

BULLETIN

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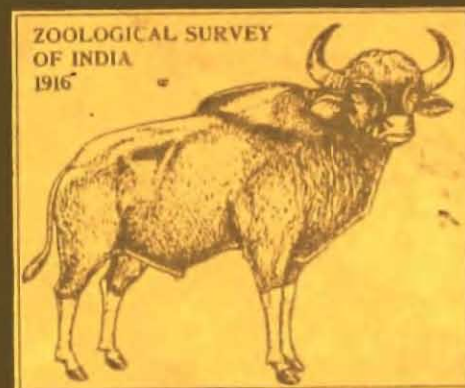
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ASPECTS OF POPULATION FLUCTUATIONS OF PHLEBOTOMID SANDFLIES (DIPTERA ; PHLEBOTOMIDAE) IN CALCUTTA AND ENVIRONS

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Zoological Survey of India, Calcutta

ABSTRACT

Fluctuation of populations of three species of phlebotomid sandflies—*Phlebotomus argentipes* Annandale and Brunetti, *P. papatasi* Scopoli and *Sergentomyia babu* (Annandale)—from four localities in Calcutta and environs has been studied from February 1978 to January 1979 in relation with temperature, rainfall, humidity and wind velocity.

The outbreak of kala-azar in North Bihar emphasised the need for a general survey of phlebotomid sandflies around Calcutta and as such a study of the fluctuation of populations of sandflies was undertaken during 1978-79 since population density is of fundamental importance both in surveillance of the disease and in control. Earlier Napier and Smith (1926) have given an account of the seasonal prevalence of *Phlebotomus argentipes* Annandale and Brunetti for 13 months from Calcutta and environs in their studies on its bionomics. Recently in a similar study Basu and Ghosh (1954, 1955) have recorded the total catch of the same species from Thakurpukur, 24 Parganas, for one year without the detailed break-up. The present study has an added significance in the context that another species of sandfly, viz. *Phlebotomus papatasi*, is suspected to be the vector of kala-azar in N. Bihar either alone or side by side with the proven vector *P. argentipes* (Joseph, 1981). A review of the literature reveals that Sinton (1924) was the first to publish a general idea of the seasonal prevalence of the then known

Indian and Cingalese species of the genus *Phlebotomus*, but without the details of the data of collection. Subsequently Dhanda and Modi (1971) and Modi *et al.*, (1978) have conducted detailed studies in Western India, and Joseph (1981) in North Bihar. The recent study by Joseph is the first of its type in India—the study of vectors while the disease is in prevalence.

MATERIAL AND METHODS

Preliminary surveys were undertaken towards the later half of 1977 in Calcutta and environs—Central Calcutta, Ballygunge, Belgachia Veterinary College, Eden Gardens and Alipur Agrihorticultural Garden (Calcutta), Botanical Garden, Mourigram and Andul (Howrah District), and Behala, Thakurpukur, Kavarapukur, Narendrapur, Lohati and Sonarpur (24 Parganas)—in houses, cattle sheds, tree holes and rat burrows. Finally four localities (Map), viz. Eden Gardens, Kavarapukur, Andul and Lohati, were selected for regular periodical surveys. Collections were made with an improvised bait trap (Joseph and

Ninan, 1980) with different baits and aspirators. Since the collection was easier by the aspirator, the former method of collection was discontinued.

Regular fortnightly collections were made per manhour during day time by aspirator tube from Eden Gardens (tree holes), Kavara-

two flies. This tree harbours squirrels and their droppings are found on the soil near the tree trunk which is a good medium for larval life. For identification of flies, they were cleared in lacto-chloro-phenol and mounted in gum-chloral medium (Lewis, 1967).

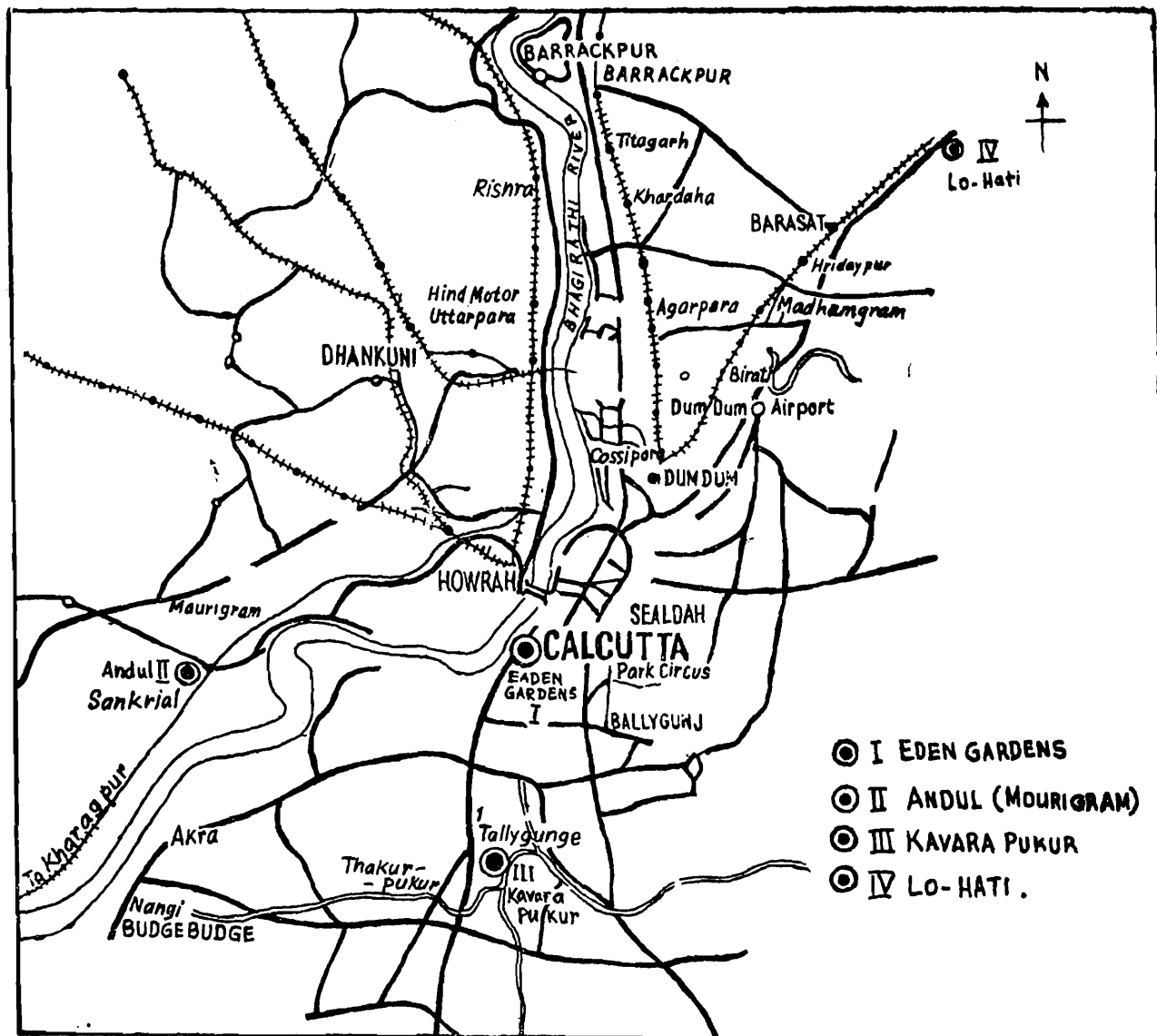


Fig. 1. Map of Calcutta and environs showing collection localities.

pukur and Lo-hati (houses and cattle sheds) and Andul (a cattle shed) for one year from February 1978 to January 1979. In Eden Gardens the flies were collected from the holes of a single tree, *Saraca asoca*, but the adjoining trees yielded none or only one or

RESULTS

A total of 4249 sandflies were collected belonging to *Phlebotomus argentipes* Annandale and Brunetti, *P. papatasi* Scopoli and *Sergentomyia babu* (Annandale) from 4 localities in and around Calcutta as given in tables

TABLE 1. Phlebotomid sandflies collected per manhour from the holes of a tree in the Eden Gardens, Calcutta, from Feb. 1978 to Jan, 1979 along with meteorological data, two collections per month.

Sp.	Coll.	Feb.'78			Mar.			Apr.			May			June			July			Aug.			Sep.			Oct.			Nov.			Dec.			Jan.'79			Total of the year			% of the Grand Total	
		M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F
<i>Sergentomyia babu</i>	1st Coll.	30	10	40	9	16	25	16	7	23	12	2	14	19	4	23	34	14	48	18	13	31	9	4	13	9	5	14	7	3	10	8	2	10	5	1	6	176	81	257	69.83	30.17
	2nd „	28	7	35	18	9	27	13	5	18	12	8	20	30	11	41	40	18	58	10	4	14	7	3	10	8	5	13	6	2	8	7	2	9	13	4	17	192	78	270		
Grand Total		58	17	75	27	25	52	29	12	41	24	10	34	49	15	64	74	32	106	28	17	45	16	7	23	17	10	27	13	5	18	15	4	19	18	5	23	368	159	527		
Temp.°C Mean. max		28.5			32.7			35.5			35.4			33.8			32.3			31.9			31.3			32.2			27.0			27.6			27.6							
Mean. min		16.5			20.7			23.0			25.7			26.4			25.5			26.2			25.4			20.7			14.5			14.7			14.7							
Rainfall Mean monthly mm.		9.0			57.9			55.4			194.0			224.2			439.2			312.4			944.7			147.7			40.5			3.9			34.9							
Humidity %																																										
Mean max. monthly		90.3			92.7			93.3			87.9			92.7			94.6			95.9			96.8			97.4			95.5			94.9			96.3							
Mean min. „		36.4			33.0			43.6			56.0			64.0			65.0			71.0			71.2			60.8			40.7			38.0			40.7							
Wind velocity-Kmph		16.2			18.7			20.8			24.0			22.9			19.8			17.8			17.4			15.6			13.9			14.7			13.0							

M= male, F=female, T=total

TABLE 2. Phlebotomid sandflies collected per manhour from a cattle shed in Andul in Howrah Dist. from Feb. 1978 to Jan. 1979 (meteorological data as in Table. 1), two collections per month.

Spp.	Coll.	Feb.'78			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.			Jan.'79			Total of the year			% of the Grand Total	
		M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F
<i>Phlebotomus argentipes</i>	1st Coll.	3	12	15	7	18	25	2	14	16	11	20	31	16	71	87	12	48	60	20	82	102	12	66	78	7	34	41	3	24	27	3	9	12	4	9	13	100	307	407	13.88	43.95
	2nd „	11	20	31	2	7	9	4	16	20	6	15	21	15	65	80	20	44	64	18	57	75	10	62	72	5	30	35	2	8	10	8	10	18	2	12	14	103	336	439		
<i>Sergentomyia babu</i>	1st Coll.	14	10	24	16	12	28	16	7	23	10	9	19	31	31	62	20	18	38	10	12	22	10	5	15	8	4	12	6	3	9	8	2	10	4	1	5	153	114	267	23.10	19.07
	2nd „	16	11	27	11	25	36	13	5	18	12	8	20	35	40	75	36	41	77	26	18	44	8	4	12	7	4	11	5	2	7	6	3	9	10	4	14	185	165	350		
Grand Total		44	53	97	36	62	98	35	42	77	39	52	91	97	207	304	88	151	23	74	169	243	40	137	177	27	72	99	16	37	53	25	24	49	20	26	46	541	922	1463		

TABLE 3. Phlebotomid sandflies collected per manhour from houses and cattle sheds in Kavarapukur of 24 Pgs. from Feb. 1978 to Jan. 1979 (meteorological data as in Table 1), two collections per month.

Spp.	Coll.	Feb.'78			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.			Jan.'79			Total of the year			% of the Grand Total		
		M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T						
<i>Phlebotomus</i>																																											
<i>argentes</i>	1st. Coll.	2	8	10	1	6	7	2	6	8	—	6	6	2	16	18	6	36	42	8	80	88	6	66	72	8	44	52	6	36	42	3	24	27	—	8	8	91 699	790	7%	52%		
	2nd „	1	8	9	1	9	10	2	8	10	—	6	6	2	20	22	14	84	98	12	84	96	4	52	56	4	40	44	3	18	21	4	24	28	—	10	10						
<i>Sergentomyia</i>																																											
<i>babu</i>	1st Coll	15	20	35	15	16	31	8	11	19	20	19	39	9	13	22	9	4	13	6	4	10	19	16	35	21	13	34	14	6	20	10	4	14	5	3	8	294 253	547	21%	20%		
	2nd „	13	18	31	11	12	23	16	18	34	14	12	26	17	11	28	5	2	7	12	14	26	12	17	29	16	10	26	12	2	14	8	6	14	7	2	9						
Grand Total		31	54	85	28	43	71	28	43	71	34	43	77	30	60	90	34	126	160	38	182	220	41	151	192	49	107	156	35	62	97	25	58	83	12	23	35	385 952	1937				

TABLE 4. Phlebotomid sandflies collected per manhour from houses and cattle sheds in Lo-hati of 24 Pgs. from Feb '78 to Jan. '79 (meteorological data as in Table 1), two collections per month.

Spp.	Coll.	Feb. '78			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.			Jan. '79			Total of the year			% of the Grand Total	
		M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F						
<i>Phlebotomus</i>																																										
<i>argentipes</i>	1st. Coll.	2	4	6	3	4	7	1	5	6	2	8	10	2	10	12	10	18	28	18	30	48	10	28	38	16	19	35	8	14	22	3	7	10	1	3	4	76	157	233	15.4	32.32
	2nd „	2	3	5	2	5	7	2	7	9	6	8	14	4	6	10	9	16	25	10	35	45	12	25	37	11	15	26	6	10	16	2	6	8	—	5	5	66	141	207		
<i>Phlebotomus</i>																																										
<i>papatasi</i>	1st „	—	—	—	2	5	7	1	2	3	2	1	3	—	3	3	3	6	9	3	7	10	—	3	3	—	2	2	—	1	1	—	—	—	—	—	—	11	30	41	2.39	7.38
	2nd „	—	2	2	3	7	10	—	2	2	1	1	2	1	4	5	5	13	18	1	4	5	—	4	4	—	1	1	—									11	38	49		
<i>Sergentomyia</i>																																										
<i>babu</i>	1st „	12	4	16	7	10	17	9	18	27	9	10	19	7	10	17	26	18	44	7	8	15	4	3	7	5	4	9	6	3	9	8	2	10	7	2	9	107	92	199	25.16	17.35
	2nd „	16	5	21	12	5	17	10	3	13	16	14	30	9	2	11	22	17	39	8	5	13	5	3	8	5	4	10	8	4	12	6	3	9	7	3	10	125	68	193		
Grand Total		32 18 50			29 36 65			23 37 60			36 42 78			23 35 58			75 88 163			47 89 136			31 66 97			38 45 83			28 32 60			19 18 37			15 13 28			396 526 922				

1-4. In the collections made from houses and cattle sheds in Lo-hati and Kavarapukur and from a cattle shed in Andul, the predominant species is *Phlebotomus argentipes*. In Lo-hati *Sergentomyia babu* is the next dominant species followed by *Phlebotomus papatasi* whereas in Kavarapukur and Andul the only other species available is *Sergentomyia babu*. In Eden Gardens where the collections were made from the holes of the single tree yielded only *S. babu*. In case of *S. babu* males are always caught in larger number whereas in the remaining 2 species it is vice versa.

Relationship between sandfly population and meteorological factors : Data pertaining to meteorological factors (temperature, humidity and wind velocity) and population density of sandflies were subjected to statistical analysis for finding out correlation coefficient (r) (table 5). It has been found that among the four collection localities, three, i. e., Andul, Kavarapukur and Lo-hati, showed positive correlation between sandfly population and meteorological factors and in some cases it is highly significant.

SEASONAL ABUNDANCE

The incidence of sandfly is low during winter and summer months, especially so in winter and only a few flies could be collected in December and January but in Eden Gardens the lowest catch is made in November. This exception is difficult to explain ; probably it may be due to the excessive feeding by the predator like *Hemidactylus brooki* Gray occurring in the tree. Their peak season is from the later half of June or beginning of July to September, but in case of *Sergentomyia babu* occurring in the single tree, *Saraca asoca*, in Eden Gardens there is a second peak during February-March. As can be seen

from the tables 1-4, the number of flies collected per manhour varies from 6 in January to 58 in July in outdoor and 13 in January to 155 in June in indoor.

DISCUSSION

The pattern of seasonal abundance of *P. argentipes*, *P. papatasi* and *S. babu* in Calcutta and environs is generally similar to that reported from Peninsular India by Mitra (1956) in Poona District, Dhanda and Modi (1971) in Aurangabad district and Modi *et al.*, (1978) in Poona. In Calcutta as well as in Peninsular India the winter is mild and consequently there is a decrease in population of sandflies but they are not totally absent. In places where the winter is severe the flies disappear in extreme cold months and begin to appear in March and showing a peak in monsoon months as has been observed by Sinton (1924) in N. W. Province (Pakistan). George (1970) has also recorded from Peshwar and Lahore areas in Pakistan a similar pattern. In their studies on bionomics of *Phlebotomus argentipes* from Calcutta and environs Napier and Smith (1926) have recorded a similar pattern of prevalence as observed by us. The slight variations exhibited may be due to the climatological differences.

From table 5 it can be observed that the temperature, humidity and wind velocity have significant effect on the fluctuation of population of sandflies, and especially humidity has greater significance. It is possible that the insignificant correlation between the population and factors in Eden Gardens may be due to the small number of flies occurring in the tree.

SOME OBSERVATIONS

The sandflies are normally restricted to the ground floor of houses but a few have

also been found in the first floor as well. They are found in larger numbers in dark corners of the rooms, behind the hanging photographs, calenders, etc. and favour holes or shelves in the walls, when present. Usually they are scarce in kitchen, but on a few occasions we have come across some flies even when the food was being cooked. *Phlebotomus argentipes* are seen in large numbers in cattle sheds whereas *P. papatasi* in living rooms. But during the peak season the two species are also found to occur in both the habitats. *Phlebotomus argentipes* also favour small holes in cattle sheds. *Sergentomyia babu* are generally seen in large numbers in bathrooms and latrines in comparison with the other rooms of the houses, and in tree holes where the other two species are comparatively rare. Bats have been noted in tree holes inhabited by these flies and *Hemidactylus brooki* have been observed predating on

tommyia babu were caught. Rodent burrows located in the city and outskirts also did not yield flies. Sinton (1924) had collected *Phlebotomus argentipes* from a tree in Zoo Gardens but not a single fly was observed by us.

It has been our experience that immediately after the rains the collection of sandflies is fairly good but a few days later there is a drop in their number. This may be due to the congregation of flies indoors during the rains and the subsequent decrease can be attributed to the destruction of larvae and pupae due to rains.

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We are indebted to the Director, Zoological Survey of India, Calcutta, for facilities of work and to Dr. S. K. Bhattacharya, Deputy Director, for encouragements. Our heartfelt thanks are also due to Shri A. K. Sanyal,

TABLE 5. Showing correlation coefficient values (r) of the sandfly populations against climatological factors

Climatological factors	Eden Gardens		Andul		Kavarapukur		Lo-hati	
	<i>S. babu</i>	<i>P. argentipes</i>	<i>S. babu</i>	<i>P. argentipes</i>	<i>S. babu</i>	<i>P. argentipes</i>	<i>S. babu</i>	
Temperature	0.9376	0.5685**	0.5781**	0.2704	0.4145	0.4142	0.4850	
Humidity	0.0585	0.9652*	0.3696	0.9725*	0.0080	0.9711*	0.1938	
Wind velocity	0.4278	0.4829	0.6471**	0.1170	0.4427	0.0162	0.5564**	

* Significant at 1% level

**Significant at 5% level

S. babu in the holes of *Saraca asoca* in Eden Gardens from which these flies have been regularly collected.

In spite of thorough search in various parts of Calcutta city in houses and cattle sheds not a single fly was caught except from a small shed on the bank of Dhakuria Lake used by the Rowing Club and a few adjoining trees where from a fairly good number of *Sergen-*

our colleague, for statistical analysis of the results.

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ON THE HOST-SELECTION, OVIPOSITION AND FECUNDITY OF THE LONG-
HORNED BEETLE BORER, ACALOLEPTA RUSTICATOR (FABRICIUS)
(COLEOPTERA : CERAMBYCIDAE)

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ABSTRACT

The host-selection and oviposition behaviour of the cerambycid borer, *Acalolepta rusticator* (Fabricius) is discussed. Host-selection in this beetle depends primarily upon the condition of the host material and secondarily upon the host identity. The mean potential fecundity was 94 (S. D.=20.35), while the realised fecundity was 61 (S. D.=23.29). The oviposition period varied between 4 and 29 days with a maximum of 34 days in one female. The number of eggs laid by one female range from 2 to 8 per day.

INTRODUCTION

Various aspects of the behaviour of cerambycid adults have been dealt with by several authors. Craighead (1921), Knull (1946) and Duffy (1953) have described the host-selection principle of cerambycid females, while Tragardh (1930) and Butovitsch (1939) recognized several different methods of oviposition. However, no published account of the host-selection, oviposition and fecundity of *Acalolepta* (= *Dihammus*) *rusticator* (Fabricius) is available, although Beeson and Bhatia (1939) have furnished a brief description of the behaviour of an allied species, *A. cervina* (Hope), from Indian mainland. The present communication summarises different aspects of the host-selection and oviposition behaviour, including the fecundity estimates of this timber borer.

MATERIAL AND METHODS

During the course of last two years, while studying the ecological interaction and economic status of some of the Xylophagous insects of the islands of Andaman and Nicobar, a large number of logs infested with the immature stages of *A. rusticator* was collected from several field sites. The total number of logs of different host-tree species, infested with *A. rusticator* was recorded. Some of the sample logs were taken to the laboratory and were held in galvanized iron cages for adult emergence. Upon emergence, the adult beetles were sexed and paired in breeding-jars, made of glass (36 cm.×22 cm.×22 cm.), containing a layer of sandy soil at the bottom. They were provided with fresh leaves and twigs of *Ficus religiosa* L. for food and logs of different host-trees for oviposition

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sites. Both the food and host material were renewed at definite intervals. The number of eggs laid by the females on subsequent days was recorded until they died. After they died, all the females were dissected and the number of mature unlaidd eggs were determined.

All the breeding studies were conducted at Port Blair, under the laboratory conditions. During the course of these studies maximum and minimum temperature recorded in the laboratory was 29.5°C and 26.0°C respectively, while the relative humidity ranged between 69.0% and 91.5%.

RESULT AND DISCUSSION

Host-selection and Oviposition: Richardson's (1925) statement that, in many insects contact with an appropriate surface seems to be a necessary prerequisite for oviposition, was confirmed for *A. rusticator*. Prior to oviposition, the female crawls slowly along the host surface with extruded ovipositor. This searching procedure was observed to take place upto 30 minutes or even more in several females. Oviposition occurs immediately after the selection of the oviposition site. The female chews a transverse slit through the bark, inserts her ovipositor and deposits one egg in the outer bark. The egg-pit is subsequently sealed with a resinous substance after oviposition.

In the islands of Andaman, *A. rusticator*

was found to oviposit on a number of timber yielding tree species. Among them *Artocarpus chaplasha* Roxb., *Canarium euphyllum* Kurz, *Pterocymbium tinctorium* Merrill, *Salmalia insignis* Schott and Endl., and *Semecarpus kurzii* Engler are most important. Percentage estimates of logs of different species (Table 1) infested by *A. rusticator*, under field conditions, suggest that logs of *A. chaplasha* were the most preferred host material; no clear cut preference was found between *P. tinctorium* and *S. insignis*. Laboratory studies on 50 newly emerged females, placed in sets of 5, in breeding-jars, along with 5 males, containing logs of different host-tree species (5 logs/jar), suggested a similar mode of host preference (Table 2).

