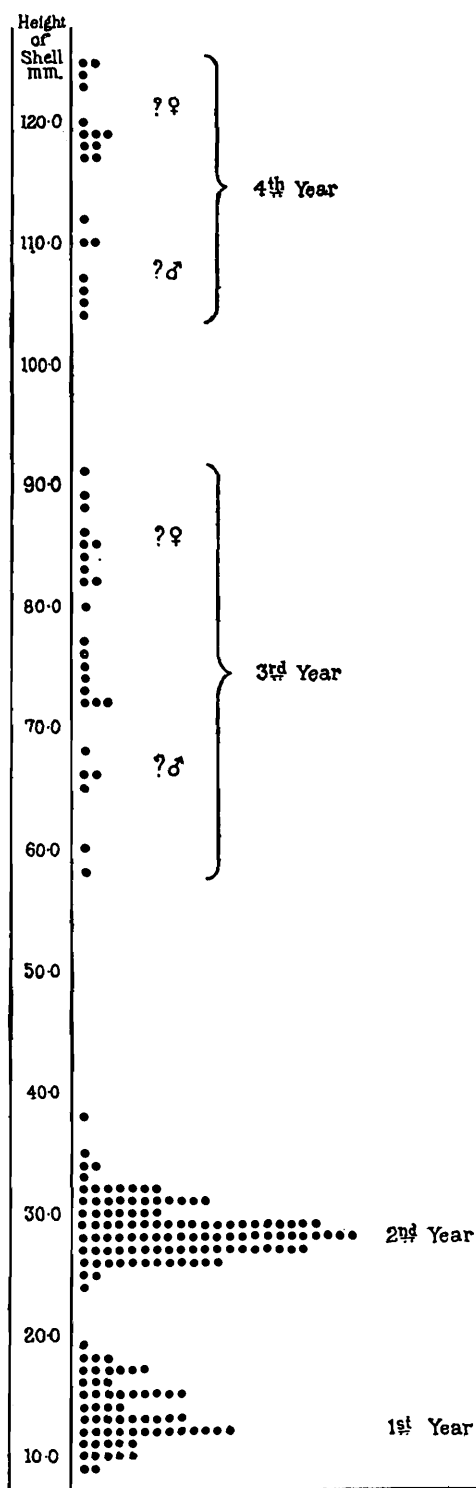


FIG. 8.—Growth stages of *Pyrazus palustris* (Linn.).

In the smallest individuals, having a height of approximately 12 mm., the radula presents the appearance that is characteristic of the genus,

or even of the family. In each row there are in all seven teeth, the dental formula being 2. 1. 1. 1. 2, and each of these teeth are characterised by possessing a number of cusps on their margins. As age progresses and the size of the animal increases a gradual change takes place, the number of individual cusps on the teeth gradually becomes less until in the final largest stage of all the central tooth presents only a single pointed median cusp. The lateral tooth has developed enormously and now consists of a single cusp with a trace of a second one to the outer side, while in the two marginals we find one large cusp with traces of one or two small ones on the mesial side of it.

This change is a very gradual one but even in different parts of the radula of the same individual it is possible to detect slight changes and the gradual reduction in the number of cusps seems to be brought about by a process of fusion rather than by suppression. The accompanying figures (fig. 11, p. 550) show very clearly the way in which this change is carried out.

This extremely interesting change in the character of the radula appears to be confined to this single species. I have already mentioned that I could detect no difference in the radulae of examples of *Littorina scabra* of different ages and I have also examined individuals of different sizes and ages of *Telescopium telescopium* found in the same locality as these examples of *Pyrazus palustris* but here again I was unable to detect any change. Finally examples of *Cerithidea obtusa* obtained from Port Canning, near Calcutta, show that in the adults of this species the radula is of the usual type and agrees closely with the condition found in the youngest stages of *P. palustris*.

9. *Mytilus variabilis* Krss.

In the shallow water on the shore side of a small coral reef that fringes the coast at Tor in the Gulf of Suez are beds of mussels, *Mytilus variabilis* Krss. At the time when I was stationed at Tor in 1916, these beds appeared to be rapidly disappearing and the mussels becoming killed off owing to an accumulation of sand and mud that was covering the beds, and by a simultaneous deposit of a white chalk-like material.

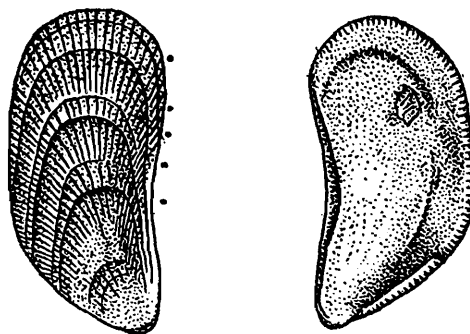


FIG. 9.—*Mytilus variabilis*, showing the rings of growth.

In order to try and determine whether it was possible to ascertain the age of examples of this species a number were collected and examined.

Every shell, that was not encrusted with the above-mentioned chalky-deposit, exhibited a number of rings, more or less distinct, that ran concentrically across the outer surface of the shell, and these rings fall into two categories. The first series of rings are well marked, and are approximately equidistant from each other, while the second series are less marked, though still quite distinct, and are invariably situated much nearer to the ring of the first series on its proximal side than to the ring distal to it.

I do not propose to enter very deeply into a discussion of the varied question whether the age of an oyster can be determined by the number of rings on its shell. Petersen (1908 and 1918) came to the conclusion that "for the practised observer, it is possible to estimate roughly the age from the outer appearance of the shell," and Massy (1913) arrived at exactly the opposite conclusion. In the case of these mussels, however, it seems to me that the above-mentioned rings do in all probability give one a true estimate of the age of the individual.

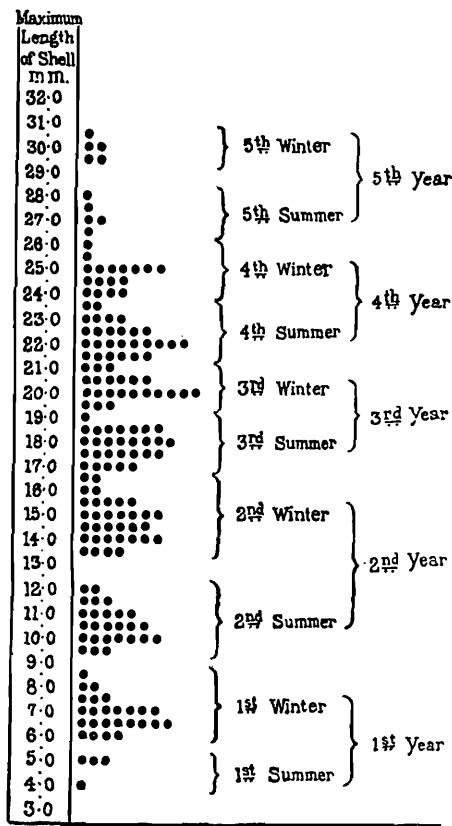


FIG. 10.—Growth stages of *Mytilus variabilis* Krss.

I selected a number of examples and measured the distance from the extreme apex of the shell to the furthestmost points on the various concentric rings and the results are given in the accompanying figure 10. It will be noticed that these measurements fall into very definite groups, that is to say, that allowing for slight individual variations, each example has increased the size of its shell by approximately the same amount between the formation of one ring and the next. I believe that the amount of shell formed between a ring of the primary series and the secondary ring immediately following it represents a winter's growth,

and the much larger amount of shell laid down between the secondary rings and the next following primary ring represents a summer's growth. If this be so then the distance from primary ring to primary ring is one year's growth and the number of primary rings serve as a correct guide to the age. The maximum length of life then of this species would thus appear to be five years though, judging from the number of examples in the two largest groups, most individuals would seem to die off after the fourth year, only a few surviving for the fifth. On the other hand a physiological character of the glands of the mantle margin is that the shell-formation proceeds at different rates at different times—a phase of activity being followed by a period of more or less rest, in which calcium is stored up. A study of the observations made by Miss Massy on the formation of rings in the Oyster, to which I have referred above, brings out an interesting point that seems to me to have a very distinct bearing on this question. Fortunately she gives full details of all her examples, and I have been able to make a careful analysis of her data. She has summed up the results of her observations in the following words: "it is obvious, therefore, that if I have been at all correct in determining the number of rings, it is not of much use to apply the study of growth rings in ascertaining the age of a wild oyster." She, however, does not appear to have noticed that there is a distinct correlation between the size of the oyster and the number of rings present in oysters of the same age.

I have taken the data that Miss Massy gives in her paper and in the following Tables I have tabulated the number of rings present in the oysters of different sizes but of $1\frac{1}{2}$, $2\frac{1}{2}$ and $3\frac{1}{2}$ years growth respectively.

Table I.—Oysters of $1\frac{1}{2}$ years growth.

Distance from hinge to ventral margin of shell in mm.	No of specimens.	No. of individuals exhibiting the following No. of rings.					Average No. of rings present.
		2	3	4	5	6	
11—20	4	4	...	...	...	...	2.00
21—30	16	13	3	...	...	...	2.19
31—40	25	10	13	1	1	...	2.72
41—50	39	16	17	4	2	...	2.79
51—60	18	...	8	10	...	...	3.56
61—70	2	...	...	1	1	...	4.50
TOTAL	104	43	41	16	4	...	

Table II.—*Oysters of 2½ years growth.*

Distance from hinge to ventral margin of shell in mm.	No. of specimens.	No. of individuals exhibiting the following No. of rings.						Average No. of rings present.
		2	3	4	5	6	7	
21—30	24	5	19	...	...	...	...	2.79
31—40	59	2	38	14	5	...	..	3.37
41—50	103	2	58	26	14	3	...	3.59
51—60	74	...	32	30	10	2	...	3.76
61—70	46	...	16	10	15	4	1	4.22
71—80	10	...	...	7	...	3	...	4.60
TOTAL	316	9	163	87	44	12	1	

Table III.—*Oysters of 3½ years growth.*

Distance from hinge to ventral margin of shell in mm.	No. of specimens.	No. of individuals exhibiting the following No. of rings.							Average No. of rings present.
		2	3	4	5	6	7	8	
21—30	4	...	4	...	...	...	...	...	3.00
31—40	19	3	12	3	1	...	...	...	3.11
41—50	56	2	30	17	4	3	...	...	3.57
51—60	48	...	12	20	13	3	...	...	4.15
61—70	43	...	3	18	14	6	2	...	4.44
71—80	32	...	3	6	14	6	2	1	4.78
81—90	2	...	...	...	1	...	1	...	6.00
91—100	1	...	...	...	...	...	1	...	7.00
TOTAL	205	5	64	64	47	18	6	1	

A study of these tables shows very clearly that in oysters of the same age there is a marked tendency for the number of rings to increase proportionally to the size to which the individual may attain. In all three series the average numbers of rings present for any given size are very fairly constant, such differences as are present being probably due to insufficient numbers examined and differences in physical conditions in different areas.

No one, I think, will deny that the formation of a ring is due to a period of shell formation followed by a partial or complete arrest of activity in the shell-producing glands of the mantle-margin, and the above tables show that the amount of shell produced during each period of activity increases up to the time when the animal attains to a size of 80 mm. and thereafter begins to diminish. Petersen found that in Danish oysters from the Lim Fjord, this diminution in the rate of growth occurred at 60 to 70 mm. The number of such periods of activity through which a given individual may pass in any given time varies so enormously, viz., from 2 to 5 in $1\frac{1}{2}$ years, from 2 to 7 in $2\frac{1}{2}$ years and from 2 to 8 in $3\frac{1}{2}$ years, that one must agree with Miss Massy that in the case of oysters they are of themselves quite useless as a guide to the probable age.

In the case of *Mytilus variabilis*, however, one is dealing not with individual rings, but pairs of rings, each pair consisting of a narrow part and a wide part, and I cannot help thinking that this difference in the rate of shell deposition corresponds to definite seasons, and is due to the markedly different conditions that exist in the Gulf of Suez in winter and summer respectively, and thus the rings do give a correct estimate of the age of the individual.

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NOTE ON THE RADULA OF *PYRAZUS PALUSTRIS*.

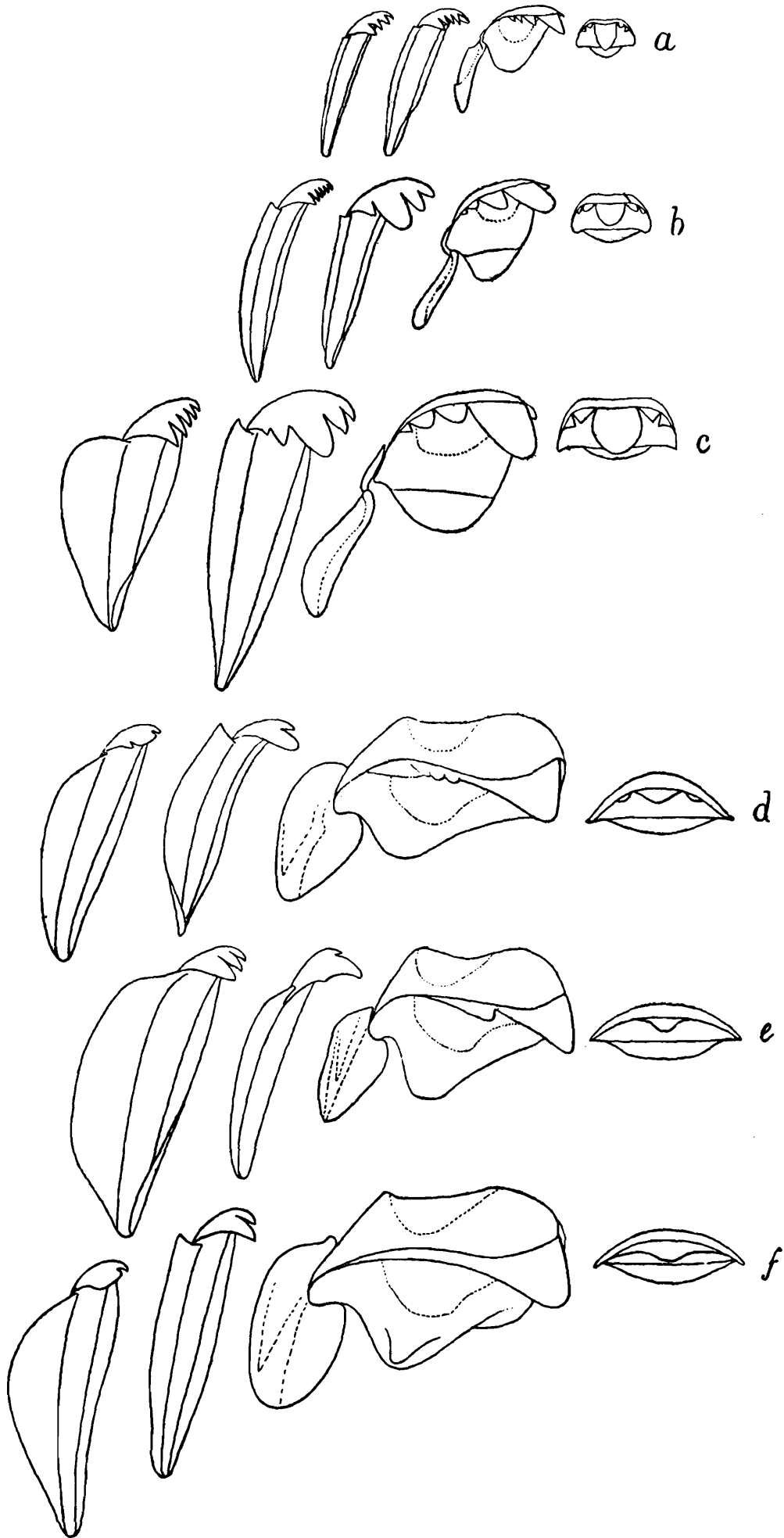
By the late N. ANNANDALE, D.Sc., C.I.E., F.R.S., Director, Zoological Survey of India.

At Major Sewell's request I have added to his paper a somewhat more detailed account of the radular teeth of *Pyrazus palustris* and of the changes which take place in their structure with the growth of the shell.

The radula of the Cerithidae has several characteristic features. Its formula is definitely 2, 1, 1, 1, 2. The central is a comparatively small tooth, transverse and sub-oval in shape. Its base is bluntly produced and it has a large central cusp, usually with several smaller denticulations on each side. The laterals have a highly peculiar structure. Each tooth is separated into two parts, a fixed basal plate and a distal free portion which articulates with the former; the cutting edge bears a large cusp and as a rule several smaller ones. The two marginals on each side are of simpler structure. Each has a membraneous flap along its outer margin and each as a rule has several cusps, one of which may be enlarged on the inner marginal or on both teeth.

In the youngest individuals of *P. palustris* examined (they are in Major Sewell's first group) the teeth are quite normal. The central is small, not very much broader than deep and irregularly oval in outline. It has a blunt central cusp with two smaller denticulations on either side. The laterals are rather more characteristic. The basal plate is elongate and band-shaped (its usual form in the family), while the distal free portion is rather broader than long and much broader than the basal plate. It has, as is usual, a prominent boss at its lower extremity and a large cusp with one small cusp or denticulation on the inner side and three, which diminish in size from within, on the outer side. The marginals are sub-equal and not much longer than the lateral. Each has five denticulations, of which the outermost is rather larger than the others.

The series of drawings which I have had made from six radulae extracted from molluscs of different ages show very clearly what happens in the course of growth. Fig. 11*a* represents the radular teeth of a young individual with a shell about 1 cm. long, fig. *b* that of an individual probably in the second year of life, fig. *c* that of an individual in the third year, while *d*, *e*, *f* are from adult or sub-adult individuals of different ages. It will be seen from these figures that three important changes take place: (i) the central becomes gradually lower and more transverse and its lateral extremities become pointed and produced; (ii) both parts of the laterals, and especially the distal portion, become relatively wider, and (iii) the cusps of all the teeth are reduced in number, the central and laterals becoming unicuspid and the marginals bicuspid. It should be noted that the magnification of fig. 11*d*, *e*, *f* is less than that of figs. *a*, *b*, *c*.

FIG. 11.—Radular teeth of *Pyrazus palustris*.

Except in the central, in which the main cusp is relatively smaller in the adult than it is in the young, the reduction in number of the cusps is accompanied by an increase in relative breadth and evidently comes about by a fusing of the cusps or denticulations rather than by an actual numerical reduction.

There are several points of general interest to be noted. In the first place, the radula of the young of this mollusc is much more like that of other species in the family than is that of the adult. In the second place these radular changes in the course of growth are a specific (or possibly a generic) and not a family character, for no such changes exist in the species of *Telescopium*, *Cerithidea* and *Tympanotonos* examined, though they have been observed in specimens of *P. palustris* from several different localities. Thirdly, Major Sewell has not observed that they are correlated with any change of habits on the part of the mollusc. On this last point, however, further observations are desirable.

THE ORIENTAL SPECIES OF THE GENUS *MUSCA* LINNAEUS.

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(Plates XXIX—XXXIII.)

In several recent papers one of the writers has recorded his studies of all the existing types of the species of the genus *Musca*, and as a result of this work it has been possible to accord the species their final names. In the present paper, the second ¹ of a series on the Oriental Muscidae, we propose re-describing all those species of *Musca* at present known to us from the Region. It should be noted, however, that this paper is not meant to be final, but rather a preliminary contribution with that end in view. Although our knowledge of the Oriental species is much more complete than that of those of other Regions, further study of fresh material of a few of the rarer species is necessary before systematic work on the family can be completed.

Although the primary object of this paper is a systematic study of the species, we have endeavoured to make it of practical use to medical and veterinary officers to whom a knowledge of the species is of the first importance. Keeping this object in view it is necessary to explain shortly some of the terms used in the keys and descriptions.

EXTERNAL CHARACTERS OF USE IN DETERMINING SPECIES.

General Colour.—In the first place it should be noted that the majority of the species of this genus are greyish flies with well-marked dark stripes on the dorsal surface of the thorax. The males of three species, *vitripennis*, *tempestiva* and *albina* are, however, metallic and thoracic stripes are absent. The females of *tempestiva* and *albina* are not metallic and have well marked thoracic stripes; the female of *vitripennis* has a distinct metallic sheen but also has stripes.

Head.—The males of the majority of the species are sub-holoptic, the front, or area between the eyes, being very narrow. The males of the three species *domestica*, *fletcheri* and *inferior* are dichoptic, the front being about half the width of an eye. In this type of front the eyes are referred to in the key as “widely separated,” (Pl. XXIX, fig. 3). In some males, e.g. *nebulo*, *sorbens* and *spinohumera*, the front, though still dichoptic, is much narrower, varying from one-fifth to one-eighth the width of an eye, in this type the eyes are referred to in the key as “well separated,” (Pl. XXIX, fig. 4). In the majority of the species the front is very narrow, with the eyes almost approximated in the middle line. The eyes in this type are referred to as “narrowly separated,” (Pl. XXIX, fig. 5).

¹ The first is “A revision of the Sarcophaginae of the Oriental Region” by the Junior Author, (*Rec. Ind. Mus.* XXVI, p. 193). It is hoped that the remaining groups will be revised by the end of 1925.

In the males of a few species, and in one female, the eyes are hairy. In the male *vitripennis* and in both sexes of *dasyops* the hairs are very numerous and can easily be seen with a pocket lens. In the males of *gibsoni* and *hervei* the hairs are very scanty and can only be seen with a high power. The remaining species of the genus have bare eyes. In some males the upper and middle facets of the eyes are distinctly larger than the remainder. This character is well seen in the male of *xanthomelas*.

There are very few reliable characters to be found on the head of the females. The front is always wide, and its width in relation to the width of an eye is of some use in separating the species, but it should be remembered that there is considerable variation in different specimens of the same species. The parafront, the sclerite situated between the outer margin of the frontal stripe and the inner margin of the eye, always bears a number of bristles, (parafrontal bristles, often called orbital bristles), arranged in one, two, three or more rows. In many of the species in which the bristles appear to be arranged in one row it should be noted that there is a second row commencing at the lower third of the frontal stripe; this arrangement is seen in *domestica*. In the female of *conducens*, however, there is a single row of bristles down to the lower end of the frontal stripe. In *Musca bezzii* there are three rows of bristles, while in the female *albina* there are four and even five. Here again it is necessary to point out that there is considerable variation in the number and arrangement of these bristles in the same species. The characters of the frontal stripe, the narrow dark band in the middle of the front, are of doubtful use in separating the species; the width varies considerably and if the fly has been pinned before it has hardened the whole front is apt to collapse and the stripe may appear very narrow; in the female *albina* the frontal stripe is strikingly narrow and the eyes widely separated.

In the majority of the species the palp is black, but in *conducens*, *planiceps*, *inferior* and *crassirostris* it is yellow or yellowish. This character together with others is of considerable use in recognizing these species.

The structure of the proboscis should always be noted, especially in specimens in which it is partially or completely extended. On examining the extended proboscis of *domestica* or *nebulo* it will be noted that the mentum or posterior wall of the labium is not markedly dilated and does not project downwards to form a bulbous portion, (Pl. XXIX, fig. 13), this type of mentum is common to the majority of the species, which are not biting flies. An enlarged and strongly chitinized mentum indicates that the species is either on the way to becoming a biting fly or is one already. This change in the structure of the mentum is seen in *conducens* which, though a blood feeder, is not a true biting fly. The enlargement of the mentum is associated with a diminution in the number of the prestomal teeth and increase in their size; in *conducens* the prestomal teeth though reduced in number and considerably enlarged are not strong enough to scratch the skin in order to draw blood. In *Musca planiceps*, however, the teeth are used to scarify the skin and this species is a true biting fly. This type of proboscis has reached its highest de-

velopment in *M. inferior* and *M. crassirostris*, (Pl. XXIX, fig. 14); the mentum and teeth have become strongly chitinized and there is a well developed interdental armature. The proboscis in these species is a most efficient scratching organ. It is however quite an erroneous idea to think that the proboscis of *crassirostris* is anything more than a special adaptation to the blood sucking habit. Structurally it is exactly similar to the proboscis of *domestica*. If the proboscis of *crassirostris* is examined with a hand lens, especially when the labella are everted and the teeth exposed, it is suggestive of a piercing organ, (*Stomoxys*), but there is no doubt whatever that the proboscis does not penetrate the skin.

Thorax.—The number and arrangement of the bristles, (macrochaetae), on the thorax is of considerable use in separating the species, but it should be remembered that they are very variable and if used alone are sure to lead to errors in determination, (Pl. XXIX, figs. 7 and 10).

In *Musca domestica*, the type of the genus, there are normally three presutural dorso-central bristles, the most anterior the smallest, and four posterior dorso-central bristles. There are no presutural acrostichal bristles and only one behind the suture at the posterior end of the scutum. This number and arrangement is common to most of the species and is well seen in *M. bezzii*, *pattoni*, etc. It is not uncommon to find specimens in which the first presutural dorso-central bristle is absent or greatly reduced; occasionally one of the post-sutural dorso-central bristles also is absent or reduced in size. In a few species, e.g., *planiceps*, *senior-whitei* and *crassirostris* there are only two presutural dorso-centrals and only two post-sutural, the most anterior of the latter being very small, hardly to be called a macrochaete. The reduction of these bristles is even more marked in *M. fletcheri* and *M. inferior* in which the two presutural dorso-central bristles are very small and hardly to be called macrochaetae, and there are only two strongly developed post-sutural bristles, but the extreme limit in the reduction of bristles is seen in *M. albina* in which there is only one post-sutural dorso-central and the acrostichal bristles are entirely absent. Further, in this species the sterno-pleural bristles are also absent. The arrangement of the bristles of the thorax is seen in Plate XXIX, figs. 7 and 10.

Abdomen.—On examining the abdomen of a species of *Musca* it will be noted that there are only four visible tergites. If the abdomen is cleared in potash and mounted flat after slitting the tergites in the middle line it will be noted that there are six stigmatic openings in the male and five in the female. The apparent first tergite has two stigmatic openings, and it is evident that it represents two tergites fused together. The anterior strip may be either the true first tergite or the second, making the apparent first tergite either the true second or the true third. The sternite corresponding to the apparent first tergite evidently belongs to the larger part of the latter.

It is not possible to express a final opinion on the number of tergites and sternites; we do not know for certain yet whether the true first tergite has entirely disappeared or whether it is reduced and is represented by the slip of chitin at the anterior end of the first tergite. The apparent first sternite evidently belongs to the larger part of the apparent first tergite. Extensive comparative and developmental

studies are necessary before it can be affirmed that an explanation applicable to one genus of the Muscidae Calyptratae is true for another.

To avoid any confusion the word "apparent" is to be understood before the words "tergite" and "sternite" in the keys and descriptions.

The colour of the tergites and sternites is of very considerable value when taken in conjunction with other characters for separating the different species. Here again there is of course much variation but each species has a more or less characteristically marked abdomen. The sternites are orange in the majority of species, but in some they are black (*bakeri*, *hervei* and *lucens*; Pl. XXIX, figs. 1 and 2). In *hervei* the ventral margins of the tergites adjacent to the sternites are also black, (Pl. XXIX, fig. 2). In some of the species it is not uncommon to see the first tergite black and the others orange, as is the case in *conducens*.

So far we have not been able to discover any reliable characters in either the male or the female hypopygium for separating the species. The differences are so small and there is so much variation that we would not recommend anyone to attempt to use these structures in separating species.

Venation.—The venation of *Musca* is illustrated in Plate XXIX, fig. 8. In the majority of the species cell R₅, (1st posterior), is narrowly open; in *M. lucidula* it is closed. There is some variation in the bend of vein M₁+₂, (4th longitudinal), it may be rounded as in *tempestiva* or more or less angled as in *domestica*. The position of the medio-cubital, (posterior), cross-vein in relation to the bend is somewhat variable.

The most valuable characters on the wing are to be found in the number and arrangement of the hairs on the posterior border of the base of the radial vein, and in the presence or absence of the small bristles on the ventral side of vein R₄+₅, (Pl. XXIX, fig. 6). The hairs on the base of the radial vein are fairly constant for each species and are most useful in separating closely allied species. The small bristles on the ventral side of vein R₄+₅ may be limited to the base of the vein only, (*domestica*), or they may extend in a row up to and beyond the radio-medial, (anterior), cross-vein, (Pl. XXIX, fig. 6). The number of hairs and the presence or absence of the bristles on vein R₄+₅ and their arrangement are largely used in separating the species in the keys. Occasionally the hairs and bristles may be entirely rubbed off, and if there is any doubt as to their presence or absence the wing should be removed, placed in absolute alcohol for a few minutes, then in clove oil, and later mounted in canada balsam on a slide ventral side uppermost. A row of scars, (Pl. XXIX, fig. 9), on the ventral side of the vein extending up to and beyond the radio-medial cross-vein will leave no doubt as to whether the species possesses these bristles or not. It should be noted, however, that there are normally some circular pit-like areas on the ventral side of vein R₄+₅ which may be mistaken for bristle-scars; they are not so numerous as the latter and do not extend in a continuous row up to and beyond the radio-medial cross-vein.