Both Craighead (1921) and Duffy (1953), in applying Hopkin's host-selection principle to cerambycid beetles, agreed that the condition of the host material was the most important factor in oviposition, and that a species would select a new host in the favourable condition, rather than the old host in which the conditions were unfavourable. Duffy concluded that the host condition, rather than host variety was an important factor. On the contrary, Knull (1946) described the cerambycid females as to be selective primarily to the host and secondarily to the condition of the host material.

Duffy's view appeared to be more applicable to *A. rusticator* in Andamans, although

TABLE 1. Percentage of logs of different host-tree species infested by *A. rusticator*, under field conditions.

	<i>Artocarpus chaplasha</i>	<i>Canarium euphyllum</i>	<i>Pterocymbium tinctorium</i>	<i>Salmalia insignis</i>	<i>Semecarpus kurzii</i>
No. of logs examined	3897	3201	4239	3670	2907
Percentage infection	72.66	21.71	52.32	48.59	20.03

TABLE 2. Host-selection in 50 *A. rusticator* females

No. of eggs in different host-logs after 7 days of emergence of the females

Test No.	No. of females	<i>Artocarpus chaplasha</i>	<i>Canarium euphyllum</i>	<i>Pterocymbium tinctorium</i>	<i>Salmalia insignis</i>	<i>Semecarpus kurzii</i>	Total
1	5	32	6	19	21	8	86
2	5	37	8	24	25	5	99
3	5	24	5	15	17	8	64
4	5	26	8	17	17	4	72
5	5	29	4	16	13	7	69
6	5	20	6	13	11	5	55
7	5	33	5	22	20	7	92
8	5	13	3	6	7	1	30
9	5	35	3	11	13	2	64
10	5	28	5	16	14	0	63
Total	50	282	53	159	158	42	694

TABLE 3. Oviposition by *A. rusticator* females in freshly cut, dry older and decaying logs of *A. chaplasha*.

No. of eggs in the subsequent days after the emergence of females

Condition of logs	No. of females	5	6	7	8	9	10	11	12	13	14	15	Total
Freshly cut	10	17	29	42	49	38	15	18	29	17	13	5	272
Dry older	10	—	12	13	24	11	—	13	19	7	7	1	107
Decaying	10	—	—	12	7	5	4	3	7	11	2	—	51

there was an indication of preference for host identity (Table 2). To test the condition preference in the preferred hosts, a pair of adults were placed in each of 30 breeding-jars, 10 containing freshly cut logs, 10 containing dry older and other 10 containing decaying ones. Eggs were removed and logs were replaced daily. Oviposition was heaviest on the freshly cut logs (Table 3). It appears, therefore, that host-selection in *A. rusticator* depends primarily upon the condition of the host material and secondarily upon the host identity.

Fecundity : The number of eggs laid by one female ranged between 2 and 8 (mean 5)

per day, and oviposition continued throughout the life of adult females with occasional intervals of 1-3 days. The mean potential fecundity of 50 females was found to be 94 (S. D.=20.35), while the realised fecundity of the same beetles was 61 (S. D.=23.29).

The difference between the potential and realised fecundity appeared primarily to be due to the length of adult life; short lived females generally laid fewer eggs than long lived ones. Under the laboratory conditions, the oviposition period generally ranged between 4 and 29 days (mean 11 days). The maximum oviposition period was recorded to be 34 days in one female. Under field

conditions, however, the presence of suitable host material with abundant oviposition sites and climatic factors were appeared to be the additional factors influencing the number of eggs laid.

ACKNOWLEDGEMENTS

Grateful acknowledge is made to the Director, Zoological Survey of India, for his able guidance and constant inspiration, and to Dr. A. K. Das, Officer-in-Charge, Andaman and Nicobar Regional Station, Z. S. I., for his keen interest and for providing facilities to carry out this work. Appreciations are expressed to all the members of the staff of Andaman and Nicobar Regional Station, Z. S. I., for their active co-operations.

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A NEW SPECIES OF THE GENUS *LEUCOPIS* (DIPTERA : CHAMAEMYIDAE)
FROM NORTH WEST INDIA

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AND

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ABSTRACT

A new species *Leucopis simlai* sp. nov. is described here along with a short biological note.

INTRODUCTION

While determining the insect predators of aphids collected at Simla, we came across a new species of the genus *Leucopis*. The larvae are predators of aphids and the adults were emerged from the reared in the laboratory.

SYSTEMATIC ACCOUNT

Family—CHAMAEMYIDAE

Genus—*Leucopis* Meigen

Leucopis simlai sp. nov.

(Figs. 1 A, B & C)

Description : Female : Head ash coloured. Body about 2 mm long and 1 mm wide across 3rd and 4th abdominal segments. Wing 2.5 mm long. Two pairs of vertical setae on vertex, inner vertical setae being small, outer longer. Ocelli present, frons and parafacials without any prominent stout seta ; arista elbow shaped, bare, 3rd segment of the antenna semicircular, widened at apex ; frons and epistome ash colour. Thorax grey, dorsum light ash coloured, with two faint longitudinal

narrow darker stripes running parallel to each other. Dorsal thoracic setae black. Pleura dark. Scutellum greyish white. Setae small, sparse and with acute apices.

Abdomen conical, ash coloured, 2nd and 3rd segments with two black dorsomedial spots, narrowing towards tip, covered sparsely with small black setae, Venter ash coloured with a faint dark line ventromedially. Scutellum squarish with two pairs of long marginal setae. Halteres bright white.

Legs ash coloured to light yellow. Coxa, trochanter and basal $\frac{3}{4}$ of femur ash coloured rest light yellowish ; apical $\frac{3}{4}$ of tibia greyish, rest light yellowish ; 1st and 2nd segments of tarsi light yellowish rest gradually darker towards tip.

Wings clear and hyaline ; costa not broken, anal and second basal cells complete ; anal vein not reaching wing margin.

Material : Holotype 1 ♀, (Regd. No. 6570/H6), India, Himachal Pradesh, Simla, 25.11.1980. Coll. S. C. Poddar, aphid host *Macrosiphum rosaeiformis* ; paratype, 3 ♀, Regd.

No. 6571/H6 collection data same as holotype. Types are deposited in the Zoological Survey of India, Calcutta.

Remarks : This species in having yellow fore tarsi approaches to *L. bella* Loew and *L. simplex* Loew. Due to the presence of yellow tarsi and body being more than

2 mm it comes more close to *L. bella* Loew but it differs from *bella* by the following : (i) Presence of ash coloured basal abdominal tergite, (ii) Presence of two dorsal black spots on each of 2nd and 3rd abdominal segments.

From *L. simplex* Loew the species differs

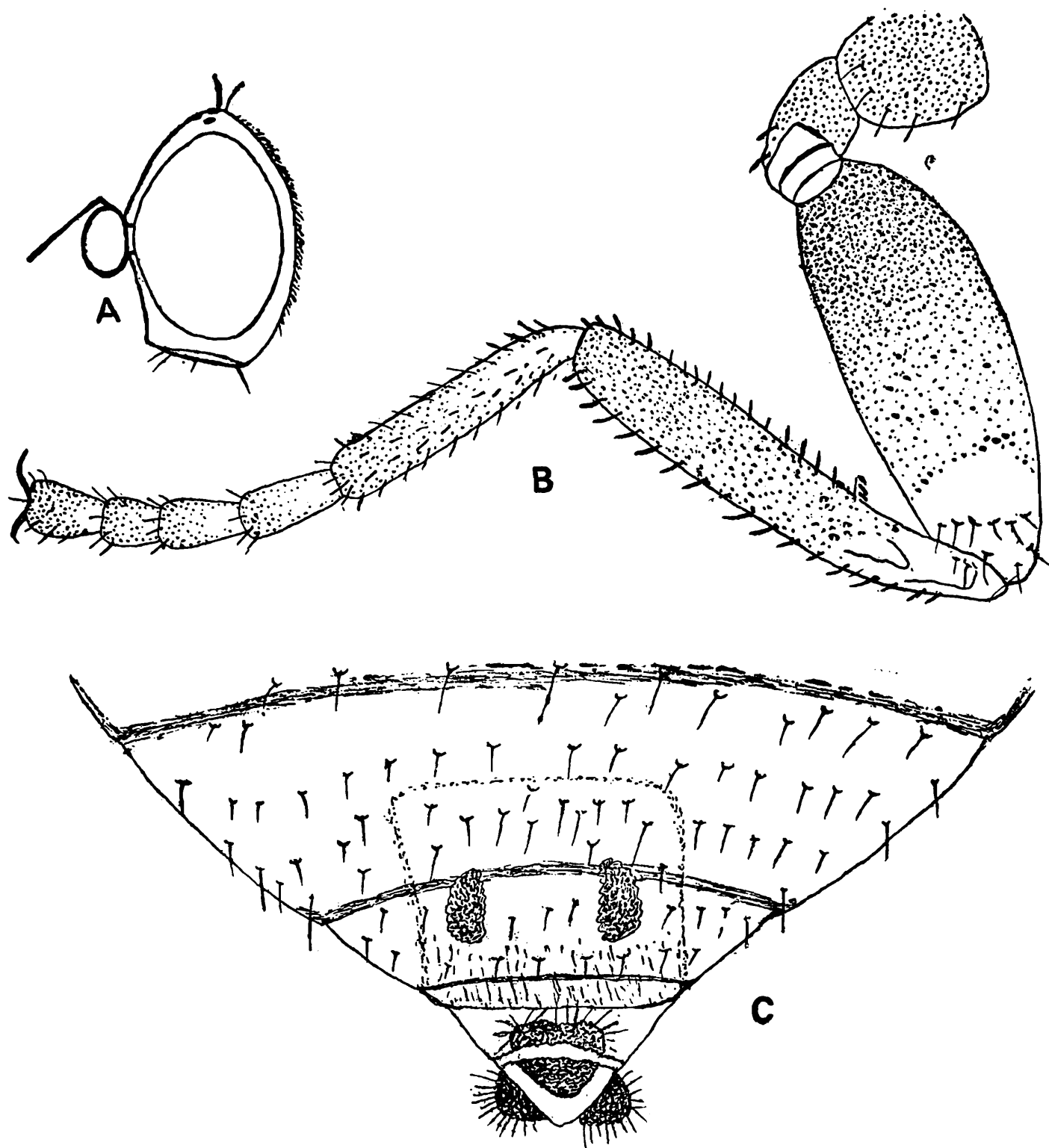


Fig. 1. *Leucopis simlai* sp. nov. A, head ; B, hind leg ; C, abdomen (dorsal).

by the following (i) Presence of two dark brown strips on thorax, (ii) Presence of two dorsomedian black spots on third abdominal segment.

Biological notes : Eggs of this species were observed to be attached in maximum number with rose buds and tender shoots but less in number with leaves. But those eggs were not preserved and reared. Only the larvae which were collected in the aphid colony were reared in the laboratory by supplying fresh aphid material as food every day. The larvae were seen to prefer nymphs of the aphids rather than the adults as their food. One larva usually consumed 15 to 20 aphid nymphs of 3rd and 4th instar per day. After 5-6 days the larvae began to pupate. The pupation

period was 8-10 days. After this the adult flies emerged. In the laboratory condition it was observed that the adults remain alive for 2 days without any food.

ACKNOWLEDGEMENTS

The first author is grateful to the Director, Zoological Survey of India, Calcutta for encouragement, the second author to the University Grants Commission, New Delhi for financial assistance to carry out this work.

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A NEW SPECIES OF *LONCHOPTERA* MEIGEN (DIPTERA : LONCHOPTERIDAE) FROM NORTH WEST INDIA

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ABSTRACT

Lonchoptera guptai sp. n. is described from North West Himalaya.

Through the courtesy of Dr. V. K. Gupta of Delhi University we have received a small collection of Lonchopteridae which include one new species. Hitherto only three species of *Lonchoptera* Meigen are known from India, viz., *Lonchoptera lutea* Panzer, *L. anderssoni* Joseph and Parui and *L. brunettii* Joseph and Parui.

Key to Indian Species of the genus *Lonchoptera* Meigen

1. Wings hyaline with yellowish tinge. 2
Wings with a distinct sub-apical dark brown band. ... *brunettii* Joseph & Parui
2. Thorax shining brown with an indistinct median stripe, antennae black. ... *lutea* Panzer
Thorax yellow or black without stripe. 3
3. Legs pale yellow, hind femur apically brown marked, antennae dark brown. ... *guptai* sp. n.
Legs yellow without apical marking on hind femur, antennae yellow. ... *anderssoni* Joseph and Parui

Lonchoptera guptai sp. n.

Female: Body length 2.5 mm, wing length 3.5 mm.

Head black to dark brown with black bristles, the hairs of proboscis and those on lower part of occiput yellow. Antenna including arista dark brown.

Thorax black to dark brown with black bristles; anterior border and posterolateral sides of mesonotum comparatively lighter coloured; scutellum posteriorly lighter coloured; pleura dark brown to yellowish-brown. Legs pale yellow, tarsi and sometimes tibia brownish, hind femur apically marked brown. Fore femur with 1d; fore tibia with 1pv; mid femur in holotype with 1ad whereas in paratype 1p; mid tibia in holotype with 2d, 1a whereas in paratype 1d, 1ad and 1p; hind femur with 2d, 1pv; hind tibia in holotype with 2d, 1ad, 2v whereas in paratype an additional ad also present.

Wings (Fig. 1) light yellowish with light brown veins. $m_{1+4} : m_{1+2} : m_1 = 14 : 14 : 28$. The proportional length of these divisions are that the first and second divisions are equal

and the third equal to the combined first and second divisions. Halteres light yellowish, stalk lighter than knob.

Abdomen black or dark brown, ventrally lighter coloured.

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We are grateful to Dr. B. K. Tikader, Director and Dr. S.K. Bhattacharyya, Deputy Director, Zoological Survey of India, Calcutta, for encouragements.

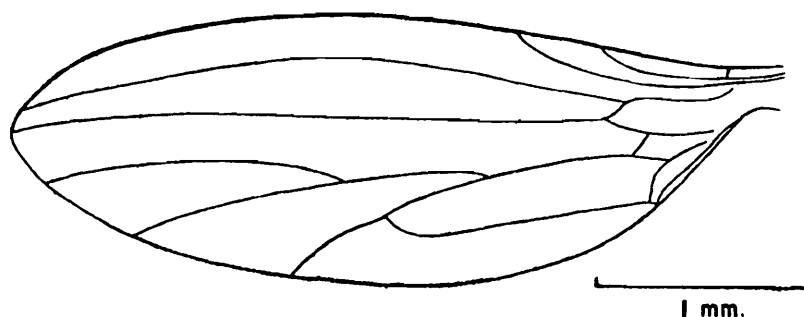


Fig. 1. *Lonchoptera guptai* sp. n., wing.

Holotype ♀, India : N. W. Himalaya : Garhwal : Ghangharia, 1. vi. 1965, Coll. D. Ram. In Delhi University, Delhi. *Paratype* ♀, Regd. No. 6572/H₆, details as for holotype.

Lonchoptera guptai sp. n. is quite similar to *L. lutea* Panzer but can be readily recognised by the uniform dark brown mesonotum and the proportional length of the divisions of m (m_{1+4} , m_{1+2} , m_1), in the latter division 3 being about thrice the length of divisions 1 or 2.

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STUDIES ON SPIDERS OF THE GENUS *CASTIANEIRA* KEYSERLING
(FAMILY : CLUBIONIDAE) FROM INDIA

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ABSTRACT

A revisionary study of Indian spiders of the genus *Castianeira* Keyserling (Family Clubionidae) is given with illustrations, descriptions and key. Only five species of this genus are known so far from India.

INTRODUCTION

The spiders of the family Clubionidae are very common in India and it is a large family of spiders. The members of this family are of two-clawed hunting spiders commonly encountered on foliage or on the ground, where they may make tubular retreats in rolled up leaves, or under stones, in litter, etc. Though the family is very large but the genus *Castianeira* from India received a little attention by previous worker. Only Simon (1897), Gravely (1931) and Tikader & Biswas (1980) have published some work on the genus *Castianeira* from India. These spiders run over on the ground and may resemble large ants or mutillid wasps. They resemble in form and manner of movement like large carpenter ants and they have been found associated with the ants on the ground.

I have received *Castianeira* collection from our Head quarters and Western Regional Station, Poona for my study. I also got the

opportunity to study the type specimens of Gravely, which were deposited in National Collection of Zoological Survey of India, Calcutta.

I have illustrated and redescribed four known species and described one new species in this paper and have also included internal genitalial characters of all the species, because the superficial architecture of epigyne of different species is of almost uniform pattern. Key to the species is also given for easy identification. Type specimens of new species are deposited in the National Collections of Zoological Survey of India, Calcutta.

Genus *Castianeira* Keyserling

Castianeira Keyserling, 1897. *Verh. zool.-bot. Ges. Wien*, 37 : 335.

Castaneira : Simon, 1897. *Hist. Naturelle des Araign.*, 2 : 172.

Castaneira : Gravely, 1931. *Rec. Indian Mus.*, 33 (3) : 272.

Characters : These spiders are of medium size, brown or black in colour, with the abdomen ringed or otherwise marked with white or some other bright colour. Cephalothorax oval, convex and provided with a well marked median furrow. These spiders run about over the ground and may resemble large ants or mutillid wasps. Abdomen dorsally provided with sclerotized scutum.

Type-species : *Castianeira rubicunda* Keyserling.

Distribution : AFRICA, ASIA, MALAYSIA, INDIA, AMERICA.

Key to species of the genus **Castianeira**

- | | |
|--|------------------------|
| 1. Eyes approximately uniform size, two lines almost parallel, slightly convergent distally; anterior coxae very dark, almost black, the remaining coxae much paler. ... | <i>C. zetes</i> |
| Eyes not uniform size, two lines not parallel, strongly convergent laterally, coxae more uniformly coloured. ... | ... 2 |
| 2. Anterior median eyes much larger than the anterior laterals. ... | ... 3 |
| Posterior median eyes much larger than the posterior laterals. ... | <i>C. flavipes</i> |
| 3. Chelicerae very strong and prominent, dorsal sclerotized scutum large. ... | <i>C. indica</i> |
| Chelicerae weak, not prominent, dorsal sclerotized scutum small. ... | ... 4 |
| 4. Legs with strong longitudinal markings as in <i>C. zetes</i> ; posterior tibiae dark with conspicuous band at apex. ... | <i>C. albopicta</i> |
| Legs without longitudinal markings or white bands. ... | <i>C. himalayensis</i> |

1. **Castianeira zetes** (Simon)

(Figs. 1-4)

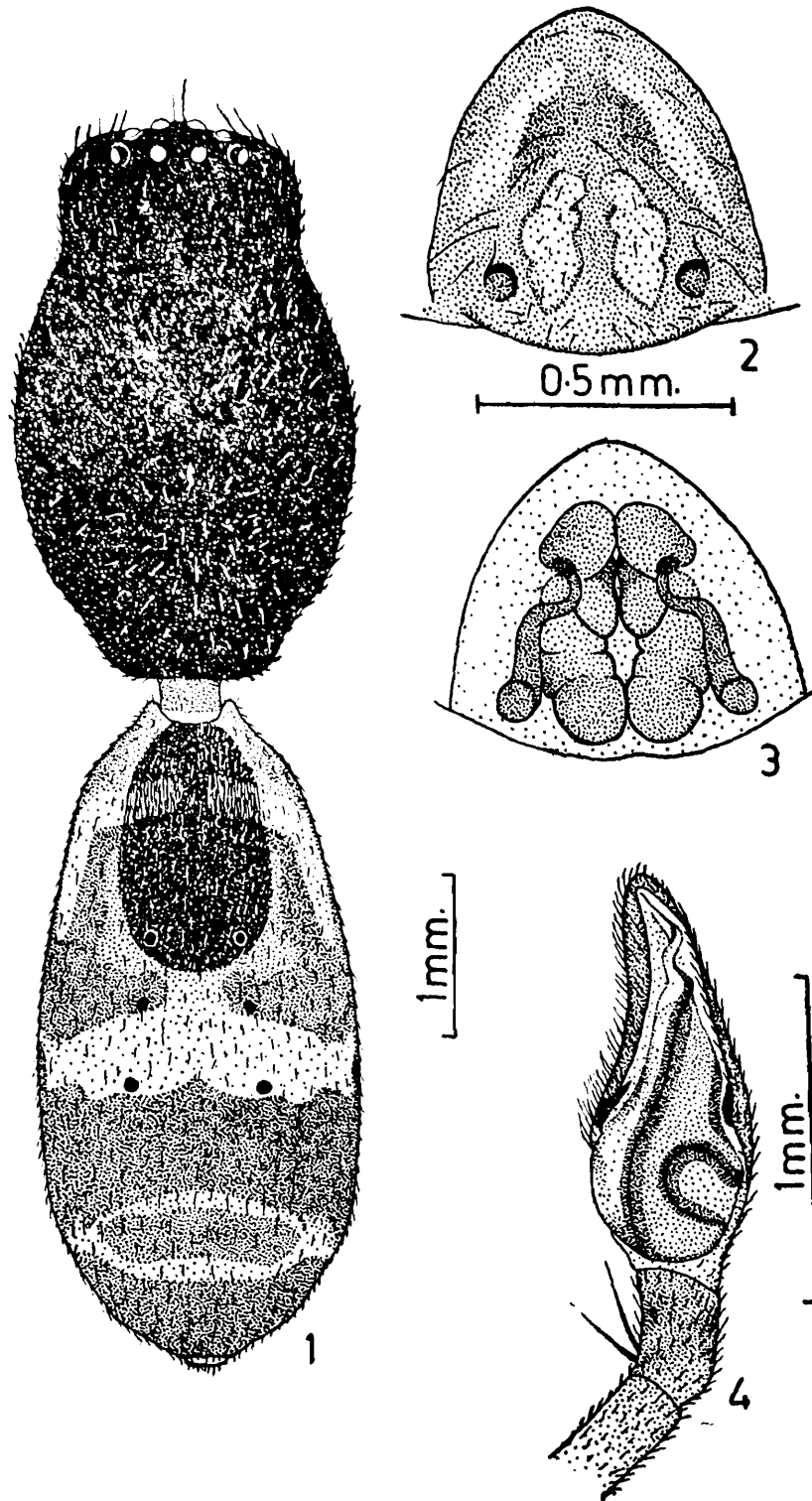
1897. *Castaneira zetes* Simon, *Bull. Mus. Hist. nat., Paris*, 3 (7) : 294.
1906. *Castaneira zetes* : Simon, *Annls Soc. ent. Fr.*, 75 : 302.
1931. *Castaneira zetes* : Gravelly, *Rec. Indian Mus.*, 33 (3) : 273.
1954. *Castianeira zetes* : Roewer, *Katalog der Araneae*, 2 : 60.9

General : Cephalothorax, abdomen and legs brown in colour, Total length 9.20 mm. Carapace 4.20 mm. long, 2.50 mm. wide; abdomen 4.80 mm. long, 2.10 mm. wide.

Cephalothorax : Longer than wide, wider in front. Convex, clothed with fine hairs, middle provided with a fovea. Eyes pearly white both row straight but posterior row slightly long. Sternum heart-shaped, longer than wide, clothed with fine hairs. Labium brown but anterior margin white. Maxillae brown but anterior end white and provided with scopulae. Chelicera moderately strong, outer margin three and inner margin provided with three teeth. Legs moderately strong, clothed with hairs and spines. Legs formula 4123. Tibia and metatarsus I provided with three and two pairs of ventral spines respectively. Male slightly smaller than female, male palp as in Fig. 4.