If the beginner makes himself familiar with the characters noted above he should have no difficulty in using the keys. Occasionally one finds an atypical specimen which it is not possible to name, it should be submitted to an expert. Lastly the beginner should never attempt to name a damaged or a greasy specimen. The keys have been tested and will be found, we hope, of considerable use in determining the Oriental species at present known to us. In using them, and in consulting the descriptions, all examinations should be made with the head of the specimen directed towards the observer. The figures of abdomens in Plates XXX—XXXIII are drawn in this position also. The appearance of the abdominal pattern if viewed in the reverse direction is usually quite different. The drawings of the abdomens on Plates XXX—XXXIII have been executed by Mrs. Patton and the junior Author.

Key to the males of the Oriental species of the genus Musca.

- | | |
|--|----------------------|
| 1. Species with metallic thorax and no stripes | 2 |
| Species without metallic thorax and with dark stripes .. | 4 |
| 2. Eyes densely pubescent. 1st abdominal tergite yellow with a broad metallic green stripe; 3rd tergite with a large greyish patch. Kashmir | <i>vitripennis.</i> |
| Eyes bare | 3 |
| 3. Sternopleural bristles absent. Eyes well separated. 1st abdominal tergite light orange with a median basal dark spot; 2nd tergite with a similar spot produced forwards to form an incomplete median stripe; 3rd tergite similar; 4th tergite with a light median silvery patch and admedian dark spots. Ceylon; Baluchistan .. | <i>albina.</i> |
| Sternopleural bristles present. Eyes closely approximated. 1st abdominal tergite black. Kashmir .. | <i>tempestiva.</i> |
| 4. Eyes hairy, densely or sparsely so | 5 |
| Eyes bare | 7 |
| 5. Eyes densely hairy. Thorax with two broad black stripes. 1st abdominal tergite black with blue admedian spots on posterior border. China .. | <i>dasyops.</i> |
| Eyes with a few scattered microscopic hairs | 6 |
| 6. Thorax with four broad black stripes. 1st abdominal tergite dark brown except for narrow posterior bands and margins of tergites, which are orange. Indian Hills .. | <i>gibsoni.</i> |
| Thorax with four broad black stripes. 1st abdominal tergite with two small round silvery admedian spots. China; Shillong; Simla | <i>hervei.</i> |
| 7. Thorax with two broad black stripes | 8 |
| Thorax with four broad black stripes | 11 |
| 8. Eyes narrowly separated | 9 |
| Eyes well separated | 10 |
| 9. 1st abdominal tergite mainly orange, the anterior margin black; 2nd tergite with a black median stripe, well marked adjacent and marginal silvery stripes; 3rd tergite similar with a much narrower dark median stripe. Sternites orange. South India .. | <i>villeneuvei.</i> |
| 1st abdominal tergite entirely black. Sternites black. Ceylon | <i>lucens.</i> |
| 10. Thorax bluish. 1st abdominal tergite entirely dark orange to black | <i>vetustissima.</i> |
| Thorax greyish. 1st abdominal tergite orange, sometimes dark orange with a dark median stripe .. | <i>sorbens.</i> |
| 11. Squamae with hairs on their upper and anterior surface. 1st abdominal tergite dark brown to black with bluish grey patches on posterior border | <i>inferior.</i> |
| Squamae bare | 12 |

12. Eyes widely separated, front from a third to about half width of an eye 18
 Eyes well separated, front from one-fifth to one-eighth an eye 14
 Eyes either narrowly separated or closely approximated .. 18
13. 1st abdominal tergite mainly black, the lower border narrowly orange with yellow pollinosity on each side of the median black stripe. Vein R₄₊₅ with ventral bristles extending to beyond the radio-medial cross vein. Root of radial-vein with five or six hairs. Carnatic Coast *fletcheri*.
 1st abdominal tergite mainly orange with a broad median black stripe and black anterior margin. Vein R₄₊₅ with a few bristles on ventral side at base, not extending to cross-vein. Root of radial vein with one small hair. Extreme North India and possibly at large Ports .. *domestica*.
14. Vein R₄₊₅ with a row of bristles on ventral side extending to beyond the radio-medial cross vein. Root of radial vein with five, sometimes seven, small hairs. 1st abdominal tergite orange to black with a narrow brown band at lower border and margins; 2nd tergite with a broad median black stripe extending some distance along anterior border of tergite. Indo-Gangetic Plain; Ceylon *spinohumera*.
 Vein R₄₊₅ with a few basal hairs ventrally but none extending towards the radio-medial cross-vein .. 15
15. 1st abdominal tergite entirely dark orange or black; 2nd tergite with a broad median black stripe widening out anteriorly and posteriorly, silvery spots at side of stripe and at margins of tergite well marked. Eyes with distinct area of enlarged facets. Plains of India .. *xanthomelas*.
 1st abdominal tergite mainly light orange .. 16
16. 2nd abdominal tergite with a narrow median black stripe and silvery margins; 3rd tergite similar *nebulo*, (var.)
 2nd abdominal tergite orange with a broad median black stripe 17
17. 2nd abdominal tergite light orange with a broad median black stripe and silvery margins; 3rd tergite orange with a narrower median black stripe, admedian dark stripes and broad intervening and marginal silvery stripes; 4th tergite orange with silvery lateral stripes. Throughout Oriental Region *nebulo*.
 1st and 2nd tergites very similar to those of *nebulo*, but 3rd and 4th tergites with dark brown admedian and much darker greyish intervening stripes. Throughout Oriental Region *vicina*.
 18. Sternites black 19
 Sternites orange 20
19. Ventral margin of tergites close to sternites also black. 1st abdominal tergite dark brown or black with two small admedian spots of silvery colour near posterior border. Eyes minutely pubescent. S. China; Burma; Assam; Simla *hervei*.
 Ventral margin of tergites close to sternites orange. 1st abdominal tergite black without any silvery spots. Philippine Islands ... *bakeri*.
20. Vein R₄₊₅ with ventral bristles to beyond the radio-medial cross vein 21
 Vein R₄₊₅ with ventral bristles at base only .. 25
21. 1st abdominal tergite mainly black .. 22
 1st abdominal tergite either light or dark orange .. 23

22. 1st abdominal tergite except for a narrow orange band at the postero-lateral margin black; 2nd tergite orange with a broad median black stripe and admedian and lateral silvery stripes. Root of radial vein with seven hairs. Indian Hills *bezzii*.
- 1st abdominal tergite mainly black except for a narrow bluish white band on posterior border; 2nd tergite with a broad median black stripe and two narrower black admedian stripes. Root of radial vein with never more than two hairs. Plains of India, Calcutta; Malaya; Java .. *senior-whitei*.
23. Proboscis with mentum large and well chitinized, (and if labella everted prestomal teeth well seen), 1st abdominal tergite light orange, anterior margin dark brown and a dark brown spot at middle of posterior border; 2nd tergite light orange with well marked yellow pollen, and a small dark median spot at the posterior border sometimes extending forwards as a faint median stripe; 3rd tergite similar, the stripe more distinct .. *planiceps*.
- Mentum neither markedly nor strongly chitinized .. 24
24. 2nd tergite dark orange with a broad median black stripe, adjacent and marginal silvery spots; 3rd tergite very similar but median stripe with narrower adjacent and marginal silvery spots, the latter forming stripes. Java; Assam; Calcutta *illingworthi*.
- 2nd tergite light orange with a broad median black stripe, broad adjacent stripes and large marginal silvery spots; 3rd tergite very similar but median black stripe narrower. Plains of India.. .. *pattoni*.
25. Palpi light orange. Mentum very large and strongly chitinized, forming a distinct bulb at the base of the proboscis. Abdomen olive green; 1st tergite mainly black with a median black stripe, (in some specimens the tergite is mainly olive green, only the anterior border being black), 2nd tergite with a narrow median black stripe extending some distance along the anterior border of the tergite forming a narrow band; 3rd tergite with a narrower median black stripe. Throughout Oriental Region *crassirostris*.
- Palpi black, mentum not large and chitinized .. 26
26. 1st tergite mainly light orange .. 27
- 1st tergite either dark orange or black .. 28
27. 1st tergite except for a dark median anterior patch entirely orange; 2nd, 3rd and 4th tergites orange except for a faint dark median stripe on 2nd and 3rd. Widely distributed in Region *ventrosa*.
- 1st tergite with or without a complete black median stripe; 2nd tergite dark orange with a broad median black stripe and silvery stripes on each side, *no marginal silvery spots*; 3rd tergite similar but with well marked silvery stripe on each side of the median dark stripe and at the margins. South India; Ceylon; Burma .. *yerburyi*.
28. 1st tergite dark orange; 2nd light orange with yellowish white pollinosity and a broad black median stripe; 3rd tergite similar but with a narrower dark median stripe. Widely distributed in Region *conducens*.
- 1st tergite black 29
29. Inner thoracic stripes in front of suture as broad as the outer pair. 2nd tergite orange with a broad median black stripe extending along the upper border of the tergite forming a broad median band; 3rd tergite greyish with a narrow black stripe and dark brown admedian stripes. Kashmir *prashadi*.
- Inner thoracic stripes in front of suture much narrower than the outer pair. 2nd tergite dark orange with a broad median stripe and silvery adjacent and marginal spots; 3rd tergite similar but median stripe narrower. S. India; Ceylon *pulla*,

Key to the females of the Oriental species of the genus Musca.

- | | | |
|---|-----------------------|----|
| 1. Thorax and abdomen with metallic sheen, the former with four black stripes. 1st abdominal tergite black .. | <i>vitripennis.</i> | |
| Thorax without metallic sheen and with either two or four dark thoracic stripes | | 2 |
| 2. Eyes densely hairy. 1st abdominal tergite black with admedian bluish white spots on posterior border .. | <i>dasyops.</i> | |
| Eyes bare | | 3 |
| 3. Sternopleural bristles absent | <i>albina.</i> | |
| Sternopleural bristles present | | 4 |
| 4. Thorax with two black stripes | | 5 |
| Thorax with four black stripes | | 8 |
| 5. Stripes on thorax very broad and not divided in front of the suture | | 6 |
| Stripes not quite so broad and always divided in front of the suture | | 7 |
| 6. 1st abdominal tergite orange, the anterior margin black, and with a black median stripe; 2nd tergite orange with silvery reflections and a broad median black stripe. Sternites orange | <i>villeneuvei.</i> | |
| 1st tergite light orange without any markings; 2nd tergite similar with some blue reflections. Sternites black .. | <i>lucens.</i> | |
| 7. Thorax greyish. Abdomen greyish with dark brown and yellowish stripes. 1st tergite dark brown | <i>sorbens.</i> | |
| Thorax bluish. Abdomen bluish with black stripes and bands. 1st tergite black | <i>vetustissima.</i> | |
| 8. Sternites black | | 9 |
| Sternites orange | | 10 |
| 9. Ventral margins of tergites adjacent to sternites also black. 1st tergite black with bluish white admedian spots .. | <i>hervei.</i> | |
| Ventral margins of tergites adjacent to sternites orange. 1st tergite dark brown with bluish white admedian spots on posterior border | <i>bakeri.</i> | |
| 10. Vein R ₄₊₅ with bristles ventrally to beyond the radio-medial cross vein | | 11 |
| Vein R ₄₊₅ without bristles beyond the base ventrally .. | | 19 |
| 11. Squamae with hairs on upper surface. 1st tergite orange with two large round admedian bluish white spots on the posterior border | <i>inferior.</i> | |
| Squamae bare | | 12 |
| 12. 1st abdominal tergite mainly black | | 13 |
| 1st abdominal tergite mainly orange | | 14 |
| 13. 1st abdominal tergite black with two admedian greyish-blue spots. 2nd tergite similar but with larger marginal greyish-blue spots; Root of radial vein with seven hairs. Parafrontal bristles in three rows. Large species | <i>bezzii</i> | |
| 1st abdominal tergite also black with greyish-blue admedian spots, forming a partial grey posterior band; 2nd tergite brown with dark median stripes and intervening and marginal greyish-blue spots or stripes. Root of radial vein with four hairs. Parafrontals with one row of bristles. Smaller species | <i>senior-whitei.</i> | |
| 14. Presutural dorso-centrals small. 1st tergite dark orange with a broad median black stripe and large bluish white spots on each side on the posterior border, the anterior margin of the tergite black. 2nd tergite orange with a narrow median dark brown and admedian triangular stripes and marginal yellowish spots not quite reaching the anterior border. Root of radial vein with five hairs. Mentum large and strongly chitinized .. | <i>fletcheri.</i> | |
| Presutural dorso-centrals well developed | | 14 |

15. 1st tergite orange without any definite markings except a median dark spot on posterior border; 2nd tergite orange with a dark median stripe, rest of tergite yellow pollinose. Root of radial vein with one hair. Mentum large and strongly chitinized *planiceps*.
 1st abdominal tergite dark orange with black stripes and bands. Root of radial vein with from one to seven hairs. 10
16. Root of radial vein as a rule with three hairs 17
 Root of radial vein either with one or seven hairs 18
17. 2nd, 3rd and 4th tergites mainly greyish white, the two former with dark median stripes well-marked, and well-marked admedian spots, their bases spreading out and forming posterior bands *gibsoni*.
 2nd, 3rd and 4th tergites mainly dark orange with sharply defined dark and white bands and stripes *illingworthi*.
18. Root of radial vein with one, rarely with two or three hairs *pattoni*.
 Root of radial vein with five to seven hairs *spinohumera*.
19. Palps light orange. Mentum large and strongly chitinized forming a characteristic black bulb at the base of the proboscis. Abdomen olive green *crassirostris*.
 Palps black. Mentum not enlarged to form a bulb at the base of the proboscis 20
20. 1st abdominal tergite either wholly or mainly black 21
 1st abdominal tergite either light or dark orange 22
21. 1st tergite entirely black; 2nd olive green with a broad black median stripe expanding anteriorly and with a narrow posterior black band. Parafrontals in one row. Small species *tempestriva*.
 1st tergite black with large bluish grey patches on each side of middle line of posterior border forming a more or less complete band; 2nd tergite olive green with narrow dark median and admedian stripes. Parafrontals in three rows. Large species *prashadi*.
 1st abdominal tergite almost entirely light orange 23
 1st abdominal tergite dark orange 25
23. 1st abdominal tergite light orange except for the extreme anterior border in the middle line, which is black. Remaining tergites orange without any markings, (sometimes 2nd and 3rd with a faint median dark stripe), thorax dark bluish *ventrosa*.
 1st tergite light orange except extreme anterior border in the middle line; remaining tergites with dark and light stripes well marked. Thorax greyish or bluish 24
24. T 2nd and 3rd tergites mainly bright orange; 2nd and 3rd tergites with a dark median stripe and well marked silvery stripes on each side and at the margins. Thorax bluish *yerburyi*.
 All abdominal tergites not so conspicuously orange but much more silvery; 2nd tergite with extensive silvery markings, a broad median black stripe, dark admedian stripes and silvery margins; 3rd tergite very similar. Thorax grey *nebulo*.
25. Inner thoracic stripes in front of the suture much narrower than behind it and narrower than the external stripes; 2nd tergite dark orange with a broad median black stripe and silvery admedian and marginal stripes, and a broad dark basal band *pulta*.
 Inner thoracic stripes in front of the suture as wide as behind it, and as wide as the external pair 26
26. Parafrontal bristles in one row throughout 27
 Parafrontal bristles in one row up to the lower third of the frontal stripe, thence in two rows 28

27. 2nd abdominal tergite olive green with a dark median stripe expanding anteriorly to form a partial band, and posteriorly to form a complete band along the posterior margin of the tergite; 3rd tergite olive green with a narrower median stripe and a very narrow posterior dark band .. *conducens*.
 2nd tergite orange with a median dark stripe expanding posteriorly to form a dark band, and with silvery margins;
 3rd tergite similar but median stripe and band narrower *xanthomelas*.
 28. Parafrontals narrowing distinctly towards vertex .. *domestica*.
 Parafrontals not narrowing towards the vertex .. *vicina*.

Short description of the Oriental species.

In the descriptions of the species no attempt is made to give details but only those characters are noted which are of use in identification.

The synonymy is now complete and the types of the species marked with an asterisk have been examined by the senior author.

Musca Linnaeus.

Byomya R.-D.; *Plaxemyia* R.-D.; *Placomys* R.-D.; *Philaematomyia* Aust.; *Pristirhynchomyia* Brun.; *Ptilolepis* Bezzi; *Eumusca* Towns.; *Promusca* Towns.; *Viviparomusca* Towns.; *Awatia* Towns.; *Lissosterna* Bezzi.

Musca domestica L.

? *Musca aurifacies* R.-D.; ? *Musca riparia* R.-D.; ? *Musca stomoxidea* R.-D.; ? *Musca campicola* R.-D.; ? *Musca vagatoria* R.-D.; ? *Musca hottentota* R.-D.; ? *Musca vicina* R.-D. nec Macq.; ? *Musca rivulans* R.-D.; *Musca corvina* F.; *Musca ludifica* F.; *Musca umbraculata* F.; ? *Musca frontalis* Rond.; * *Musca minor* Macq.; * *Musca australis* Macq.; ? *Musca lateralis* Macq.; ? *Musca chiliensis* Macq.; ? *Musca pellucens* Meig.; * *Musca pampasiana* Big.; * *Musca vicaria* Wlk.; * *Musca antiquissima* Wlk.; * *Musca calleva* Wlk.

Male.—Front wide, nearly half that of an eye; frontal stripe broad, black, with a slight waist about the middle; parafrontals narrow, black with bluish sheen, grey at lower border; cheeks silvery or yellowish.

Four thoracic stripes, each as wide as the front, complete, i.e., extending the whole length of the scutum.

Abdomen (Pl. XXX, fig. 1): first tergite with upper half black and lower half orange with a broad triangular stripe base upwards; second tergite orange with a broad black median stripe, the upper end spreading out a little along the margin, edged with indistinct silvery stripes, and with marginal yellowish white patches; third tergite with a similar median stripe edged with silvery stripes, clove brown admedian stripes and silvery margins; fourth tergite similar but all stripes narrower.

Female.—Front very wide, almost equal to that of an eye; frontal stripe very broad, black (brownish in immature specimens), almost half the width of an eye; parafrontals broad below but narrowing towards the vertex, dark bluish above, greyish below, at middle about a quarter the width of the frontal stripe; cheeks either silvery or yellow.

Four thoracic stripes, broad, about half the width of the frontal stripe, complete, the median pair often narrower than the external pair,

Abdomen (Pl. XXXII, fig. 27): first tergite usually entirely dark orange, often appearing black, sometimes the first tergite is not unlike that of the male; second tergite greyish yellow, often with a bluish sheen in fresh specimens, narrow to broad median black stripe and narrow to broad admedian black stripes spreading out along lower border of tergite; third tergite similar but median and admedian stripes narrower; fourth tergite greyish yellow with faint admedian dark stripes.

Specimens of this species have been sent us by Dr. Prashad from Kashmir, (Gandarbul, 6000 ft.), collected in June, and by Mr. Bainbrigge Fletcher from Kumaon, (Muktesar, 7000 ft.)

The male can be recognized by the wide front, almost half that of an eye, and the female by the characteristic parafrontals narrowed at the vertex. There are only a few hairs on vein R_{4+5} on the ventral side near the base, never extending outwards, and there is only one hair on the root of the radial vein.

2. **Musca vicina* Macquart (*nec* R.-D.)

* *Musca flavinervis* Thoms.; * *Musca flavifacies* Big.; * *Musca flavipennis* Big.;
? *Musca analis* Macq.; ? *Musca divaricata* Awati.

Male.—Front less than one-fifth that of an eye and less than half that of the front of *domestica*. In other respects similar to that species.

Abdomen (Pl. XXX, fig. 2): first and second tergites lighter orange; tergites iii and iv lighter than those of *domestica*.

Female.—Very similar to the female *domestica*, but parafrontals not narrowed to the same extent.

Abdomen (Pl. XXXII, fig. 28); first and second tergites much more orange than in *domestica*.

This species is one of the commonest in the Orient and is widely distributed even at high altitudes. One of the writers has examined many hundreds of specimens of *M. domestica* from different localities in Great Britain but has never yet seen this species. It first appears in the Palaearctic Region in the Mediterranean area.

The male can easily be distinguished from the male of *domestica* by the narrower front, the female is however difficult to distinguish from the female of that species.

3. *Musca nebulo* F.

* *Musca determinata* Wlk. *nec* Patton; ? *Musca multispina* Awati.

Male.—Front narrow, about one-sixth to one-seventh the width of an eye and less than a quarter that of the male *domestica*, cheeks silvery, sometimes yellow.

Four thoracic stripes, broad, parallel, twice as broad as front, complete.

Abdomen (Pl. XXX, fig. 3): first tergite light orange, anterior border black, with black median stripe; second tergite light orange with a

broader median black stripe edged with well marked silvery stripes, and silvery marginal spots; third segment similar, the median stripe narrower; fourth tergite with a median dark area never forming a complete stripe.

Female.—Front wide but considerably less than that of an eye; frontal stripe about one-fifth that of front; parafrontals greyish except vertex, which is dark.

Thoracic stripes similar to those of male. Ground colour of thorax light grey.

Abdomen (Pl. XXXII, fig. 29); first tergite light orange, the middle of the anterior border black, no complete median dark stripe, but always with a dark spot at middle of posterior border of tergite; second tergite silvery with a median black stripe and dark brown admedian stripes, the marginal area often with a bluish tinge; third tergite similar but with the median dark stripe narrower; fourth tergite mainly silvery with some brown patches.

This species is widely distributed throughout the Oriental Region; in India it is common in some of the hill stations. It is the important bazaar fly and swarms on all food stuffs.

4. **Musca yerburyi* Patton.

* *Musca incerta* Patton nec Wlk.

Male.—Front very narrow, about one-twelfth an eye.

Thorax with four dark stripes, the ground colour with a bluish tinge.

Abdomen (Pl. XXX, fig. 4); first tergite orange, the anterior border black, the median stripe often incomplete, but always a dark spot in middle of the posterior border; second tergite bright orange with a broad median black stripe extending a little along the anterior margin, edged with well marked silvery stripes, *the margins of tergite always without any silvery spot or stripe*; third tergite with a narrower median stripe, edged with silvery stripes as on preceding segment, broad dark brown admedian stripes and silvery margins, fourth tergite with a variable dark median patch and narrow to very narrow admedian stripes and silvery margins.

Female.—Front about half the width of an eye.

Thorax as in male.

Abdomen (Pl. XXXII, fig. 30); first tergite similar to that of male; second also similar but always with marginal silvery spots; third tergite similar to second; fourth with a narrow, somewhat incomplete, median dark stripe and silvery margins.

This species is widely distributed in South India and is mainly a bazaar fly. The male can be distinguished from *nebulo* by noting that there are never marginal silvery spots on the second tergite. If there is still any doubt in separating the species it should be noted that the thorax is always darker than in *nebulo*; the silvery stripe on each side of the median black stripe on tergites ii and iii is also very characteristic.

5. **Musca sorbens* Wied.

* *Musca humilis* Wd.; * *Musca spectanda* Wd.; * *Musca latifrons* Wd.; * *Musca mediana* Wd.; * *Musca angustifrons* Thoms.; * *Musca bivittata* Thoms.; * *Musca sordidissima* Wlk.; * *Musca eulaeniata* Big.; *Musca scapularis* Rond.; * *Musca dichotoma* Bezzi; * *Musca biseta* Hough.; *Musca conducens* Patt. nec Wlk.; ? *Musca promisca* Awati.

Male.—Front narrow, one-sixth to one-eighth an eye.

Two broad thoracic stripes not interrupted at suture.

Abdomen (Pl. XXX, fig. 5): first tergite either light or dark brown; if only dark along anterior border, there are usually two well marked admedian brown spots; second tergite with dark brown median stripe spreading out along the anterior border of the tergite to fuse with the dark area of first tergite, edged with broad silvery stripes and with silvery marginal spots; third tergite with a narrower dark median stripe, edged with silvery stripes and with marginal spots; fourth tergite with narrow dark median stripe, narrow dark brown admedian stripes and marginal silvery patches.

Female.—Front about equal to an eye in width. Frontal stripe narrow with straight sides; parafrontals wide, equal to about half the width of the frontal stripe at middle, grey; cheeks grey.

Two thoracic stripes divided in front of the suture.

Abdomen (Pl. XXXII, fig. 31); first tergite black; second tergite with wide black median stripe widening out anteriorly and posteriorly, edged with bluish white spots, broad admedian dark brown to black stripes widening out anteriorly and posteriorly, and marginal greyish yellow spots; third tergite similar, the median stripe narrower, the admedian spots varying in width according to the angle at which the specimen is held; fourth tergite with narrow dark median stripe and indistinct dark admedian ones.

Musca sorbens is one of the most widely distributed subtropical and tropical house and bazaar flies. As it breeds in cow dung as well as in horse and human excreta it is common to find it on cattle and horses far from human dwellings. The female deposits its eggs in patches of cow dung in the field and it is common to find large numbers of its larvae in very small patches of dung. Many of these larvae fail to become full grown and as a result pupate prematurely and hundreds of small specimens of adults hatch out of such puparia. These small specimens are extremely persistent in the way in which they settle on the human body searching for sweat or exudations from cuts, sores, etc. They are also common on animals behaving much as do the species of Group II (Hæmatophagous species). It is quite common to see large numbers sitting round the eyes of small children, feeding on any discharge from the eye. *M. sorbens* is therefore an important carrier of the bacteria of eye diseases.

This species is also abundant on human food especially when exposed for sale in bazaar shops. It is therefore of very peculiar interest as it links up the true house frequenting species such as *nebulo* and *vicina* with those of Group II which are only found on animals.

M. sorbens is easily distinguished from the next species by its greyer thorax, and in the male by its wider front.

6. **Musca vetustissima* Wlk.

? *Musca pumila* Macq.; **Musca niveisquama* Thoms.; *Musca humilis* auctt. nec Wied.;
Musca corvina Froggatt nec F.; *Musca minor* Patton nec Macq.

Male.—Front very narrow, about one-twelfth an eye.

Thorax with two very broad black stripes, the ground colour bluish grey.

Abdomen (Pl. XXX, fig. 6): first tergite black; second orange with a broad black median stripe, broadly edged silvery, and with marginal silvery spots which often coalesce with the silvery stripes forming a white band as shown in figure; third tergite with a narrower median black stripe edged with broad silvery stripes, and with broad silvery marginal spots, posterior margin often with a narrow dark brown posterior band; fourth tergite with a median dark area and silvery marginal spots.

Female.—Front wide, nearly equal to an eye in width. Parafrontals steel grey.

Thorax with two broad black stripes divided in front of suture. Ground colour bluish grey.

Abdomen (Pl. XXXII, fig. 32): first tergite black; second with a broad black median stripe, broad black posterior band, narrow black admedian stripes and remainder of segment bluish grey; third tergite similar but stripes narrower and either with or without a black posterior band; fourth tergite with median dark area and silvery margins.

Musca vetustissima is widely distributed in the Oriental Region and breeds mainly in human excreta, its habits are similar to those of *sorbens*. In Australia it is known as the "camp" or "bush fly," and in that Continent takes the place of *sorbens*.

7. *Musca vitripennis* Meig.

* *Musca osiris* Wd.; ? *Musca sugillatrix* R.-D.; ? *Musca phasiaeformis* Meig.

Male.—Front about one-tenth width of eye. Eyes densely pubescent. Thorax dark metallic green without any stripes.

Abdomen (Pl. XXX, fig. 7): first tergite orange with a broad dark metallic green area; second brown with a broad dark green median stripe; third with a large greyish patch occupying middle of tergite and a small median spot near posterior border; fourth almost entirely greyish with some metallic sheen, and small brown spots at lower margins.

Female.—Front slightly wider than an eye; frontal stripe narrow, black, about one-third width of front; parafrontals wide, grey, metallic at vertex; cheeks grey.

Four dark thoracic stripes; admedian pair narrow, complete; outer pair forming a dark spot in front of suture, behind it indistinct and tending to merge into the admedian stripes; ground colour of thorax greyish with some metallic sheen.

Abdomen (Pl. XXXII, fig. 33): first tergite dark grey to black with some metallic sheen; second tergite grey with a broad median stripe and a black band at posterior margin, with some metallic sheen; third tergite

dark grey with a narrow dark median stripe and metallic sheen; fourth tergite dark grey without any definite dark markings.

This species was sent to one of us by Dr. Prashad from Kashmir; a male from Baniar on cattle and a female from Kukarnag on a horse. The male can always be recognised by its densely hairy eyes, and the colour of the female is very characteristic. As elsewhere it is usually found on or near animals. It breeds in cow and horse dung.

8. *Musca tempestiva* Fallen.

Musca cuprea Macq.; ? *Musca nana* Meig.