Abdomen : Long, clothed with fine hairs, slightly wider in posterior end than anterior. Dorsally in front provided with small sclerotized scutum and three pairs of longitudinally arranged minute sigilla as in Fig. 1. Ventral side uniform pale colour. Epigyne as in Fig. 2. Internal genitalia as in Fig. 3.

Distribution : INDIA : Madras, Bangalore, Barkuda Island (Cilka lake), Orissa; Calcutta, Kalimpong, West Bengal; Assam; Dacca (Type-locality), Maharashtra, BHUTAN.



Figs. 1-4. • *Castianeira zetes* (Simon)

- | | |
|---|------------------------|
| 1. Dorsal view of female, legs omitted. | 3. Internal genitalia. |
| 2. Epigyne. | 4. Male palp. |

2. *Castianeira flavipes* (Gravely)

(Figs. 5-8)

1981. *Castianeira flavipes* Gravely, *Rec. Indian Mus.*, 33 (3) : 275.

1954. *Castianeira flavipes*: Roewer, *Katalog der Araneae*, 2 : 611.

General: Cephalothorax, abdomen and legs brown. Total length 5.00 mm. Carapace 2.20 mm. long, 1.80 mm. wide; abdomen 2.80 mm. long, 1.80 mm. wide.

Cephalothorax: Longer than wide, slightly wider in front, convex, clothed with fine hairs, middle provided with a fovea. Eyes pearly white, posterior row procurved and anterior row slightly recurved; eyes of posterior rows slightly larger in size than anterior row. Sternum nearly oval, deep brown, clothed with fine hairs. Labium wider than long, brown but anterior margin white. Maxillae longer than wide, brown, but anterior margin white and provided with scopulae. Chelicera moderate, inner row provided with two and outer row of three small teeth. Legs moderately strong, clothed with hairs and spines. Tibia and metatarsus of I provided with three and two pairs of ventral spines respectively. Male slightly smaller than female and more dark, male palp as in Fig. 8.

Abdomen: Longer than wide, clothed with hairs, anterior dorsal side provided with small sclerotized scutum and three pairs of longitudinally arranged minute sigilla as in Fig. 5. Ventral side uniform pale colour. Epigyne as in Fig. 6. Internal genitalia as in Fig. 7.

Distributions: INDIA: Bangalore, Karnataka; Nilgiri, Tamil Nadu; Burkuda Island (Type-locality), Chilka lake, Orissa.

3. *Castianeira indica* sp. nov.

(Figs. 9-12)

General: Cephalothorax deep brown, abdomen brown and legs reddish-brown. Total length 5.30 mm. Carapace 2.20 mm. long, 1.90 mm. wide; abdomen 3.00 mm. long, 2.00 mm. wide.

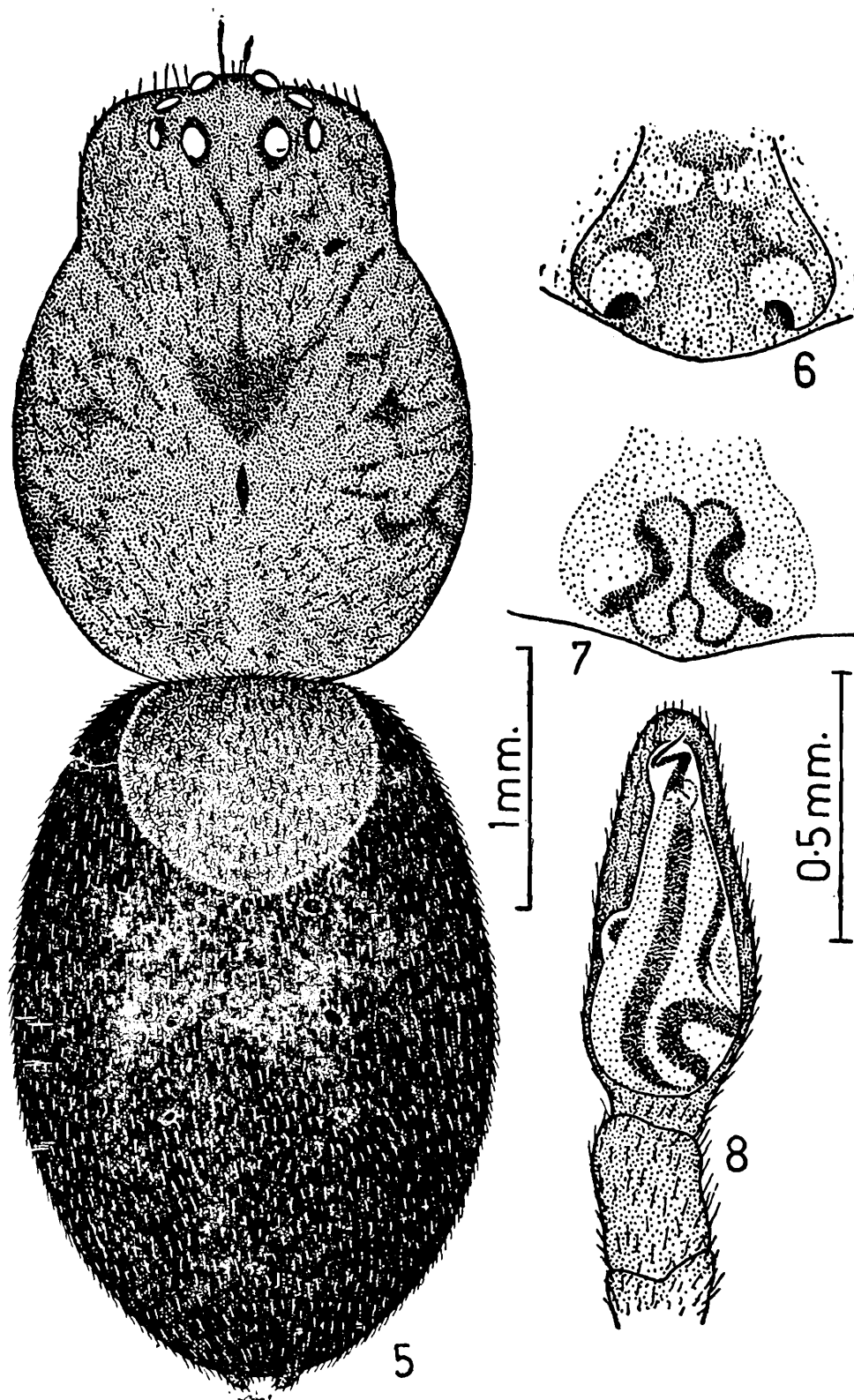
Cephalothorax: Longer than wide, wider in front than behind, convex, cephalic region high, middle provided with a fovea. Eyes pearly white, anterior row shorter than the posterior row and nearly straight, posterior row slightly procurved. Anterior row of eyes nearly equal in size but larger in size than posterior eyes. Sternum nearly oval, slightly longer than wide, red colour, clothed with fine hairs. Labium longer than wide, with prominent lateral notch, red in colour. Maxillae also red like labium but anterior margin white and scupulated. Chelicera very strong, outer margin three and inner margin provided with six teeth. Legs moderately strong, clothed with hairs and spines. Tibia and metatarsa of I provided with 8 and 5 pairs of ventral spines, respectively. Legs formula 1423. Male palp as in Fig. 12.

Abdomen: Longer than wide, wider behind the middle, clothed with hairs, anterior half of the dorsal side provided with large sclerotized scutum as in Fig. 9. Ventral side uniform pale colour. Epigyne as in Fig. 10. Internal genitalia as in Fig. 11.

Holotype female, *paratype* 11 ♀♀, *allotype* 1 ♂ in spirit, 12.10.1979. Coll. B. K. Tikader. Regd. No. 5096-98/18.

Type-locality: INDIA: MAHARASHTRA: Flower garden, Poona University Compound, Poona.

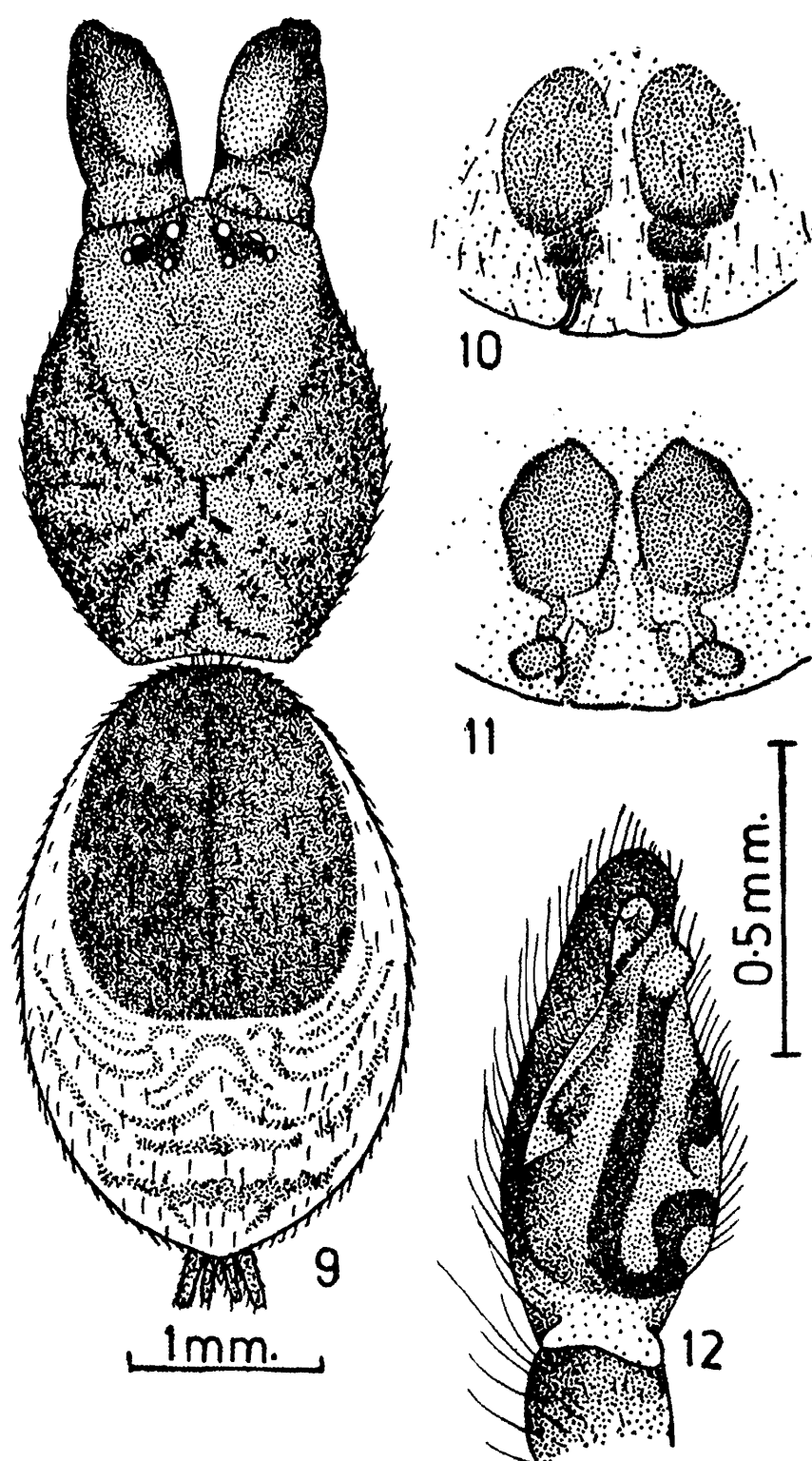
This species close to *Castianeira flavipes*



Figs. 5-8. *Castianeira flavipes* (Gravely)

5. Dorsal view of female, legs omitted.
6. Epigyne.

7. Internal genitalia.
8. Male palp.

Figs. 9-12. *Castianeira indica* sp. nov.

- | | |
|---|-------------------------|
| 9. Dorsal view of female, legs omitted. | 11. Internal genitalia. |
| 10. Epigyne. | 12. Male palp. |

(Gravely) but it is separated as follows : (i) Anterior median eyes larger than others but in *C. flavipes* posterior median eyes larger than others. (ii) Chelicerae very strong,

prominent and dorsal sclerotized scutum large but in *C. flavipes* the chelicerae not strong or prominent and dorsal sclerotized scutum small. (iii) Epigyne also structurally different.

4. *Castianeira albopicta* (Gravely)

(Fig. 13)

1981. *Castianeira albopicta* Gravely, *Rec. Indian Mus.*, 33 (8) : 275.

1954. *Castianeira albopicta* : Roewer, *Katalog der Araneae*, 2 : 611.

General : Cephalothorax, abdomen and legs light brown. Total length 6.00 mm. Carapace 2.80 mm. long, 1.80 mm. wide ; abdomen 3.00 mm. long, 1.30 mm. wide.

Cephalothorax : Longer than wide, slightly wider in front, convex, clothed with fine hairs, middle provided with a fovea. Cephalic region slightly high. Eyes pearly white, bases of all eyes encircled by black patch. Posterior row straight and longer than anterior row ; anterior row slightly recurved, ocular quad nearly square. Sternum heart-shaped, pointed behind, light brown, clothed with fine hairs. Labium nearly as long as wide, deep brown but anterior margin white. Maxillae longer than wide light brown, anterior margin provided with scopulae. Chelicera strong, inner margin provided with two and outer margin with three small teeth. Legs moderately strong, clothed with hairs and spines. Legs formula 4132. Tibia and metatarsus of I provided with three and two pairs of ventral spines.

Abdomen : Long, clothed with fine hairs ; anterior dorsal side provided with a small sclerotized scutum as in Fig. 13. Ventral side uniform pale colour. This specimen is subadult female, epigyne is not developed.

Distribution : INDIA : Pashok (*Typelocality*) Darjeeling, West Bengal.

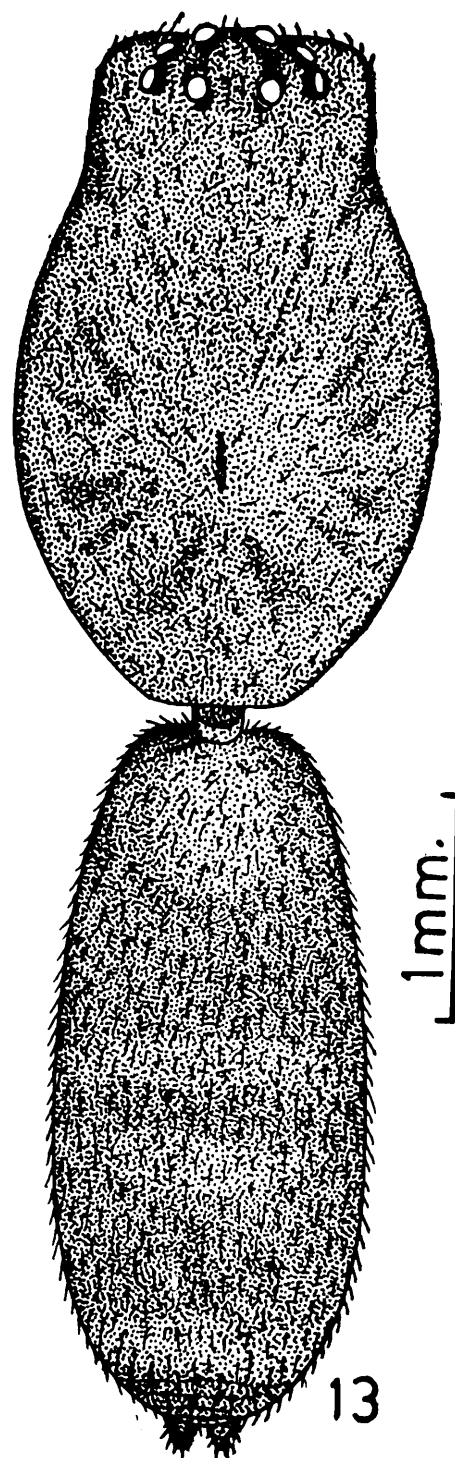
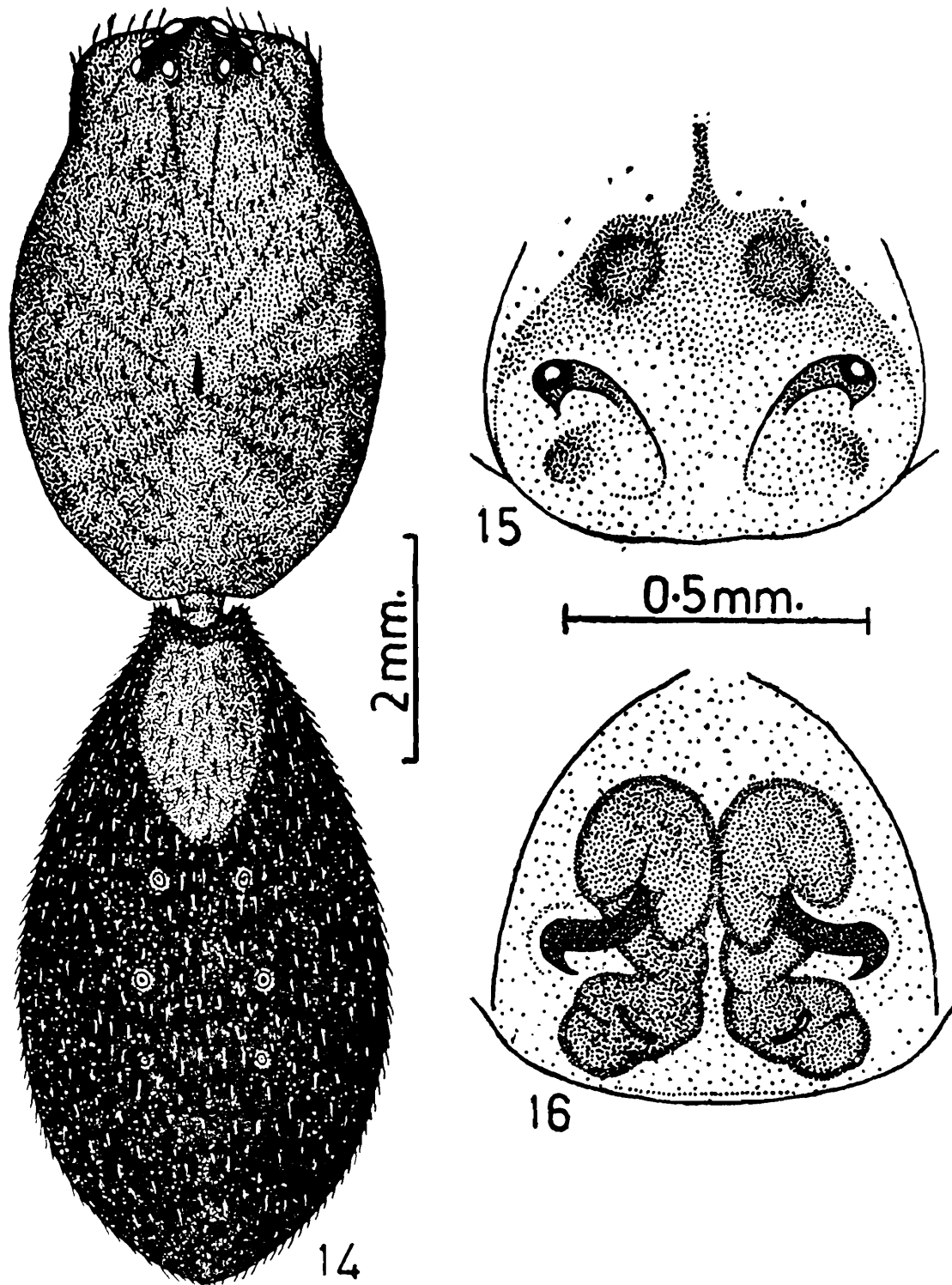


Fig. 13. *Castianeira albopicta* (Gravely)

13. Dorsal view of sub-adult female, legs omitted.



Figs. 14-16. *Castianeira himalayensis* (Gravely)

- 14. Dorsal view of female, legs omitted.
- 15. Epigyne.
- 16. Internal genitalia.

5. *Castianeira himalayensis* (Gravely)

(Figs. 14-16)

1931. *Castianeira himalayensis* Gravely, *Rec. Indian Mus.*, 33 (9) : 275.1980. *Castianeira himalayensis* : Tikader & Biswas, *Rec. zool. Surv. India, Occ., Pap.* No. 30 : 72.1954. *Castianeira himalayensis* : Roewer, *Katalog der Araneae*, 2 : 611.

General : Cephalothorax, abdomen and legs brown. Total length 11.40 mm. Carapace 5.10 mm. long, 3.00 mm. wide ; abdomen 6.00 mm. long, 3.20 mm. wide.

Cephalothorax : Longer than wide, slightly wide in front, convex, cephalic region slightly high, middle provided with a fovea. Eyes pearly white, posterior row straight and slightly longer than anterior row, anterior row slightly recurved and eyes slightly larger than the posterior row. Sternum heart-shaped, pointed behind, brown colour, clothed with fine hairs. Labium nearly as long as wide, deep brown, anterior margin provided with conspicuous white. Maxillae longer than wide, anterior end wide, brown but anterior margin provided with white and scopulate. Chelicera strong, inner margin provided with two and outer margin with three small teeth. Legs strong and long, clothed with hairs and spines. Legs formula 4132. Tibia and metatarsus of I provided with three and two pairs of ventral spines respectively.

Abdomen : Longer than wide, clothed with fine hairs, wider behind the middle. Anterior end of dorsal side provided with a small sclerotized scutum as in Fig. 14.

Ventral side nearly the same colour like dorsal but mid-ventrally provided with a conspicuous longitudinal deep brown band extending from epigastric furrow up to base of spinnerets. Epigyne as in Fig. 15. Internal genitalia as in Fig. 16.

Distribution : INDIA : Tindharia (*Type-locality*). Darjeeling, Calcutta, West Bengal.

ACKNOWLEDGEMENTS

I am thankful to Dr. Salil Gupta, Superintending Zoologist, Acarology Division, and Dr. Bijan Biswas, Asst. Zoologist, Zoological Survey of India, Calcutta, for kindly providing the type specimens of the genus *Castianeira* which are deposited in the National Collections of Zoological Survey of India, Calcutta. I am also thankful to Dr. Animesh Bal, Asst. Zoologist, Zoological Survey of India for assisting me in various way. The illustrations used in this paper are prepared by Shri P. W. Garde and Shri D. J. Kamble, Artists of the Western Regional Station, Poona, to whom my thanks are also due.

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A NEW GENUS AND ONE NEW SPECIES UNDER SUBFAMILY GNORIMINAE
CHAUDHRI FROM INDIA (ACARINA : PHYTOSEIIDAE)

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AND

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ABSTRACT

Garhwalicus, a new genus under subfamily Gnoriminae Chaudhri, family Phytoseiidae, is proposed here to accommodate *Garhwalicus himalayensis* described as new to science from India.

INTRODUCTION

Chaudhri (1975) erected the subfamily Gnoriminae from Pakistan with *Gnorimis tabella* Chaudhuri as its type species. He diagonalised the subfamily by having : 1. 12 pairs of lateral setae, 2. 3 pairs of sublateral setae, 3. 2 pairs of setae around ventrianal shield and 4. 6 pairs of preanal setae. The present material examined by the authors is very interesting in the sense that it also possesses 3 pairs of sublateral setae and 12 pairs of lateral setae but it differs from the former in having 1. 7 pairs of preanal setae. In addition, the genital shield is quite peculiar and in sharp contrast with that of *G. tabella*. Weighing the similarities and dissimilarities of characters it is considered that the present species can very well be fitted in the subfamily Gnoriminae provided the definition of the subfamily is slightly modified in the light of characters as exhibited by the present material. However, it will not be proper to

place the species in the genus *Gnorimus* as 1. structurally the genital and sternal shields are different, 2. metasternal and metapodal plates are absent and 3. ventrianal shield being robust with 7 pairs of preanal setae. In view of these sharp differences from *Gnorimus*, a new genus, viz. *Garhwalicus* under the subfamily Gnoriminae is proposed here to accommodate the new species.