Male.—Front very narrow.

Thorax black with some metallic sheen.

Abdomen (Pl. XXX, fig. 8): first tergite all black; second grey with a broad median black band extending almost to middle of tergite, a narrow black band along posterior border; third tergite with a narrower black band along anterior border and a much narrower dark posterior band, with a narrow median dark stripe; fourth tergite grey, often with a dark patch about the middle not forming a definite stripe.

Female.—Front wide, equal to an eye in width. Frontal stripe black and almost half an eye in width.

Thorax grey with four narrow black stripes, inner pair well marked in front of suture, but behind it tending to merge into the outer pair.

Abdomen (Pl. XXXII, fig. 34): as in male except that the black bands on the second tergite are usually wider.

This small species was sent to one of us by Dr. Prashad from Dalchigam Rakh, Kashmir.

9. **Musca lucens* Villeneuve.

Male.—Front very narrow, eyes closely approximated in middle line. A large-lensed area present.

Thorax with two broad black stripes, united in front of the suture. Ground colour yellowish with some blue pollinosity.

Abdomen: first tergite entirely black; second yellow with a broad median black stripe extending in front to form an anterior, and behind to form a posterior band; third tergite yellow without a median stripe but with a dark posterior band; fourth tergite yellow. Sternites all black.

No bristles on vein R_{4+5} except near base.

Female.—Front almost the width of an eye. Frontal stripe about one-third width of an eye. Vertex steel blue.

Thorax: ground colour bluish with two broad black stripes, which in one specimen seen are divided anterior to the suture.

Abdomen: first tergite light brown, unmarked; second similar with blue pollinosity; third similar. Sternites black.

Re-described from specimens from Ceylon, (Trincomali and Hara-gam) in British Museum, (Yerbury), which we believe to be Villeneuve's *lucens*.

10. **Musca albina* Wied.

* *Musca speculifera* Bezzi ; *Musca beckeri* Schnabl.

Male.—Eyes well separated.

Thorax dark metallic without any stripes.

Abdomen yellow ; first tergite with a dark median spot on posterior border ; a similar spot on second and third tergites ; fourth tergite with a silvery patch.

Female.—Front very wide, equal to width of an eye ; frontal stripe very narrow ; parafrontals wide with four rows of bristles.

Thorax silvery with four black stripes.

Abdomen (Pl. XXXII, fig. 35) : first tergite yellow with a dark posterior band, which may only be limited to the middle of the posterior border ; second tergite silvery with a broad black median stripe and a black posterior band.

We have seen a single female of this species from Baluchistan, in the Indian Museum collection, and several specimens of both sexes in Col. Yerbury's collection from Ceylon now in the British Museum. The male is very like the male of *lucidula*, and as they both occur in Egypt *lucidula* can only be distinguished from *albina* by the presence of sternopleural bristles, which are always absent in *albina*. In a recent paper Bezzi has erected the genus *Lissosterna* for this species.

11. **Musca pulla* Bezzi.

* *Musca craggi* Patton.

Male.—Front narrow, one-seventh to one-eighth that of an eye.

Thorax with four black stripes, the inner pair always much narrower than the external in front of the suture.

Abdomen (Pl. XXX, fig. 9) : first tergite dark brown to black ; second brown with a broad median black stripe expanded below and spreading out a little along the middle of the anterior border, edged with indistinct silvery spots and with a large yellowish white marginal spot ; third tergite brown with a narrower median black stripe, edged with silvery spots, the posterior border of the tergite with a narrow dark band.

Female.—Front wide, about equal to that of an eye ; frontal stripe about equal to half of this.

Thorax with four black stripes as in the male, the inner pair narrower than the outer in front of the suture.

Abdomen (Pl. XXXII, fig. 36) : first tergite dark brown to black ; second tergite brown with a dark median stripe, a dark band along the posterior border and also along the anterior border, the former usually the broader with well marked marginal yellowish spots ; third tergite similar but stripes and bands narrower.

This species is widely distributed in parts of Ceylon and South India. It can readily be recognized by the narrow presutural inner thoracic stripes. Bezzi first recorded it from East Africa.

12. **Musca ventrosa* Wied.

* *Musca xanthomela* Wlk. ; * *Musca pungoana* Karsch ; * *Musca nigrithorax* Stein ;
Musca kasauliensis Awati.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four broad black stripes on a dark bluish grey ground ; in some lights the thorax appears of a uniform shining black colour.

Abdomen (Pl. XXX, fig. 10) : orange throughout without any definite bands or stripes ; sometimes there is a faint dark median stripe on the second and third tergites as shown in the figure.

Female.—Front a little more than half the width of an eye.

Thoracic and abdominal markings similar to those of male. The figure of the abdomen (Pl. XXXII, fig. 37) shows an appearance commonly encountered, with dark semi-digested blood showing in the gut through the tergite wall.

This characteristic species with its dark thorax and orange abdomen is widely distributed in the Oriental Region. It is commonly seen flitting about on cattle and horses.

13. **Musca villeneuvei* Patton.

Male.—Front very narrow with eyes closely approximated.

Thorax with two broad black stripes ; the light bluish grey median presutural stripe is well marked.

Abdomen (Pl. XXX, fig. 11) : first tergite brown, its upper border black with an indistinct and incomplete median dark stripe ; second tergite brown with a broad black median stripe expanding T-shape along the anterior border, edged with silvery patches, with marginal yellowish white spots, lower border with a very narrow dark band ; third tergite similar but the median black stripe narrower, and lower border with a wider dark band ; fourth tergite brown with a very narrow dark median stripe, edged with silvery stripes and marginal spots or patches.

Female.—Front about half the width of an eye.

Thorax with two very broad black stripes as in male.

Abdomen (Pl. XXXII, fig. 38) : with markings similar to those of the male except that the abdomen is darker brown.

The original specimens of this species were collected on elephant dung at Nilambur, South India. We have since seen a specimen from Ootacamund in the Pusa collection. It can be readily recognized by the two broad black thoracic stripes, which are not divided in front of the suture.

14. **Musca dasyops* Stein.

Male.—Front narrow, eyes densely hairy.

Thorax blackish with two broad black stripes.

Abdomen : first tergite black with two greyish admedian spots on the posterior border ; second tergite with a broad median black stripe black admedian stripes forming a posterior black band with the median stripe, intervening areas and margins greyish.

Female.—Front wide ; eyes densely hairy.

Thorax and abdomen similar to those of male except that the whole of the first tergite is black. (Pl. XXXII, fig. 39).

Recorded from Africa, Mount Kilimandjaro ; and China.

15. **Musca gibsoni* Patton & Cragg.

? *Musca latiparafrons* Awati.

Male.—Front narrow, eyes closely approximated, with scanty small hairs.

Thorax with four broad black stripes.

Abdomen (Pl. XXX, fig. 12) : first tergite dark brown, the sides and posterior border orange, and with a large dark brown median stripe ; second tergite orange with a broad black median stripe, adjacent silvery stripes and silvery marginal spots ; third tergite similar but median stripe narrower and admedian dark stripes well marked and forming an almost complete dark posterior band.

Female.—Front broad, parafrontals greyish yellow, bluish at vertex. Eyes finely hairy under a high power.

Thorax similar to that of male.

Abdomen (Pl. XXXII, fig. 40) : first tergite orange, anterior and posterior margins black and with a broad black median stripe sometimes incomplete ; second tergite with a narrower median dark stripe spreading out widely along the anterior border of the segment, dark admedian stripes and silvery marginal spots ; third tergite similar but the dark stripes much narrower and the intervening and marginal spots yellowish white.

This species is widely distributed in South India at elevations of 4,000 ft. upwards. We have also seen specimens from Sikkim and N. E. Assam, (Dibrugarh), in the Indian Museum collection. It is only found on and near animals and breeds in patches of cowdung dropped in the field.

16. **Musca pattoni* Aust.

Male.—Front very narrow, eyes closely approximated.

Thorax with four broad black stripes.

Abdomen (Pl. XXX, fig. 13) : first tergite light orange, the anterior border black with a narrow black median stripe ; second tergite with a broader median black stripe, edged with broad silvery yellowish white patches and with marginal white spots ; third tergite with a narrower median dark stripe, otherwise similar to second.

Female.—Front almost the width of an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXII, fig. 41) : first tergite orange with anterior margin black and with or without a narrow dark median stripe, a dark median patch on the posterior border forming an incomplete band ; second tergite with a broad black median stripe somewhat T-shape anteriorly, edged with well marked broad silvery stripes and marginal spots, intervening areas forming narrow dark admedian stripes widening out posteriorly to form incomplete brown bands ; third tergite similar but the median black stripe narrower.

Musca pattoni is widely distributed in India, Burma and Ceylon, and is common on animals in the field and about cowdung.

It is closely allied to *M. spinohumera* and can only be distinguished by noting the following characters :—the eyes of the male are narrowly separated whilst those of the male *spinohumera* are well separated.

The first tergite of the male abdomen in *spinohumera* has a broader black median area. The root of the radial vein has from one to three hairs whilst in *spinohumera* it has from five to seven. It should be noted that in both species vein R_4+5 has a row of small bristles on its ventral side extending up to and beyond the radio-medial cross vein.

Musca pattoni is oviparous and deposits a stalked egg; *M. spinohumera* is larviparous.

17 *Musca spinohumera* Awati.

Male.—Front narrow, about one-eighth to one-ninth of an eye. Eyes well separated.

Thorax with four broad black stripes.

Abdomen (Pl. XXX, fig. 14): first tergite light orange with a broad median black area forming a broad black stripe; second tergite light orange with a narrower median black stripe, adjacent and marginal silvery spots; third tergite similar but median stripe much narrower.

Female.—Front wide, but distinctly less than that of an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 43): first tergite orange with a median black stripe and black anterior border and greyish patches on each side of the median line on the posterior border; second tergite with a black median stripe spreading out anteriorly and forming an incomplete band, admedian brown triangular stripes and silvery intervening and marginal spots; third tergite with a median dark stripe variable in its width and sometimes incomplete posteriorly, otherwise similar to second tergite.

Musca spinohumera is an uncommon species which appears to be principally confined to the Indo-Gangetic Plain. We know it from Pusa in Bihar, from Kathiawar and from Ceylon. It breeds in cow dung.

18. **Musca xanthomelas* Wied.

Musca albomaculata auct. nec Macq.; *Musca dorsomaculata* auct. nec Macq.; *Musca convexifrons* auct. nec Thoms.

Male.—Front very narrow, eyes narrowly separated; area of large facets at middle and inner part of eye usually well marked.

Thorax with four broad black stripes.

Abdomen (Pl. XXX, fig. 15): first tergite dark brown to black; second tergite with a broad dark brown median stripe, forming a band on posterior border, admedian brown stripes and intervening and marginal silvery stripes and spots; third tergite with a much narrower median stripe edged with silvery stripes, band on posterior border much narrower.

Female.—Front wide, equal to width of an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 46): first tergite brown or dark brown, a broad black median stripe and a narrow posterior dark band; second tergite similar but median stripe narrower and posterior band broader third tergite similar.

The species is widely distributed in India.

19. ***Musca hervei** Villen.

Male.—Front narrow, eyes narrowly separated, with small scanty hairs.

Thorax with four broad black stripes.

Abdomen (Pl. XXXI, fig. 16): first tergite black with admedian posterior bluish white spots; second tergite orange with broad median black stripe, brown admedian stripes and intervening and marginal silvery spots; third tergite similar but median stripe narrower. All sternites black as well as ventral margins of tergites, suggesting the appearance of a line enclosed in brackets.

Female.—Front wide, equal the width of an eye.

Thorax and abdomen similar to that of male, tergites and sternites similarly coloured.

This species is recorded by Villeneuve from Southern China; we have seen one male from Upper Burma collected by Mr. Bainbrigge Fletcher. The Pusa collection contains a specimen from Shillong, and that of the Indian Museum a series from the Simla Hills.

20. ***Musca illingworthi** Patton.

Male.—Front narrow, eyes narrowly separated.

Thorax with four broad black stripes.

Abdomen (Pl. XXXI, fig. 17): first tergite brown, the anterior border black and a rather diffuse dark brown patch in the middle line which may form an incomplete basal dark band; second tergite with a broad black median stripe widening out anteriorly, a broad silvery stripe on each side, triangular brown admedian stripes and marginal silvery spots; third tergite similar, but stripes narrower.

Female.—Front about half the width of an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 44); first tergite almost entirely black; second tergite with a narrower median and admedian stripe; third tergite similar to that of male.

So far this species is only recorded from Java, but we have also seen specimens from N. E. Assam, (Dibrugarh, and Sadiya), and from Calcutta.

21. ***Musca bakeri** Patton.

Male.—Front narrow, eyes narrowly separated.

Thorax with four broad black stripes.

Abdomen (Pl. XXXI, fig. 18): first tergite black, (in some specimens only the anterior part is black with a black median stripe on the remainder); second tergite either light or dark brown, (the latter in the majority of specimens), with a broad black median stripe and a narrow black anterior band extending the length of the middle third of the tergite, large silvery admedian spots and silvery marginal patches; third tergite similar except that the marginal spot is larger.

Female.—Front more than half the width of an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 45): greyish with black stripes and bands; first tergite black with bluish grey admedian spots sometimes

extending almost the whole width of the tergite and forming a band; second tergite with a broad median black stripe and two narrow admedian ones which broaden out at the posterior border of the segment, forming a narrow posterior band, a similar band anteriorly; third tergite similar but without anterior band.

This species is only recorded at present from the Philippine Islands.

22. **Musca prashadi* Patton.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four broad black stripes on a rather shiny ground.

Abdomen (Pl. XXXI, fig. 19): first tergite black; second orange with a broad median black stripe extending along the anterior border as a black band narrowing towards the margins, a similar but much narrower band on the posterior border of the tergite; third tergite with a narrow median dark stripe broadly edged with yellowish white spots, marginal yellow patches and intervening areas forming dark stripes.

Female.—Front wide, about equal to width of an eye; frontal stripe comparatively narrow, about one-quarter an eye width; parafrontals wide, equal to width of frontal stripe.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 47): first tergite black or dark brown with yellowish grey admedian spots on posterior border, the spots sometimes extend along the lower border and form a band; second tergite yellowish grey with a dark median stripe, well marked triangular admedian stripes, their bases directed outwards and backwards; third tergite very similar, median and admedian stripes much narrower.

This species is common in Kashmir on cattle and horses at an altitude of 6000 ft.; it is related to *Musca autumnalis* but differs from it as follows:—in the male the thorax is much darker and the abdomen not nearly so brown, the front is narrower, and there are two bristles on the root of the radial vein. In the female the thoracic stripes are much narrower, and the abdomen has a characteristic olive green colour.

23. **Musca bezzii* Patton & Cragg.

? *Musca pilosa* Awati.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four broad black stripes.

Abdomen (Pl. XXXI, fig. 20): first tergite black except for the posterior margin on each side of the broad median black stripe being orange; second tergite with a broad median black stripe expanding T-shape for a short distance along the anterior border, with silvery edging in most specimens, white marginal spots and the intervening areas bright orange; third tergite with narrower median black stripe, broadly edged with yellowish white stripes, large marginal spots and posterior border of tergite often with a narrow band.

Female.—Front wide, but less than half an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 48): first tergite either entirely black or with admedian bluish grey spots near the posterior border, which may be

more extensive in extent than just small spots ; second tergite with a broad black median stripe broadly edged with bluish grey spots, triangular admedian black stripes, broadening posteriorly, and marginal silvery patches ; third tergite very similar but stripes narrower.

This large handsome species is widely distributed in India at altitudes of from 1,500 ft. upwards. It is common in most of the hill stations. We have seen a specimen from as far North-West as Kulu in the Indian Museum collection.

24. **Musca fletcheri*, sp. nov.

Male.—Front wide, about one-third that of an eye, parafacials and cheeks silvery ; palps dark brown to black ; mentum strongly chitinized and bulbous.

Thorax with four broad black stripes, the inner pair ending abruptly some distance before the posterior border of the scutum. Two feebly developed presutural dorsocentral bristles and only two post-sutural's.

Abdomen (Pl. XXXI, fig. 21) : first tergite mainly black, the posterior border on each side of the median black stripe narrowly yellow ; second tergite yellow with a broad median black stripe narrowly edged by bluish white stripes, the median stripe spreading out along the middle of the posterior border forming a narrow band ; third tergite similar but with very narrow median black stripe and dark orange admedian triangular spots posteriorly ; fourth tergite yellow. First sternite black, remainder orange. Wing with a row of bristles along the ventral side of vein R_{4+5} to well beyond the radio-medial cross vein ; root of radial vein with five, sometimes with four hairs. Squamae without hairs.

Female.—Front wide, about equal to that of an eye ; frontal stripe wide and bulging, about half the width of the front ; parafrontals with two rows of bristles. Palps and proboscis as in male.

Thorax similar to that of male.

Abdomen (Pl. XXXIII fig. 49) : first tergite mainly orange, the anterior border black, a broad median black stripe with bluish white spots on each side ; second tergite grey with a narrower median dark stripe, dark brown admedian stripes widening out posteriorly ; third tergite grey without any definite median stripe but a dark patch in rubbed specimens, admedian brown stripes not reaching the anterior border ; fourth tergite grey with narrow admedian stripes. Wing bristles and hairs as in male. Squamae as in male.

We have much pleasure in naming this species in honour of Mr. T. Bainbrigge Fletcher, Imperial Entomologist, who sent us five males and two females taken on cattle at Samalkota ; we have also found one specimen from Shencottah, Western Ghats in the Indian Museum collection. Types in the Pusa collection, co-types in authors' collections. Judging from the amount of chitinization of the mentum and the size of the prestomal teeth this species is almost certainly a biting fly. It is very closely allied to *M. inferior* but can be distinguished at once by the less heavily chitinized mentum and the absence of hairs on the dorsal surface of the squamae, which are always present in *inferior*,

25. * **Musca conducens** Wlk.

Pristirhynchomyia lineata Brun.; *Musca sorbens* Patton nec Wlk.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four broad stripes, often fused especially in front of the transverse suture, the thorax then appearing to be two-striped.

Abdomen (Pl. XXXI, fig. 22) ; first tergite either dark brown or black, if the former the posterior lateral margins lighter orange ; second tergite yellow with a narrow black median stripe extending along the anterior border to form a median band ; third tergite similar but median stripe narrower.

Female.—Front about half the width of an eye ; parafrontal bristles in a single row.

Thorax with four black stripes never tending to unite as in the male.

Abdomen (Pl. XXXIII, fig. 50) : first tergite orange, the anterior border black, a broad median black stripe, and a narrow posterior band ; second tergite grey with an olive sheen, a narrower median black stripe and a broader posterior band ; third tergite similar but with a much narrower median stripe and posterior band.

This small species is widely distributed in India ; it is common in Ceylon, where the male is often two-striped. The species is of peculiar interest as, though it has well developed prestomal teeth, it is unable to draw blood but can undoubtedly scratch off a scab or crust and feed on the serous fluid below.

26. * **Musca planiceps** Wied.

* *Musca cingalaisina* Big.; * *Musca pollinosa* Stein ; *Philaematomyia indica* Awat i.

Male.—Front very narrow, eyes narrowly separated.

Thorax with four rather narrow dark stripes.

Abdomen (Pl. XXXI, fig. 23) : first tergite yellow, the extreme anterior border black, and a narrow brown median stripe often incomplete ; second tergite yellow with a narrow median lunule on anterior and posterior borders, these being sometimes joined by a faint brown stripe, triangular admedian stripes and silvery marginal spots ; third tergite yellow, a dark median posterior spot which may be prolonged anteriorly but in the majority of specimens never forms a complete stripe, edged with silvery patches and a narrow dark posterior band.

Female.—Front about half an eye in width, and frontal stripe about half the width of front.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 51) : first tergite yellow, the anterior border in the middle line black and extending back to form a narrow dark median stripe ; second tergite brown with a black or brown median spot on posterior border which may extend forward to form a complete or incomplete median stripe, silvery edging, and marginal silvery patches which may be broad and confluent in the middle of the segment leaving only brown subdorsal spots on anterior and posterior margins, posterior margin nearly always with a narrow posterior band ; third tergite similar but with a narrow dark brown to black stripe, and a rather broader dark posterior band.

This species is widely distributed in India and Ceylon; it can be readily recognized by its strongly chitinized mentum and prestomal teeth, and by its yellowish golden abdomen. It is undoubtedly a blood sucker as first noted by Awati. We have so far not seen it sucking blood though we have both studied its habits in the field. It probably feeds on cattle.

27. **Musca senior-whitei* Patton.

Male.—Front narrow, eyes well separated.

Thorax with four dark stripes. Ground colour slate blue.

Abdomen (Pl. XXXI, fig. 24): first tergite black with two narrow slate blue bands on each side of the median stripe and extending to the margins; second tergite slate blue with a broad black median stripe expanding T-shape at the anterior end, narrow dark brown to black admedian stripes, and silvery marginal patches; third tergite similar but median stripe narrower.

Female.—Front almost the width of an eye; frontal stripe narrow, about one-third of front.

Thorax as in male except that the stripes are narrower.

Abdomen (Pl. XXXIII, fig. 52): with markings very similar to those of male except that the blue bands on the first tergite are as a rule wider, as are also the admedian stripes on the fourth tergite.

This species is common in the Bezvada district of the Madras Presidency and also around Calcutta. We have seen a specimen from Penang in the Indian Museum collection. It also occurs in Java.

28. **Musca inferior* Stein.

* *Philaematomyia gurneyi* Patton & Cragg.

Male.—Front broad, a little less than a quarter width of an eye. Thorax with four broad black stripes.

Abdomen (Pl. XXXI, fig. 25): first tergite black or dark brown with posterior admedian bluish grey spots; second tergite with a broad black median stripe, edged with broad slate blue stripes, narrow clove brown admedian stripes and broad marginal silvery spots; third tergite very similar but with a narrower black median stripe, and the admedian brown stripes extending on to the posterior border of the tergite.

Wing with bristles ventrally on vein $R_4 + R_5$ extending beyond the radio-medial cross vein; root of radial vein with four or five hairs. Squamae with hairs on the anterior border of the dorsal surface.

Female.—Front wide, about half that of an eye.

Thorax similar to that of male.

Abdomen (Pl. XXXIII, fig. 53): first tergite black with a large slate blue spot on the posterior border on each side of the middle line; second tergite with a rather narrow black median stripe, broadly edged with slate blue patches, dark admedian stripes and silvery marginal patches; third tergite similar but the median stripe narrower and the admedian dark stripes produced along the posterior border.

Bristles and hairs of veins, and squamae as in male.

This striking species is the only one which has hairs on the dorsal surface of the squamae. It is widely distributed in India and is a true biting fly. One of us has bred it from patches of cowdung. It is possibly larviparous.

29. **Musca crassirostris* Stein.

Musca modesta Meij.; * *Philaematomyia insignis* Aust.

Male.—Front narrow, eyes well separated.

Thorax with four narrow black stripes.

Abdomen (Pl. XXXI, fig. 26) : first tergite black, the posterior border grey with a greenish tinge ; second tergite grey, a narrow median black stripe, extending along the anterior border T-shape ; third tergite grey with a narrow black stripe.

Female.—Front very wide, almost equal to an eye width.

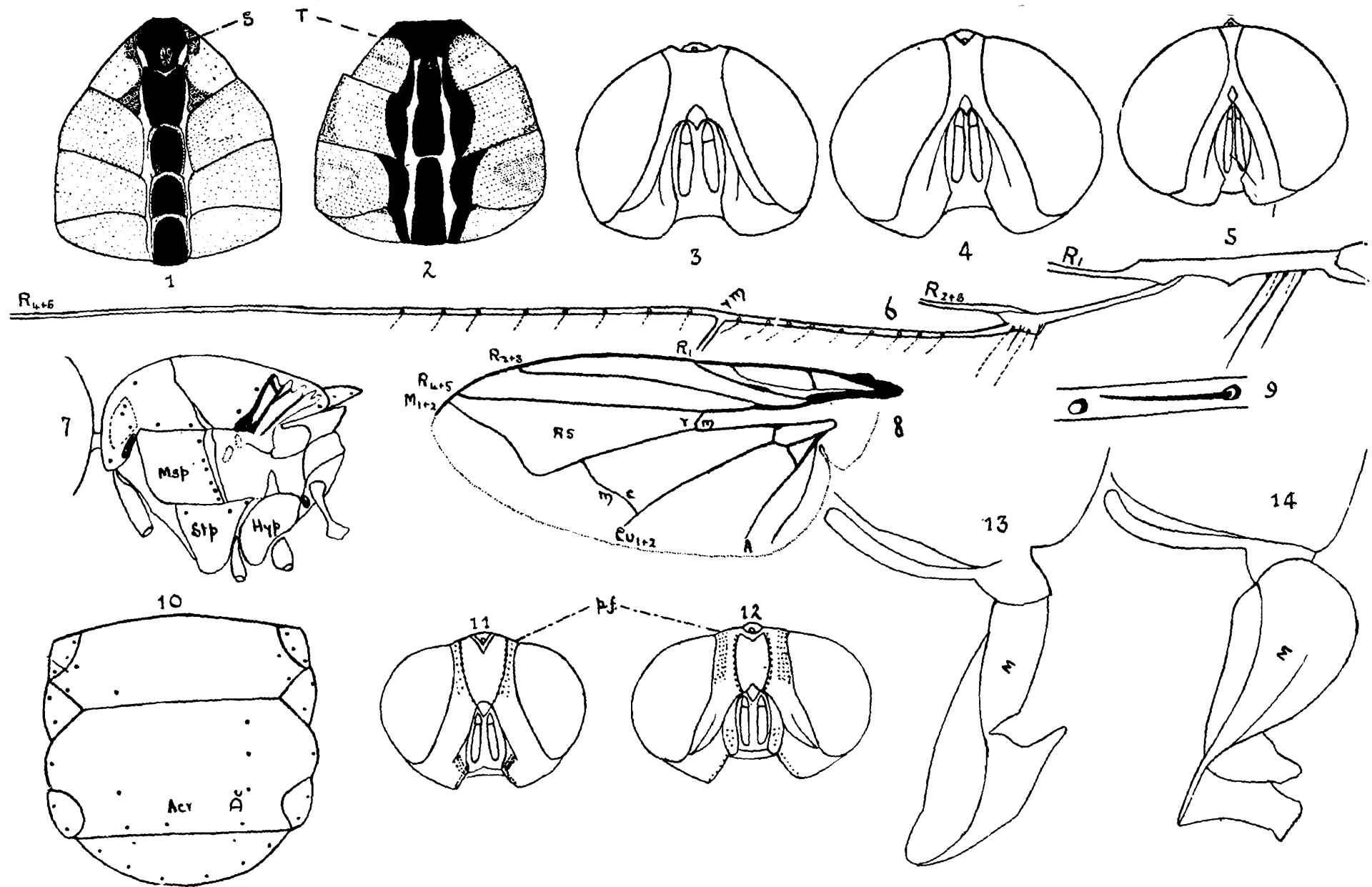
Thorax with stripes similar to those of male.

Abdomen (Pl. XXXIII, fig. 42) : first tergite greyish green, the anterior border black, a narrow median black stripe either present or absent, or existing as an indefinite median black patch on the posterior border of the tergite ; second tergite grey with a narrow median black stripe, and a black band on the anterior border ; third tergite grey with a black band along the anterior border and an incomplete median black stripe.

This species is one of the commonest blood sucking flies of India, where it is found throughout, as also in Burma and Ceylon. It is very characteristically marked and the mentum is highly chitinized and markedly bulbous and the prestomal teeth thorn-like.

EXPLANATION OF PLATE XXIX.

- FIG. 1.—Ventral surface of *Musca bakeri* showing black sternites,—S.
- FIG. 2.—Ventral surface of *Musca hervei* showing black sternites and edges of tergites,—T.
- FIG. 3.—*Musca domestica* showing eyes “widely separated” in male.
- FIG. 4.—*Musca sorbens* showing eyes “well separated” in male.
- FIG. 5.—*Musca ventrosa* showing eyes “narrowly separated” in male.
- FIG. 6.—Radial Vein. Dorsal surface bristles in full, ventral surface bristles in dotted lines.
- FIG. 7.—Side of thorax showing location of bristles. Msp.-mesopleuron. Stp.-sternopleuron. Hyp.-hypopleuron.
- FIG. 8.—Venation in *Musca*.
- FIG. 9.—Part of vein $R_4 + R_5$ showing a bristle and a bristle scar.
- FIG. 10.—Dorsum of thorax showing location of bristles. Acr.-acrostichal. Dc.-dorsocentral.
- FIG. 11.—*Musca domestica*, female, showing arrangement of parafrontal bristles,—p. f.
- FIG. 12.—*Musca bezzii*, female, showing arrangement of parafrontal bristles, —p. f.
- FIG. 13.—*Musca nebulo* showing normal sized mentum,—M.
- FIG. 14.—*Musca crassirostris* showing enlarged mentum,—M.
- (R. S.-W. *ad nat. del.*)



R. S.-W., *ad nat.*, del.

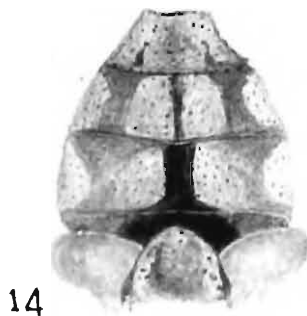
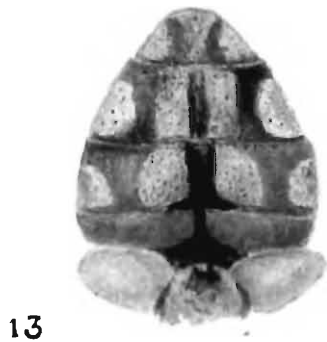
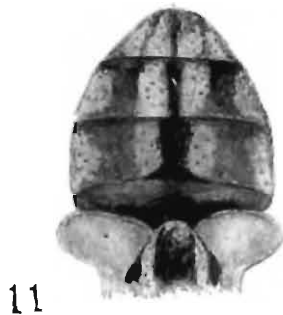
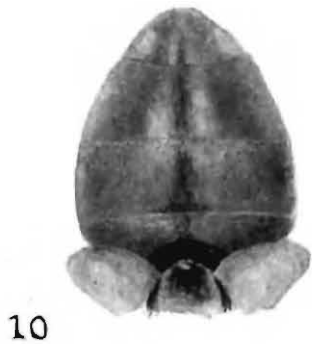
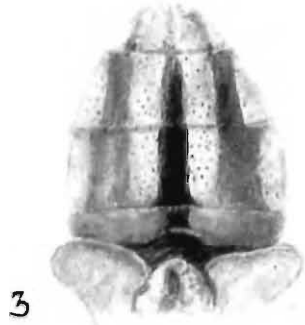
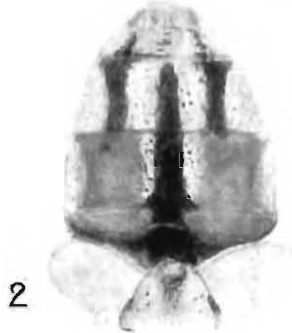
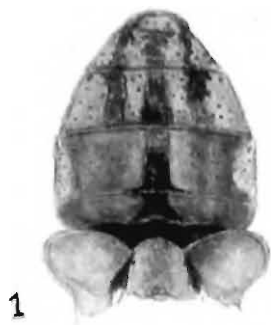
THE GENUS *Musca*

EXPLANATION OF PLATE XX X.

Male abdomens.

- FIG. 1.—*Musca domestica*.
- FIG. 2.—*Musca vicina*.
- FIG. 3.—*Musca nebulo*.
- FIG. 4.—*Musca yerburyi*.
- FIG. 5.—*Musca sorbens*.
- FIG. 6.—*Musca vetustissima*.
- FIG. 7.—*Musca vitripennis*.
- FIG. 8.—*Musca tempestiva*.
- FIG. 9.—*Musca pulla*.
- FIG. 10.—*Musca ventrosa*.
- FIG. 11.—*Musca villeneuvei*.
- FIG. 12.—*Musca gibsoni*.
- FIG. 13.—*Musca pattoni*.
- FIG. 14.—*Musca spinohumera*.
- FIG. 15.—*Musca xanthomelas*.

(E. M. P. *ad nat. del.*)



ZINCO COLLOTYPE CO., EDINBURGH.

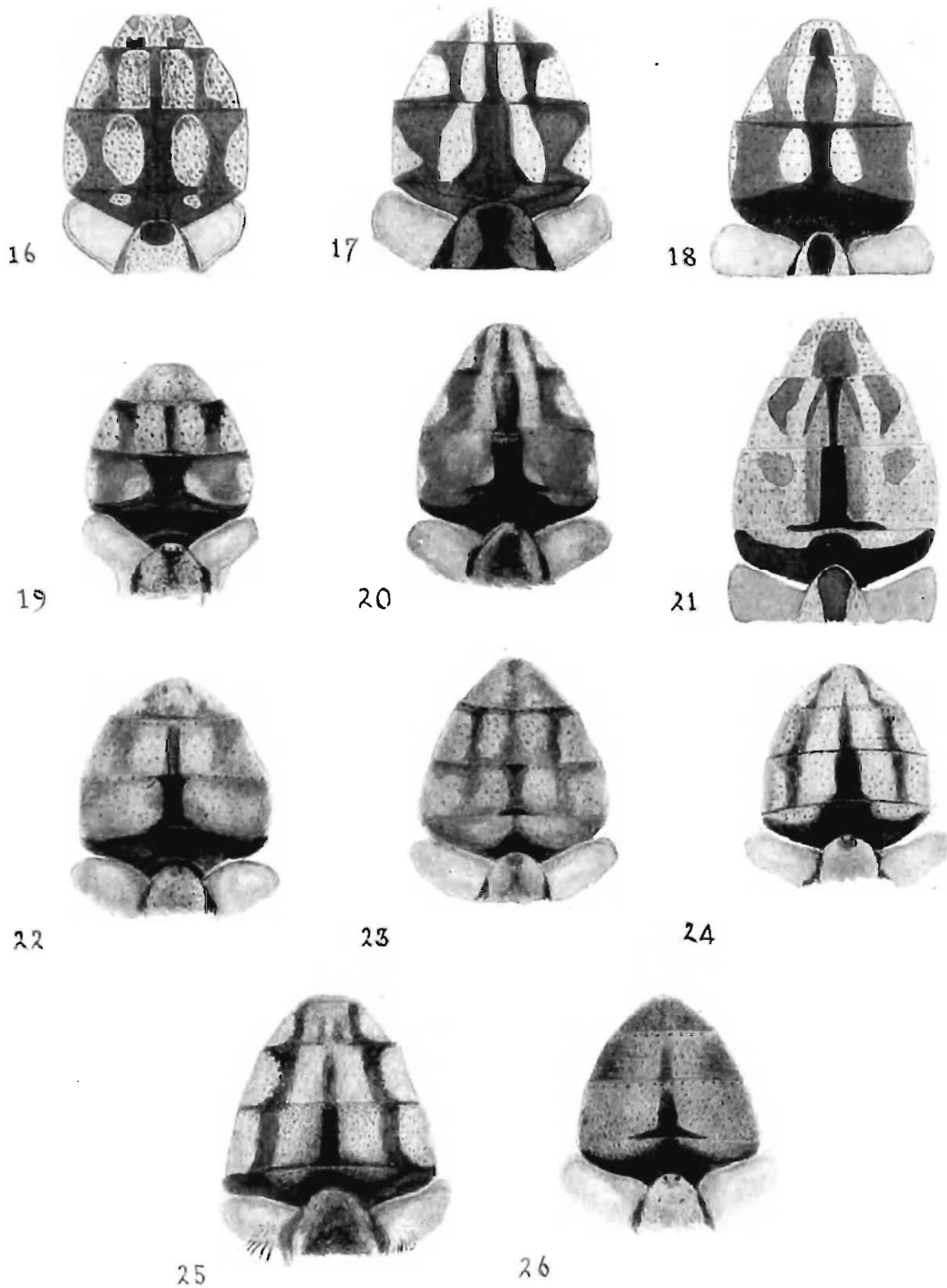
Oriental species of *Musca*.

EXPLANATION OF PLATE XXXI.

Male abdomens.

- FIG. 16.—*Musca hervei*.
FIG. 17.—*Musca illingworthi*.
FIG. 18.—*Musca bakeri*.
FIG. 19.—*Musca prashadi*.
FIG. 20.—*Musca bezzii*.
FIG. 21.—*Musca fletcheri*.
FIG. 22.—*Musca conducens*.
FIG. 23.—*Musca planiceps*.
FIG. 24.—*Musca senior-whitei*.
FIG. 25.—*Musca inferior*.
FIG. 26.—*Musca crassirotris*.

(E. M. P. et R. S.-W. *ad nat. del.*)



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EXPLANATION OF PLATE XXXII.

Female abdomens.

FIG. 27.—*Musca domestica*.

FIG. 28.—*Musca vicina*.

FIG. 29.—*Musca nebulo*.

FIG. 30.—*Musca yerburyi*.

FIG. 31.—*Musca sorbens*.

FIG. 32.—*Musca vetustissima*.

FIG. 33.—*Musca vitripennis*.

FIG. 34.—*Musca tempestiva*.

FIG. 35.—*Musca albina*.

FIG. 36.—*Musca pulla*.

FIG. 37.—*Musca ventrosa*.

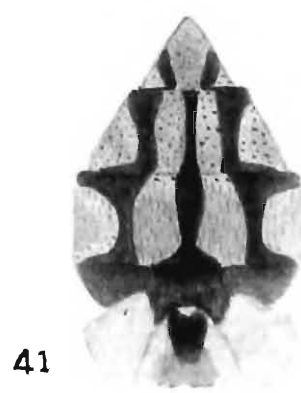
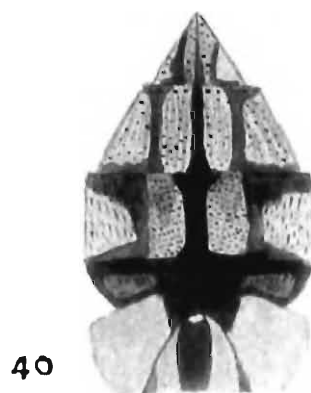
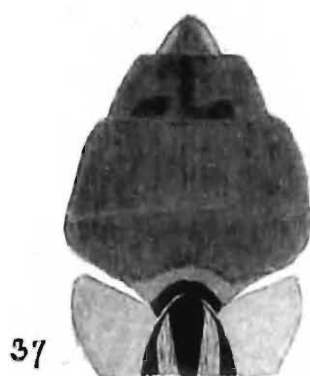
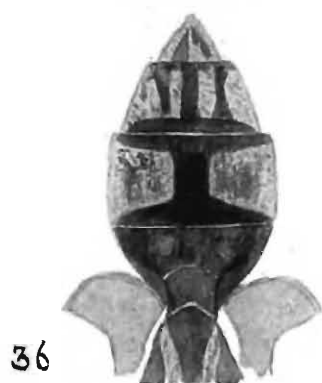
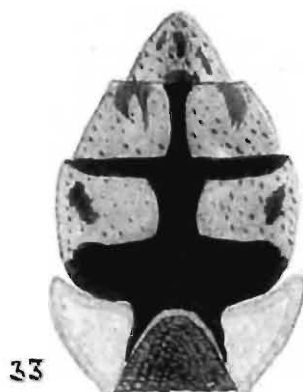
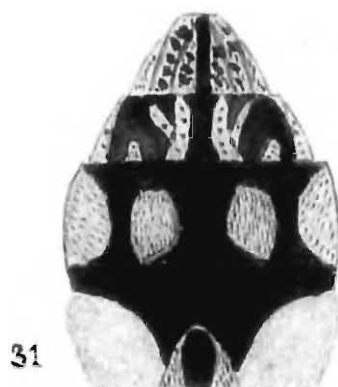
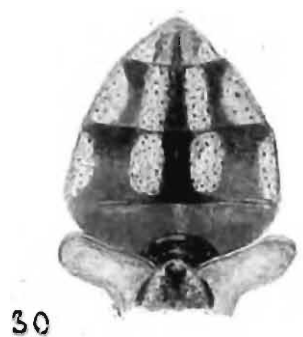
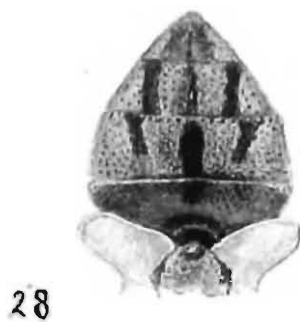
FIG. 38.—*Musca villeneuvei*.

FIG. 39.—*Musca dasyops*.

FIG. 40.—*Musca gibsoni*.

FIG. 41.—*Musca pattoni*.

(E. M. P. et R. S.-W. *ad nat. del.*)



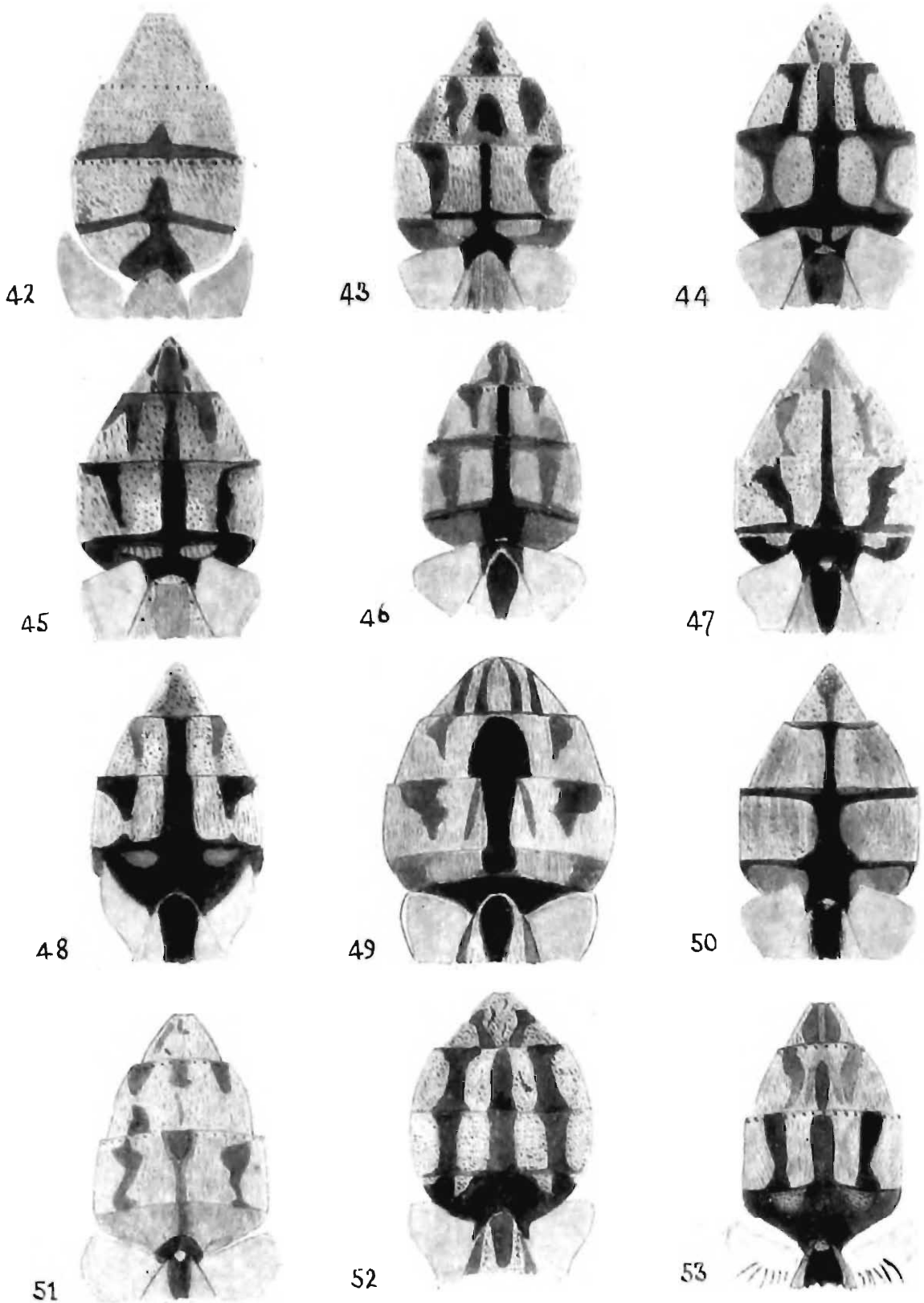
ZINCO COLLOTYPE CO., EDINBURGH.

EXPLANATION OF PLATE XXXIII.

Female abdomens.

- FIG. 42.—*Musca crassirostris*.
FIG. 43.—*Musca spinohumera*.
FIG. 44.—*Musca illingworthi*.
FIG. 45.—*Musca bakeri*.
FIG. 46.—*Musca xanthomelas*.
FIG. 47.—*Musca prashadi*.
FIG. 48.—*Musca bezzii*.
FIG. 49.—*Musca fletcheri*.
FIG. 50.—*Musca conducens*.
FIG. 51.—*Musca planiceps*.
FIG. 52.—*Musca senior-whitei*.
FIG. 53.—*Musca inferior*.

(R. S.-W. *ad nat. del.*)



ZINCO COLLOTYPE CO., EDINBURGH.

Oriental species of *Musca*.

NOTES ON FISHES IN THE INDIAN MUSEUM.

VII. ON A NEW GENUS OF " GLOBE-FISHES " (FAM. TETRAODONTIDÆ).

By SUNDER LAL HORA, D.Sc., *Officiating Superintendent,
Zoological Survey of India.*

Plate XXXIV.

The fish described in this note was collected by Capt. A. W. Michie of the pilot vessel S.S. " Lady Fraser " at the mouth of the river Hughli in a depth of 15 fathoms on a bottom of sand and mud. It is a highly modified representative of the family Tetraodontidae, but its characters are so distinct that a new genus must be set up for it. I propose for it the name :—

Kanduka¹, gen. nov.

The new genus may be defined as follows :—

A genus of Tetraodontidae consisting of almost spherical, ball-like fishes of moderate size, with spine-like outgrowths covering the whole of the head and body except the lips and the bases of the fins, *without a dorsal fin*, with the anal fin vestigial and with the caudal peduncle much reduced and somewhat retractile, as also the pectoral and the vestigial anal ; eyes small ; nostrils forming imperforate, incompletely bifid tentacles.

Kanduka michiei, sp. nov.

(Pl. XXXIV, figs. 1-7.)

The general form of the species is that described for the genus. The back is somewhat flattened and the depth and the breadth are considerably greater than the length. The length of the head is two-fifths of the total length without the caudal. The eyes are situated somewhat in the posterior half of the head ; the greatest diameter of the eye is contained 5 times in the length of the head. The interorbital distance is one and a half times the length of the snout and 3.5 times the diameter of the eye. The nostril is situated much nearer to the eye than to the tip of the snout. It consists of two broad flaps, which are joined at the base and are imperforate in the centre. The mouth is small and transverse, both the upper and the lower jaws possess well-marked, median sutures. The lips are fleshy, papillated and continuous at the angles of the mouth. The gill-openings are very small and are situated in definite pouches at the bases of the pectorals, which are small and about one-third the length of the head ; they are somewhat spiral in their horizontal axes and can be retracted into pouches. There is a slight ridge along the back but no trace of the dorsal. The anal

¹ *Kanduk* in Sanskrit means a small ball.

fin is vestigial and is situated in a pouch into which the anus also opens; the horizontal axis of this fin is also somewhat spiral. The fin itself has the appearance of a white papilla in which the degenerate rays can be detected with difficulty. The caudal fin is very small; it is subtruncate at its extremity. In spite of its small size it is very much larger than the caudal peduncle which seems to be completely withdrawn into a pouch situated immediately above that which contains the anal fin and the anus. The entire fish is covered with long, pointed, needle-like spines, which are absent on the lips and near the bases of the fins. Each spine is tetraradiate at the base but all the radii are situated on one side of the spine only.

The colour in spirit is black with numerous, irregular, oblique, white stripes, which are narrow on the upper part of the body and much broader below. On the dorsal surface these stripes form a dendritic pattern. The lateral fins are white, the caudal fin is provided with numerous black blotches arranged in rows.

The total length of the specimen without the caudal is 54 mm., that of the head 21.8 mm., that of the snout 10 mm. The diameter of the eye is 4.2 mm., and the interorbital width is 15 mm.

Kanduka michiei possesses a superficial resemblance to certain species of *Tetraodon* such as *T. lineatus* as figured by Bleeker¹ and *T. nigropunctatus* as figured in Day's *Fishes of India*.²

Locality :—Sandheads off the mouth of the river Hughli at a depth of 15 fathoms.

The type-specimen is preserved in the collection of the Zoological Survey of India.

So far as can be judged from a single specimen in spirit the animal is not able to deflate itself but retains its ball-like appearance constantly. Capt. Michie thus describes the form of the specimen, "when first caught it was exactly the shape of a hard ball and only crumpled up a little after being in spirit for five or six days." *Kanduka* is thus, so to speak, the culmination of a series of *Gymnodontes*, a large number of which are able to assume a subspherical shape by taking water or air into their bodies and thus to cause the spines with which their integument is usually armed to stand out rigidly all over their surface.

Unfortunately we know little or nothing of the habits of *Kanduka michiei*. The only specimen was taken on a soft bottom in the muddy water of the mouth of the Ganges. Sciagraphs show a small Gastropod shell in its alimentary canal, but we have no further information as to its food.

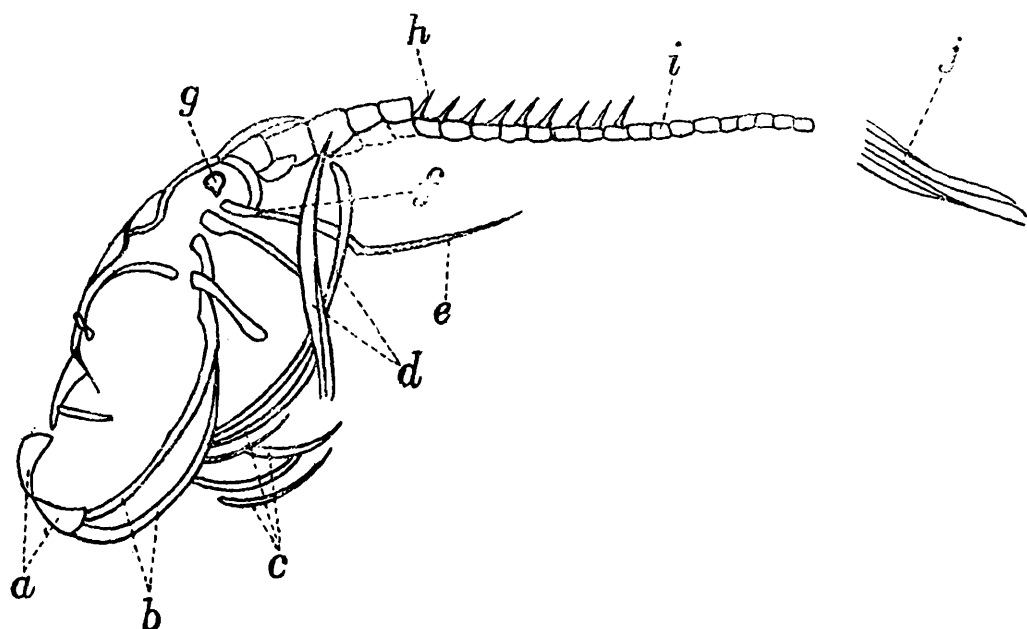
*Skeleton*³ :—The skeleton of the *Tetraodontidae*, as in the other *Plectognathi*, is not completely ossified. Owing to this fact the sciagraphs, on which the following description is based, do not show all the bones and even in those which are indicated the precise limits are not clearly marked. In spite of this, however, it is clear that the skeleton is similar in all essential respects to that of the fishes of the family

¹ Bleeker, *Atlas Ichthyol.* V, p. 70, pl. cxxii, fig. 1 (1865).

² Day, *Fishes of India*, p. 704, pl. clxxx, fig. 4 (1878).

³ For an account of the skeleton of the *Plectognathous* fishes see Regan, *Proc. Zool. Soc. London* II, pp. 284-297 (1902), and other references contained in his paper,

Tetraodontidae, but exhibits marked peculiarities in correlation with the shape of the fish. On account of its subspherical form the skull and the vertebral column are not in the same plane, the skull being bent downwards and forwards at an angle of 140° . The change in the axis thus brought about has resulted in a considerable change in the direction and position of the various bones of the skull. The nasal region has been greatly reduced, the orbital region is as well marked as usual, but the otic region is greatly increased probably at the expense of other sensory organs associated with the skull. Anteriorly the vertebral column is also slightly bent.



***Kanduka michiei*, sp. nov.**

Lateral view of the skeleton as seen in a sciagraph $\times 2$ (from a photograph).
a=jaw bones; *b*=suspensorium; *c*=branchiostegal rays, etc.; *d*=clavicle;
e=postclavicle; *f*=supraclavicle; *g*=otocyst; *h*=neural spine; *i*=centrum;
j=caudal fin.

With the exception of the caudal there is no trace of any fin in the sciagraphs.

There is nothing peculiar in the structure of the vertebrae. The anterior vertebrae (4 or 5) have, as usual in the family, well-marked, bifid, divergent neural spines and are somewhat flattened on their under surface. There are about 21 to 22 vertebrae. The structure of the vertebral column near the base of the caudal fin is not well defined in the sciagraphs and, therefore, it is difficult to say with certainty whether the tail-fin, which apparently appears to be retractile, is retractile or not.

In the region of the skull all the important bones are clearly shown in the sciagraphs. The "teeth" appear to be better calcified along their inner border than along the outer border. The suspensorium of the jaws is almost vertical in its upper half and is only slightly bent forwards in the lower. Another bone is clearly indicated forming the side of the roof of the mouth and running from the nasal region of the skull to a point half way to the suspensorium. The branchiostegal rays and probably the bones of the hyoid apparatus are also indicated.

The clavicle is almost vertical with its upper end reaching as far upwards as the vertebral column. There is an indication of a bone, probably the supraclavicle, which is horizontal in position and appears to suspend the splanchnic arch from the otic region of the skull. The postclavicle is a thin, elongate bone directed horizontally backwards, probably to give support to the abdominal viscera. There are two other bones indicated in the sciagraphs; one is directed downwards and backwards from just below the posterior extremity of the supraorbital ring, while the second, which is situated almost parallel to it, runs backwards from the otic region. These may possibly represent certain ossified portions of the opercular bones.

Relationships of the genus Kanduka :—It is quite obvious from the structure of the skeleton and of the teeth that the genus *Kanduka* belongs to the family Tetraodontidae. It is, however, analogous in some respects to *Hyosphaera* Evermann and Kendall¹ among the Diodontidae, but the fins are still more degenerate. Its nearest allies are probably to be found in the genus *Tetraodon* (s.s.), from which it is probably derived; but it is distinguished from all other Tetraodontidae by the absence of the dorsal fin, by the very small size of the caudal peduncle, by the vestigial character of the anal and by the fact that all the fins are situated in little pouches, into which they can be more or less completely retracted, thus giving the fish a completely spherical form practically without protuberances of any kind. The skeletal peculiarities referred to above are in themselves quite sufficient to distinguish *Kanduka* generically from the other genera of the Tetraodontidae.

I have to express my great indebtedness to Major J. A. Shorten, I.M.S., of the Calcutta Medical College for the pains he has taken in making sciagraphs of the fish in different positions for me.

¹ Evermann and Kendall, *Bull. U. S. Fish. Comm.* XVII, p.131, pl. ix, figs. 11, 12 (1897).

EXPLANATION OF PLATE XXXIV.

Kanduka michiei, sp. nov.

Figures 1—3 are natural size, untouched photographs of the fish.

FIG. 1.—Front view.

FIG. 2.—Lateral view.