The present paper re-diagonalises the subfamily, a new genus is proposed giving diagnostic characters and the new species is described and illustrated. The type of the new species is deposited in the collection of the Zoological Survey of India. The setal nomenclature as of Rowell *et al.* (1978) is followed. The measurements given in the text are in microns.

Subfamily GNORIMINAE

Diagnosis : Dorsal shield light to heavily sclerotized with 12 pairs of lateral setae

of diverse shape and nature, 3 pairs of sublateral setae, 2 pairs of setae present on membrane around ventrianal shield, ventrianal shield large to robust, reticulate with 6-7 pairs of preanal setae, a pair of paranal and a long serrate postanal seta present, a fold like structure present on ventrianal shield little anterior to anal region. Type genus : *Gnorimus* Chaudhri, 1975.

Key to the genera of GNORIMINAE

1. Ventrianal shield with 7 pairs of preanal setae, metapodal and metasternal plates absent. ...

Garhwalicus
gen. nov.

- Ventrianal shield with 6 pairs of preanal setae, 2 pairs of metapodal plates and one pair of metasternal plates distinctly present. ...

Gnorimus
Chaudhri

Genus *Garhwalicus* gen. nov.

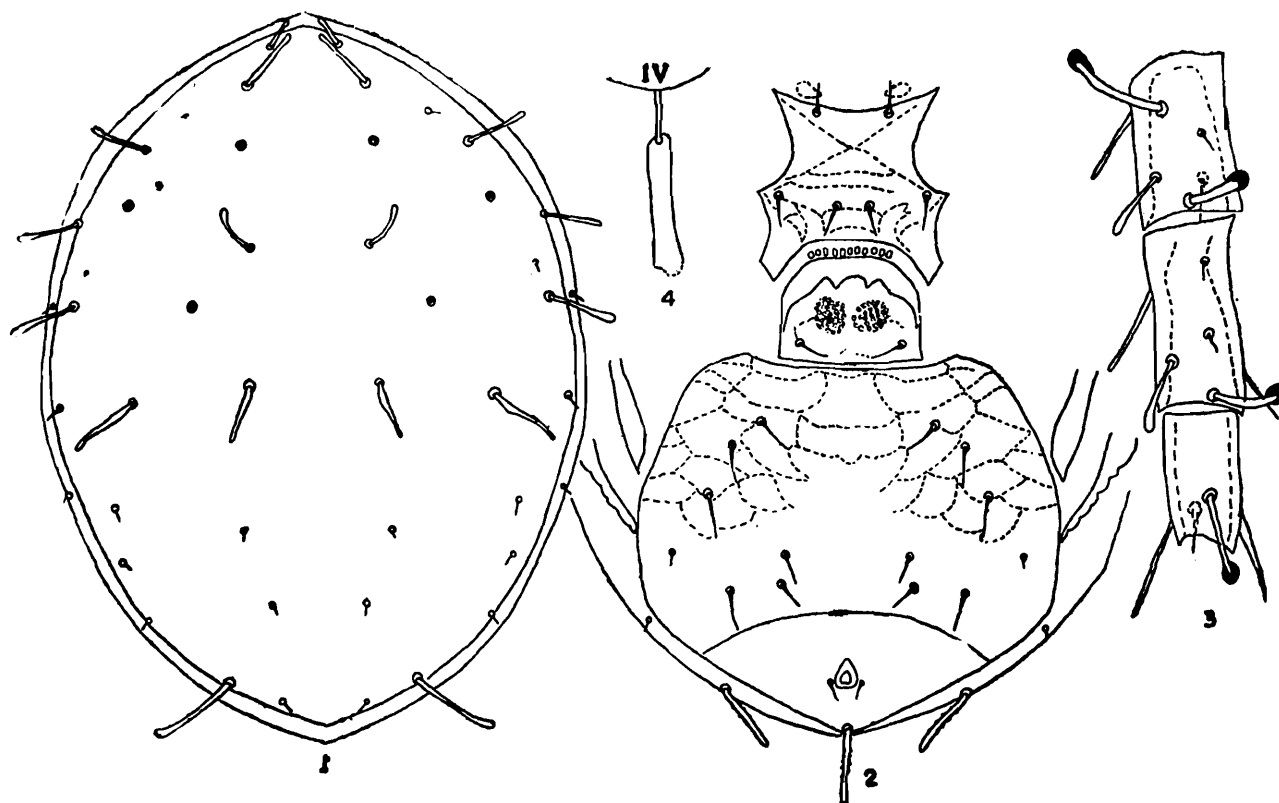
Diagnosis : Dorsal shield heavily sclerotized with 12 pairs of lateral setae of diverse sizes, 3 pairs of sublateral setae, ventrianal shield robust, reticulate with 7 pairs of preanal setae, metapodal and metasternal plates absent, sternal shield robust, reticulate with 3 pairs of conspicuously long setae.

Type species : *Garhwalicus himalayensis* sp. nov.

Garhwalicus himalayensis sp. nov.

(Figs. 1-4)

Female : Dorsal shield 370 long, 278 wide, heavily sclerotized smooth, with 12 pairs of setae in lateral series, 6 pairs on dorsocentral series and 2 pairs on median series ; 3 pairs of sublateral setae present on interscutal membrane. Most of the dorsal setae rod like, a few with widened base ; some



Figs. 1-4. *Garhwalicus himalayensis* sp. nov., female : 1. Dorsal shield ; 2. Ventral surface ; 3. Leg IV ; 4. Spermatheca.

of the setae both on lateral and dorsocentral series small. Measurements of setae : j1-18, j4-31, (setae broken, not represented in slide), j5-29, j6-34, J2-7, J5-4, j3-38, z2-5, z3-44, z4-36, (setae broken in slide), s4-5, s5-44, Z1-6, S2-44 (broken in slide), S3-5, S4-5, S5-5, Z5-60, z1-broken, Z4-6, Interscutal membrane heavily sclerotized with 3 pairs of sublateral setae measuring : r3-38, R1 and R4 being small. Ventrally the sternal shield reticulate, 67 long, 100 wide, with 3 pairs of moderately long sternal setae ; metasernal plate with seta absent. Genital shield granulated on either sides of the shield, 67 wide, with a pair of genital setae. Ventrianal shield robust, 190 long, 210 wide, reticulate anteriorly with 7 pairs of preanal setae ; a distinct fold present on the shield little anterior to the anal region. One pair of paranal and a conspicuously long rod like serrate post anal seta present ; 2 pairs of setae present on the membrane around ventrianal shield : JV5-51 long. Leg IV with 2 macrosetae on genu (one large 27 long, second one 18 long), tibia also with 2 macrosetae (18 and 20 long), basitarsus with one macroseta-22 long-all being spatulate. Spermatheca as figured. Chelicera not possible to examine because of position of the specimen. Peritreme extends anteriorly upto z3.

Material : Holotype : ♀, INDIA : Uttar Pradesh, Uttar Kashi, Siror vill., 6. ix. 1979, ex undetermined plant. Coll. S. K. Gupta, (ZSI Reg. No. 3177/17).

Remarks : This new species is easily recognised by having 2 pairs of spatulate macrosetae on each of genu and tibia of leg IV, in having characteristic setae on dorsal shield, in having serrate and rod like post-anal, seta and by granulation of genital shield.

ACKNOWLEDGEMENTS

The authors express grateful thanks to the Director, Zoological Survey of India, Calcutta for the facilities. The junior author is also thankful to the Principal, M. B. B. College, Agartala, for encouragements and to the authorities of the University Grants Commission, New Delhi, for providing financial help.

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DESCRIPTION OF TWO NEW SPECIES OF CRAB-SPIDERS OF THE GENERA
DIAEA AND *BOMIS* (FAMILY : THOMISIDAE) FROM INDIA

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Zoological Survey of India, Calcutta

ABSTRACT

The two new species of spiders, described in this paper, were collected from Calcutta. The new species belong to the genera *Diaea* Thorell and *Bomis* Koch.

INTRODUCTION

Spiders of the family Thomisidae have received attention very recently by Tikader (1960-1980). *The Fauna of India* (Family : Thomisidae) has been published by Tikader (1980) after the *Fauna of British India, Arachnida* by Pocock (1900) where the family Thomisidae were not included, though the thomisid spiders are abundant in our country. While examining the spider collection deposited in the Arachnida Section, we came across two new species of spiders of the genera *Diaea* and *Bomis*, which are described in this paper.

All the type specimens are deposited in the National Collection of the Zoological Survey of India, Calcutta.

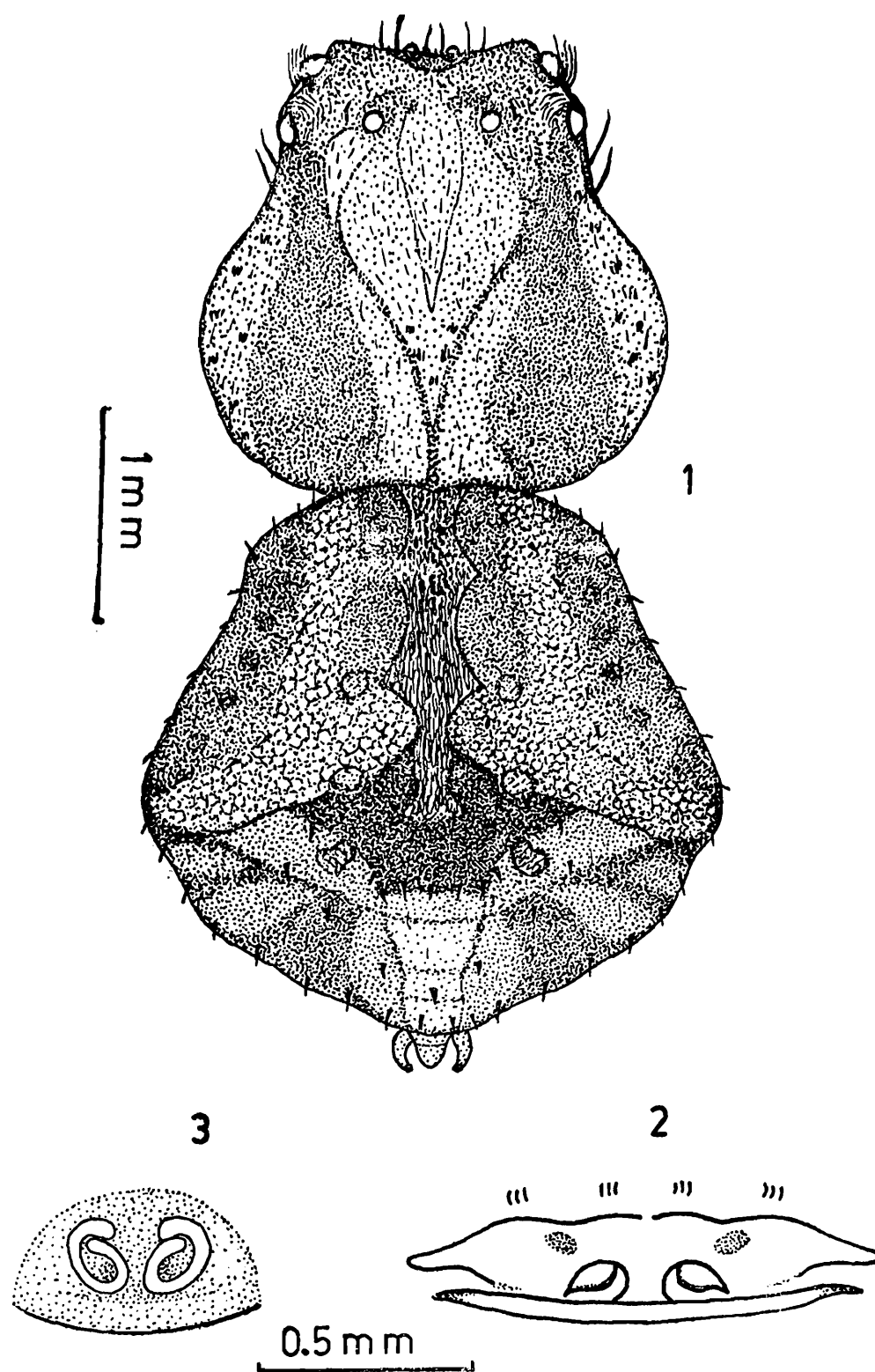
1. *Diaea bengalensis* sp. nov.

(Figs. 1-3)

General : Cephalothorax and abdomen light to deep brown, legs light brown. Total length 5.00 mm. Carapace 2.20 mm. long, 2.40 mm. wide, abdomen 2.80 mm. long, 2.80 mm. wide.

Cephalothorax : Longer than wide, convex narrowing in front, clothed with hairs, lateral two sides provided with conspicuous longitudinal light brown patches extending from base of lateral eyes to near the base of thorax, mid-dorsally with a longitudinal light brown broad patch extending from ocular area to base of thorax. Eyes black, lateral eyes situated on the shallow tubercles, ocular quad wider than long and narrowing in front. Clypeus moderate. Sternum heart-shaped, clothed with hairs. Legs I and II conspicuously long, clothed with hairs and spines ; II pair of legs darker than I pair, metatarsi of I and II pairs of legs provided with four pairs of ventral spines, III and IV pairs of legs comparatively very short and without ventral spine.

Abdomen : Oval and broader behind, clothed with spine-like hairs, spines arranged in longitudinal rows on the dorsum. Two longitudinal white patch on the anterolateral sides. Presence of three pairs of sigilla on the dorsum. Ventral side uniform pale colour. Epigyne and internal genitalia as in Figs. 2 and 3,

Figs. 1-3. *Diaea bengalensis* sp. nov.

1. Dorsal view of female, legs omitted. 2. Epigyne. 3. Internal genitalia.

Holotype: Female, *paratype* one female (immature) in spirit, deposited at Z. S. I., Calcutta Regd. No. 5099-5100/18,

Type-locality: The Agri-Horticultural Society of India, 1, Alipore Road, Calcutta, India, 26. v. 1981, Coll. *Bijan Biswas*.

This species in general resembles *Diaea jaintious* Tikader, but it is separated as follows : (i) Metatarsi of I and II pair of legs provided with four pairs of ventral spines but in *D. jaintious* I and II pair of legs with six pairs of ventral spines, (ii) Presence of three pairs of sigilla on the dorsum of abdomen but in *D. jaintious* no such sigilla, (iii) Epigyne also structurally different.

2. *Bomis calcuttaensis*, sp. nov.

(Figs. 4-6)

General : Cephalothorax and legs light yellowish green, abdomen light yellow. Total length 4.40 mm. Carapace 1.90 mm. long, 2.00 mm. wide, abdomen 2.50 mm. long, 3.10 mm. wide.

Cephalothorax : Rectangular, wider behind, convex, clothed with short hairs. Eyes round, dark ringed with white tubercles, both rows recurved but posterior row less recurved than anterior and longer ; ocular quad longer than wide, lateral eyes slightly larger and tubercles contiguous. Posterior medians further away from each other than from the adjacent laterals. There are two white semi-circular line obliquely run from the postero-lateral eyes and unite in the middle of posterior extremity of the cephalothorax. Clypeus high and sloping downwards. Legs stout, short, clothed with hairs and spine-like hairs, legs nearly equal in length, claw tufts very prominent. Sternum heart-shaped, clothed with fine hairs.

Abdomen : Wider than long, nearly semi-circular in the shape, clothed with characteristic white spine-like tubercles decorated on the whole area of the dorsum of abdomen. Presence of longitudinally branched centrally

placed stripes. Two pairs of sigilla present on the dorsum. Ventral side uniform pale brown but posterior portion encircled by three ridge of semi-circular white spine-like pattern. Presence of two deep brown area on the postero-lateral side. Epigyne and internal genitalia as in Figs. 5 and 6.

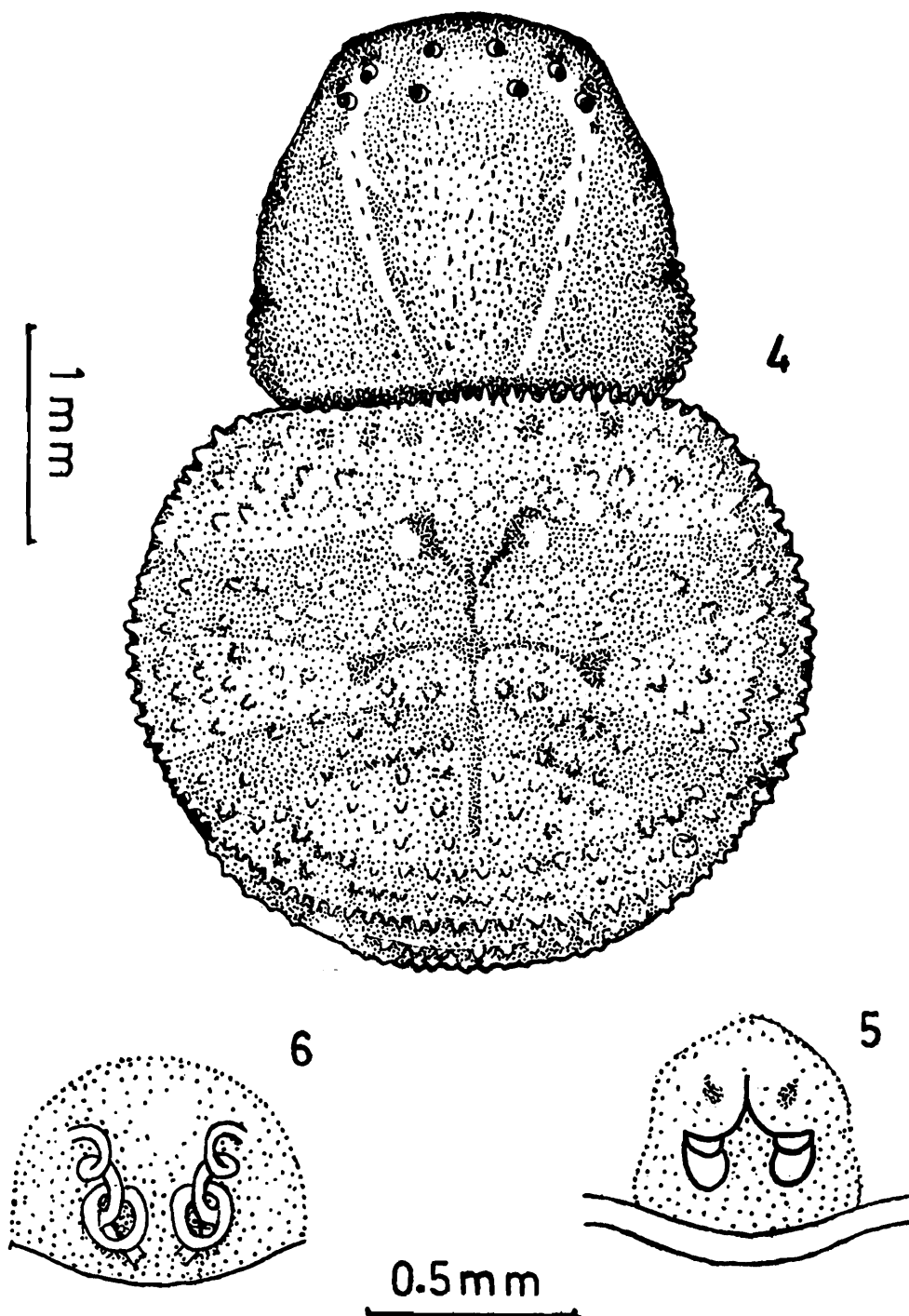
Holotype : Female, **paratype** one female and **allotype**, one sub adult male in spirit, deposited at Z.S.I., Calcutta Regd. No.5101/18—5103/18.

Type-locality : The Agri-Horticultural Society of India, 1 Alipore Road, Calcutta, India, 26. v. 1981, Coll. *Bijan Biswas*.

This species in general resembles *Bomis khajuriai* Tikader, but it is separated as follows : (i) Presence of white semi-circular line on the cephalothorax which arises from the postero-lateral eyes and runs obliquely and unite in the middle of posterior extremity of the cephalothorax but in *B. khajuriai* no such line. (ii) Abdomen decorated with characteristic white spine-like tubercles on the whole dorsal area and presence of two pairs of sigilla which attached on the branched stripes but in *B. khajuriai* no such pattern, (iii) Epigyne also structurally different.

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Our thanks are due to Dr B. K. Tikader, Director, Zoological Survey of India, for encouragement and offering useful suggestions during the preparation of this paper. Thanks are also due to Dr. S. K. Bhattacharya, Deputy Director, Dr. S. K. Gupta, Superintending Zoologist, for suggestions, and to Shri S. K. Chanda, Artist of Zoological Survey of India, for preparation of illustrations.



Figs. 4-6. *Bomis calcuttaensis* sp. nov.

4. Dorsal view of female, legs omitted. 5. Epigyne.
6. Internal genitalia.

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A NEW SPECIES OF *PLATYSEIELLA* MUMA (ACARI : PHYTOSEIIDAE),
WITH COLLECTION RECORDS OF TWELVE OTHER SPECIES

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ABSTRACT

Platyseiella mumai sp. nov. is described from Tripura. In addition, twelve other species are reported from this region.

INTRODUCTION

The genus *Platyseiella* Muma is so far known by its type, *P. platypilis* Chant (Chant, 1965; Muma & Denmark, 1970) and is reported only from Florida. The authors, while studying Phytoseiidae of Tripura, collected an interesting species of this genus and the same is described here as new to science. The present material conform with the generic diagnosis in all essential features except in having 3 pairs of setae each on sternal and ventrianal shields, respectively instead of 2 pairs on each shield, as mentioned by earlier workers. It is interesting that a genus which was so far known only from Nearctic region is occurring in India. In addition to the description of new species, 12 other species of this family are reported here, 6 of which were hitherto unknown from the state. The nomenclature of setae is after Rowell *et al.* (1978). All the measurements are in microns. The entire collection was made by the senior author.