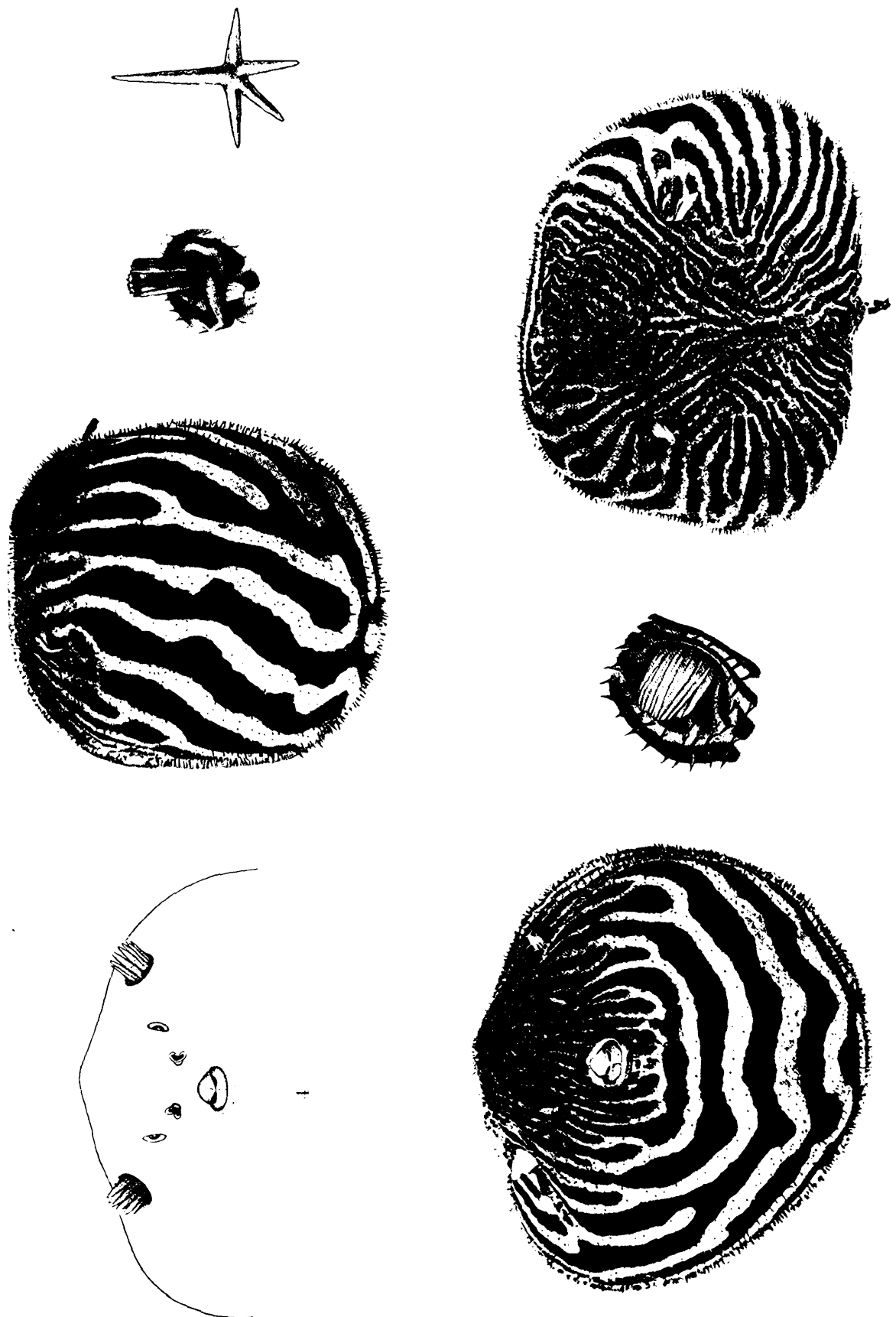
FIG. 3.—Dorsal view.

FIG. 4.—Outline drawing of front view showing mouth, jaws,
nasal tentacles, eyes and pectoral fins (nat. size).

FIG. 5.—Pectoral fin, $\times 2$.

FIG. 6.—Caudal and anal fins, $\times 2$.

FIG. 7.—An epidermal spine, $\times 20$.



KANDUKA MICHEL, gen. et sp. nov.

R. C. Mondul photo.
S. C. Mondul del.

DESCRIPTION OF A NEW GENUS OF MYRMECOPHILOUS
SCARABEIDAE (COLEOPTERA) OF INDIA.

By DR. F. SILVESTRI (*Portici, Italy*).

The late Dr. N. Annandale, Director of the Zoological Survey of India, whom I will remember always with the deepest sorrow and greatest admiration, sent me for study some specimens of a small coleopteron found by him under stones in a nest of *Ponera tesserinoda*. I describe the specimens as belonging to a new species for which it has been necessary to propose a new genus also.

Gen. **Ponerotrogus**, nov.

(Figs. I—III.)

Corpus contractum fere $\frac{1}{3}$ longius quam latius, latitudine majore ad elitrarum partem subanticam sistente, inter pronotum et elitrarum marginem posticum lateralem vix angulatum, praeter pronoti angulum anticum et elitrarum superficiem ad suturam bene convexum, nitidum.

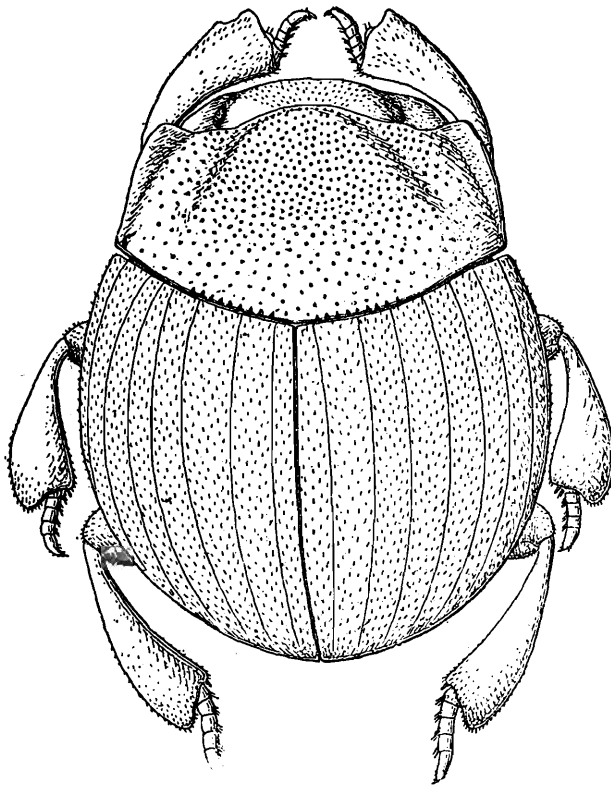


Fig. I.

Animalculum pronum et contractum.

Caput declive, postice breviter in prothorace inclusum, ab oculis extrorsum et antrorsum expansum margine laminari, circumlitione

(clypei incisura exclusa) transverse semiovale, clypeo profunde angulatim inciso et ad incisionis latera parum producto; oculis in partem superam angusta ovali et in partem inferam (pone antennarum radicem) parum majore ovali divisus; antennis inferis, 8-articulatis, clava badia, 3-lamellata, quam articuli omnes praecedentes, simul sumpti, c. $\frac{1}{3}$ brevior; labro brevi, triangulari setis supramarginalibus longiusculis $9 + 9$, setis aliis subtilioribus et superficie mediana infera, parum longe a margine antico, setis 3—4 robustis longiusculis nec non setis duabus robustis brevissimis et setis nonnullis submedianis robustioribus brevibus et brevissimis aucta, mandibulis parvis parte dentali inermi, laminari, laciniis numerosis perparvis setiformibus instructa, mola parva et mandibulae dexteræ postice serrata; maxillis primi paris lobo interno quam externum brevior apice parum clavato, papillis minimis, ad apicem setiformibus, vestito, lobo externo apice lato supra papillis setiformibus brevibus omnino vestito, subtus verrucoso, palpo maxillari articulo ultimo longo, fusiformi; labio stipilibus parvis, inter sese

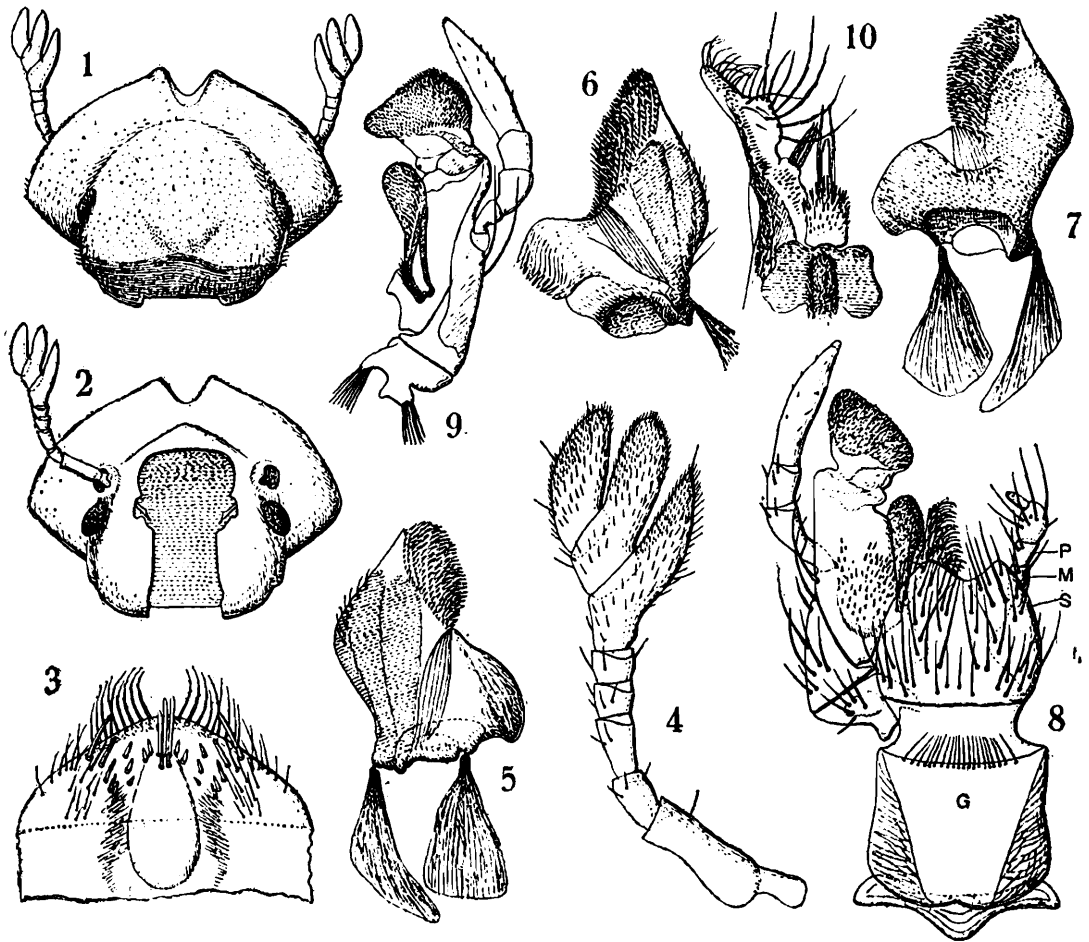


Fig. II.

1. Caput pronum; 2. idem supinum labro et appendicibus buccalibus abruptis; 3. labrum supinum; 4. antenna; 5—6. mandibula dextera prona et supina; 7. mandibula laeva supina; 8. labium cum maxilla primi paris et glossae parte dextera distalis; G gula, L glossa, M stipes labialis, P palpus labialis, S submentum; 9. maxilla primi paris dextera prona; 10. glossa prona (brachio dextero omisso).

late separatis, articuliformibus, submento magno antice sinuato, gula robusta longa et lata, palpis 3-articulatis brevioribus, articulo secundo longiore et crassiore, glossa basi mediana conice parum producta, setis duabus longiusculis et duabus brevibus instructa, lateraliter brachii instar producta, brachiis maxillae primis paris lobi interni apicem sub-

attingentibus setis longiusculis et brevibus instructis. Pronotum c. 4-9 latius quam longius angulo antico paullum producto; presternum a pedum foramine ad partem medianam depressum ad pedum coxas continens, parte postica quam cetero parum magis elevata et media carinata. Scutellum elitrīs clausis haud visibile; mesosternum breve, postice profunde sinuatum, medium vix angulatum, opacum. Elytrae convexae, ad suturam antice subplanae, abdomen totum obtegentes, longitudinaliter, subtiliter 7-lineatae; metasternum magnum, paullum

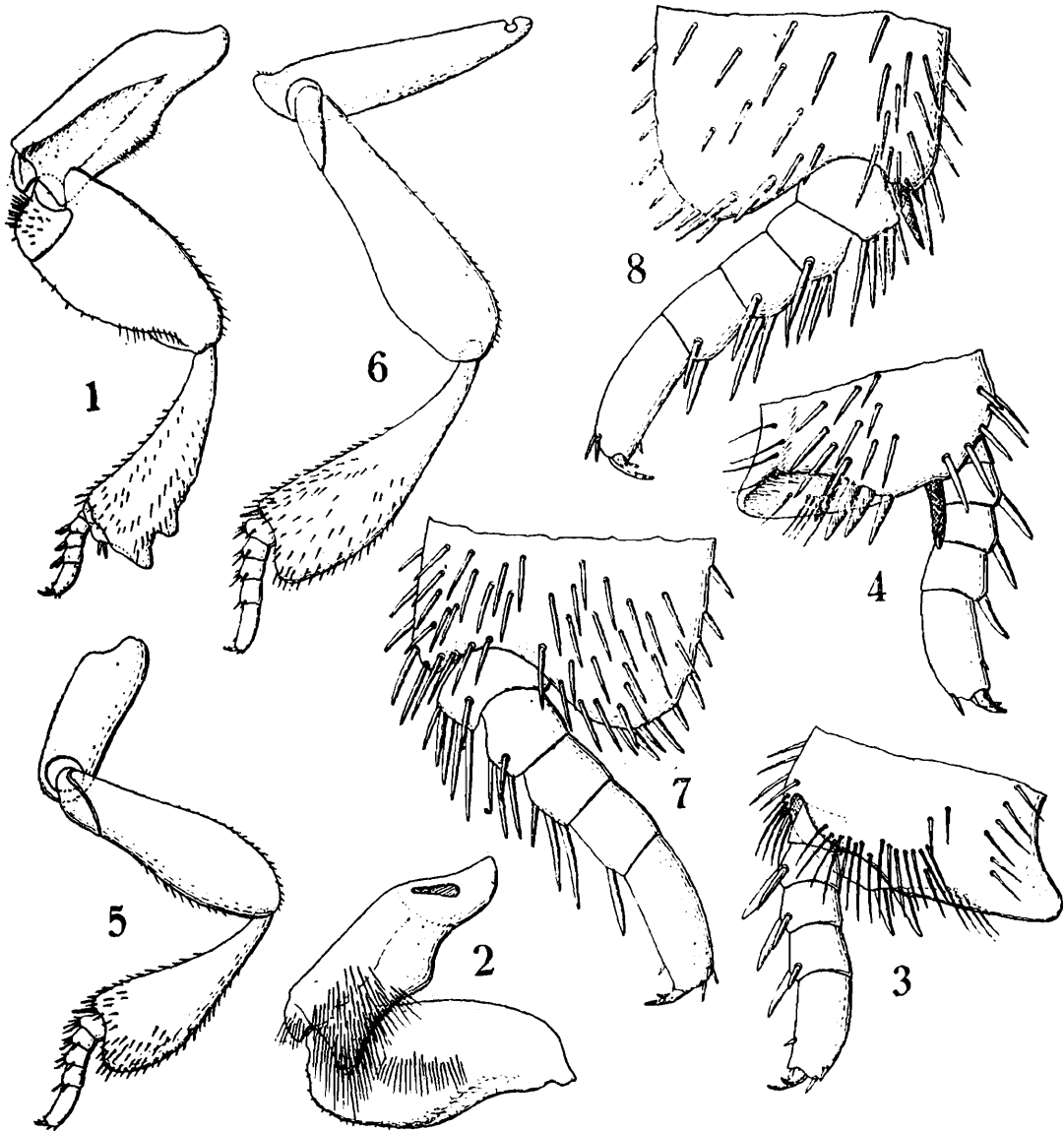


Fig. III.

1. Pes primi paris supinus; 2. ejusdem coxa, trochantere et femur supina; 3-4. pedis paris primi pars distalis a tibiae apice supra et subtus inspecta; 5. pes secundi paris et; 6. pes tertii paris subtus inspecti; 7-8. pedis paris tertii pars distalis a tibiae apice supra et subtus inspecta.

convexum, nitidum. Pedes breves, 1ⁱ, 2ⁱ et 3ⁱ paris forma vide fig. III, 1-8, tibiis omnibus calcare sat longo armatis¹, tarsis brevibus articulo ultimo quam ceteri singuli longiore, praetarsium unguibus brevioribus parum arcuatis.

¹ Clar. Collega E. Wasmann, novo examine, amicissime certiore me fecit de parvi calcaris praesentia etiam in *Cyclotrogi* speciebus.

Abdomen sternitis manifestis 6; pygidium breve et declive, postice et subtus tantum manifestum.

Species typica: *Ponerotrogus annandalei*, sp. nov.

Observatio. Genus hoc ad *Cyclotrogus* Wasm. valde affine, sed corpore longiore quam latiore, inter elytrarum basim et pronotum angulo parvo obtuso affecto, antennarum flagello longiore, tibiatarum secundi et tertii paris calcare longiore et angulo apicali externo brevior bene distinctum est.

***Ponerotrogus annandalei*, sp. nov.**

Corpus niger capite et pronoto sat crebre et subtiliter punctatis, punctis (saltem partim) setam brevissimam gerentibus, pronoti margine postico mediano breviter triangulari et margine postico submediano utrimque incisionibus triangularibus 8—9 impresso. Elytrae inter sulcos longitudinales setis brevissimis sat numerosis instructae sunt.

Long. corp. ad mm. 3·4, lat. maxima 2·5.

Habitat. Exempla nonnulla sub saxo in nido *Ponera tesserinoda*, Dr. N. Annandale, cui speciem dico animo dolente et grato, legit.

[According to the late Dr. Annandale's notes in the field station-book these beetles were found on two occasions in August and October, 1923 at Barkuda Island in the Chilka Lake in the nests of *Ponera tesserinoda* Mayr. The nests of this ant, according to the notes, consist of flat chambers immediately under stones with narrow passages going into the earth. In these passages *Ponerotrogus annandalei* was found with a wood-louse which has been identified by Dr. B. Chopra as *Cubaris granulatus* Collinge. (B. Prashad).]

SOME INDIAN SPIDERS OF THE FAMILY LYCOSIDAE.

By F. H. GRAVELY, D.Sc., *Superintendent, Government Museum, Madras.*

The Lycosidae or Wolf Spiders are, for their abundance, probably the most neglected of all families of Indian spiders, with the single exception of the Attidae or Jumping Spiders. Superficially they are all much alike, being of a dull brownish general colour, so that there is little about them, except the abundance of certain of the smaller species, to attract the general collector; and their abundance is outweighed by the agility with which they evade casual pursuit. It is not altogether surprising, therefore, that a large proportion of species appear to be new, including several of the commonest forms. It is possible, and indeed I think likely, that this proportion is not quite as high as the present paper suggests, for as explained on pages 258-259 of the first of this series of papers (Gravely, 1915) I am chiefly concerned to put on record descriptions and figures of the common Indian species, so as to facilitate reference to them by other workers in this country; and I am not in a position to obtain a sufficient knowledge of the general literature to ensure that no synonyms are created even if this were essential to my object, which fortunately it is not. Given clear comparative descriptions and adequate figures it will not be difficult for anyone wishing to study the family as a whole to determine what names are redundant; but such extended work can only be made possible with any approach to completeness by the stimulation of collecting locally, which is the object of the present paper.

Working, as I have been able to do, with ample material of most species, and living specimens of several in abundance at my doors for reference at any time, it has been possible to correlate males and females with a fair degree of certainty. In many species, as in many Mygalomorphs, mature males have parts of the palps or first legs decorated with a snow-white pile. In other species, so far as I have been able to ascertain, they are always without this. But in many species I have found that two forms of male occur, one with this hair and the other without, in which connection it is interesting to recall the "high" and "low" males of the crab *Dotilla intermedia*, recorded by Kemp in *Rec. Ind. Mus.* XVI, 1919 (pp. 331-333, text-fig. 10). It is perhaps likely that further collecting may show that two such forms of male occur in other species also.

My thanks are due to Mr. Hirst and the authorities of the British Museum for facilities to examine species described in Thorell's "Spiders of Burma," to M. Berland of the Paris Museum who kindly compared specimens with some of Simon's species, and especially to the late Dr. Annandale for constant help with literature and in other ways, as well as for supplying most of the material described, which belongs to the Zoological Survey of India, in the collections of which all the types of new species have been deposited. The rest of the material belongs either to the Madras Museum or to the British Museum.

The following species of Lycosidae have been recorded from India, or may not improbably prove to occur there :—

Group HIPPAEAE.

Genus **Anomalomma** Simon.

- A. lycosinum*, Simon, 1891, p. 200. Tjibodas, Java.
A. micans, Simon, 1898, p. 24. Montalvan in Luzon, Philippines.
A. pygmaea (Thorell) 1890 (3), pp. 313-315. Penang.

Genus **Hippasa** Simon.

- H. agelenoides* (Simon) 1884, pp. 334-335. Minhla.
 (Thorell) 1887, pp. 300-301 and 304-305. Burma.
 Thorell, 1895 (1), p. 218. Tharrawaddy and Rangoon.
 Pocock, 1900, p. 251. ?Konkan and Dehra Dun
 (Simon).
H. greenalliae (Blackwall), 1867, pp. 387-388. Meerut, Agra or Delhi.
 (Thorell) 1887, pp. 300-301.
H. holmerae, Thorell, 1895 (1), pp. 218-221. Tharrawaddy.
 Pocock, 1900, p. 251. Tharrawady and Singapore.
H. lycosina, Pocock, 1900, p. 250. E. Poona, Kanara, Nasik, Uran.
H. olivacea (Thorell) 1887, pp. 297-300. Rangoon and Bassein.
 Thorell, 1895 (1), pp. 217-218. Kyeikpadem and Tharrawaddy.
 = *simonis*, Thorell from Bhamo and Me-tan-ja.
H. pantherina, Pocock, 1899, p. 752. Trivandrum.
 Pocock, 1900, p. 250. Trincomali, Trivandrum, Ootacamund, Coimbatore, Ramnad, Bangalore, Poona Dist., E. Khandesh.
 = *greenalliae*, Simon, 1885, p. 31, *nec* Blackwall from Ramnad and Collegal.
H. partita (Cambridge) 1876, pp. 599-600. Near Alexandria.
 Simon, 1897, p. 290. Egypt, Arabia, Central Asia, Karachi.
H. pisaurina, Pocock, 1900, p. 250. E. Khandesh, E. Poona, Bangalore.
H. simonis (Thorell) 1887, pp. 301-305. See *H. olivacea*.

Group LYCOSEAE.

Genus **Flanona** Simon.

- F. puellula*, Simon, 1897 (1), p. 349. Ceylon.

Genus **Lycosa** Latreille.

In drawing up the following list, which has to include many species that I have not seen, it has been necessary, for the sake of uniformity, to adopt Simon's nomenclature throughout. Simon (1897 (1), p. 361), gives *Lycosa*, Thorell, as a synonym of *Pardosa*. On p. 355 he specifically mentions *L. amazonia*, Thorell, as a *Pardosa*; and Thorell (1895 (1),

p. 242) places Simon's *P. birmanica* in the genus *Lycosa* as accepted by himself. In the present list, therefore, following Simon, the following species referred by Thorell to the genus *Lycosa* are all transferred to the genus *Pardosa* — *amazonia*, *birmanica*, *ludia*, *ipnochoera*, *nicobarica*, *pinangensis*, *psummodes*, *pusiola*, *rabulana*, *sumatrana*, *tenasserimensis*, *tenera*, *thalassia*, *tristicula*, *vagula*. The shape of the labium, on which this arrangement is based, does not, however, seem to me to afford a satisfactory basis of classification, at least for the Indian species; and I have retained such of the above species as I have seen in the genus *Lycosa* in the descriptive part of the paper, as I find myself unable to detect the difference by which Simon separates them. See page 598, footnote 3.

The remaining species are as follows :—

- L. (?) brevimetatarsis*, Strand, 1907 (1), pp. 442-445. Java.
L. catula (Simon) 1885, p. 457. Collegal.
 Pocock, 1900, p. 254. Coimbatore, Yercaud.
L. chaperi (Simon) 1885, p. 8. Guntakal.
 Pocock, 1900, p. 254. Guntakal.
L. comotti (Thorell) 1887, pp. 307-309. Bharno.
L. conspersa (Thorell) 1877, pp. 529-530. Celebes.
 (Thorell) 1897, p. 22. Rangoon and Bharno.
 = *subinermis* (Thorell) 1895 (1), pp. 234-235. Rangoon.
L. fragilis (Thorell) 1890, p. 136. Sumatra.
 (Thorell), 1891-92, pp. 154-157 Singalang, Sumatra.
L. fuscana, Pocock, 1901, p. 485. E. Poona.
L. goliathus, Pocock, 1901, p. 484. Helvak, Satara District.
L. indigatrix, Walckenaer, 1837, p. 339. Coromandel Coast.
 Simon, 1884, pp. 366-367. Pondicherry and Wagro-Karour near Bellary.
 Pocock, 1900, p. 254. Chingleput.
L. inominata, Simon, 1886, p. 142. Cambodia.
 Simon, 1904, p. 287. Cambodia.
L. inops (Thorell), 1890, pp. 135-136. Sumatra.
 (Thorell) 1891-92, pp. 151-154. Sungei Bulu, Sumatra.
L. irani, Pocock, 1901, p. 485. E. Poona.
L. leucostigma (Simon) 1885, p. 10. Guntakal.
L. madani, Pocock, 1901, p. 486. Chopda, E. Khandesh.
L. maindroni, Simon, 1897 (2), p. 296. Karachi.
L. mastersi, Pocock, 1901, pp. 484-485. Jaoli, Satara District.
L. nigrotibialis (Simon) 1884, pp. 330-332, fig. 1. Minhla.
 (Thorell) 1887, pp. 305-307. Minhla.
 (Thorell) 1895 (1), p. 236. Tharrawaddy, Rangoon, Thayetmyo and Tenasserim.
 Pocock, 1900, p. 253. No additional localities.
L. obscurides (Strand) ? var. *seuberti* (Strand) 1907 (1), pp. 445-446.
 Java¹.
L. orophila (Thorell) 1887, pp. 310-312. Me-tan-ja.

¹*L. obscura*, Koch, from Australia, appears to have been renamed *obscurides* by Strand in "Fauna Arctica," Vol. IV, but I have not been able to consult this paper. In the work referred to above he records a variety from Java and names it *seuberti* provisionally, but is doubtful whether it is really distinct.

L. ovicula (Thorell) 1895 (1), pp. 230-232. Rangoon.

L. palliclava, Strand, 1907 (2), p. 567. Ceylon.

L. phipsoni, Pocock, 1899, p. 751. Bombay.

Pocock, 1900, p. 253, fig. 85. Bombay ; Jaoli, Satara District ; Uran ; Kanara ; Nasik.

L. pictula, Pocock, 1901, p. 486. Chopda, E. Khandesh.

L. prolifica, Pocock, 1901, p. 485. E. Poona.

L. semoni, Simon, 1901 (2), p. 350. Buitenzorg.

L. stictopyga (Thorell) 1895 (1), pp. 232-234. Rangoon and Tharrawaddy.

L. subinermis (Thorell) = *conspersa* (Thorell), see Thorell, 1897, p. 22.

*L. subinermis*¹, Simon, 1897 (2), p. 295-296. Karachi.

L. tagax (Thorell) 1897, p. 24. Burma.

*L. tenebrosa*² (Thorell), 1897, p. 24. Burma.

L. wroughtoni, Pocock, 1899, pp. 751-752. Bulsor, Gujerat.

Pocock, 1900, p. 253. Same locality.

L. yerburyi, Pocock, 1901, p. 486. Trincomali.

Genus **Lycosella** Thorell.

L. minuta, Thorell, 1890, pp. 139-140. Sumatra.

Thorell, 1891-92, pp. 183-185. Mt. Singalang, Sumatra.

L. tenera, Thorell with var. *hisulcata*, 1890, p. 139. Sumatra.

Thorell, 1891-92, pp. 179-183. Mt. Singalang, Sumatra.

Genus **Ocyale** Audouin.

O. atalanta Audouin, 1826, p. 150.

Simon, 1897 (1), p. 342. Egypt, Ethiopia, Senegal,

Guinea and Congo Coasts, Ceylon and Burma.

Pocock, 1900, p. 252. No additional localities.

Genus **Venonia** Thorell.

V. coruscans, Thorell, 1895 (2), p. 333. Singapore.

Workman, 1896, pl. 96. Singapore.

Genus **Zantheres** Thorell.

Z. gracillimus, Thorell, 1887, pp. 318-321. Bhamo.

Group CYCLOCTENEÆ.

Genus **Galliena** Simon.

G. montigena, Simon, 1897 (1), p. 353. Java.

¹ This name will have to be changed as it is preoccupied by Thorell's species, of which Simon was evidently not aware, describing his as new.

² This name appears to be preoccupied, having been used in 1877 by Keyserling (*Verh. z. b. Wien* XXVI, p. 665) for an American species which he referred to the genus *Trochosa* (= *Lucosa*).

Group PARDOSEÆ.

Genus **Acroniops** Simon.

A. heterophthalmus, Simon, 1897 (1), p. 362.

Genus **Evippa** Simon.

E. rubiginosa, Simon, 1885, p. 11. Guntakal.

E. praelongipes (Cambridge) 1870, pp. 822-823, pl. 1, figs. 3 a-f. Sinai.
Simon, 1897 (2), p. 290. Karachi.

Genus **Pardosa** Koch.

P. amazonia (Thorell) 1895 (1), pp. 236-239. Rangoon and Tharrawaddy.

P. birmanica, Simon, 1884, pp. 333-334. Minhla.

(Thorell) 1895 (1), pp. 242-244. Tharrawaddy, Rangoon,
Java, Sumatra.

=*ipnochoera* (Thorell) 1890 (2), p. 138. Sumatra.

(Thorell) 1891-2, pp. 176-178. Ajer Mancior
Sumatra.