***Platyseiella mumai* sp. nov.**

(Fig. 1)

Female : Dorsal shield gently rugose, 285 long, 128 wide, with 14 pairs of setae, setae j4, j5, j6, J5 and z5 small and simple while the remaining setae long, thick and serrate. Measurements of setae : j1—25, j4—7, j5—5, j6—5, J5—5, j3—34, z2—11, z4—9, s4—146, s6—61, Z5—90, z5—5, Z4—90 (Z4 apparently appear to be slightly longer and thicker than Z5). Sternal shield as figured, with 3 pairs of sternal setae ; metasternal setae on interscutal membrane. Genital shield narrower than greatest width of ventrianal shield. Ventrianal shield 100 long, 67 wide, with 3 pairs of preanal setae, 4 pairs of setae present on the membrane around ventrianal shield. Metapodal plates present, longer one 28 long. Fixed digit of chelicera multidentate, movable digit with 2 teeth. Spermatheca as figured. Macrosetae on leg IV : genu-38, tibia-61, basitarsus-34, distitarsus-33, all being spatulate,

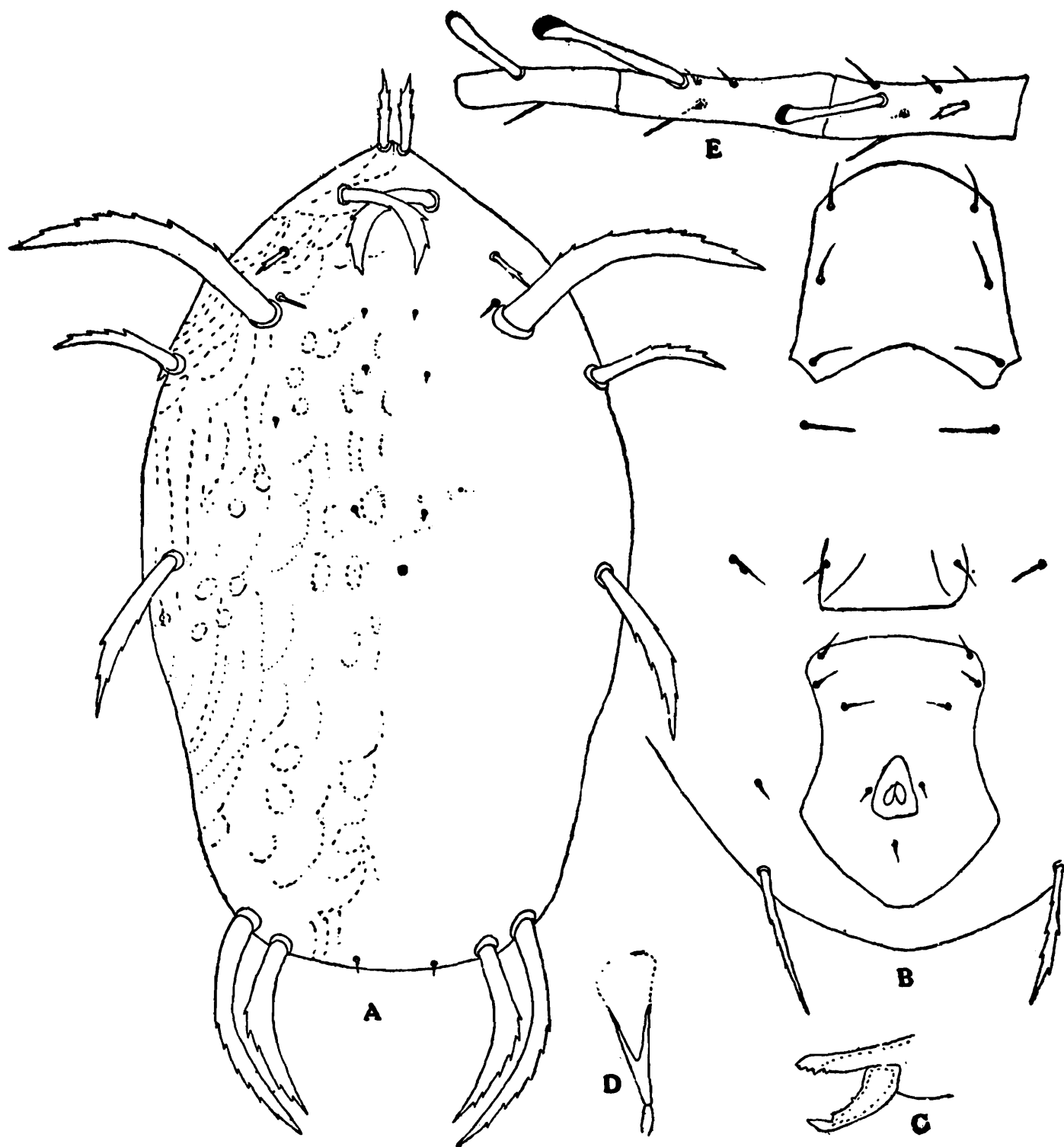


Fig. 1 (A-E). *Platyseiella mumai* sp. nov. : A—Dorsal shield, B. Ventral surface, C. Chelicera, D. Spermatheca, E. Leg IV.

Male : Unknown.

Holotype : ♀, India : Tripura, Agartala, Amtali, 10. vii. 1977, ex undetermined plant (ZSI Reg. No. 3137/17).

Paratypes : 3 ♀♀, data same as for holotype (ZSI Reg. No. 3138/17).

Remarks : This new species is distinguished from the only known species of this genus, *P. platypilis* Chant, by setae *z2* and *z4* which are longer than those of *platypilis* and the former being weakly serrate. In addition, the shape and number of setae on vent-

rianal shield also differ (3 pairs of setae present on the new species while 2 pairs present in *platypilis*).

Phytoseius (Phytoseius) roseus Gupta

Phytoseius (Dubininellus) roseus Gupta, 1969, *Israel J. agric. Res.*, 19 : 119.

Material examined : 1 ♀, Tripura, Agartala, 10. vii. 1977, ex *Rosa indica*.

Remarks : This species is recorded from Tripura for the first time. Earlier to this, it was known from Gujarat, Punjab and West Bengal. It appears to be a common species and abundantly available on guava. So far, this mite has not been seen to be attacking any phytophagous mite in the nature. However, when this mite was kept on tetranychid infested leaf in laboratory, it showed its preference for eggs to the other stages.

Amblyseius (Paraphytoseius) bhadrakaliensis Gupta

Amblyseius bhadrakaliensis Gupta, 1969, *Bull. ent. Soc. India*, 10 : 127.

Material examined : 3 ♀ ♀, Tripura, Agartala, 10. xii. 1978, ex *Albizia lucida*.

Remarks : This species has been reported from Andaman Isl., Assam, Bihar, Jammu & Kashmir, Meghalaya, Orissa, Tripura and West Bengal on a wide range of plants. It is a fairly common species and appears to be active predator of tetranychid mites.

Amblyseius (Paraphytoseius) narayanani Ehara and Ghai

Typhlodromus (Amblyseius) orientalis Narayanan, Kaur & Ghai, 1960 *Proc. Nat. Ins. Sci.*, 26B, 394.

Amblyseius narayanani Ehara & Ghai, Ehara, 1967, *Mushi*, 40 : 77.

Material examined : 2 ♀ ♀, Tripura, Agartala, 28. vii. 1977, ex *Eupatorium odoratum*

Linn.; 4 ♀ ♀, Agartala, Ranirbazar, 4. vi. 1978, ex *E. odoratum* Linn.

Remarks : Since the description of this species from Maharashtra, this is the second record of the species.

Amblyseius (Euseius) coccineae Gupta

Amblyseius coccineae Gupta, 1975, *Intl. J. Acar.*, 1 : 33.

Material examined : 2 ♀ ♀, Tripura, Agartala, Sepai Jola, 21. vi. 1979, ex *Lagestroemia flosreginae*; 3 ♀ ♀, same locality and date, ex *Shorea robusta* Gaertn; 8 ♀ ♀, same locality and date, ex *Schima wallachi*.

Remarks : This species was described from West Bengal and now is known to have wide distribution in India, viz. Andhra Pradesh, Meghalaya, Pondicherry, Orissa and Tamil Nadu, on a wide range of plants.

Amblyseius (Euseius) ovalis (Evans)

Typhlodromus ovalis Evans, 1953, *Ann. Mag. nat. Hist.*, (12) 6 : 458.

Material examined : 1 ♀, Tripura, Agartala, Amtali, ex undetermined plant; 5 ♀ ♀, Bisalgarh, 4. ix. 1977, ex bamboo; 8 ♀ ♀, 2 nymphs, Durjoynagar, 24. vii. 1977, ex *Holarrhena antidysenterica* Wall.; 2 ♀ ♀, 2 ♂ ♂, 1 nymph, Amtali, 10. vii. 1977, ex *Macrocos paniculata*; 9 ♀ ♀, Sekerkot, 8. vii. 1978, ex jackfruit; 9 ♀ ♀, 2 nymphs. 1 larva, Durjoynagar, 24. vii. 1977, ex *Cassia fistula* Linn.

Remarks : This is also a cosmopolitan species and in India it is known from Andaman Isl., Andhra Pradesh, Gujarat, Kerala, Karnataka, Manipur, Meghalaya, Maharashtra, Pondicherry, Tamil Nadu, Tripura and West Bengal on twenty two plants. It was found to be efficient predator of a number of tetranychid species in Tripura.

Amblyseius (Euseius) pruni Gupta

Amblyseius pruni Gupta, 1975, *Intl. J. Acar.*, 1 : 40.

Material examined : 2 ♀♀, 1 nymph, Tripura, Agartala, Champaknagar, 10. xii. 1978, ex *Erythrina ovalifolia*; 2 ♀♀, Durjoy-nagar, 24. vii. 1977, ex jute.

Remarks : Since the description of the species from West Bengal, it has been reported from Assam, Meghalaya and Tripura. Besides, the unpublished records indicate that it is fairly common in northern India (Himachal Pradesh and Jammu & Kashmir) mostly on fruit trees and was seen to feed upon eggs of *Eotetranychus* sp. and *Tetranychus* sp.

Amblyseius (Euseius) rhododendronis Gupta

Amblyseius rhododendronis Gupta, 1970, *Oriental Ins.*, 4 : 187.

Material examined : 1 ♀, Tripura, Agartala, 10. xii. 1978, ex undet. plant.

Remarks : Since the description of the species from West Bengal collected on *Rhododendron* sp. and *Shorea robusta*, this is the second report of the species from India.

Amblyseius (Amblyseius) largoensis (Muma)

Amblyseiopsis largoensis Muma, 1955, *Ann. ent. Soc. Am.*, 48 : 266.

Material examined : 1 ♀, Tripura, Agartala, Bisalgarh, 4. ix. 1977, ex banana; 3 ♀♀, 3 nymphs, Durjoynagar, 24. vii. 1977, ex mango; 1 ♀, same locality and date, ex *Cassia fistula*; 4 ♀♀, 10. xii. 1978, ex litchi.

Remarks : This is one of the few phyto-seiid mites known to be cosmopolitan in distribution and has been reported from Andaman, Isl., Assam, Gujarat, Himachal Pradesh, Karnataka, Manipur, Orissa and West Bengal on 35 plants of diverse types. This is an efficient predator of tetranychid mites.

Amblyseius (Typhlodromips) daturae Gupta

Amblyseius daturae Gupta, 1975, *Intl. J. Acar.*, 1 : 34.

Material examined : 1 ♀, Tripura, Agartala, Amtali, 10. vii. 1977, ex undetermined plant.

Remarks : This species is known from Andaman Isl., Assam, Himachal Pradesh, Tamil Nadu, Tripura and West Bengal.

Amblyseius (Typhlodromips) suknaensis Gupta

Amblyseius suknaensis Gupta, 1970, *Oriental Ins.*, 4 : 185.

Material examined : 3 ♀♀, Tripura, Agartala, Mohanpur, 28. vii. 1978, ex *Eupatorium odoratum*.

Remarks : This is a fairly common species in India and is known from Andaman Isl., Assam, Kerala, Meghalaya, Orissa, Tripura and West Bengal.

Amblyseius (Typhlodromips) syzygii Gupta

Amblyseius syzygii Gupta, 1975, *Intl. J. Acar.*, 1 : 44.

Material examined : ♀ 1, Tripura, Durjoynagar, 24. vii. 1977, ex jute.

Remarks : Earlier this mite has been reported from Orissa, Tripura and West Bengal.

Typhlodromus (Typhlodromus) eharai Gupta

Typhlodromus eharai Gupta, 1980, *Entomologist's mon. Mag.*, 115 : 209.

Material examined : 12 ♀♀, Agartala, Amtali, 10. vii. 1977, ex undetermined plant.

Remarks : Recently, this species has been described from West Bengal and the present report is the first from Tripura.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Zoological Survey of India, Calcutta and to

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FIRST RECORD OF THE BATFISH, *PEGASUS LATERNARIUS* CUVIER
(PEGASIDAE : PEGASIFORMES) FROM INDIAN WATERS

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ABSTRACT

Pegasus laternarius Cuvier was first reported only from China and Ceylon. In 1977, two specimens were collected off Madras at a depth of 15—25 metres over shell/gravel grounds. A short description of the species with ecological notes is given.

INTRODUCTION

During a routine cruise of R. V. CHOTA INVESTIGATOR along the Madras coast on 7. 5. 1977, a haul made with otter-trawl over shell/gravel grounds in depths ranging between 15 and 25 metres yielded *Pegasus laternarius* Cuvier, an interesting Batfish hitherto unknown from Indian waters. This species was previously reported only from China and Ceylon, with some doubt from Java (De Beaufort & Briggs, 1962). The present record from Madras is the first report of this species from Indian waters. The other species of the genus *Pegasus* known from Indian waters are *P. volitans* L., and *P. draconis* L.

SYSTEMATIC ACCOUNT

P. volitans (Syn. *P. volans* L., *P. natans* L., *P. pristis* Blkr., *Leptopegasus natans* Blkr. and *Parapegasus natans* Blkr.) is known from Pearl Banks, Ceylon (Munro, 1955), Orissa Coast near the mouth of River Mahanadi (Jones & Pantulu, 1958), Porto Novo (Krishnamurthy, 1961), Kovalam (Jayadev Babu, 1966), Thondi in Palk Bay (Sriramachandra Murthy,

1969), and Appa Island (Venkateshwarlu, 1974).

Similarly, *P. draconis* (Syn. *P. volans* Blkr. (nec L.), *P. draco* Kaup, *P. pauciradiatus* Ogilby, *Pegasus papilio* Gilbert, *Zalises umite-ngu* Jordon & Snyder, *Zalises draconis* Franz, and *P. umitengu* Jordon, Tanaka & Snyder) has been reported from Andamans (Day, 1876), Ceylon (Munro, 1955), Pudumadam in Gulf of Manaar (Sriramachandra Murthy, 1969), and Maldives (De Beaufort & Briggs, 1962), while *P. laternarius* is known only from China and Ceylon with certainty (De Beaufort & Briggs, 1962). The present report is thus the first record of *P. laternarius* from Indian Seas.

***Pegasus laternarius* Cuvier**

(Plate 1)

Pegasus laternarius Cuvier 1817, 332 ; De Beaufort & Briggs, 1962, 181.

Pegasus volans Günther 1870, 148 (nec L.), Johnstone, 1904, 214 (nec L.), *Parapegasus volans* Munro 1955, 290 (nec L.).

Material : 2 specimens, 50.0 & 60.00 mm S. L. ; inshore waters of Madras, 15-25 m

depth over shell/gravel bottom, otter-trawl haul, Lat. 13°N., Long. 80°24'E., R. V. CHOTA INVESTIGATOR cruise on 7. 5. 77 (A. K. Nagabhushanam, Coll.).

Description : D.5 ; A. 5 ; P. 11 ; V.I.2 ; C.8.

Trunk with 3 rings and eleven tail rings. Pectoral rays spiny, the fifth much stronger than others. Brownish and fins spotted.

Distribution : Indo-West Pacific (China, Sri Lanka, Madras, Java ?). On the other hand, *P. volitans* and *P. draconis* are widely distributed in the Indo-Pacific region.

Remarks : Further reports of all these three species (adults, eggs and juveniles) from the seas around India would be worth recording. It is probable that *P. laternarius* is much more common than what present data would indicate. The otter-trawl is a very selective gear ; possibly dredges with fine-mesh covers would be better to capture more specimens.

Key to the Indian species of the Genus *Pegasus* (After De Beaufort & Briggs, 1962)

- | | |
|---|-----------------------|
| 1. Twelve tail rings. Pectoral rays not spiny. No pits on occipit (<i>Pegasus</i> s. str.) ... | <i>P. volitans</i> |
| 2. Eleven tail rings. Pectoral rays spiny, the fifth much stronger than the others. No pits on occipit (<i>Spinipegasus</i>). ... | <i>P. laternarius</i> |
| 3. Eight tail rings. Pectoral rays spiny, the fifth not stronger than the others. Two deep pits on the occipit (<i>Zalises</i>) ... | <i>P. draconis</i> . |

LABORATORY OBSERVATIONS

The specimens were brought alive and introduced into an aquarium (150 l. capacity) in the laboratory. Natural conditions were simulated with sand, shell/gravel, hydroids

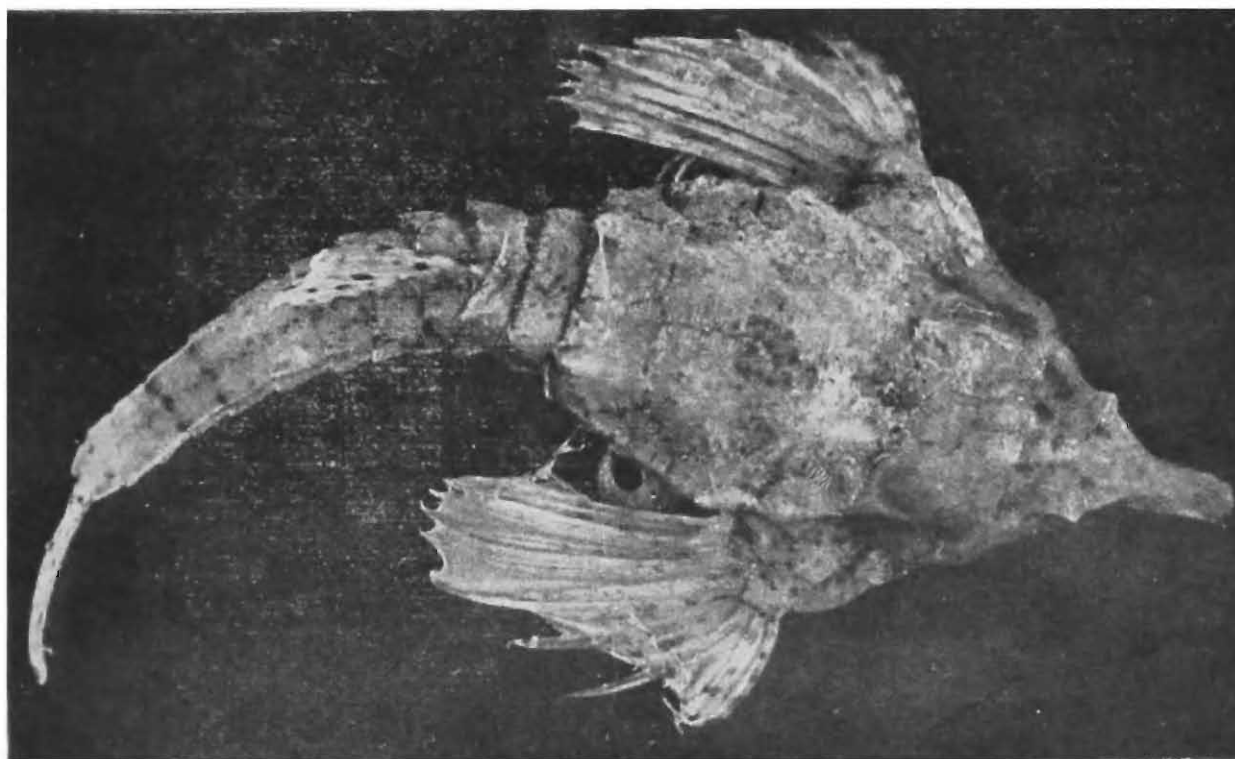
and stones carpeting the floor of the aquarium. The seawater in the aquarium was kept well aerated.

The fish were observed to swim entirely with the aid of strong lateral movements of the powerful caudal fin, the fan-like pectorals being used exclusively for gliding purposes. On the floor of the tank, the recurved pelvic fins are used to anchor the fish around hydroids or stones ; they, along with the strongly developed pectoral fins aid in lifting the fish off the substratum ; besides, they, along with the pectorals, help in crawling movements when the fish stalks small prey.

Feeding : Although the fish were offered a variety of dried and powdered prawn and fish-meal, it was only on the smaller zooplankters contained in living plankton regularly supplied to them, that were voraciously fed upon by the fish. The mode of feeding was carefully observed : The fish suddenly shot out its tubular protrusible mouth when a copepodite or small copepod swam within range. The prey appeared to be sucked in forcibly in a rush of seawater impelled with a sudden expansion of the fish's buccal cavity. After ingestion, the extra volume of seawater also taken in with the prey was expelled through the gill-covers after the fish had levered itself from the substratum by means of its pelvics and pectorals. The fish ignored dead organisms and crushed prawn and fish meal. When not feeding the protrusible mouth is recessed into the head. Anteriorly the head is provided with a pair of stout vibratile processes, the exact nature of these could not be investigated since the fish both died within 21 days of capture. These processes are situated just ventral to the protrusible tube-like mouth, but are inserted into the skin fold below it on the head itself,

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PLATE I



Dorsal view of *Pegasus laternarius* Cuvier measuring 60.0 mm S L., collected from inshore waters of Madras.

ACKNOWLEDGEMENTS

We are thankful to the Director, Zoological Survey of India, and to Dr. A. Daniel, Deputy Director, Marine Biological Station, Z. S. I., Madras, for much encouragement and for providing the facilities for this work. Our thanks are also due to the boat crew of R. V. CHOTA INVESTIGATOR and to Mr. E. Seshan for photographing the animals.

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ON THE GENERIC RELATIONSHIP OF THE EEL-LIKE FISH, *PILLAIA KHAJURIAI*
TALWAR, YAZDANI & KUNDU (PERCIFORMES, MASTACEMBELOIDEI)

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ABSTRACT

A new genus is proposed for the reception of *Pillaia khajuriae* Talwar, Yazdani & Kundu, 1977, and its affinities discussed.

INTRODUCTION

The genus *Pillaia* was established by Yazdani (1972) for a remarkable new eel-like fish, *P. indica* from the Khasi Hills (Meghalaya) who later (Yazdani, 1976) proposed a new family Pillaiidae under the suborder Mastacembeleidei, for its reception. The genus remained monotypic until Talwar, Yazdani and Kundu (1977) discovered a second species, *P. khajuriae* from the Garo Hills (Meghalaya) and the Kaziranga Wildlife Sanctuary (Assam) which exhibited sharp differences with the type-species. As further study has revealed that *P. khajuriae* possesses a higher number of vertebrae, the generic relationship of the species has now been reviewed and a new genus is proposed for its inclusion.

The various characters of *Pillaia indica* have been studied by dissecting specimens as well as by examining alizarin preparations. The osteology of *Garo khajuriae* has, however,

been studied from x-ray photographs of the type-specimens.

SYSTEMATIC ACCOUNT

Family PILLAIIDAE

Garo, gen. nov.

Body elongate (eel-like) and naked. Head rather conical; mouth wide, terminal, with an indistinct fleshy rostral appendage. Gill openings wide, separate, free from isthmus. Eyes laterally placed. Dorsal and anal fins confluent with the long caudal fin; no spines in dorsal and anal fins; dorsal fin with 40-44 soft rays, its origin at about midpoint of the body (without caudal fin); anal fin with 37-38 soft rays. Pectoral fin fairly large, with 19-20 rays. Caudal fin with 12 unbranched rays. Vertebrae 65.

Type-species: *Pillaia khajuriae* Talwar, Yazdani & Kundu, 1977.

The genus *Garo* differs from the monotypic genus *Pillaia* by the following combination of characters;

<i>Pillaia</i>	<i>Garo</i>
(i) Head much depressed ; eyes dorsally placed.	Head rather conical ; eyes laterally placed.
(ii) Pectoral fins small, each with 7-9 rays.	Pectoral fins relatively large, each with 19-20 rays.
(iii) Dorsal-fin rays 34-36.	Dorsal-fin rays 40-44.
(iv) Dorsal-fin origin distinctly in the posterior half of body (without tail).	Dorsal-fin origin at almost midpoint of body.
(v) Caudal fin short and moderately tapering, with 8-10 unbranched rays.	Caudal fin long and tapering, with 12 unbranched rays.
(vi) Vertebrae 62	Vertebrae 65

DISCUSSION

Pillaia indica Yazdani, known from the Khasi Hills at altitudes ranging from 1070 to 1525 m, is a sluggish, mud-burrowing form (Yazdani, 1978). Its depressed head, dorsally placed eyes, small pectoral fins with few rays, are characters well adapted for its way of life. On the other hand, *Garo khajuriae* appears to be an active form occurring at a much lower altitude in the Garo Hills (Meghalaya) and in the plains of Assam. Its conical head, laterally placed eyes, tapering tail and fairly well developed pectoral fins with a remarkably higher number of rays, seem to be well-suited for an active life.