P. evippina, Simon, 1897 (2), p. 296. Karachi.

P. fidelis (Cambridge) 1872, p. 319. Jericho, Beirut, Egypt, Bombay.

=*venatrix*, Lucas. See Simon, 1897 (1), p. 360.

P. ipnochoera (Thorell)=*birmanica*, Simon.

P. irretita, Simon, 1886, p. 140. Bachiou, Cambodia.

Simon, 1901, p. 69. Lige, Saigon, Singapore and Borneo.

Simon, 1904, p. 288. Cochin-China.

P. laidlawi, Simon, 1901 (1), p. 69. Perak.

P. ludia (Thorell) 1895 (1), pp. 245-247. Tharrawaddy.

P. nicobarica (Thorell) 1891, pp. 68-71. Nicobars.

P. pinangensis (Thorell) 1890, p. 137. Pinang.

(Thorell) 1891-92, pp. 166-169. Pinang.

?=*vagabunda* van Hasselt *nec* Lucas from Sungei Abu and Limun in
Sumatra; Thorell, *loc. cit.* p. 169.

P. psammodes (Thorell), 1887, pp. 312-314. Rangoon.

P. pusiola (Thorell) 1890, p. 316. Nias and Pinang.

(Thorell) 1891, pp. 157-161.

(Thorell) 1891-92, pp. 157-161. Ajer Mancior and Kaju,
Sumatra; Sarawak, Borneo.

(Thorell) 1895 (1), p. 239. Tharrawaddy.

Simon, 1905, p. 70. Java.

P. rabulana (Thorell) 1890, p. 138. Sumatra.

(Thorell) 1891-92, pp. 173-176. Padang Pandjong in
Sumatra.

P. spinicrus (Thorell) 1890, p. 140. Pinang.

(Thorell) 1891-92, pp. 186-190. Pinang.

P. sumatrana (Thorell) 1890, p. 136. Sumatra.

(Thorell) 1891-92, pp. 161-166. Mt. Singalang, Sungei
Bulu and Ajer Mancior in Sumatra.

P. tenasserimensis (Thorell) 1895 (1), pp. 239-242. Tenasserim.

P. thalassia (Thorell) 1891, pp. 65-68. Nancowry.

P. timida (Simon) 1882, p. 221, fig. Tes, Yemen.

Simon, 1897 (2), p. 290. Karachi and Ceylon.

P. tristicula (Thorell) 1887, pp. 315-317. Bhamo.

P. vagula (Thorell) 1890, pp. 137-138. Sumatra and Java.

(Thorell) 1891-92, pp. 169-173. Ajer Mancior in Sumatra ;
Tjibodas in Java.

P. venatrix, Lucas=*fidelis* (Cambridge).

In addition to the above records Blackwall (1864, p. 36) describes *Sphasus lepidus* as a new species from the East Indies. The genus appears, however, to have been overlooked by Simon, and I am unable to place it. It is also not improbable that additional species may prove to be common to India, especially the dry northern regions, and to N. Africa, Arabia, and Persia. For this reason species from these regions, of which there are very few in the collection before me, have been dealt with only in cases where I have been able to identify them with species already described.

Genus *Hippasa* Simon.

Of the species of this genus already recorded from India all but two (possibly three¹) are before me. These two — *H. partita* (Cambridge) and *H. greenalliae* (Blackwall)—come from the dry northern regions. In neither species are the original descriptions adequate for purposes of identification, no mention being made of the characters of the vulva. Simon states that the former has a wide distribution extending from India (Karachi) through Central Asia and Arabia to Egypt, where the type specimens were collected near Alexandria. The latter was described from two immature specimens from "Meerut, Agra and Delhi" and its identity remains quite uncertain.

The females of the remaining Indian species may be distinguished thus :—

1 {	Of large size (carapace nearly 10 mm. long)	..	2.
	Of small size (carapace not more than about 5 mm. long)	..	7.
2 {	Pit of vulva exposed	..	3.
	Pit of vulva covered	..	6.
3 {	Pit of vulva triangular		<i>H. himalayensis</i> , p. 593.
	Pit of vulva rounded in front ..	..	4.
4 {	Pit of vulva semicircular ..	..	5.
	Pit of vulva transversely elliptical ..	..	<i>H. olivacea</i> , p. 593.
5 {	Posterior margin of vulva straight ..	..	<i>H. lycosina</i> , p. 593.
	Posterior margin of vulva with strong median notch	..	<i>H. nilgiriensis</i> , p. 593.
6 {	Plate covering pit of vulva reddish brown throughout, deeply impressed medially in front, posterior margin with median notch, the convexities on either side of this small, not elevated ..	..	<i>H. loundesi</i> , p. 594.
	Plate covering pit of vulva with its posterior angles produced into a pair of large and strongly elevated reddish processes, otherwise colourless	..	<i>H. pantherina</i> , p. 594.
7 {	Sternum with dark median stripe as in all preceding species ..	..	8.
	Sternum unicolorous ..	..	<i>H. madraspatana</i> , p. 595.

¹ There is some doubt as to the identity of the species I have referred to *agelenoides*, Simon. See below, p. 594.

- | | | | |
|---|---|---|-----------------------------------|
| 8 | { | Plate of vulva with a pair of outwardly directed truncate processes behind | <i>H. ? agelenoides</i> , p. 594. |
| | | Plate of vulva pointed behind | |
| 9 | { | Plate of vulva triangularly pointed, not much produced | <i>H. pisaurina</i> , p. 595. |
| | | Plate of vulva produced into a definite tongue-like or more pointed process | |
| | | | <i>H. holmerae</i> , p. 595. |

Males are less frequently met with than females, and can best be determined by their association with them. Those of *H. himalayensis* and *H. lycosina* I am unable to distinguish in any other way. Those of *H. pantherina* have the palps relatively shorter, the tibia being not more than four times as long as broad instead of about five times as long. The proportions, however, are not constant even in the few specimens before me, and it is noticeable that in *H. pantherina* from Madras (city) and Orissa the length is scarcely more than twice the breadth, being much greater in specimens from Kambakkam (about 50 miles north of Madras), Cochin and (?) Ceylon.

The males of *H. olivacea*, *H. nilgiriensis* and *H. loundesi* are not known to me.

Those of the remaining species, like their females, are much smaller than any of the preceding. Between those of *H. ? agelenoides*, *pisaurina* and *holmerae* I am unable to find any differences. *H. madraspatana* may easily be recognised by the absence of the dark median stripe on the sternum and by its entirely different colouration, which resembles that of the female.

Hippasa himalayensis, sp. nov.

Fig. 1 A.

Localities.—Darjiling District of E. Himalayas : Sevok, 1,000 ft.; Pashok, 2,000-3,500 ft.; Kalimpong 600-1,500 ft. and 2,000-4,500 ft., W Himalayas : Simla.

Size, colouration, etc., much as in *H. pantherina*, from which it is, however, clearly distinguished by the form of the vulva (fig. 1 A).

Hippasa olivacea (Thorell).

Fig. 1 C.

Localities.—Keikpedem and Pegu. Also one specimen without record.

Distinguished by the form of the vulva only (fig. 1 C).

Hippasa lycosina Pocock.

Fig. 1 B.

Localities.—Helvak, Koyna Valley, Satara District, and Bombay. Also distinguished solely by the form of the vulva (fig. 1 B).

Hippasa nilgiriensis, sp. nov.

Fig. 1 D.

Locality.—Gudalur Ghat, Nilgiris, 3,000-6,000 ft.

Also distinguished solely by the form of the vulva (fig. 1 D).

Hippasa loundesi, sp. nov.

Fig. 1 E.

Locality.—Yercaud, Shevaroy Hills.

Distinguished by the form of the vulva only (fig. 1 E).

Hippasa pantherina Pocock.

Fig. 1 F.

Localities.—? Ceylon ; Krusadai Island, Gulf of Manaar ; Trivandrum, Travancore ; Chalakudi and Trichur, Cochin State ; Jalarpet, Salem District ; Madras City ; Red Hills and Kambakkam Hill, Chingleput District ; Barkuda Island (Ganjam District) and Barkul (Orissa), Chilka Lake ; Balighai, Orissa.

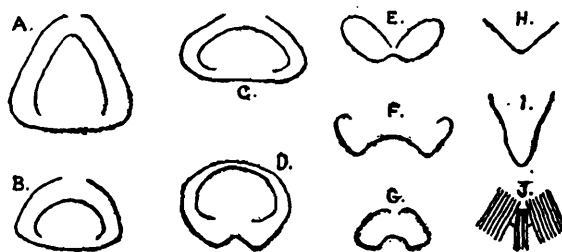
Distinguished from the preceding species by the form of the vulva (fig. 1 F), and apparently also by the shorter palps of the male (above, p. 592). Distinguished from the following species by its much greater size. This seems to be one of the commonest spiders over the greater part of India.

Hippasa ? agelenoides Simon.

Fig. 1 G.

Localities.—Parambikulam, Cochin State, 1,700-3,200 ft.; North Malabar ; Gudalur, foot of Nilgiris, ca. 3,000 ft.

Distinguished from all the preceding species by its much smaller size, and both from these and from the following species by the form of the

FIG. 1.—*Hippasa* spp. Vulva.

- A. *H. himalayensis*, n. sp.
 B. *H. lycosina* (Thorell).
 C. *H. olivacea*, Pocock.
 D. *H. nilgiriensis*, n. sp.
 E. *H. loundesi*, n. sp.

- F. *H. pantherina*, Pocock.
 G. *H. ? agelenoides*, Simon.
 H. *H. pisaurina*, Pocock.
 I. *H. holmerae*, Thorell.
 J. *H. madraspatana*, n. sp.

vulva (fig. 1 G), which when cleared of hair somewhat resembles that of *H. pantherina*. Until the hair is removed, however, the plate of the vulva appears to be simply truncate behind. There can be little doubt, I think, that these specimens (in which slight local differences possibly exist) are identical with those recorded by Simon from the Konkan ; but it is not improbable that closer examination of the vulva of specimens from Burma will show that the true *agelenoides* from that country is distinct, as already suggested by Pocock ; and very possibly the Dehra Dun form may also prove to be distinct.

***Hippasa pisaurina* Pocock.**

Fig. 1 H.

Localities.—Bangalore and Seringapatam, Mysore ; Poona ; Siripur Saran, Bihar.

Distinguished by the form of the vulva (fig. 1 H).

***Hippasa holmerae* Thorell.**

Fig. 1 I.

Localities.—Kalimpong, E. Himalayas, 600-1,500 ft.; between Tengueh and Nan Tien, Yunnan ; Tharrawaddy, Lower Burma.

The dorsal surface of the abdomen is inclined to be more strongly chequered than in the preceding species, especially in the Kalimpong specimens, where a reddish anterior median line, followed by pairs of large dorsal and smaller and less regular lateral light brown spots contrast strongly with a background of black. How far this is characteristic of the living spider is, however, uncertain, as in all species the prevailing grey colouration seems to be more or less replaced by mottled brown and black after prolonged immersion in spirit. The form of the vulva, by which the species can alone be distinguished with certainty, is shown in fig. 1 I.

***Hippasa madraspatana*, sp. nov.**

Fig. 1 J.

Locality.—Madras city. Two males and one female were found running on garden paths, several females in lairs spun among grass in a low-lying, and in the rains waterlogged, part of the Museum compound. The latter were found in November, shortly after the rains.

The colour of this species is quite unlike that of any other Indian *Hippasa*. The carapace is brown with a wide border of whitish hair and sometimes variegated with the same. The upper surface of the abdomen is of a rather pale ochraceous or golden brown hue, often with a distinct anterior median browner area. The sides of the abdomen are dark brown in the male, dark brown above and white below in the female, each of the different colour areas being sharply defined in outline. The sternum, coxae and spinnerettes are dark brown, the legs dark brown annulated with white hairs in both sexes. The plate covering the pit of the vulva is somewhat angularly convex behind and bears three pencils of hair, one medially and a pair laterally (fig. 1 J).

Genus ***Ocyale*** Audouin.

***Ocyale atalanta* Audouin.**

Localities.—Peradeniya and Haragama, Ceylon (the latter with young, "caught as it had captured a butterfly"); Barkuda Island, Chilka Lake ; Siripur, Saran, Bihar. The Siripur specimen is very small and if it belongs to this species cannot be fully mature, the vulva being pale in colour and without a definite median piece. It may be a new species, but it would be unwise to describe it as such without more material.

Genus **Lycosa** Latreille.

This immense genus contains a number of the commonest Indian spiders, but many even of these have yet to be described. The smaller species, such as *L. birmanica*¹, are often to be found in very large number hunting their prey on open ground, especially in moist situations; but as they are very active and not very conspicuous they have not come much under the notice of collectors. Certain large species, such as *L. indigatrix*, live in burrows where they are also reasonably secure from general collectors. Several species, especially the common and widely distributed *L. nigrotibialis*, are very variable in size and other characteristics, which complicates the determination of specific limits. The best characters appear to be found in the eyes, vulva and colour. Colour, however, in this as in other groups of spiders, is a character which must be used with great caution. And it often fails to give any good indication in material that has long been in spirit.

All species of *Lycosa* known to me appear to have the same fundamental colour scheme — one median and one pair of lateral pale longitudinal stripes on a dark ground on the carapace, and similar stripes broken into a series of pale blotches on the abdomen. On the carapace these stripes vary in width and distinctness; but though not strictly constant within specific limits the mean often differs so greatly in different species as to afford a most useful guide in conjunction with other characters. The colour of the abdomen similarly shows much individual variability and yet is a most useful guide, especially when the mean colouration of a species can be determined by the examination of large numbers of fresh specimens. The median pale band is ususally deep ochraceous, and is confined to the anterior half of the abdomen. In many species it is altogether absent, the dark bands on either side of it coalescing throughout to form a dark median band. The lateral bands when continuous are usually whitish; but in many species they also are deep ochraceous and broken up into a series of patches which give the spider an irregularly mottled appearance. In considering the colour of species the possibility of such variations from the mean, always on these lines, and therefore always in the direction of the mean of some other species, must be constantly borne in mind.

In all the species before me there are three teeth on the ventral margin of the chelicerae, though in a few of them the tooth nearest the base is minute.

To the following key to the species of Indian Lycosidae now before me I have added footnotes indicating the probable position of other Indian species. In some cases I have had to rely entirely upon descriptions, but in others I have been able to use notes which I recently made in the British Museum.

- | | | | |
|---|---|--|-----------------------------|
| 1 | { | Area occupied by posterior eyes nearly square (fig. 2A); posterior medians not more than one diameter apart | 2. |
| | | Area occupied by posterior eyes much broader behind than in front (fig. 2B); or posterior medians more than one diameter apart | 5. |
| 2 | { | Anterior portion of median piece of vulva hidden beneath the enlarged anterior chitinized margin of the cavity (fig. 3 B) | <i>L. barnesi</i> , p. 599. |
| | | Cavity and median piece of vulva exposed throughout | 3. |

¹ Concerning the genus of this species and its allies see above, pp. 588—9.

3	Median piece of vulva spade-shaped, the transverse posterior part being about as long as broad (fig. 3 A); very large species (male with conspicuous white hair on all legs, but especially on tibia and tarsus of first two pairs)	<i>L. indigatria</i> ¹ , p 599.
	Median piece of vulva T-shaped, the transverse posterior portion slender like the longitudinal portion	 4.
4	Posterior median eyes separated from each other by about a diameter as seen from above ² and from laterals by slightly more than a diameter; anterior row almost straight as seen from in front; pale lateral bands on abdomen complete and very strongly marked; abdomen pale beneath (males of two forms — one with patella and tibia of first legs nearly black and upper surface of tarsus thickly clothed with long white hairs, the other with these joints coloured like those of the other legs)	<i>L. bistrata</i> , p 600.
	Posterior median eyes separated from each other by less than a diameter and from laterals by about a diameter; anterior row slightly more precurved as seen from in front; pale lateral bands on abdomen incomplete behind and less distinct; abdomen (? always) black beneath (male ? always with first legs coloured like the others)	<i>L. prolifica</i> ³ , p 600.
5 ⁴	Posterior median eyes not more than a diameter apart; median piece of vulva T-shaped or hourglass-shaped	 6.
	Posterior median eyes more than a diameter apart; or median piece of vulva not T-shaped or hourglass-shaped	 10.
6	Dorsal surface of carapace and abdomen without extensive white areas medially (male coloured like female so far as known)	 7.
	Dorsal surface of carapace with broad median band of whitish hair; dorsal surface of abdomen more or less completely covered by a large patch of same colour, rest of body very dark in colour (vulva as in fig. 3 G; male with anterior tibiae and tarsi clothed with decumbent white hair)	<i>L. himalayensis</i> , p 603.
7 ⁵	Upper surface of abdomen with dark median band, often incomplete behind, lateral pale areas coalescing behind; size large, sometimes very large. Vulva variable, median piece usually narrow or keeled in front (fig. 3 C—E)	<i>L. nigrotibialis</i> , p 600.
	Upper surface of abdomen mottled, with dark-bordered deep ochraceous median patch in front. Almost always smaller, never very large	 8.

¹*L. wroughtoni*, Pocock, from Bulsar, Gujerat, is closely allied to this species. It is known from the male sex only, and is said only to differ in colour.

²Actually by rather less as seen from in front. When the two species are compared they can easily be separated, the posterior eyes being larger and therefore closer together in *L. nigrotibialis* than in *L. bistrata*; but it is very difficult to define either with such precision as to make it easily recognisable in the absence of the other.

³*L. fuscana*, Pocock, from E. Poona and *L. pictula*, Pocock, from Chopda, E. Khandesh, resemble *L. prolifica* in the arrangement of the eyes and may be identical with it. The types of both are darker in colour, especially those of the former in which, moreover, the median piece of the vulva is very long and slender in an elongated narrow cavity.

⁴The median piece is occasionally indistinct in the first group, e.g., in *L. irani*, Pocock.

⁵*L. orophila* (Thorell), *L. subinermis*, Simon (nec Thorell), *L. comotti* (Thorell), *L. tenebrosa* (Thorell, described from an immature specimen only), *L. incminata*, Simon, *L. irani*, Pocock, *L. mastersi*, Pocock, and *L. yerburyi*, Pocock, probably belong to this group. The last three can easily be distinguished from the species before me by the structure of the vulva. In *L. irani* the median piece is indistinct. Pocock's description of the vulva of *L. chapteri*, Simon, suggests affinities with *L. irani* but does not refer to the eyes. I have not been able to consult the original description. *L. comotti* appears to be very closely related to *L. madani* and may possibly prove to be identical with it.

8 ¹	Moderately large species, usually 12-18 mm. long; anterior line of eyes straight or slightly procurved (middles of laterals very slightly lower than middles of medians), rarely lightly recurved	..	..	9.
	Smaller species, not more than about 9 mm. long; anterior line of eyes lightly recurved (middles of laterals very slightly higher than middles of medians), rarely quite straight	..	..	9.
9	Longitudinal portion of median piece of vulva narrow or keeled, T-shaped; anterior line of eyes very slightly procurved as a rule	..	..	9.
	Longitudinal portion of median piece of vulva very broad and flat, hourglass-shaped (fig. 3 F); anterior line of eyes straight as a rule	..	..	9.
10	Posterior median eyes not more than a diameter apart, anterior line extending to their outer margins or beyond	..	..	11.
	Posterior median eyes more than a diameter apart, anterior line not extending to their outer margins	..	..	12.
11 ²	Body and legs not covered with long erect hair; vulva (fig. 3 H) a single plate with a pair of oblique slits (male coloured like female)	..	..	11.
	Body and legs covered with long erect hair; vulva (fig. 3 I) a pair of minute plates each with a single aperture (male coloured like female)	..	..	12.
12 ³	Area occupied by posterior eyes broader than long and much broader behind than in front; medians not very widely separated; sternum pale, or (rarely) with dark border	..	..	13.
	Area occupied by posterior eyes not much longer than broad, and not much wider behind than in front; medians very widely separated; sternum often black, especially in the middle	..	..	19.
13	Vulva flat in the middle line or narrowly keeled	..	..	14.
	Vulva with a median lobe	..	..	17.
14	Cleft of vulva (fig. 4 A) linear, sharply defined, narrow throughout (male apparently resembling female in colour)	..	..	15.
	Cleft of vulva broader or not sharply defined	..	..	15.
15	Cleft of vulva (fig. 4 B) narrow behind, with more or less circular expansion in front (male resembling female in colour)	..	..	16.
	Cleft of vulva not markedly constricted behind	..	..	16.
16	Cleft of vulva (fig. 4 C—E) parallel-sided or ill-defined (male either resembling female in colour or with palps black throughout)	..	..	16.
	Cleft of vulva (fig. 4 F) narrow in front, very broad behind, lateral margins very prominent (male coloured like female)	..	..	16.

L. stictopyga, p. 602.*L. madani*, p. 602.*L. kempi*, p. 602.*L. leucostigma*, p. 603.*L. punctipes*, p. 603.*L. moulmeinensis*, p. 604.*L. carmichaeli*, p. 604.*L. sumatrana*, p. 604.*L. fletcheri*, p. 606.

¹ The difference in the eyes is very minute and, being slightly variable, extremes sometimes have the character of the other species. The difference in size is, however, more definite, and is clearly correlated with the minute difference in the eyes. I have, therefore, no hesitation in regarding the species as distinct.

² *L. conspersa* (Thorell) and *L. ovicula* (Thorell) are probably allied to these two species, though the structure of the vulva appears to be somewhat different. *L. maindroni*, Simon, is separated from *L. leucostigma* only by reason of its colour and may perhaps be identical with it. *L. tagax* (Thorell), known from the male only, probably also belongs to this group.

³ Many, possibly all, of the species in this group would be placed by Simon in the genus *Pardosa*, which differs according to his definition in having the labium at least as broad as long and not more than half as long as the maxillary processes, which are relatively narrow. While agreeing that the arrangement of the eyes, on which my classification is based, does not give grounds for generic separation, I find the shape of the labium even harder to use. I have therefore followed Thorell in regarding these species as *Lycosa*. *Pardosa* I confine to species with the carapace very high in front, these forming a more distinct group among the species before me.

- 17 { A conspicuous transverse plate, keeled in the middle line, present behind median lobe of vulva (fig. 4 G) and between ends of side pieces which are obliquely truncate and slightly concave (male coloured like female) .. *L. sutherlandi*, p. 606.
 No such plate visible, side pieces of vulva more distinctly bilobed behind or on inner side 18.
- 18 { Side pieces of vulva (fig. 4 H) curved inwards so that bilobed extremity is directed inwards, both lobes being in contact with median lobe (palps of male with tarsus and extreme tip of tibia black, the rest white) .. *L. mackenziei*, p. 606.
 Side pieces of vulva (fig. 4 I) straighter, only in contact with median lobe on inner side behind (male either coloured like female or with tibia and tarsus of palps black, patella and tip of femur white) .. *L. annandalei*, p. 606.
- 19 { Vulva (fig. 4 J) with minute, grooved and bluntly pointed projection in middle line behind (palps of male with white hair from tip of femur to base of tarsus) .. *L. birmanica*¹, p. 607.
 Vulva (fig. 4 K) with flat quadriangular plate in middle line behind (male as in preceding) .. *L. quadrifer*, p. 608.

***Lycosa indigatrix* Latreille.**

Incl. *L. catula* Simon.

Figs. 2 A and 3 A.

Localities.—Killinochchi, Ceylon; Horsleykonda, Chittoor District; Jalarpet, Salem District; Mysore; Bangalore; S. Arcot; Palavaram, Chingleput District; and Madras City. A specimen from Waltair, with a broad, flattened, plate-like rather than keel-like median bar to the vulva, which resembles this species in other respects, is perhaps distinct. The lines of white spots on the ventral surface of the abdomen,

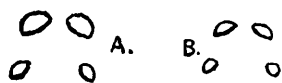


FIG. 2.—*Lycosa* spp. Posterior eyes.

A. *L. indigatrix*, Latreille.

B. *L. nigrotibialis*, Simon.

by which *L. catula* is distinguished from *L. indigatrix* are variable in extent and distinctness, and do not appear to me to provide a sound specific character. It is possible, however, that they may be characteristic of distinct local races, for all the three specimens from Bangalore possess them, although none of the more numerous ones before me from Madras do so. Other localities are represented by a single specimen each, none of which show them. The upper surface is of a somewhat uniform dull brown colour, without longitudinal stripes. This appears to be the largest common Indian *Lycosa*, reaching a total length of 24 mm., with carapace 12 mm. long.

***Lycosa barnesi*, sp. nov.**

Fig. 3 B.

Locality.—Dhoni Forest, ca 1,500-4,000 ft., S. Malabar. A single specimen, 12 mm. long (carapace 5 mm.).

This species is closely related to the next, but has the cavity of the vulva (fig. 3 B) covered by a large, transverse, strongly chitinized

¹ *L. laidlawi* (Simon) is closely allied to this species.

plate. It is also much darker in colour, the dorsal surface of the abdomen being of a very dark brown with the pair of longitudinal bands deep ochraceous and somewhat broken. The abdomen is paler below, but even there it is speckled with black. The carapace bears a median ochraceous band, very broad in front, then two still broader dark bands, then two broad but somewhat broken ochraceous lateral bands immediately above the narrow dark margin. The eyes are exactly as in the following species.

***Lycosa bistrata*, sp. nov.**

Localities.—Kalare, Bangalore and Bandipur, Mysore ; Madras City (*types*) ; Vettuvankeni and Ennur, Chingleput District ; Gmatia, Birbhum District ; Calcutta ; Darjiling District 1,000-3,000 ft.

This species is one commonly found hunting on more or less open ground like *L. birmanica*. It is of about the same size as the last, often rather smaller. It closely resembles it in general structure and appearance though the vulva is different and the colour much paler. The detail of the vulva is somewhat variable, as in *L. nigrotibialis*, the median piece sometimes having somewhat inconspicuous transverse branches behind instead of the usual conspicuous ones ; the edges of the cavity, also, bend inwards to a variable extent.

The anterior row of eyes is also somewhat variable, being straight or lightly procurved. The medians are distinctly larger than the laterals in both rows.

There are two distinct kinds of male, as already indicated in the key, one resembling the female in colour, the other with the patella and tibia of the first pair of legs nearly black and the upper surface of the tarsus clothed with thick white hair.

***Lycosa prolifica* Pocock.**

Localities.—Poona District (*cotypes*) ; Pimpalner, W. Khandesh ; Kas, 3,700 ft., Satara District.

In size, variability and general appearance this species closely resembles the next. The eyes, however, are arranged as in the preceding species, the posterior laterals being much nearer to each other and somewhat further from the medians than in *L. nigrotibialis*. The posterior eyes are somewhat larger and closer together than in *L. bistratus* and the anterior row is somewhat more distinctly procurved than is usual in that species.

***Lycosa nigrotibialis* (Simon).**

Incl. *L. goliathus*+*phipsoni* Pocock.

Figs. 2 B and 3 C-E.

Localities.—Jalarpet, Salem District ; Bangalore ; Taloshi, ca. 2,000 ft., Medha, ca. 2,200 ft., and Poona and Khandala, ca. 2,500 ft., Poona District, Bombay Presidency ; Zangi Nawar, 20 miles west of Nushki, Baluchistan ; Afghanistan ; Taru, Peshawar ; Rawalpindi, Punjab ; Pusa, Siripur and Katihar, Bihar ; Gmatia, Birbhum District, and

Calcutta, Bengal ; Simla and Dharampur, *ca.* 5,000 ft., W Himalayas ; Nepal Valley, 4,500-6,500 ft., E. Himalayas ; Sukna, *ca.* 1,000 ft., Singla 1,500 ft., Kalimpong 2,000-4,500 ft., Darjiling District, E. Himalayas ; Sibsagar and Garo Hills, Assam ; Assam-Bhutan Frontier, Mangaldai District ; Arakan and Rangoon, Burma ; Talé Sap, Singora Province, Siam ; Yunnan. Podaspur.

Thorell (1887, p. 305) has already called attention to the extraordinary range of variation found in this species. Sometimes it is even larger than *L. indigatrix*, but this is exceptional. Usually it is about 20 mm. long, with carapace about 10 mm. Often, however, it is no bigger than *L. kempi*. Not only is it extremely variable in size, but the lower surface may be either an intense and uniform black as in *L. indigatrix*, uniformly

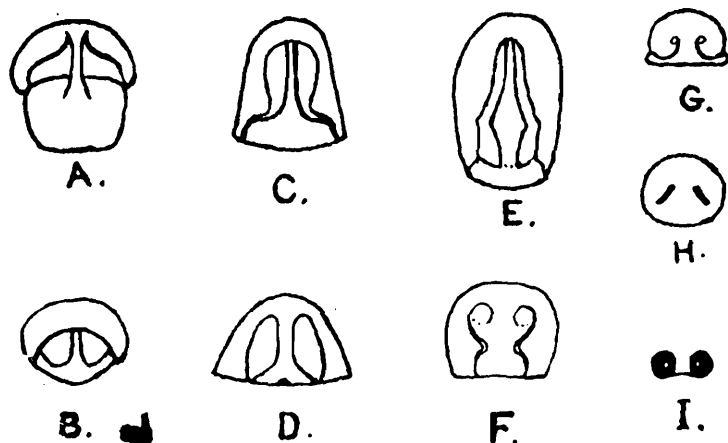


FIG. 3.—*Lycosa* spp. Vulva.

- A. *L. indigatrix*, Latreille.
- B. *L. barnesi*, n. sp.
- C. *L. nigrotibialis* (Simon) usual form.
- D. *L. nigrotibialis* (Simon) from a co-type of *L. phipsoni*, Poc.
- E. *L. nigrotibialis* (Simon) from a co-type of *L. goliathus*, Poc.
- F. *L. kempi*, n. sp.
- G. *L. himalayensis*, n. sp.
- H. *L. leucostigma*, Simon.
- I. *L. punctipes*, n. sp.

pale yellowish, or yellow with more or less definite greyish or black longitudinal bands. The upper surface of the abdomen is marked longitudinally with a dark median band of somewhat ribbed appearance, bordered on either side by a pale band, with darker colour beyond, becoming gradually paler below. This colour scheme, though subject to the usual variation in intensity, is quite distinct from that of *L. indigatrix*, which is mottled more as in *Ocyale atalanta*.

The structure of the vulva varies considerably in detail. Usually the cavity is quite broad, and its sides follow to some extent the course of the T-shaped median piece (fig. 3 C.). Sometimes, however, the sides are straight instead of angulate behind, as in *L. phipsoni*, Pocock. (fig. 3 D), and the cavity may be much longer than broad as in *L. goliathus*, Pocock (fig. 3 E). In two specimens, one from the Second Defile of the Irrawaddy and one from outlying spurs of the Kakhyin Hills, the anterior part of the median piece is expanded into an extensive circular plate which in the former fills and in the latter nearly fills the anterior part of the cavity. These form a transition to *L. Kempi* and may

perhaps represent a distinct local race, possibly even a distinct species. No trace of colour pattern remains in either.

The male resembles the female in general colour, but it is not possible to say definitely that secondary sexual characters are not developed, in some specimens at least, without an examination of fresh material, which I have not got.

***Lycosa madani* Pocock.**

Localities.—Kavalai, 1,300-3,000 ft., Cochin State; Bangalore, ca. 3,000 ft., Mysore; Horsleykonda, ca. 3,000-4,100 ft., Chittoor District; Barkuda Island, Chilka Lake; Siripur, Saran, Bihar.

Maximum length about 14 mm., carapace 6 mm.

This species is only distinguished from *L. nigrotibialis* by its mottled rather than longitudinally striped colour pattern and by its smaller size. The former character is often unrecognizable in spirit material, and the latter is somewhat indefinite. Identifications of spirit material are consequently apt to be a little uncertain, especially when the material is old. The vulva is like that found in the more typical forms of *L. nigrotibialis*, with T-shaped median piece.

***Lycosa kempi*, sp. nov.**

Fig. 3 F.

Localities.—Darjiling District, 1,000-3,000 and 6,000 ft., and Singla, 1,500 ft.; Assam-Bhutan frontier, Mangaldai District, Assam (*type*).

Maximum length 18 mm., carapace 9 mm.

The colour is of the same mottled pattern as in the last species, often distinctly speckled with greyish black. The anterior row of eyes is straight, with very slight variation in either direction. The broad median piece of the vulva (fig. 3 F) is the most distinctive character of the species. The male is coloured like the female.

***Lycosa stictopyga* (Thorell).**

Localities.—Lahore, Punjab; Siripur, Saran, Bihar; Calcutta; Singla, 1,500 ft. and Kalimpong 2,000-4,500 ft., Darjiling District; Garo Hills; Singapore.

A much smaller species than any of the last four, being of about the size of *L. bistrata*. Maximum length 9 mm., carapace 4. It is readily distinguished from the last named by the more trapezoidal arrangement of the posterior eyes. From the larger, but more closely related, species with similar posterior eyes it may be separated by the faint recurvature of the anterior eyes which are rarely straight as in *L. kempi*, never procurved as in the others. The vulva is intermediate between that of *L. madani* and that of *L. kempi* and is very variable, extremes being very like one or other of these. Normally the median piece is broad and hourglass-shaped with a distinct keel behind; but it may be broad and flat or may be more slender and T-shaped.

The male is coloured like the female.

***Lycosa himalayensis*, sp. nov.**

Fig. 3 G.

Localities.—Singla 1,500 ft., Ghumti 2,500 ft., Pashok 2,500, 3,000 and 3,500 ft.; Soom 4,000-5,000 ft.; Kalimpong; Sitong Ridge 4,700 ft. and Nam Ting Pokri, Sitong Ridge; Sureil 5,000 ft. All these localities are in the Darjiling District. There is also a single specimen from Sonarpur, Assam.

Maximum length 13 mm., carapace $6\frac{1}{2}$ mm.

This is one of the most easily recognizable of all species of *Lycosa*, both by its dark ground colour with patch of white hair on the abdomen in the middle line in front and by the structure of the vulva (fig. 3 G), which is particularly strongly chitinized.

In all the males I have seen the tibia and tarsus of the first legs is clothed with decumbent white hair.

***Lycosa leucostigma* Simon.**

Fig. 3 H.

Localities.—Trivandrum; Cochin State; Madras City; Ennur, and Kambakkam Hill, 200-800 ft., Chingleput District; Barkuda Island, Chilka Lake; E. Khandesh, Bombay Presidency; Siripur., Saran, Bihar; Gmatia, Birbhum District; Calcutta.

Length up to about 9 mm., carapace 5 mm.

The simple vulva and small eyes, with the anterior row extending at least to the outer margins of the posterior medians, at once separates this species and the next from all others known to me. This one may easily be distinguished from the next by its short hair and more mottled and usually darker colour.

The vulva consists of a more or less circular plate with a pair of oblique slits in it (fig. 3 H). The male resembles the female in colour.

***Lycosa punctipes*, sp. nov.**

Fig. 3 I.

Localities.—Ulsoor tank, Bangalore (*type*); Ennur, Chingleput District; Lucknow; Ballia village tank, Lalganj, Mirzapur; Siripur, Saran, Bihar; Berhampur Court, Bengal; Calcutta.

Length 8 mm., carapace $4\frac{1}{2}$ mm.

A small, intensely hairy, yellowish or greenish grey spider found among vegetation on the surface and edges of tanks. The carapace, sternum and appendages are yellowish. The abdomen bears a pair of longitudinal rows of white spots, either round or produced laterally into transverse lines, and sometimes completely obscured by the extension dorsally of the general ventral covering of white hair. There are normally three white spots on the dorsal surface of the protarsus; one at the tip of the patella and one near the middle of the tibia, but the full number is not always developed, especially on the first pair of legs.

The vulva consists of a pair of small circular plates, each with an aperture slightly towards the inner side (fig. 3 I). The male resembles the female in colour.

***Lycosa moulmeinensis*, sp. nov.**

Fig. 4 A.

Locality.—Moulmein, Lower Burma.Maximum length 7 mm., carapace $3\frac{1}{2}$ mm.

Scarcely a trace of the original colour remains in any of the specimens, which are very old. There appears, however, to have been a pale median band along the whole length of the abdomen, formed by the suppression of the median ochraceous patch and its dark borders and the fusion of the pale lateral bands in the middle line; and superimposed on this there appears to have been a series of transverse white lines as in the preceding species. The sternum appears to have borne a longitudinal dark median stripe. The vulva with its narrow median cleft is the most distinctive character of the species (fig. 4 A).

There is no indication of any secondary sexual colouration in the single male present.

***Lycosa carmichaeli*, sp. nov.**

Fig. 4 B.

Localities.—Amangarh, Bijnor District, U. P.; Kathgodam, 1,200 ft., Kumaon, W. Himalayas; Sevok, 1,000 ft., Darjiling District (*type*), Darjiling, 6,000 ft.; Assam-Bhutan Frontier, Mangaldai District (river-bed). Sukhwani.

Maximum length 19 mm., carapace $8\frac{1}{2}$ mm.

The colour is not well shown on any of the specimens before me, but the abdomen appears to be without the anterior dorsal ochraceous patch on the abdomen, its dark borders being united across the middle line right to the front. There has evidently, also, been a considerable amount of whitish pile all over the upper surface of the body, and the abdomen appears to have been marked in addition with narrow transverse bands of a more snowy white. The cavity of the vulva (fig. 4 B) is widely expanded in front, and its floor is raised in the middle line behind forming the stem of the T-shaped median piece. There are a pair of apertures on either side of the cavity behind, but they are much smaller than in the previous species and although situated against the arms of the median piece they are much farther from their ends.

The male does not appear to differ from the female in colour.

***Lycosa sumatrana* Thorell.**

Fig. 4 C-E.

Localities.—Anuradhapura, Ceylon; Parambikulam, 1,700-3,200 ft. and Chalakudi, Cochin State; Yercaud, Shevaroy; Bangalore, *ca.* 3,000 ft. and Bandipur, *ca.* 3,000 ft., Mysore; Gudalur, *ca.* 3,000 ft., Ootacamund, *ca.* 6,700-8,000 ft., Keti, *ca.* 6,500 ft., and Stillbrook Garden, Coonoor, Nilgiris; Madras City; Red Hills, Chingleput District; Horsleykonda, *ca.* 3,000-4,100 ft., Chittoor District; Bombay; Bandra nr. Bombay; Saugor, C. P.; Siripur, Saran, Bihar; Gmatia, Birbhum District;

Kierpur, Purneah District; Calcutta; Dum-Dum nr. Calcutta; Simla, W. Himalayas; Nepal Valley, 4,500-6,500 ft.; Darjiling District, 1,000-3,000 ft., Sukna, 1,000 ft., Singla, 1,500 ft., Ghumti, 1,500-5,000 ft., Tindharia, Rungneet Tea Estate, 4,500-5,000 ft., Pashok, 3,000 ft., Kalimpong, 2,000-4,500 ft., Sureil, 5,000 ft., near Sureil, 6,000 ft., Darjiling District; Rangamati, Chittagong Hill Tracts; Garo Hills, Assam; Camorta, Nicobars.

This species is common on damp ground with *L. birmanicus*.

Maximum length 10 mm., carapace $4\frac{1}{2}$ mm.

The general colour is dull brownish. The carapace is black round about the eyes, with broad median and submarginal pale bands. The sternum is usually pale in the female but is sometimes dark, especially in E. Himalayan specimens. The sternum is often dark in the male. The abdomen is mottled above, whitish below, with more or less distinct median ochraceous patch in front. The legs are uniformly dark or banded. The vulva (fig. 4 C-E) is somewhat variable in detail, the dark side-pieces sometimes being longer than broad instead of broader than

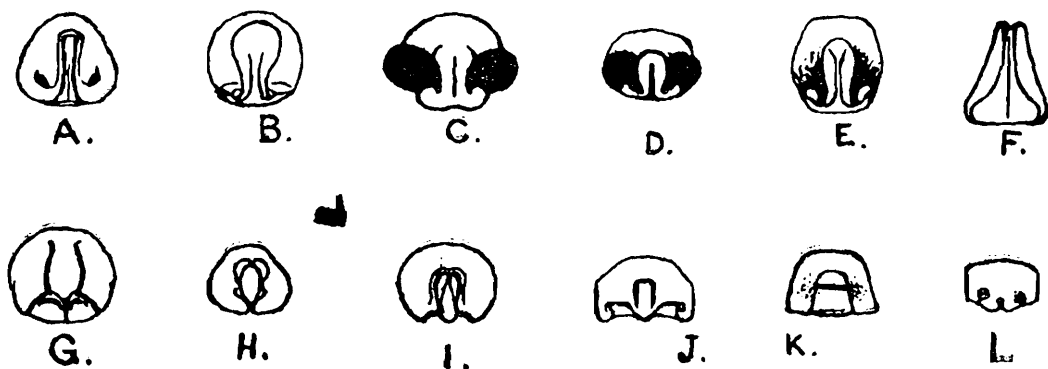


FIG. 4.—*Lycosa* spp. and *Venonia* sp. Vulva.

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| A. <i>L. moulmeinensis</i> , n. sp. | G. <i>L. sutherlandi</i> , n. sp. |
| B. <i>L. carmichaeli</i> , n. sp. | H. <i>L. mackenziei</i> , n. sp. |
| C. <i>L. sumatrana</i> , Thorell, usual form. | I. <i>L. annandalei</i> , n. sp. |
| D. <i>L. sumatrana</i> , Thorell, transitional form. | J. <i>L. birmanica</i> , Thorell. |
| E. <i>L. sumatrana</i> , Thorell, from Garo Hills. | K. <i>L. quadrifer</i> , n. sp. |
| F. <i>L. fletcheri</i> , n. sp. | L. <i>V. himalayensis</i> , n. sp. |

long. But they are almost always of darker colour than the rest of the vulva and the broad plate behind them renders the species easy to recognize as a rule (fig. 4 C). In some specimens, however, especially those from eastern localities and the hills of Cochin State, the side pieces are produced backwards on the inner side of the small aperture beneath their posterior margins, thus leaving a longer, narrower and more clearly defined cleft between them (fig. 4 D). This is still more marked in specimens from the Garo Hills (fig. 4 E), and it may be necessary to recognize it as a distinct race when more material is available. The single specimen from Camorta in the Nicobar Islands is of the normal type. Unfortunately there are none present from Burma.

The male is often difficult to distinguish from that of *L. annandalei* (see below). Two forms occur, one coloured like the female, the other with the whole of the palps and usually the sternum and bases of legs, especially the first pair, black.

Lycosa fletcheri, sp. nov.

Fig. 4 F.

Localities.—Abbotabad, Hazara District, North-West Frontier Province (*type*); Sutlej Valley below Simla and Dharampur, *ca.* 5,000 ft., W Himalayas.

Maximum length 12 mm., carapace 5 mm.

The area occupied by the eyes is black; behind this the carapace is brownish with large pale dorsal area and broad but not very sharply defined pale submarginal band. The abdomen is mottled, with ochraceous patch in the middle line in front. The sternum is darker at the margin than in the centre. The legs, which are long and slender, are mottled.

The structure of the vulva, which is the most distinctive character of the species, is shown in fig. 4 F and has been described in the key.

The male resembles the female in colour.

Lycosa sutherlandi, sp. nov.

Fig. 4 G.

Localities.—Singla, 1,500 ft. (*type*); Pashok, *ca.* 1,000 ft.; Kalimpong, 2,000-4,500 ft., all in the Darjiling District of the E. Himalayas.

Maximum length 10 mm., carapace 5 mm. Legs very long and slender.

This species appears to have the same colour scheme as the last. The vulva, however, is entirely different (fig. 4 G). There is a median lobe, acuminate behind, extending about two-thirds of the distance to the posterior margin; on either side of this are the side pieces, whose truncate or slightly concave posterior extremities cover the paired apertures. Behind these is an extensive flattened plate, finely keeled in the middle line.

The male does not appear to differ in colour from the female.

Lycosa mackenziei, sp. nov.

Fig. 4 H.

Localities.—Bangalore, *ca.* 3,000 ft., Mysore State (*type*); Siripur, Saran, Bihar; Dinapore, Bihar; Calcutta.

Maximum length $8\frac{1}{2}$ mm., carapace 4 mm.

In colour this species closely resembles the last three. The vulva (fig. 4 H) has a median lobe as in *L. sutherlandi*, but the side pieces are curved round so that their extremities, which are bilobed, practically meet behind it, and there is no distinct posterior plate.

The femur, patella and tibia of the palps of the male are white, the tibia alone being tipped with black; the tarsus is black, tending to a slightly paler shade at the tip.

Lycosa annandalei, sp. nov.

Fig. 4 I.

Localities.—Trivandrum, Travancore; Bangalore, *ca.* 3,000 ft., Mysore; Ootacamund, Nilgiris; Madras City (*type*); Red Hills, Chingleput

District ; Horsleykonda, *ca.* 3,000-4,100 ft., Chittoor District ; E. Khandesh, Bombay Presidency ; Mooltan, Punjab ; Siripur, Saran, Bihar ; Gmatia, Birbhum District ; Calcutta, Salt Lakes and Dum-Dum near Calcutta, and Berhampur Court, Bengal ; Sitong, *ca.* 4,700-4,800 ft., Darjiling District ; Chittagong ; Silcuri, Cachar.

Maximum length 12 mm. (usually at least 1 mm. less than this), carapace $5\frac{1}{2}$ mm.

This species is found chiefly beside water.

The general colour is usually olivaceous rather than brown in fresh specimens, but it soon becomes brown in spirit ; and there is usually a fine mid-dorsal line of white hair on the carapace. The general pattern, however, resembles that of the four preceding species. The vulva (fig. 4 I) is of the same general plan as that of the last species, but the side pieces do not curve inwards to meet behind the median lobe, which extends to the posterior margin.

It is probable that two forms of the male occur in this species, as in *L. sumatrana* with which it is commonly found. But I know of no certain means of distinguishing between the two species in the case of the form which resembles the female in colour. Most such males are small in size ; and I therefore refer them with some degree of certainty to *L. sumatrana*, this being as a rule somewhat smaller than *L. annandalei*. But it is not unlikely that some at least really belong to *L. annandalei*. In the second form of male the tibia and tarsus of the palps are black, but the dorsal surface of the patella and the tip of the femur are clothed with glistening white hair, which at once distinguishes them in life from the corresponding male of *L. sumatrana* in which the palps are black throughout. In spirit the distinction is, however, less obvious, as the silky hair of *L. annandalei* becomes almost invisible when wet, and may even reveal a uniformly black colouration beneath, while the femur and patella of spirit specimens of *L. sumatrana* often appear less dark than the tibia and tarsus.

***Lycosa birmanica* Thorell.**

Fig. 4 J.

Localities.—Bangalore, Mysore State ; Ootacamund, *ca.* 6,700-8,000 ft. and Coonoor, *ca.* 5,700-6,000 ft., Nilgiris ; Madras City ; Ennur, Chingleput District ; Horsleykonda, *ca.* 3,000-4,100 ft., Chittoor District ; Barkuda Island, Chilka Lake, Ganjam District ; Bandra, nr. Bombay ; Burhanpur, C. P. ; Mowai, Bara Banki, U. P. ; Siripur, Saran, Bihar ; between Chaibassa and Chakradharpur, Singbhum District and Purulia, Manbhum District, Chota Nagpur ; Gmatia, Birbhum District, Calcutta and Dum-Dum, Bengal ; Singla, 1,500 ft., Darjiling District ; Tavoy. Also Sukhwani.

Maximum length 8 mm., carapace 3 mm.

An extremely common species found running about among dead leaves or on open ground, especially in damp places.

The carapace is uniformly dark, without the pale median and sub-marginal bands found in the preceding species. The sternum is almost always dark. The abdomen is mottled, ochraceous and black, with the anterior median area entirely black or with only a streak of ochraceous

colouration. The legs are strongly banded. The area occupied by the posterior eyes is not so much wider behind than in front as in the preceding species, being almost square instead of strongly trapezoidal.

The vulva (fig. 4 J) is deeply grooved in the middle line almost to the posterior margin which is produced backwards to form a triangular projection between the side pieces.

The palps of the male are usually black to near the tip of the femora, but may be quite pale. From the tip of the femora to the base of the tarsus they are clothed with dense white hair, the rest of the tarsus being black. Usually the whole of the tarsus except the extreme base is black, but the area of white hair is sometimes more extensive. In this case the femora and sternum are usually pale instead of dark in colour. I have seen no males with palps coloured like those of the female, although I have examined a large number.

***Lycosa quadrifer*, sp. nov.**

Fig. 4 K.

Localities.—Anuradhapura (*type*), Peradeniya and Hambantota, Ceylon; Parambikulam, 1,700-3,200 ft., Cochin State; Bangalore, ca. 3,000 ft., Mysore State; Covelong, Ennur and Kambakkam Hill, 200-800 ft., Chingleput District; Madras City.

This species seems to be widely distributed in S. India, but never to be common. In Ceylon, however, it appears to replace *L. birmanica*, for which I mistook both sexes when collecting specimens at Anuradhapura, where it was abundant. I therefore refer the Hambantota specimen, which is a male, to this species. Both sexes are indistinguishable from *L. birmanica* in size and colour, but in the female the vulva (fig. 4 K) is quite different, the median piece being depressed and truncate behind, so that when viewed from above the posterior portion of it appears to be a quadrangular plate separating the ends of the side pieces, which are also truncate.

Genus ***Venonia*** Thorell.

***Venonia himalayensis*, sp. nov.**

Fig. 4 L.

Localities.—Rungneet Tea Estate, 4,500-5,000 ft. (*type*) and Darjiling, 6,000 ft., Darjiling District.

Maximum length $3\frac{1}{2}$ mm., carapace $1\frac{1}{2}$ mm.

The carapace is low, not strongly convex in outline as in Workman's figure of *V. coruscans* from Singapore. The cephalic portion is narrow and almost parallel sided; the posterior portion is broader. The anterior eyes are strongly procurved, and do not extend beyond about the middles of the posterior medians¹ which are separated from each other by about a diameter. The four posterior eyes are about equal in size, rather large and prominent; they form a quadrangle which is about as long, and about twice as wide behind, as it is wide in front. The carapace

¹ In Workman's figure of *V. coruscans* they extend quite to their outer margins.

is dark reddish brown, sometimes with a purplish sheen. Both it and the abdomen are covered with glistening golden pile. The sternum is ochraceous. The legs are ochraceous banded with grey. The abdomen is dark brownish above with pale spots arranged in three longitudinal bands on the upper surface, and pale oblique stripes on the sides extending upwards from the pale ventral surface.

The vulva is shown in fig. 4 L. The palps of the male appear to be somewhat slenderer than in *V. coruscans*. The male does not appear to differ from the female in colour.

Genus **Pardosa** Koch.

As already explained (*antea*, pp. 588, 589) I include in this genus only species in which the carapace is much elevated and vertical in front. It is with some hesitation that I describe three of the four species before me as new. They are so common and so widely distributed that they may easily prove to be identical with species already known from outside India. Two such species, *P. fidelis* (Cambridge) and *P. timida* (Simon) have already been recorded; but the descriptions of these do not seem to agree with the specimens before me. As I am unable to identify them it seems best to describe them and give them names by which they can, for the present, be referred to even though these may have to be relegated to synonymy later on.

They may be distinguished as follows :—

- | | | | |
|---|---|--|---------------------------------|
| 1 | { | Vulva with well developed orifice beneath posterior end of each side piece (fig. 5 A) ; sternum with dark median stripe (palps of male black) .. | <i>P. pusiola</i> , p. 609. |
| | | Vulva not as above ; sternum uniformly pale .. | .. 2. |
| 2 | { | Space between side pieces of vulva (fig. 5 B) entirely covered in (palps of male black, with whitish hair on upper side of femur) .. | <i>P. atropalpis</i> , p. 610. |
| | | Space between side pieces of vulva not covered in behind .. | .. 3. |
| 3 | { | Vulva (fig. 5 C) broader than long ; space between side pieces very narrow, its anterior half covered by slender tongue-like process ; side pieces very broad (palps of male black, with white hair on upper side of femur and inner side of patella) .. | <i>P. ooklêyi</i> , p. 610. |
| | | Vulva (fig. 5 D) longer than broad ; space between side pieces broad, only partially covered in front by broad tongue-like process ; side pieces very narrow (palps of male pale, except tarsus which is brown). | <i>P. leucopalpis</i> , p. 610. |

Pardosa pusiola Thorell.

Fig. 5 A.

Localities.—Peradeniya, Ceylon ; Sureil, 5,000 ft., Darjiling District.

Maximum length 8 mm., carapace $3\frac{1}{2}$ mm.

The general colour of this spider is very dark. The carapace bears a deep ochraceous median band between a pair of black lateral bands, beyond which it is mottled. The abdomen is dark at the sides, with pale median band, at the anterior end of which the usual lenticular ochraceous patch is distinguishable with traces of dark outline. In colour, therefore, this species closely resembles *Lycosa moulmeinensis*. The femora are strikingly marked with black on the inner side. The

hind legs are much the longest. The vulva (fig. 5 A) is somewhat like that of *L. sumatrana*, but the apertures beneath the posterior ends of the side pieces face more inwards and are very broad.

The male is usually darker in colour than the female. Its palps and the basal two-thirds of the first femora are black throughout.

***Pardosa atropalpis*, sp. nov.**

Fig. 5 B.

Localities.—Bangalore, ca. 3,000 ft. and Bandipur, ca. 3,000 ft., Mysore State ; Gudalur, ca. 3,000 ft., foot of Nilgiris ; Madras City (*type*) ; Horsleykonda, ca. 3,000-4,100 ft., Chittoor District ; Nellore ; ? Barkuda Island, Chilka Lake, Ganjam District (male only). Found abundantly at Madras and Bangalore.

Maximum length $5\frac{1}{2}$ mm., carapace $2\frac{1}{2}$ mm.

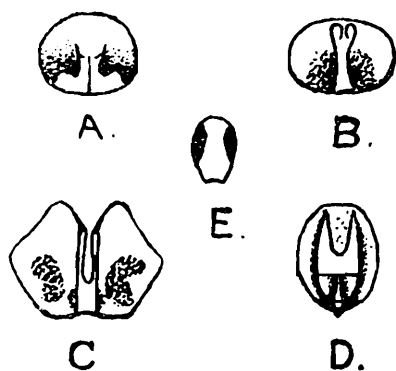


FIG. 5.—*Pardosa* spp. and *Evippa* sp. Vulva.

- A. *P. pusiola* (Thorell).
- B. *P. atropalpis*, n. sp.
- C. *P. oakleyi*, n. sp.
- D. *P. leucopalpis*, n. sp.
- E. *E. rubiginosa*, Simon.

The colour pattern is as in the preceding species, but the median pale band on the carapace and abdomen is less definite, while the sides of both carapace and abdomen are much paler. The femora, like the other joints of the legs, are uniformly pale in colour, as are also the palps of the female. The hind legs are much the longest.

The vulva (fig. 5 B) is of the same general form as that figured by Simon for *L. timida*, but the median piece is much narrower.

The palps of the male appear black throughout in spirit, but have the upper surface of the femora covered with ash-coloured pile, which shows only on drying.

***Pardosa oakleyi*, sp. nov.**

Fig. 5 C.

Localities.—Plentiful among grass on open ground at Ootacamund, 6,700-8,000 ft., Nilgiris (*type*) ; two specimens from Siripur, Saran, Bihar.

Maximum length 5 mm., carapace $2\frac{1}{2}$ mm.

In colour this species closely resembles the last, except that it is slightly darker. The female is, however, distinguished by the large angular side pieces of the vulva (fig. 5 C), with a narrow cleft between them of which the anterior half is filled by a slender tongue-shaped median piece. The male can be distinguished by the purer white pile on the upper surface of the femora of the palps, and by the continuance of this pile on to the inner side of the patella.

***Pardosa leucopalpis*, sp. nov.**

Fig. 5 D.

Localities.—Galle, Ceylon ; Madras City (*type*) ; Ennur, Chingleput District ; Barkuda Island, Chilka Lake, Ganjam District.

Maximum length 8 mm., carapace $3\frac{1}{2}$ mm.

A slightly larger species than *P. atropalpis* and quite as abundant, indistinguishable from it in general colour. The vulva (fig. 5 D) is very long, with extremely narrow side pieces. These are much narrower than the oval cavity between them, over the anterior part of which there is a short broad tongue-like process. Within this cavity the posterior ends of the side pieces bend forward dorsally round a pair of conspicuous orifices in its lateral walls, to disappear behind a transverse plate of soft tissue.

The femur, patella and tibia of the palps of the male are pale as in the female, the tarsus is brownish; they are covered with whitish pile, which is very dense on the tibia and tarsus, but sparser and often scarcely visible on the femur and patella.

Genus **Evippa** Simon.

In this genus the superior claws are long and slender and toothed at the base only, the anterior part of the carapace is somewhat abruptly elevated, forming a distinct angle with the low posterior part and the margin of the chelicerae bears only two teeth.

Evippa rubiginosa Simon.

Fig. 5 E.

Locality.—Cuddapah.

Maximum length 7 mm., carapace 3 mm.

A specimen in the Indian Museum collection from Samagooting, Assam, probably belongs to the same species. Larger specimens (maximum length 10 mm., carapace 5 mm.) from Kachh probably belong to a different species, possibly *E. praelongipes* (Cambridge), the vulva being slightly different. But without more extensive material it is impossible to determine specific limits with certainty.

The ocular area of *E. rubiginosa* is black, the rest of the carapace brown with broad median and narrower and somewhat broken submarginal pale bands. The sternum is pale. The dorsal surface of the abdomen is chequered. The legs are strongly banded and very spiny. The vulva is shown in fig. 5 E. It is small and inconspicuous.