The suborder Mastacembeloidei, a perciform derivative, is placed in its own order by many workers. Yazdani (1978) remarked that among the members of this group the family Mastacembelidae appears to be more primitive than Pillaiidae and Chaudhuriidae, and it seems probable that Chaudhuriidae evolved from a stock resembling Mastacembelidae through stages comparable to Pillaiidae. Further, he surmised that among members of Pillaiidae, *Pillaia indica* exhibits a close resemblance with members of Mastacembelidae.

The present study also suggests that *Garo* is less specialized than *Pillaia* and exhibits several remarkable resemblances with members of Mastacembelidae.

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THE CAUVERY RIVER ECOSYSTEM AND THE PATTERNS OF ITS FISH DISTRIBUTION*

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ABSTRACT

An investigation of the fish resources of the Cauvery river system in S. India, has revealed the occurrence of 142 species of fishes. The river by virtue of its natural physiography is divisible into three zones : mountainous, plateau and plains. Each zone is characterised by diverse ecological features which is reflected in the composition of the fish fauna also. The faunal distribution is analysed and the causative factors of the patterns are discussed.

INTRODUCTION

Cauvery, Krishna and Godavary rivers in Southern India constitute the three major perennial drainages of the Deccan plateau. The Mahanadi though it can also be stated to belong to the peninsular drainage system, differs significantly from the other three in that it does not originate in the Western Ghats. These three rivers are the very subsistence for the agricultural and economic prosperity of the southern states, Andhra Pradesh, Karnataka and Tamil Nadu. It is no wonder as such, that the waters of these rivers have been utilised to the maximum possible extent for irrigation and hydroelectric purposes. Of these, the Cauvery is perhaps the best tapped river system. The aquatic faunal resources of these three river systems show a remarkable pattern, each having its own peculiar fish species. In recent years a number of exotic and indige-

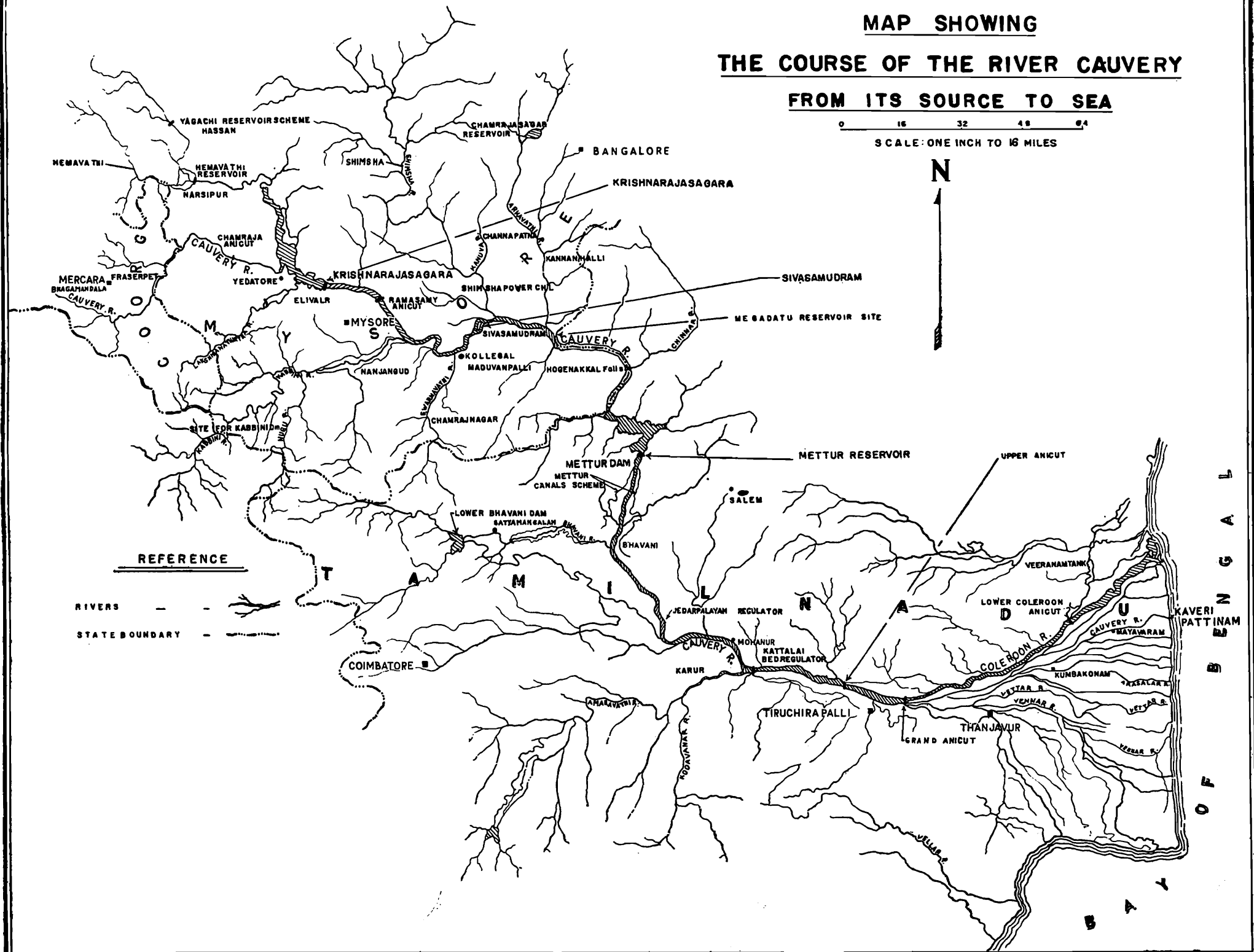
nous species have been introduced and transplanted into these rivers, competing with the existing species and affecting the natural faunal balance and ecosystem. Many weirs, anaicuts, dams have been constructed disturbing the continuity of distribution of a large number of economically valuable species. Further, so far there has been no consolidated account of the fish fauna of any of these rivers as is the one available for the Ganga by Hamilton (1822).

THE CAUVERY RIVER

The Cauvery is physically perhaps, the most remarkable river of the Peninsula. Though not large as compared to the other two south Indian rivers the Krishna and Godavary, or the North Indian Ganga, it is about 850 km long and draining about 89,600 km². It is considered India's fourth largest river and

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0 16 32 48 64
SCALE: ONE INCH TO 16 MILES



Tamil Nadu's biggest and almost the very life line of that state. It takes its origin at the Brahmagiri hills in the Sahayadri range in Western Ghats at Coorg, Karnataka state at an elevation of *ca* 1355 m (5149 ft.) alt. (12°25'N, 75°34'E) and joining the Bay of Bengal at Kaveripattinam in Tamil Nadu. At its origin at Talai-cauvery it is a small channel, religiously supposed to be emanating from a perennial spring (Pl. II, Fig. 1). It runs through a deep gorge of thick evergreen jungle for about 19 km in a narrow channel of hardly 3 metres (Pl. II, Fig. 2) width up to Bhagamandala, where it meets its first tributary the Kannige, which again is a shallow narrow stream. Upto the Krishna Raja Sagar Dam near Mysore it is simply a rocky mountain stream at most places shallow or moderately deep with a swift run off. The Krishna Raja Sagar Dam is the first man-made barrier in its course. Just below this, above the confluence of Shimsha, the river crosses the 2,000 ft. contour at Sivasamudram island on either side of which it branches off in a succession of falls and rapids to a total drop of about 85 metres. "Below this island the river plunges through a succession of wild gorges, with right angle bends conforming to the NW/SE and SW/NE stresses of the plateau edge. The Hogenaikal falls with a drop of about 18 metres (70 ft.) may be taken as the end of its plateau course" (Spate, 1957). Some 50 km. above Hogenaikal at "Pannandu Chakravani" (12 whirl pools) where after a fall of *ca* 30 ft. strong vertices are formed during floods in a succession of deep rock pools; Mekatadu (the Goat's leap) is also here: these act as effective barriers to fish movement and dispersal to upstream areas. The second manmade barrier is placed in the narrow gorge west of Salem at Mettur. Below Mettur, the Cauvery enters its plains course. At Grand Anaicut near Tiruchira-

palli the third and the last but the oldest of the three man-made barrier is built across the river.

ZONATION

Conforming to the geographical features discussed above, the river can be broadly divided into the following three zones:

1. The stretch of the river from its origin up to Shivasamudram.—*Mountainous course*.
2. The stretch below Shivasamudram up to Hogenaikal.—*Plateau course*.
3. The stretch below Hogenaikal up to its confluence with the Bay of Bengal.—*Plains course*.

Each one of these zones is characterised by attendant geological features. In the mountainous course the river flows through steep gradients in narrow channels over rocky and boulderous beds. The second zone has the river flowing along less steep gradient, over a pebbly bottom, fitted as if to the natural geological contour. The last zone is characterised by the river meandering leisurely through broad deltaic areas gathering silt and sand to join finally the Bay of Bengal at Kaveripattinam.

FISH FAUNA AND THEIR DISTRIBUTIONAL PATTERN

It is a remarkable fact that the fish fauna inhabiting the entire Cauvery system is influenced by the ecological and geographical parameters discussed above. The zonation thus marked is also justified by the fish distribution though species widely distributed are not of any consideration.

ZONE I.—This zone is characterised by impoverished fish fauna as is naturally to be expected. Till the river reaches somewhat

plain territory near Bhagamandala and further down near Kudige (Pl. II, Fig. 3), the channel is not very wide for sustenance of any prime fish of quality. Mostly Cobitid fishes of the genera *Noemacheilus*, *Lepidocephalus*, small *Puntius* species such as *ticto*, *sophore*, *conchoni* which are generally well acclimatized to varying conditions of stream are found. These very rarely grow to a size beyond eight inches. Catfishes such as *Mystus vittatus* are also occasionally obtained. *Varilius barila*, *Salmostoma boopsis*, *Danio aequipinnatus*, *Rasbora daniconius*, *Esonus danricus* are all again common species of little value.

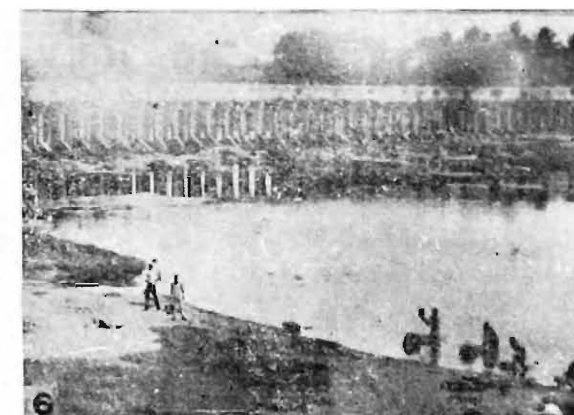
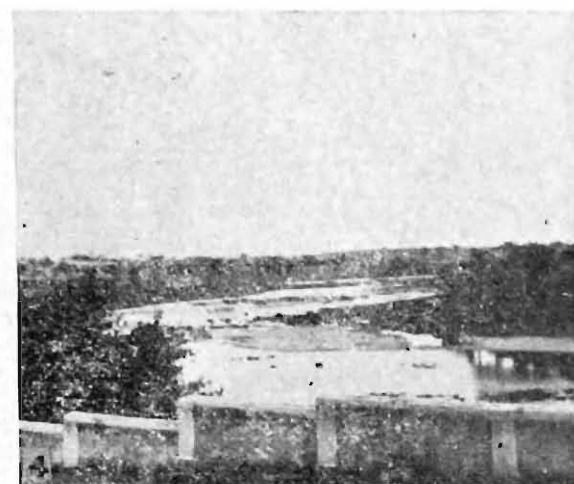
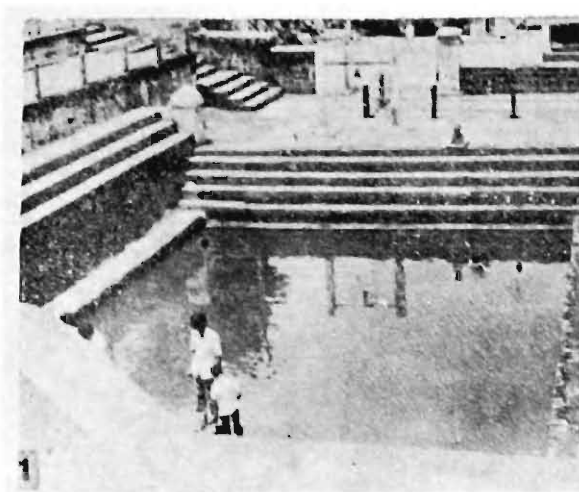
However, after the river emerges out of the gorge and runs down to slightly less elevated terrain at Kudige, where Harangi river meets, at Ramanathapura where a fish sanctuary exists, and at Holenarsipur where Hemavathi river joins (Pl. II, Fig. 4), the pattern changes. The river is wider, but still flowing over rocky boulderous surfaces and forming deep rock pools. The fish species also change accordingly. *Notopterus notopterus*, *Glossogobius giuris*, *Tor khudree*, *Tilapia mossambica*, *Cirrhinus reba*, *Anguila bengalensis* which are all species of larger size (up to 18 to 20 inches in length) and which requires shallow to moderately deep waters are obtained.

Krishna Raja Sagar Dam, the first major obstruction in the free flow of the river at 19 Km west of Mysore City impounds the river to a water spread area of 54 sq miles and with a depth of 124.80 ft at full level. The basic physiographic structure and zonal characteristic of the river bed continues to remain rocky and boulderous. The reservoir is stocked with artificially introduced exotic species such as the Chinese carp, Mirror Carp, etc., which are obtained in large sizes. As a follow up of such availability of large sized fishes predators like *Wallago attu* are also seen.

This feature is maintained up to Srirangapatnam 19 km north of Mysore where the river is more placid (Pl. II, Fig. 6). Common fishes like *Puntius carnaticus*, *Puntius sarana*, *Mystus punctatus*, *Mastacembelus* species which are all medium sized make their appearance. An important tributary of the Cauvery is the Kabbini which abounds in fish life. In terms of variety and quality the Kabbini contributes a large share of fish to the Cauvery system. The terrain the Kabbini flows is akin to the main Cauvery but the volume of water and width of the river is more and perhaps is the reason for the rich fish life. *Puntius narayani* was obtained in this zone which is endemic here.

ZONE II : The Shivasamudram Falls (Fig.5) of the Cauvery is a major distributional barrier for many fish species. The river flowing at an altitude of 620 metres falls 85 metres to form a large cascade or sheet of water quarter or half mile in width when in full floods. Near about the falls the stream with innumerable rock pools harbour many hill stream fishes such as *Garra*, *Balitora*, *Tor khudree*, etc. Below the falls up to Hogenakal the river flows fast over pebbles and rocks with thick forest cover along its banks following the contour of the land. Here a large number of carps such as *Puntius kolus*, *Puntius carnaticus* and catfishes like *Aorichthys seenghala*, *Silonia childreni*, (over 24 inches in length) *Mystus armatus*, *Mystus menoda* (about 10 inches in length) are caught. Many fishermen from Tamil Nadu poach in this area because of availability of large sized fishes in this zone. The river assumes the characteristics of a meandering stream at Kollegal but the basic features of the substratum remain unchanged. This zone is also remarkable for the occurrence of *Osteocheilus thomassi* a primitive Cyprinid

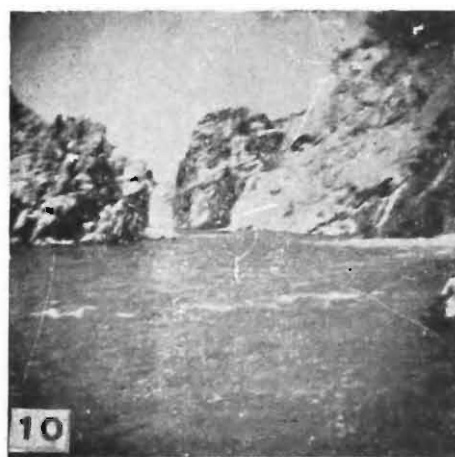
JAYARAM



1. The origin of the River Cauvery at Talaicauvery. The small channel emanates from this perennial spring.
2. Downstream view of River Cauvery as it emerges from the gorge at Bhagamandala before its confluence with R. Kannige.
3. Upstream view of River Cauvery at Kudige.
4. Upstream view of River Hemavathy at Holenarsipur.
5. Sivasamudram falls.
6. Downstream view of River Cauvery at Srirangapatnam below road bridge.

JAYARAM

PLATE III



7. & 8. View of River Cauvery at Jedarpalayam.
9 to 12. Cauvery river and falls at Hogenaikal.

fish whose closest ally lives in Thailand and Malaya. *Silurus berdmorei wynaadensis* is a catfish which again shows a noteworthy discontinuity in distribution as *Osteocheilus*. This zone is thus remarkable for its fish fauna and appears to be a transitory area between the purely hilly terrain of the river to its plains course after Hogenaikal.

ZONE III : Hogenaikal in Tamil Nadu is another landmark in the course of the Cauvery. The river cuts across gorges and drops about 18 metres (Pl. III, Figs. 9-12) (70 ft) to follow a run along the plains. The height of these falls has however been reduced by the formation of the Mettur reservoir whose water spread reaches this area more particularly during the monsoon season. Fishes are now able to ascend the falls, such as *Catla*. However up to Bhavani and Jedarpalayam the bed is still with pebbles, rocks and with occasional rock pools. The Mettur Dam at Mettur is the second impediment in the course of the river. The dam impounds an area of 59.25 sq miles in water spread and is 150 ft deep at full level. Though the Dam is an insurmountable barrier, the surplus discharge channel called the Ellis Channel, with easy gradient has assisted in the passage of fish to above the dam. However, some are washed down with injuries. The fauna changes considerably. *Catla catla* though introduced, *Puntius dobsoni*, *Puntius kolus*, *Puntius dubius*, *Labeo kontius*, *Labeo ariza*, *Labeo calbasu*, *Aorichthys seenghala*, *Silonia childreni*, *Pangasius pangasius*, *Cirrhinus cirrhosa*—all economically valuable fish and which grow to considerable size (over 36 inches in length) begin to occur. Beyond Jedarpalayam it is a wide river (Pl. III, Figs. 7,8) branching off Coleroon at Upper Anaicut and assuming the form a deltaic river. Below the Grand Anaicut,

smaller fishes such as *Cirrhinus reba*, *Danio*, *Esomus*, *Rasbora* occur. This is the zone where Hilsa also once had its run, though it is a rare phenomenon now. Five km. north of Tranquebar from Mayurum onwards, the Cauvery becomes one of the three regulated streams the whole of its waters having been utilized for irrigation. It is an insignificant stream when it joins the sea at Kaveripattinam.

DISCUSSION

Division of a river into distinct biological zones, each with a characteristic fish fauna is not new. Huet (1959) divided the European streams into four distinct zones based on fish distribution. Tropical river systems fall more or less on similar lines, the zonation being distinguished by fish fauna, nature of bottom, gradient, current velocity etc. The distributional pattern that emerge indicate that the Cauvery can be divided into three such zones as detailed. Of the three zones the last zone or the plains course is undoubtedly economically valuable not only in terms of its deltaic nature and utility of water for irrigation and agricultural purposes, but also in terms of fish life. About 60% of the fish fauna of the entire Cauvery basin is found here. The major natural barrier, Sivasamudram likewise divides the ecological face of the river into distinct areas which is also reflected by the fish life the river holds. Raj (1941) analysed this problem in detail and pointed out that whereas the Hogenaikal or Mettur Dam do not act as a barrier for the dispersal of fishes, Sivasamudram falls has prevented many fishes such *Cirrhina cirrhosa*, *A. aor*, *A. seenghala*, *Labeo fimbriatus* from colonising the upper reaches. There is a distinct transition in the fish fauna from the first zone to

the last zone as evidenced by the abundance and availability of fish of quality and of different sizes. The area of the river between Shivasamudram and Hogenalkal looks promising for better exploitation, since ecologically it is least disturbed.

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QUALITATIVE AND QUANTITATIVE COMPOSITION OF ORIBATEI IN GANGETIC DELTA OF WEST BENGAL IN RELATION TO EDAPHIC FACTORS

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ABSTRACT

The present work deals with the results of synecological study involving influence of edaphic factors like temperature, moisture, organic carbon, pH, electrical conductivity and available phosphate on soil dwelling oribatid mites extracted by modified Macfadyen expedition funnel at Bakkhali, 24-Parganas, West Bengal.

A total number of 72 soil samples were collected at monthly interval over a period of two consecutive years (January, 1977 to December, 1978). Altogether 707 individuals were extracted belonging to seven genera, viz. *Scheloribates*, *Lamellobates*, *Haplochthonius*, *oppia*, *Hoplophorella*, *Hoplophthiracarus* and *Heptacarus*. Among these *Scheloribates* was dominant comprising 98.75% of total population. Season wise analysis of Oribatei showed two peaks, namely in May and November when the factors like moisture and organic carbon content of soil also obtained their respective maximum concentration. Oribatid nymphs were counted only as the total number and maximum was found in May.

The regression, correlation and analysis of variance study was done between different soil factors and oribatid population and their interrelationship are discussed.

INTRODUCTION

Little attention has been paid to the qualitative and quantitative ecology of soil oribatid fauna of Indian subcontinent and no study has hitherto been made of the soil oribatid in gangetic delta of West Bengal. However, of late in India, Bhattacharya (1974), Choudhuri and Banerjee (1975, 1977), Bhattacharya and Raychaudhuri (1977) and Bhattacharya, Joy and Joy (1978) have studied the oribatid population of alluvial and laterite soil. Luxton (1967), Weigmann (1971, 1973) and Polderman (1974) investigated the distribution pattern of oribatids in salt marshes and inland saline areas.

The results of a study of the oribatid fauna of deltaic soil at Bakkhali, 24-Parganas with special reference to different soil factors, are presented in this paper.

SITE DESCRIPTION AND METHODS

The study was carried out in a large uncultivated area which is situated in the extreme south of 24-Parganas and Bay of Bengal is washing its southern part. The area was covered with herbs, shrubs and trees, viz. *Acanthus illicifolius* Linn. (Acanthaceae); *Alstonia scholaris* Br. (Apocynaceae); *Tylophora* sp. (Asclepiadaceae); *Caesalpinia nuga* Ait, *Tamarix dioica* Roxb. (Caesal-

pinieae); *Fimbristylis schoenoides* Vahl. (Cyperaceae); *Excoecaria agallocha* Linn., *Mallotus repandus* Nuell. (Euphorbiaceae); *Cynodon dactylon* Pers., *Echinochloa colona* Link. (Gramineae); *Thespesia populnea* Corr. (Malvaceae); *Azadirachta indica* A. Juss. (Meliaceae); *Phoenix sylvestris* Roxb. (Palmae) and *Solanum trilobatum* Linn. (Solanaceae). The area also contained debris of fallen leaves and dried twigs from the plants stated above.

For this study three plots, each 5 metre square were selected. Altogether 72 soil samples were drawn from a depth of 5 cm at monthly interval over a period of two consecutive years (from January, 1977 to December, 1978). Soil samples were drawn by stainless steel samplers having 5 cm depth and 17.36 sq cm surface area and these were inverted and placed in an expedition funnel apparatus (Macfadyen, 1953). Soil factors studied were temperature, moisture, organic carbon, pH, electrical conductivity and available phosphate. A colorimetric method for phosphate and an oven-drying method for moisture determination as described by Dowdeswell (1959) were followed. The organic carbon content was estimated by Walkley and Black (1934) method and the pH was determined from soil described by Piper (1942). The electrical conductivity and temperature were measured by electrical conductivity bridge and conductivity cell and soil thermometer respectively.