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NEW INDIAN PSYLLIDAE.

By D. L. CRAWFORD, *University of Hawaii, Honolulu, U S. A.*

In a collection of Psyllidae recently sent to me for determination by Mr. T. V. Ramakrishna, Assistant Entomologist at Coimbatore, India, there are several new and interesting species, as well as some that were described in my earlier paper on Indian Psyllidae.¹

In addition to the species represented in the Ramakrishna collection, I include several others of the genus *Diaphorina*, with a complete summary and synoptic key of all the species of this genus, so far as I know them.

Phacopteron lentiginosum Buckton.

A conspicuous and distinctive species occurring on *Garruga pinnata* (see my previous paper in *Rec. Ind. Mus.* noted above).

Pauropsylla depressa Crawford.

This species was first described in 1912², from specimens taken on *Ficus glomerata* in Pusa, Bengal. Leaf galls are formed by this species. In the Ramakrishna collection we have this species with the following data :—

- (1) On *Ficus glomerata* at Coimbatore, July, 1923.
- (2) On cinnamon shoots (*Lauraceae*) at Mangalore, March, 1919.
(Gall forming.)

Paurocephala psylloptera Crawford.

This species was first described from the Philippines but subsequently has been found to occur in Formosa, Moluccas, Borneo, Ceylon and probably throughout the old world tropics. Enderlein described this same species from Formosa under the name of *Agonoscena* which is a synonym of *Paurocephala*. The Ramakrishna collection has several specimens of this species, taken on *Ficus* shoots at Tenmalai, Travancore, S. India, October, 1923.

Diaphorina Low.

This genus was erected in 1878³ by Franz Low, first as *Diaphora* and then changed to *Diaphorina*⁴ in 1879 because the earlier name was pre-occupied in Lepidoptera. Only one species was referred by him to this genus, *D. putonii*, which was represented by several specimens collected in Italy and Greece. *Psylla aphalaroides* Put, in Spain, was referred by Low to this same species, as a synonym.

¹*Rec. Ind. Mus.*, Vol. VII, pt. V, December, 1912, pp. 419 to 437 (3 plates).

²*Rec. Ind. Mus.*, Vol. VII, p. 429, December, 1912.

³*Verh. d. zool.-bot. Ges. Bd. XXVIII*, p. 603, 1878.

⁴Same Bd. XXIX, p. 567, 1879.

A second species, *D. guttulatus*, was described by Lethierry in 1890 from specimens taken near Bombay, India. This same species now reappears and is described on a later page.

Another species, *D. citri*, was described by S. Kuwayama in 1907¹ occurring in Formosa on *Citrus* foliage. This has been erroneously referred by me to the genus *Euphalerus*, which it approximates very closely. Further study, however, convinces me that *Diaphorina* is quite distinct and should have a number of species referred to it.

Euphalerus is very similar in many respects to this genus, especially in the appearance of the genal cones. *Diaphorina*, however, may be separated on some very good characteristics, very distinct from *Euphalerus* and other related genera.

DESCRIPTION OF GENUS.

The distinctive characteristics of *Diaphorina* are as follows:—Antennae very short, about as long as width of head or less, moderately thick. Genal cones thick, porrect (extending forward in same plane with vertex or nearly so). Thorax moderately narrow and slender, dorsal surface more or less granulate (gekornelt). Forewings long, broadest near the apical end, basal half narrow; membrane more or less hyaline and usually maculated extensively with brown; pterostigma very narrow or wanting.

Diaphorina citri Kuwayama.

Diaphorina citri, Kuwayama, *Trans. Sapp. Nat. Hist. Soc.* Vol. II, p. 160, 1907.

Euphalerus citri (Kuw.) Crawford, *Rec. Ind. Mus.*, Vol. VII, pt. V, p. 424, 1912.

Locality.—Formosa, Philippine Islands, Moluccas (Amboina), Southern China (Macao), India (Pusa, Punjab Province, Manbhum District, Coimbatore).

Food plants.—*Citrus* species, and *Murrayia koenigi*.

Diaphorina guttulata Lethierry.

Proc. Asiat. Soc. Bengal, 1890, p. 165.

This is very close to *D. citri*, differing in the color pattern of the forewing and in the presence of a double row of hairs on the veins of the forewing, these being large enough to be easily visible under low power of magnification (about 25 diametres). The color pattern lacks the central clear band present in *D. citri*, and shows a more or less uniform arrangement of spots and flecks in the apical half of the forewing, with the basal half more nearly clear and hyaline.

There appears to be considerable variation in the predominant color of the forewing, depending on the amount of maculation. Lethierry (1890) described the forewing as being mostly dark and opaque with numerous white spots, but noted a variation to the other extreme in which the wing is more extensively whitish and hyaline with numerous brown spots. It is this type that has come to my attention at this time.

¹*Trans. Sapp. Nat. Hist. Soc.*, Vol. II, 1907, p. 160.

Locality.—India (Poona, Bombay), collected by T. B. Fletcher, September 8, 1911. This is also the type locality.

***Diaphorina cardiae*, n. sp.**

This also is close to *D. citri* but differs a little more widely than the foregoing species (*D. guttulata*). A distinct difference is to be noted in the appearance of the vertex and genal cones, as well as in the color pattern of the forewing. The vertex is broader and larger than in *D. citri* and the genal cones much smaller and shorter. The pubescence of the dorsal surface of thorax and head is quite conspicuous, though very short.

The forewings are more densely covered with brown flecks and spots than in *D. citri*, but there are four conspicuous clear spots on the apical margin, one in each of the four cells bordering on that margin.

Locality.—India (Coimbatore, South India).

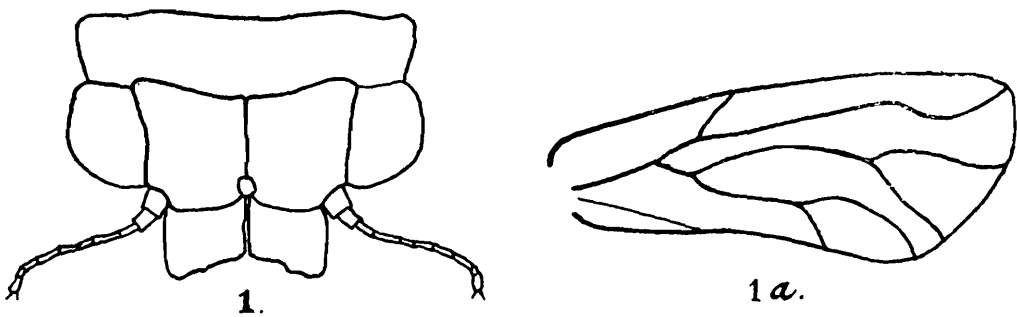
Food plant.—*Cardia cordata*.

***Diaphorina truncata*, n. sp.**

This is a very distinct species, differing from all other species of the genus quite conspicuously but apparently more closely related to a South African species. The somewhat truncate genal cones present the most conspicuous difference, while the forewings have a little more tendency toward an angular apex than the other species of the genus. The color of the body is chocolate brown, indistinctly mottled with a lighter shade of brown, while the forewings are of about the same deep brown color with numerous lighter spots giving a mottled effect.

Locality.—India (Walayar Forests), May, 1921 (Ramakrishna Coll.); Southern China (Macao)—the latter represented by one specimen taken by F. Muir.

Food plant.—*Nux vomica* shoots.



FIGS. 1, 1a. *Diaphorina truncata*, n. sp.

***Arytaina obscura* Crawford.**

Under the name *Psyllopa obscura* this species was described in my earlier paper¹ on Indian Psyllidae, only one specimen being available, which now is in the British Museum as the type of the species. In the Ramakrishna collection there are a number of specimens which

¹ *Rec. Ind. Mus.*, Vol. VII, p. 432.

seem to belong to this species, though a comparison with the type should be made before a positive assertion is made. These specimens were collected on shoots of *Dalbergia* at Coimbatore, October, 1923.

***Arytaina ramakrishni*, n. sp.**

A small whitish insect, with body of female about 1.2 mm. long (exclusive of wings) and male about 0.8 mm., forewings about 1.5 mm. General color creamy or yellowish white, with forewings about the same color but hyaline and transparent, antennae black at tip.

Head small; vertex considerably broader than long, with a deep and broad foveal depression on each side of median line. Genal cones small, much shorter than vertex, bluntly rounded, deflexed from plane of vertex. Antennae about $1\frac{1}{2}$ times as long as width of head (including eyes), moderately slender, black-tipped.

Forewings small, hyaline, clear but with a whitish color (not glass-clear), broadly rounded at apex, venation as shown in illustration; veins fine.

Female genital segment large at base, apical half abruptly narrowed into a slender and acutely pointed process; the process of the dorsal valve about twice as long as that of the ventral valve. Male genital segment small; anal valve larger and a little longer than forceps; latter very slender, acutely pointed.

Described from seven specimens (both sexes) from Coimbatore, India, October 1923, in leaves of *Chloroxylon swietenia*. Named after the collector, Mr. T. V. Ramakrishna.

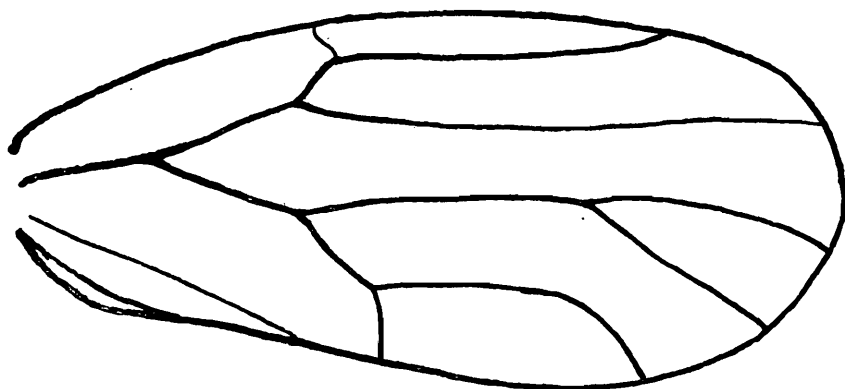


FIG. 2.—*Arytaina ramakrishni*, n. sp.

GENUS ***Dynopsylla*** Crawford.

The genus *Dynopsylla* was erected in 1913¹ for a remarkable species collected by C. F. Baker on *Ficus nervosa* in the Philippine Islands. A year later Enderlein placed a very closely similar species in the new genus *Sphingocladia*² which he erected probably without knowledge of my *Dynopsylla*.

¹*Philippine Journ. Science*, Vol. VIII, Sec. D., No. 4, August, 1913, p. 295.

²*Entom. Mitt.* III (July, 1914), p. 231. (Illustrations of wings in *Zool. Jahrb.* 41, p. 482, 1918).

In a collection of psyllids from Brazil (South America) sent to me for identification this same genus is represented by a species which is remarkably similar to the Philippine species, but unfortunately no data accompanied the specimens to show the food plant. By an interesting coincidence, the Ramakrishna collection from India contains this same species with the information that it forms galls on leaves of *Ficus nervosa*, which is the host plant of the Philippine species.

*Dynopsylla minor*¹ was doubtfully referred to this genus in 1915 and later placed in a new genus, *Thysanogyna*² because it was considered on further study to be not congeneric with the type species of *Dynopsylla*. Later, it was found to be identical with Walker's old species *Carsidara marginalis*, with which it is now merged in synonymy, my names *Dynopsylla minor* and *Thysanogyna* being now synonyms of Walker's species.

There are, therefore, three species known in the genus *Dynopsylla*, a key to which is given below. The distinctive features of this genus are (1) the peculiar venation of the forewing and (2) the shape of the head; the head is deeply cleft in front and genal cones are wholly lacking and the unusually large basal segments of the antennae are very conspicuous, the vertex is in some species produced into a pair of horn-like processes in front.

The three species are distributed as follows:—

1. *D. cornuta* Crawford.—Philippine Islands, on *Ficus nervosa* (gall-forming).
2. *D. pinnativena* Enderlein.—Formosa.
3. *D. grandis*, n. sp.—Taliparamba, North Malabar, S. India, on *Ficus nervosa* (galls), and in Brazil, South America.

Key to the species.

- A. 1. Veins of forewing with a double row of long hairs; media sinuous, closely contiguous with radius and cubitus, but not confluent; segment II of antennae not produced into a sharp point.
- B. 1. Cubital veins with a basal stem; media distinctly contiguous with radius and with Cul., antennae not hairy beyond segment II, segments III to VIII not black at tip; vertex with a pair of conspicuous horn-like processes in front.
D. cornuta Crawf.
- B. 2. Cubital veins without basal stem, branching at same point as the media; media close to but not touching radius and cubitus; antennae hairy, segments III to VIII black at tip, head covered with thick pubescence, vertex without horns, but somewhat bulging in the corresponding place.
D. pinnativena Enderl.
- A. 2. Veins of forewing without hairs; media not sinuous, but confluent with radius; segment II of antennae produced into a sharp point, head and dorsum sparsely pubescent.
D. grandis, n. sp.

***Dynopsylla grandis*, n. sp.**

Length of body 4 mm., forewing 6 mm., length of body to tip of folded wings about 7 to 8 mm. General color light brown; vertex yellowish brown, darker between posterior ocelli; prothorax brown, me-

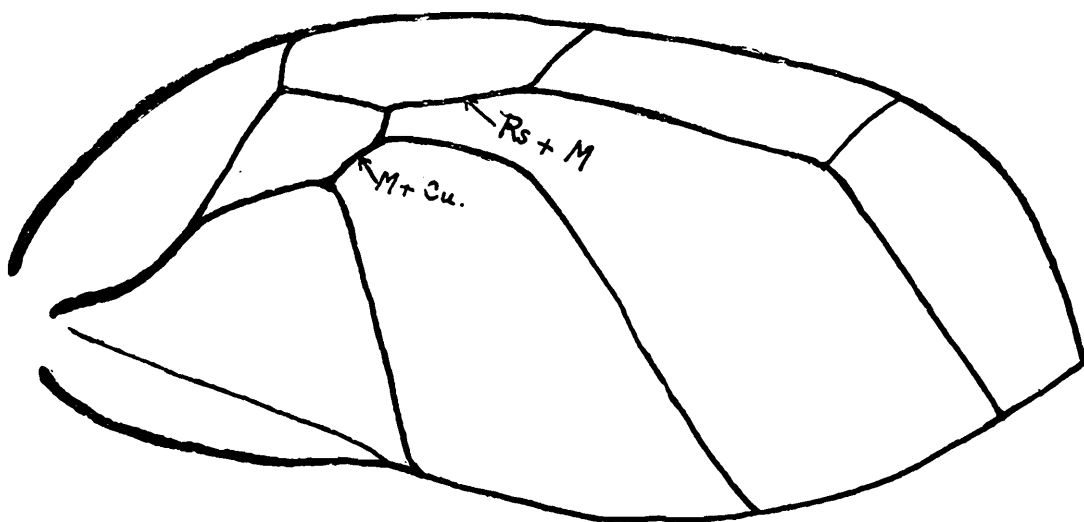
¹*Philippine Journ. Science*, Vol. X, Sec. D., No. 4, p. 263 July, 1915.

²Same, Vol. XV, No. 2, p. 157, August, 1919.

sonotum brown with yellowish stripes and bands, legs and antennae light brown.

Head about as broad as prothorax, rather large; vertex broader than long, concave between posterior ocelli, produced into a long, up-turned horn in front of each eye, clothed with long pubescence; front ocellus visible from above. Genae protruding forward around insertion of antennae making the head cleft in front between antennae. Rostrum short. Eyes very large, constituting fully half the width of the head. Antennae long, nearly as long as body (not including wings); segment I very large, thick, more than twice as long as thickness, hirsute; II not quite so thick as I, much shorter, produced into a long, acuminate point, hirsute; III—X slender, filiform, not hirsute.

Thorax very large, broad, roundly arched, dorsum pubescent. Legs stout, relatively short, pubescent; hind tibiae short, without basal spur, with four large finger-like spines at apex; basal tarsus of hind



3.

FIG. 3.—*Dynopsylla grandis*, n. sp.

legs with one black claw. Forewings large, broad, hyaline, acutely pointed, veined as in accompanying illustration, veins black, prominent. Hind wings about half as long as forewings.

Male forceps short, broad, truncate at apex, emarginate on posterior margin; anal valve about twice as long as forceps, the terminal portion cylindrical, black, nearly as long as basal part. Female genital segment very short, acutely pointed.

Locality.—described from three females collected at Taliparamba, S. India, in September, 1918, by T. V. Ramakrishna; these were found in galls on *Ficus nervosa*. Also 4 specimens (males and females) in a collection from South America (Brazil) sent by Professor J. S. Tavares. These four specimens were not labelled and no information was given as to where they were taken and what host plant, but it is assumed that they were collected in Brazil. These are almost exactly identical with the India specimens even in minor details, suggesting that the species has probably been introduced in rather recent times into one or the other of these two widely separated countries.

Megatrioza hirsuta Crawford.

Under the name *Kuwayama hirsuta* Crawford this species was described in my earlier paper on Indian Psyllidae (p. 427). It has subsequently been referred to the genus *Megatrioza*. In the present collection the specimens were collected by Ramakrishna in galls on *Terminalia* at Mundakayam, Travancore, S. India, October, 1923.

Trioza fletcheri Crawford.

This species described in my earlier paper (p. 434) turns up again in the Ramakrishna collection, the specimens having been collected from galls on leaves of *Trewia* at Coimbatore, December, 1913.

LIST OF PSYLLIDAE RECORDED FROM INDIA AND CEYLON.

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The following list of Indo-Ceylonese '*Psyllidae*' with their chief bibliographical references was prepared by the writer in connection with his recent attempt at a systematic study of this family of Homopterous insects inhabiting South India. It is published with the idea that it may serve some useful purpose to those working on this group with all its inevitable shortcomings; and no such ready reference list has been brought out till now. The classification followed is mainly that of Dr. Crawford, the well known authority on the family, and the author hereby expresses his thanks to him for the help and encouragement he is receiving in the study of this family of insects. The list also includes new South Indian species described in Dr. Crawford's paper from material submitted to him by the writer.

Sub-family PAUROPSYLLINAE.

Apsylla Crawford.

Apsylla cistellata, Buckton. Crawford, *Rec. Ind. Mus.* VII, p. 421, 1912.—*Psylla cistellata*, Buckton. *Ind. Mus. Notes* III, pp. 13 and 91 (1893), on mango shoots, Dehra Dun and Bengal; Lefroy's *Indian Insect Life*, p. 742, figs. 514 and 515.

Paurocephala Crawford=*Agonoscena* Enderlein.

P. psylloptera, Cr., *Phil. Journ. Science*, X, p. 260, 1915, on shoots of *Ficus* spp., Peradeniya, Ceylon. On shoots of *Ficus* spp., Tenmalai, W Ghats, Travancore. October, 1923. (Ramakrishna Coll.) Also recorded from the Philippines, Borneo, etc., see p. 149 *Phil. Journ. Sc.* XV, 1919.

Pauropsylla Rubsaamen.

P. ficicola, Kieffer, *Ann. Soc. Sci. Bruxelles*, XXIX, p. 169, 1905, In galls of *Ficus hookeri*. Bengal.

P. globuli, Kieffer, *Ibid.*, p. 172. Bengal.

P. depressa, Cr., *Rec. Ind. Mus.* VII, p. 429, 1912. In galls of *Ficus glomerata*. Noted on the same plant, Coimbatore. (Ramakrishna Coll.)

Noted also in galls of cinnamon leaves, S. Kanara. (Ramakrishna Coll.)

P. tuberculata, Cr., *Rec. Ind. Mus.* VII, p. 430, 1912. On pumpkin, Pusa, Bengal, also on "*Alstonia scholaris*" Probably this is the species figured in Lefroy's *Indian Insect Life*, p. 742, plate lxxx.

P. floccosa, Crawford, *Phil. Journ. Sc.* X, p. 259, 1915. On leaves of *Aglaiia roxburghiana*, Peradeniya, Ceylon.

P. spondiasae, Craw., *Phil. Journ. Sc.* X, p. 260, 1915, In leaf galls of *Spondias margiferae*. Peradeniya, Ceylon.

P. nigra, Crawford, *Phil. Journ. Sc.* XV, p. 143, 1919. Pusa, Bengal, described from one female.

Diceraopsylla Crawford.

D. brunettii, Craw., *Rec. Ind. Mus.* VII, p. 425, 1912. Darjiling, Eastern Himalayas.

Phacopteron Buckton.

P. lentiginosum, Buck., *Ind. Mus. Notes* III (5), p. 18, 1894. On *Garuga pinnata*, Poona.

" Craw., *Rec. Ind. Mus.* VII, p. 420, 1912. On *Garuga pinnata*, Dehra Dun.

" Craw., *Phil. Journ. Sc.*, XV, p. 154, 1919. Coorg.

" Ramakrishna Ayyar. *Rept. 3rd Ent. Meeting*, Pusa, 1919, p. 1030 with fig. of insects and galls. In *Garuga pinnata* galls N. Malabar. (Ramakrishna Coll.)

Kieffer's *Phacosema* and Buckton's *Phacopteron* are in the opinion of Crawford congeneric. For Kieffer's *Phacosema* and his species *P. gallicola* see p. 388, *Zeits. für Wissen. Ins-ktenbiol.*, II, 1906—from Trichinopoly, in Cinnamon galls.

Sub-family CARSIDARINAE.

Homotoma Guerin.

H. distincta, Crawford, *Rec. Ind. Mus.* VII, 1912, p. 433. Pusa, Bengal.

Macrohomotoma Kuwayama.

M. striata, Crawford, n. sp. On *Ficus* leaves, Kollegal (Ramakrishna Coll.), description not published yet.

Rhinopsylla Riley.

R. stylata, Crawford, *Rec. Ind. Mus.* VII, p. 426, 1912. One female from Simla.

Dynopsylla Crawford.

D. grandis, Crawford, n. sp. (see antea p. 619). In galls on *Ficus nervosa* leaves, Taliparamba, N. Malabar. (Ramakrishna Coll.)

D. grandis, Ramakrishna Ayyar *Rept. 3rd Ent. Meeting*, Pusa, 1919, p. 1031. (Figure of insect and gall.)

Tenaphalara Kuwayama.

T. acutipennis, Kuwayama, *Trans. Sapporo Nat. Hist. Soc.* 1908, p. 155. Formosa.

= *T. elongata*, Crawford, *Rec. Ind. Mus.* VII, p. 432, 1912. On silk cotton, Pusa, Bengal. (See also *Phil. Journ. Sci.* XV, p. 164, 1919, for Philippine record.)

Tyora Walker.

T. indica, Crawford, *Phil. Journ. Sci.* XV, p. 159, 1919. Coorg, S. India.

Cecidopsylla Kieffer.

C. schimoe, Kieffer, *Ann. Soc. Sci. Bruxelles*, 1905, p. 160. Bengal.

Sub-family PSYLLINAE.

Psylla Geoffroy.

P. cedretae, Kieffer, *Ann. Soc. Sci. Bruxelles*, 1905, p. 174. Bengal.

P. obsoleta, Buckton, *Ind. Mus. Notes* V (2), p. 35, 1900. In galls on *Diospyros melanoxylon*; Bombay. Lefroy, *Indian Insect Life*, fig. 516.

P. simlae, Crawford, *Rec. Ind. Mus.* VII, p. 426, 1912. Simla.

Euphalerus Schwarz.

E. vittatus, Crawford, *Rec. Ind. Mus.* VII, p. 423, 1912. On *Cassia fistula*. Calcutta.

Diaphorina Low.

D. citri, Kuwayama, *Trans. Sapp. Nat. Hist. Soc.* II, p. 160, 1908. = *Euphalerus citri*, Crawford, *Rec. Ind. Mus.* VII, p. 424, 1912. Adhra, Bengal, also recorded on *Citrus* from the Philippines. Noted on shoots of *Citrus* and *Murraya koenigii* in Coimbatore, S. India. (Ramakrishna Coll.)

D. guttulata, Lethierry. *Proc. Asiat. Soc. Bengal*, 1890, p. 165. Poona, Bombay; later specimens collected at Poona by Fletcher in September, 1911, which were named as *Euphalerus citri* by Crawford (*Phil. Journ. Sci.* XII, p. 168, 1917) are now found to belong to this species of Lethierry.

D. cardiae, Crawford. n. sp. (see *antea* p. 617) bred on *Cardia cordata*. Coimbatore, South India. (Ramakrishna Coll.)

D. truncata, Crawford. n. sp. (see *antea* p. 617) on shoots of *Nux vomica*. Walayar forests, Malabar. (Ramakrishna Coll.)

Arytaina Foerster=*Psyllopa* Crawford.

A. punctipennis, Crawford, *Rec. Ind. Mus.* VII, p. 431, 1912, on Indigo, Pusa, Bengal. This is probably *Psylla isitis* of Buckton and there is little doubt that the insect dealt with as Indigo Psylla in the Pusa Memoir, Ent. Series IV (6) is this insect. Also noted from Ceylon on Indigo.

A. obscura, Crawford=*Psyllopa obscura*, Crawford, *Rec. Ind. Mus.* VII, p. 432, 1912. On mango leaf, Pusa (described from one specimen). Noted also on *Dalbergia* leaves, Coimbatore. (Ramakrishna Coll.)

A. ramakrishni, Crawford, n. sp. (see *antea* p. 618). On galls in leaves of *Chloroxylon swietenia*, Coimbatore, S. India. (Ramakrishna Coll.)

Eurhinocola Crawford.

(close to *Euphyllura*).

E. gravelyi, Crawford, *Rec. Ind. Mus.* VII, p. 422, 1912. Burma.

Sub-family TRIOZINAE.

Trioza Foerster.

T. gigantea, Crawford, *Rec. Ind. Mus.* VII, p. 428, 1912. Darjiling, E. Himalayas. Described from one female.

T. hyalina, Crawford, *Rec. Ind. Mus.* VII, p. 428, 1912. Simla, W Himalayas.

T. analis, Crawford, *Rec. Ind. Mus.* VII, p. 429, 1912. Simla, W Himalayas.

T. urticae, Linn., Crawford, *Rec. Ind. Mus.* VII, p. 434, 1912. On nettle (*Urtica*). (Same as the European species.) Punjab.

T. fletcheri, Crawford, *Rec. Ind. Mus.* VII, p. 434, 1912. On *Gmelina aroborea*, Pusa, Bengal; also in galls on *Trewia*, Coimbatore, S. India. (Y. R. Rao Coll.)

T. fletcheri minor, Crawford, n. var., *Rec. Ind. Mus.* VII, p. 434, 1912. On *Terminalia arjuna*, Pusa, Bengal.

T. jambolanae, Crawford, *Phil. Journ. Sci.* XII, p. 173, 1917. On *Eugenia jambolana*, Pusa, Bengal.

Megatrioza Crawford.

M. vitiensis, Kirkaldy, *Proc. Haw. Ent. Soc.* I, p. 193, 1907. On *Eugenia*.

=*Trioza eugeniae*, Crawford *Phil. Journ. Sc.* X, p. 265, 1915. In galls on *Eugenia malaccensis*.

=*M. vitiensis*, Crawford, *Phil. Journ. Sc.* XV, p. 195, 1919. In galls on *Eugenia malaccensis*, Singapore.

M. eugenioides, Crawford, *Phil. Journ. Sc.* XV, p. 198, 1919. One specimen from Pusa, Bengal.

= *Trioza eugenioides*, Crawford, *Phil. Journ. Sc.* XII, p. 171, 1917. From Philippines.

M. hirsuta, Crawford, *Phil. Journ. Sc.* XV, p. 201, 1919. In galls of *Terminalia tomentosa*, Lonavla, Bombay.

= *Kuwayama hirsuta*, Crawford, *Rec. Ind. Mus.* VII, p. 427, 1912. Igatpuri, Bombay.

Recently recorded in galls on leaves of *Terminalia* in Mundakayam, Travancore. (Ramakrishna Coll.)

Louronota Crawford.

L. ? (Allotrioza) minuta, Crawford, *Rec. Ind. Mus.* VII, p. 433, 1912. Hazaribagh, Bengal.

Cecidotrioza Kieffer.

C. baccarum, Kieffer, *Marcellia Rev. Cecidol.* VII, p. 159, 1909. In galls of *Symplocos* sp., Kurseong, E. Himalayas.

Neotrioza Kieffer.

N. machili, Kieffer, *Ann. Soc. Sci. Bruxelles*, XXIX, p. 176, 1905. Bengal. On *Machilus gamblei*.

Ozotrioza Kieffer.

O. styracearum, Kieff., *Ann. Soc. Sci. Bruxelles*, XXIX, p. 179, 1905. Bengal.

O. laurinearum, *Ibid.*, p. 180. Bengal.

NOTE—The exact position of Kieffer's species is not definitely known to the writer ; they are only provisionally put where they are.