OBSERVATIONS

Edaphic factors : Soils of these plots are alluvial in nature, grey in colour and loamy in texture. Soil temperature varied from 21.43°C to 37.33°C in January and April respectively. Values of soil moisture, organic carbon, pH, electrical conductivity and available

phosphate ranged between 10.1% to 19.55%, 0.53% to 1.21%, 7.1 to 8.1, 1.04 mmohs/cm to 11.08 mmohs/cm and 18.75 ppm to 35.42 ppm respectively. Comparatively maximum amount of moisture and organic carbon was recorded during May and November in both the years of observation. Other soil factors showed a trend of fluctuation regarding maximum and minimum values. Mean values of soil factors (Table 1) revealed more or less identical edaphic characteristics of plots concerned. Mechanical analysis of soil samples showed more or less equal proportion of sand and silt (Table 2).

Oribatid population : The relative abundance of population was obtained (Table 1) in May and November when soil factors like moisture and organic carbon attained comparatively greater concentration. Altogether 7 genera of oribatid mites were obtained such as *Scheloribates*, *Lamellobates*, *Haplochthonius*, *Oppia*, *Hoplophorella*, *Hoplophthiracarus* and *Heptacarus* (Table 2). Among these *Scheloribates* was dominant representing two species, viz. *Scheloribates rakhali* Sanyal (in press) and *Scheloribates bhadurii* Sanyal (in press) comprising 38.75% of total population. *Lamellobates palustris* Hammer, 1958 came next to *Scheloribates* having 23.90% of total population. *Hoplophorella scapellata* Aoki, 1965 and *Hoplophorella sundarbanensis* Sanyal (in press) came next to *Lamellobates* having 11.03% of total population. The fourth, fifth, sixth and seventh genera/species in order of dominance were *Haplochthonius intermedius* Chakrabarty, Bhaduri and Raychaudhuri, 1977, *Oppia yodai* Aoki, 1965 and *O. orientalis* Sanyal (in press), *Heptacarus supertrichus* Piff, 1966 and *Hoplophthiracarus siamensis* Aoki, 1965 comprising 5.94%, 2.69%, 1.27% and 0.57% respectively. Oribatid nymphs were counted as the percen-

TABLE 1. Showing oribatid population and mean value of soil factors in different months.

Month	1977							1978						
	Oribatid (Mean)	Tempera- -ture (Oc)	Moisture (%)	Organic carbon (%)	pH	E. Ce. (mmohs/ cm)	Avail- able phosp- hate (ppm)	Oribatid (Mean)	Temper- ature (Oc)	Moisture (%)	Organic carbon (%)	pH	E. Ce. (mmohs/ Cm)	Avail- able phosp- hate (ppm)
Jan.	5	21.43	11.00	0.77	7.30	8.10	33.33	4	22.16	10.10	0.69	7.60	7.47	35.42
Feb.	9	25.90	12.00	1.10	7.20	7.00	31.25	7	23.66	10.95	0.70	7.10	6.09	33.33
Mar.	10	31.26	11.43	1.15	7.30	6.85	27.08	11	33.20	11.00	1.02	7.50	5.26	27.08
Apr.	9	30.83	15.60	0.90	7.50	5.57	27.08	10	37.33	10.50	0.53	7.35	4.57	24.10
May	15	33.83	16.65	1.19	7.10	3.10	31.25	18	35.00	19.00	1.14	7.15	5.26	27.08
Jun.	12	29.93	12.83	0.95	7.50	8.21	24.10	13	34.00	13.10	1.02	7.12	11.08	22.92
Jul.	8	32.00	11.00	0.84	7.85	1.76	24.10	8	32.66	18.30	0.67	7.95	1.30	20.83
Aug.	7	31.50	10.78	0.65	7.70	1.04	22.92	9	31.00	12.50	0.55	8.10	1.13	18.75
Sep.	10	31.13	12.00	0.60	7.85	2.88	18.75	10	33.66	12.20	0.65	7.45	2.46	18.75
Oct.	11	30.83	14.50	0.92	7.80	3.77	18.75	11	28.66	13.00	0.67	7.30	3.87	20.83
Nov.	13	30.76	17.95	1.21	7.40	1.99	22.92	15	28.33	19.55	0.77	7.15	3.60	22.92
Dec.	6	22.50	10.10	0.81	7.70	3.55	29.17	7	21.50	11.00	0.59	7.60	4.84	27.08

TABLE 2. Showing mechanical analysis of soil.

Sand (%)	Silt (%)	Clay (%)	Texture class
39.64	39.80	20.56	Loam

TABLE 3. Showing species of oribatid and their percentage of total population.

Name of the species	Jan. 1977'78	Feb. 1977'78	Mar. 1977'78	Apr. 1977'78	May 1977'78	Jun. 1977'78	Jul. 1977'78	Aug. 1977'78	Sep. 1977'78	Oct. 1977'78	Nov. 1977'78	Dec. 1977'78
<i>Scheloribates rakhalii</i>	0.88 0.55	1.46 0.82	1.75 1.64	1.17 1.92	2.05 2.46	1.17 1.64	0.88 0.82	0.88 0.55	1.17 1.37	2.05 2.19	2.34 2.46	0.58 0.82
<i>Scheloribates bhadurii</i>	0.88 0.55	1.46 1.09	2.34 1.92	1.46 1.64	3.50 3.01	2.34 2.46	1.17 1.37	1.17 1.92	1.46 1.09	1.75 1.37	4.09 3.29	1.17 1.37
<i>Lamellobates palustris</i>	1.17 0.82	2.05 1.09	2.05 1.92	1.75 1.09	4.39 4.38	2.92 2.46	1.46 1.92	1.17 1.09	1.75 1.92	2.05 2.19	3.22 3.01	1.17 0.82
<i>Haplochthonius intermedius</i>	— —	— —	— —	— 0.55	0.29 0.55	0.58 1.09	1.17 0.82	0.58 1.37	1.46 1.09	1.17 1.09	— —	— —
<i>Oppia yodai</i>	— —	— —	— —	— —	— —	— —	— 0.27	0.29 0.55	0.58 0.27	— —	— —	— —
<i>Oppia orientalis</i>	— —	— —	0.29 0.27	0.58 0.27	— 0.55	— —	0.29 —	— —	— —	0.29 —	— 0.55	0.29 —
<i>Hoplophorella scapellata</i>	0.29 0.27	0.88 0.82	1.17 1.37	1.75 1.37	0.58 0.55	1.17 1.09	0.58 0.27	0.58 1.09	0.88 0.82	0.58 0.27	— 0.27	0.58 0.82
<i>Hoplophorella sundarbanensis</i>	0.29 0.55	0.58 0.27	0.29 —	— 0.55	— —	0.58 —	— —	— —	— —	— —	0.29 0.27	0.29 —
<i>Hoplophthiracarus siamensis</i>	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— 0.27	0.29 0.55
<i>Heptacarus supertrichus</i>	— —	— —	— —	— —	— 0.55	0.58 0.27	0.29 0.27	0.58 —	— —	— —	— —	— —
Nymphs	0.58 0.55	1.17 1.37	1.17 1.64	0.88 1.09	2.05 3.01	1.46 1.37	0.88 0.55	1.17 1.09	1.17 1.37	1.46 1.92	1.75 1.92	0.88 1.09

TABLE 4. Showing relationship between oribatid population and soil factors.

	Mean	Correlation coefficient between no. of oribatid and different factors	Regression line of no. of oribatid (Y) on different factors (X) $Y = a + bX$
Y : No. of oribatid	9.92		
Temperature	29.79	0.6134**	$Y = -4.16 + 0.47 X$
Moisture	13.21	0.7158**	$Y = -0.57 + 0.79 X$
Organic carbon	0.84	0.5543**	$Y = 2.80 + 8.5 X$
pH	7.49	-0.4427*	$Y = 48.32 - 5.13 X$
Electrical conductivity	4.61	-0.0096	
Available phosphate	25.40	-0.3206	

** Significant at 1% level.

* Significant at 5% level.

tage of total number (Table 3) because of difficulty in proper taxonomic diagnosis and comprised 15.85% of total oribatid population.

Population fluctuation : Variations in oribatid population with time are shown in Fig. 1.

two peaks, one in May-June (Pre-Monsoon months) and the other in November (Winter month). The fall of population peak was found in December-January (winter months). Seasonal change in the number of oribatid

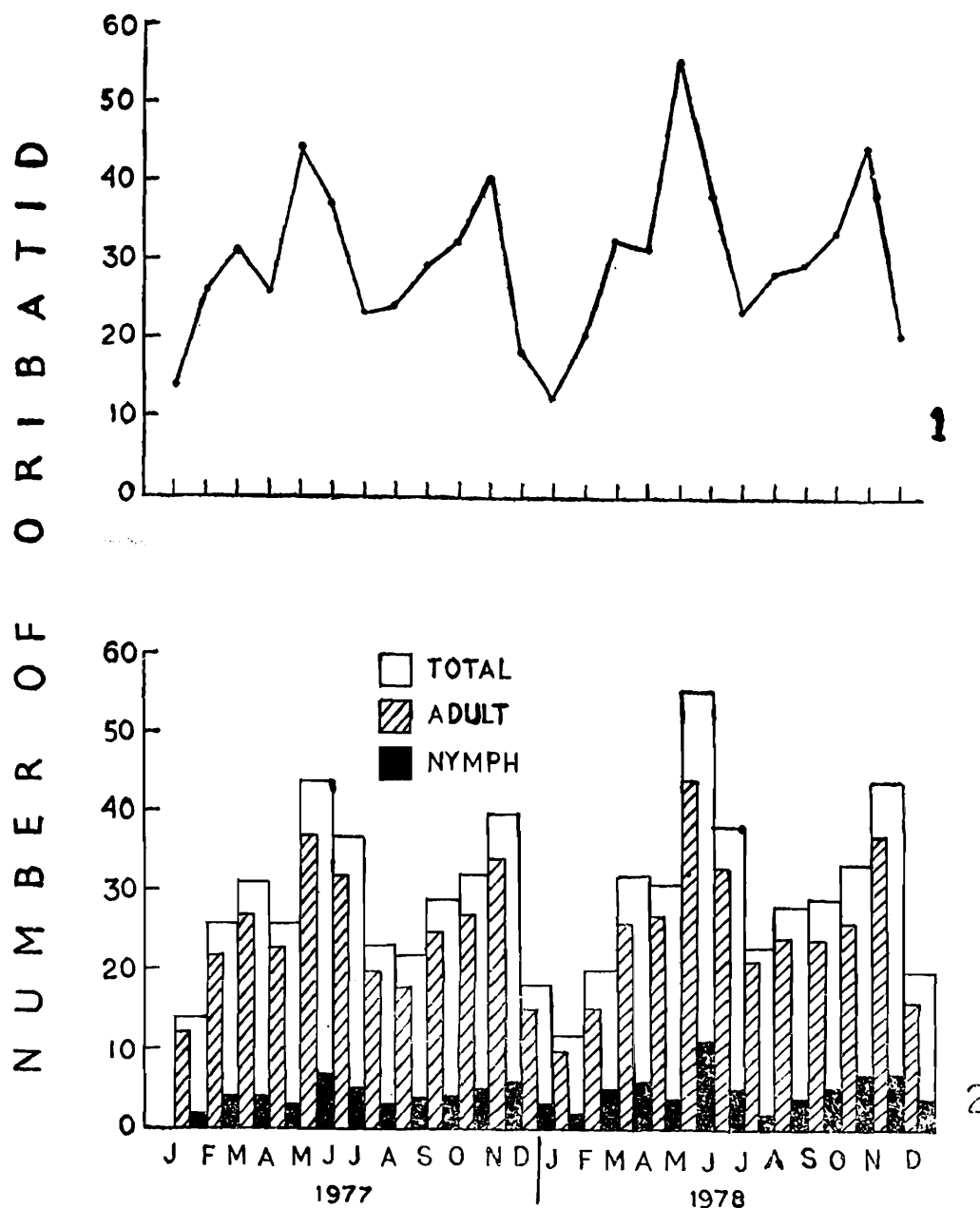


Fig. 1. Seasonal fluctuation of total oribatid mite population.

Fig. 2. Seasonal fluctuation of total, adult and nymphal population of oribatid mite.

The Faunal size as a whole obtained from different sampling sites showed variations at different times of the year during the whole sampling period. The total population showed

nymphs is shown in Fig. 2. The number raised maximum in the month of May and again in November. Population fluctuation of dominant species of oribatid is shown in

Fig. 3. All the species showed maximum population in May and a second peak in November except *Hoplophorella scapellata* which showed the peak in April. Figure 4 showed the monthly changes in faunal structure.

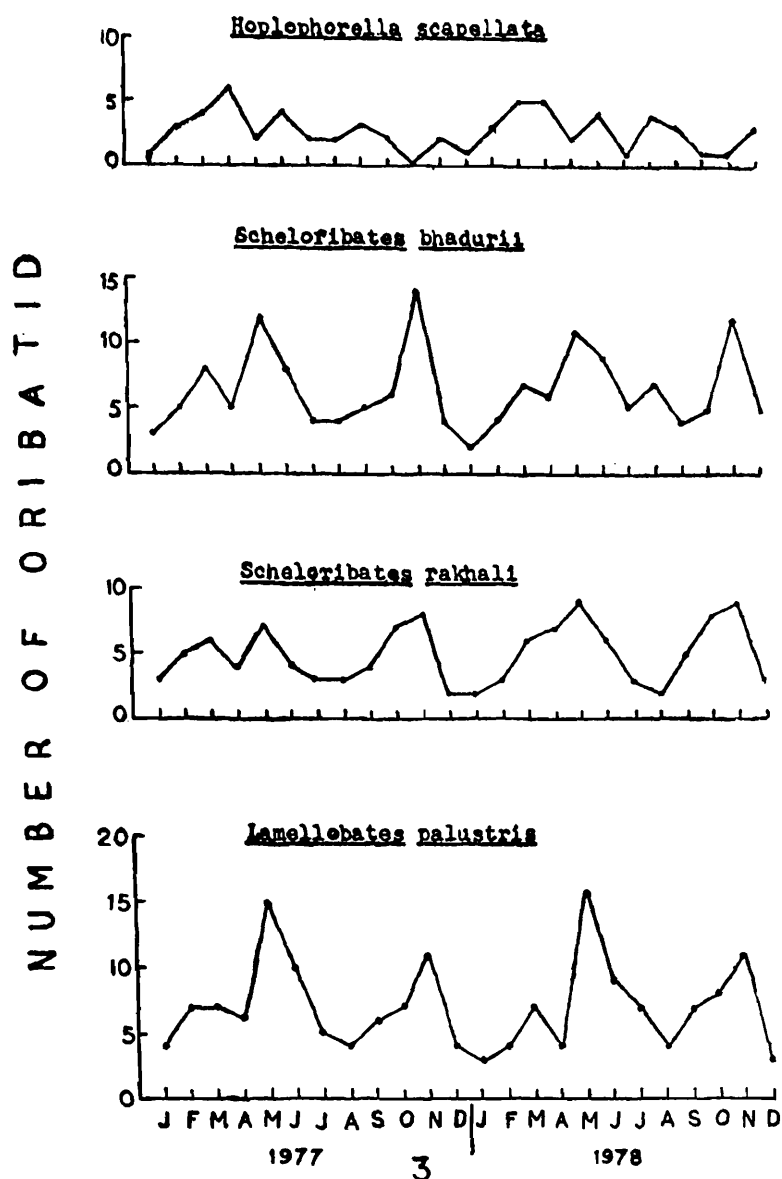


Fig. 3. Seasonal fluctuation of dominant species of oribatid mite.

Correlation between oribatid population and soil factors : The data involving soil factors and the densities of oribatid population were subjected to the statistical analysis to find out possible regressions, correlations and dependence of mean number of oribatid (Y) on each

of the six variables (soil factors) considered here. The correlation coefficient data as mentioned in the Table 4 indicated of the six variables, viz. temperature, moisture and organic carbon were significant and positively correlated with the oribatid population. The pH appeared to show significant negative

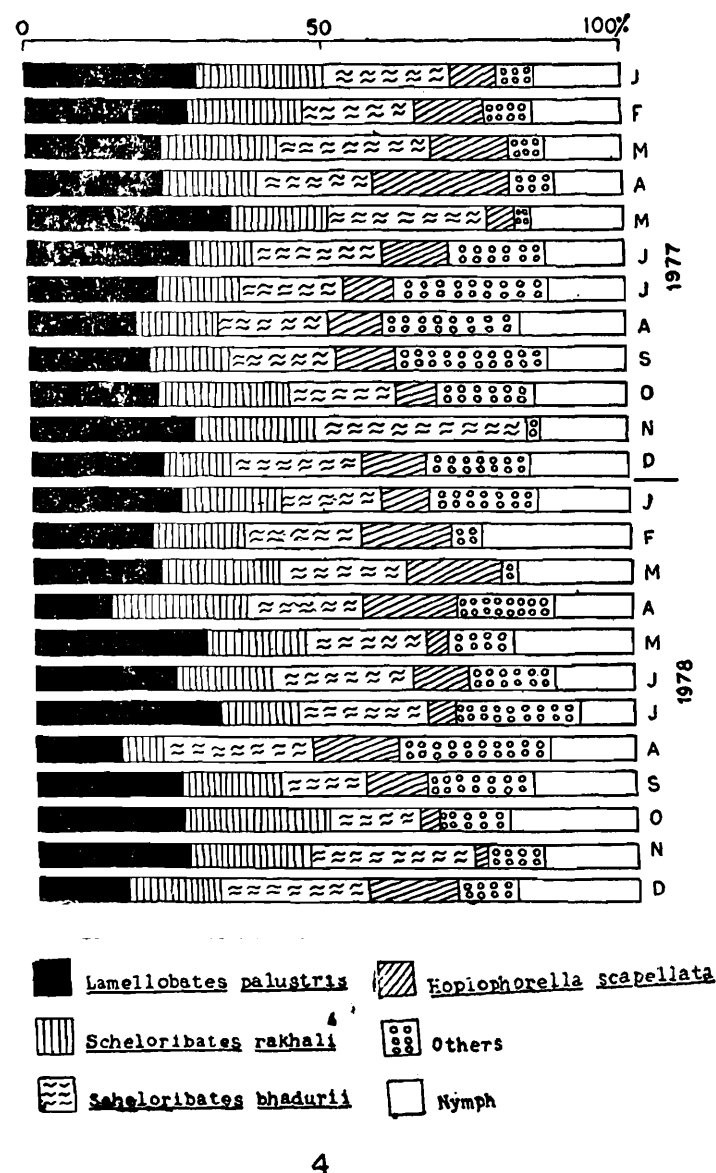


Fig. 4. Change in percentage of dominant oribatid species and nymphs for each month.

correlation with the oribatid population where as no significant association with electrical conductivity and available phosphate was observed.

The regression lines were obtained by pulling together the data for the two years.

The combined regression lines drawn along with the respective scattered diagram are shown in the Figs. 5-8.

The analysis of variance study (Table 5) showed that there was a difference between sampling years and between months of a sampling year and the seasonal pattern or monthly variation was significantly constant in both the years.

moisture and organic carbon attained their maximum concentration. The increased population with increased moisture and organic carbon content of soil was reported by Macfadyen (1952), Madge (1964), Loots and Ryke (1966), Fujikawa (1970) and Choudhuri and Banerjee (1977). It may be assumed from the present study that higher pH inhibited the population increase and the negative correla-

TABLE 5. Showing analysis of variance.

	Year	Month	Error	Total
Degree of freedom	1	11	11	23
Sum of squares	2.66	240.83	10.34	253.83
Mean square	2.66	21.89	0.94	
Frequency	2.8297	23.2872**		

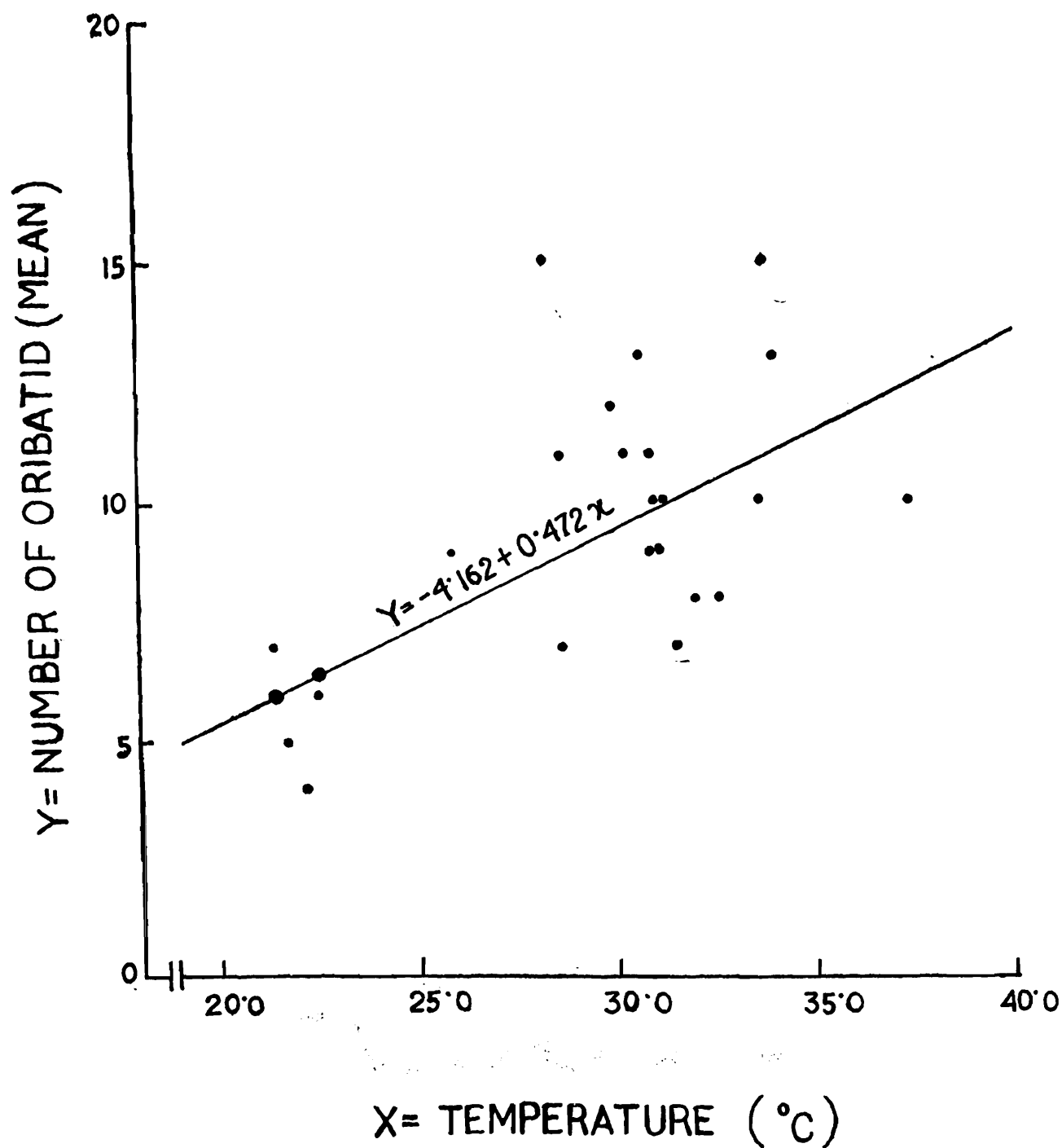
** Significant at 1% level.

DISCUSSION

The population peaks in pre-monsoon and autumn as observed in the present study followed the observations made by Riha (1951), Macfadyen (1952), Sheals (1957), Chiba et al. (1975) and others. Absence of definite winter and autumn peak was reported from gangetic alluvial soils of West Bengal by Choudhuri and Banerjee (1977). This pattern of fluctuation appeared to be a bit different from the works of Wallwork (1959, 1972), Madge (1965a, 1965b) and Usher (1975) who observed a winter maxima. The consideration of climatic and edaphic factors as well as population fluctuation of oribatid fauna leads to the conclusion that high amount of rainfall during May (early monsoon is observed in deltaic region) sets up favourable conditions for the upward migration of soil oribatid and eclosion of juveniles from eggs as peak population of nymph is found during May when factors like

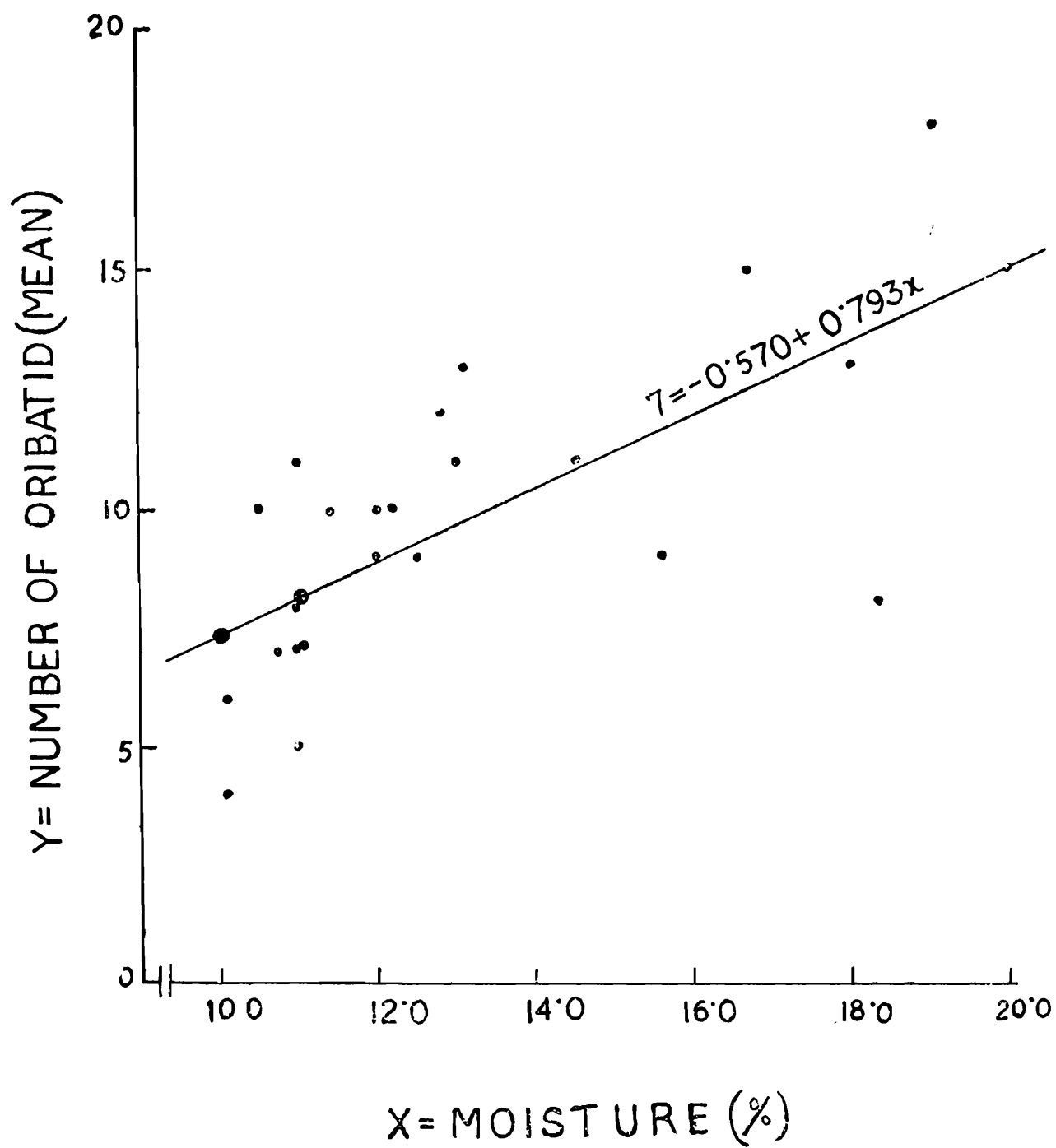
tation between pH and oribatid population recorded in the study was supported by Karpinen (1955) and Bhattacharya and Raychoudhuri (1977). It may reasonably be postulated that the oribatid species were capable of withstanding a wide range of temperature. From insignificant correlation between oribatid population and two other soil factors like soil salinity and phosphate it might be suggested that these two factors may not exert sufficient influence on faunal make up but these in combination with other edaphic factors may contribute to the population fluctuation. It may also be assumed from the study that most of the oribatid mites are salt tolerant and able to withstand the higher amount of salt in soil (Weigmann, 1971).

It may be that the biotic and abiotic factors considered here and also those components not analysed in this study collectively contribute to the population fluctuation of



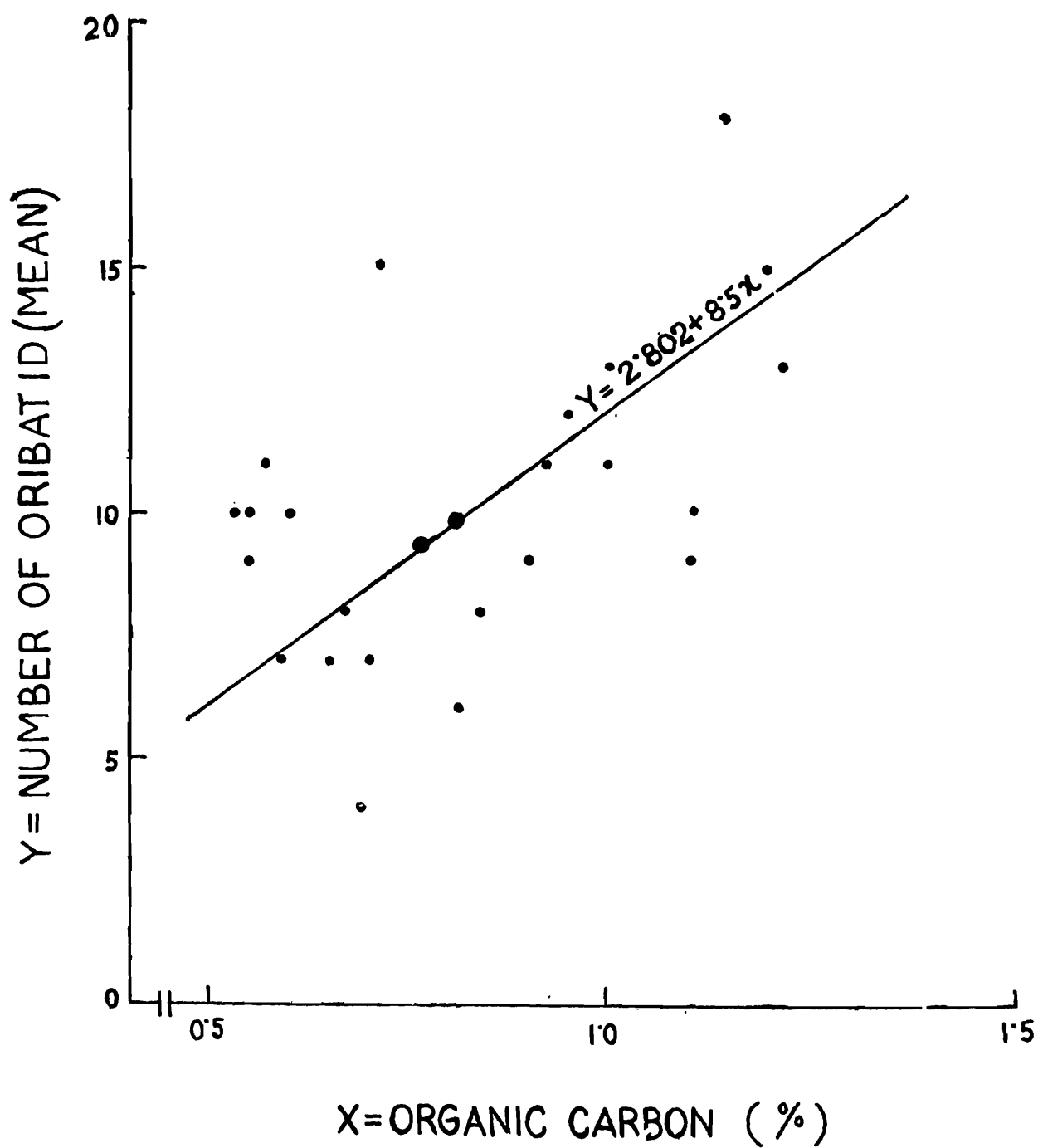
5

Fig. 5. Regression line with scattered diagram of Oribatei on temperature (°C).



6

Fig. 6. Regression line with scattered diagram of Oribatei on moisture (%).



7

Fig. 7. Regression line with scattered diagram of Oribatei on organic matter (%).

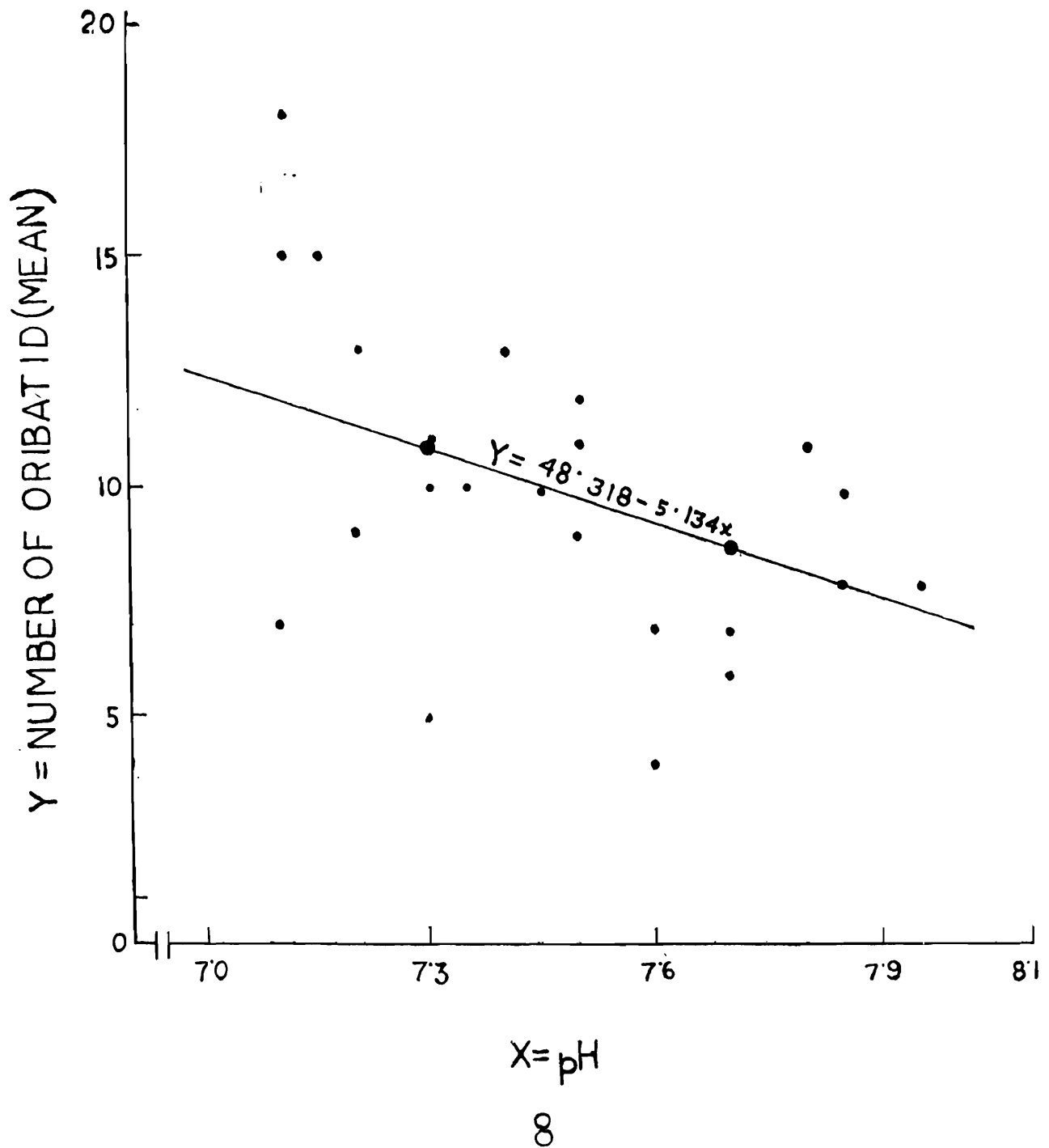


Fig. 8. Regression line with scattered diagram of Oribatei on pH.

oribatid mites in the deltaic soil of West Bengal.

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ECOLOGY OF GRASSHOPPERS IN TWO GRASSLANDS OF WEST BENGAL IN-RELATION TO SOME PHYSICAL FACTORS

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ABSTRACT

This observation presents the results of distribution of grasshoppers in two grasslands of West Bengal during the period from May—December, 1979. Higher population of grasshoppers were observed in Botanics grassland (72.7%). The number of species occurred from both the sites were also varied (16 species from Bethuadahari and 9 species from Botanics).

Fluctuations of pupulation per month showed two Peaks one in October and other in August at Botanics grassland and during August and September at Bethuadahari. Monthly fluctuations of Male, Female and nymph showed that female population was nil during July-August from both the sites and maximum nymph yielded in August.

A regression and correlation-coefficient analysis was done between physical factors and abundance of grasshoppers and their inter-relationships are discussed.

INTRODUCTION

Workers like Isely (1937), Cantrall (1943), Merton (1959), Roonwal (1976), Uvarov (1977) and Dwivedi (1977) have studied the qualitative and quantitative ecology of Orthopteran population in different parts of the world. However, the grasshopper population in the grassland of West Bengal has not been studied so far. These grasshoppers are of great economic importance as most of them are either pests or potential pests of different crops of West Bengal. Therefore, their time of emergence as hoppers and the time when they become adults may help us to forecast their outbreaks in West Bengal. For this, the present observations dealing with the effect of temperature and relative humidity on the population of grasshoppers and their distribution in two different grasslands of West Bengal has been discussed.

MATERIALS AND METHODS

During the survey period random-sampling was carried out once in a month from both the plots during the period from May 1979 to December 1979. Catchcount method (Andrewartha 1970) was employed for collecting the grasshoppers from the field. Temperature and relative humidity were recorded by a mercury thermometer (with stainless steel coverings) and a dial hygrometer respectively.

LOCATION AND CHARACTERISTICS OF SAMPLING SITES

Two sites were selected. One at Bethuadahari Grassland (75 m×60 m) is located near Bethuadahari reserve forest area in Nadia district. The other at the Botanics Grassland (55 m×45 m), is located at the Botanics Garden in Howrah district. These sites,

though about 95 km apart, contained more or less the same ecological conditions, except some differences in vegetations, e.g. the grass *Dichanthium annulatum* Stap. is present only at the Bethuadohari site. Soils of these sites were alluvium, grey in colour and clay-loam in texture.

RESULTS

A comparison of total number of grasshoppers collected from both the sites shows that the Botanics grasslands yielded the higher number (72.7%) of the total individuals collec-

ted than the Bethuadohari grassland (27.3%), although the number of species occurring in Bethuadohari was higher (16 species) Botanics grasslands, (9 species). In the monthly fluctuations of total population of grasshoppers obtained from both the plots, two clear peaks occurred in the Botanics grassland one in October and other in August and in the Bethuadohari grassland in August and September (Fig. 1).

The faunal composition is given in Table 1. Altogether 18 species occurred from both the

TABLE 1. Characteristics of two grasslands.

	Bethuadohari grassland	Botanics grassland
Mean Temperature (°C)		
Air	31.81	33.03
Soil	30.44	31.75
Mean relative humidity (%)	77.13	71.5
Vegetations : (grasses and sedges)	<i>Sporobolus diander</i> Beauv. <i>Arundinella</i> sp. <i>Dichanthium annulatum</i> Stapf. <i>Eragrostis brachyphylla</i> Stapf. <i>Digitaria marginata</i> Linn. <i>D. royleana</i>	<i>Sporobolus diander</i> Beauv., <i>Arundinella</i> sp. <i>Eragrostis brachyphylla</i> Stapf. <i>Commelina obliqua</i> Ham., <i>Vernonia cinerea</i> Less., <i>Panicum</i> sp., <i>Echinochloa colonum</i> (Lin.) Link., <i>Digitaria idscendens</i> , <i>Cynodon dactylon</i> Pers., <i>Eupatorium odoratum</i> Linn., <i>Digitaria marginata</i> Lin and <i>D. royleana</i> .
Grasshoppers :	<i>Aiolopus thalassinus tamulus</i> (Fabr.) <i>Spathosternum prasiniiferum</i> <i>prasiniiferum</i> (Walk.) <i>Phlaeoba infumata</i> Brunner <i>Oxya fuscovittata</i> (Marschall), <i>O. hyla hyla</i> Serv., <i>Atractomorpha crenulata</i> (Fabr.), <i>Trilophidia annulata</i> (Thumb.), <i>Aulacothrus luteipes</i> Walk., <i>Aulacothrus</i> sp., <i>Acrida exaltata</i> (Walk.), <i>Chorthippus indus</i> Uvarov, <i>Acrotylus humbertianus</i> Saussure, <i>Tristria pulvinata</i> (Uvarov), <i>Hieroglyphus banian</i> (F.), <i>Leva cruciata</i> Bolivar, <i>Gelastorrhinus semipictus</i> (Walk.)	<i>Aiolopus thalassinus tamulus</i> (Fabr.), <i>Spathosternum pr. prasiniiferum</i> (Walk.) <i>Epistaurus sinetyi</i> Bolivar, <i>Phlaeoba infumata</i> Brunner, <i>Oxya fuscovittata</i> (Marschall), <i>O. hyla hyla</i> Serv., <i>Atractomorpha crenulata</i> (F.), <i>Gesonula punctifrons</i> (Stal), <i>Tristria pulvinata</i> (Uvarov)

sites of which 7 are predominant and occur from both the sites except *Aulacobothrus luteipes* which occurred only in the Bethuadohari grassland. Monthly fluctuations of the sexes, nymphs and total population of these predominant species are given in figures 2 and 3. It is clear that the predominant species are much more frequent in the

Botanics glassland than in Bethuadohari. The maximum and minimum population of each of these species are variable.

Spathosternum prasiniferum prasiniferum (Walk.) is the most predominant species (24.37%) in both the plots combined. *Aulacobothrus luteipes* Walk. (23.53%) is the most

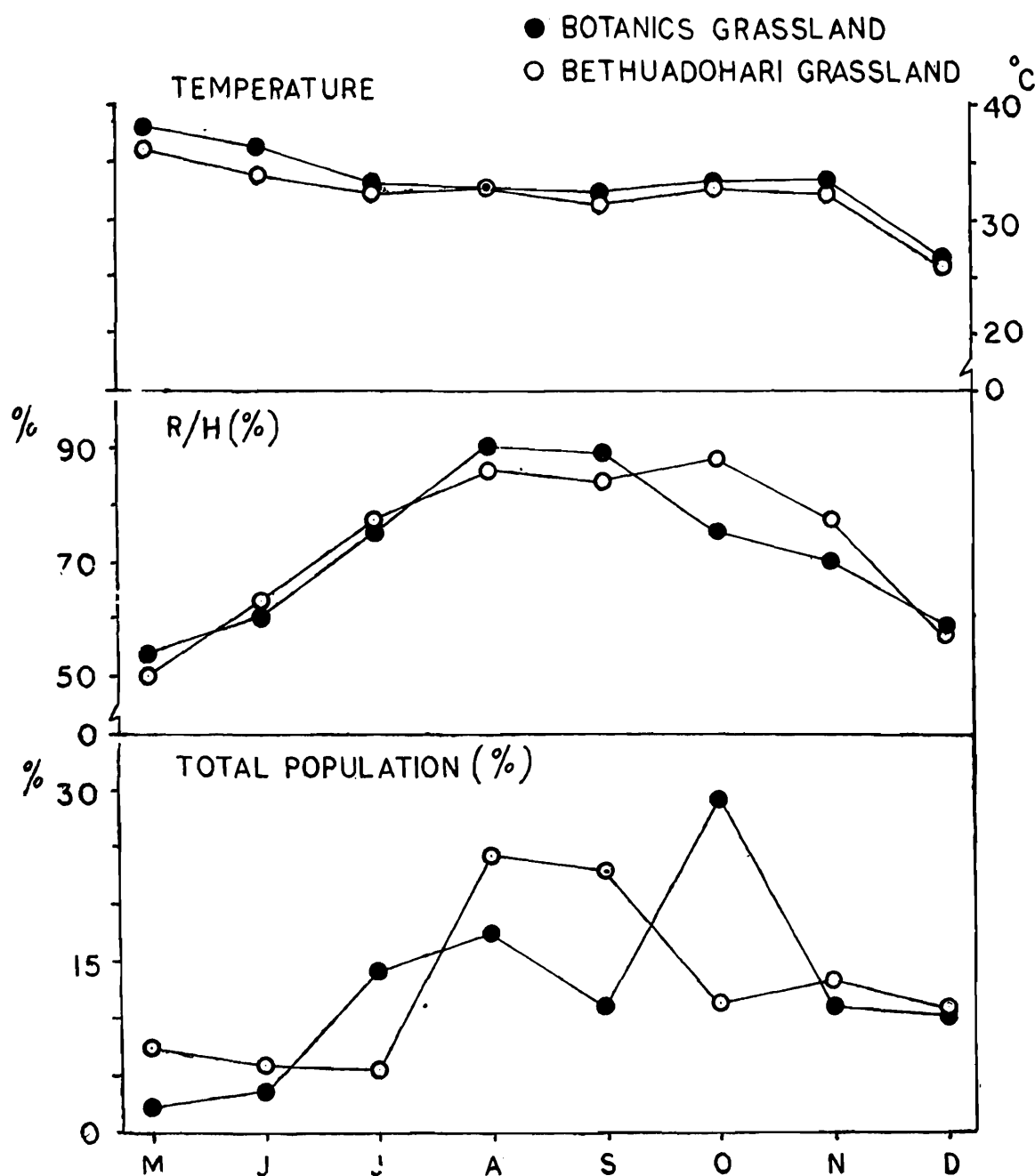


Fig. 1. Showing fluctuations of total population of grasshoppers, relative humidity and temperature in two grasslands.

dominant species in the Bethuadohari grassland. *Spathosternum* shows two peaks (in August and November) and minimum number in June in Bethuadohari grassland. In the Botanics grasslands the maximum occurs in August and October and the minimum in May. Similarly, the majority of species shows two peaks (Fig. 2 and 3). Male, female and nymph population of each species also fluctuate from one month to another. Male (2.36%), female (1.79%) and nymph (6.18%) shows the highest peak during the month of November, May, and August respectively in the Bethuadohari grassland. The corresponding highest percentage of male (2.96%); female (4.08%) and nymph (5.05%) occur during August, November and August respectively in the Botanics grassland. The female population is completely absent during July and August in both in fields. When the total male, female and nymph population of both sites are considered, it is seen that nymphs constitute the major portion of the total population (32.94%), then comes males (26.23%); and minimum population is that of female (13.54%) (Table 2).

From figure 1 it is clear that in both the sites the lowest population is associated with

the low relative humidity, higher air and soil temperature during May, but the highest population in Bethuadohari is associated with high relative humidity (92%) and moderate air and soil temperature in August. Corresponding higher population in the Botanics grassland in October when the relative humidity (74.1%), and air and soil temperatures are moderate. This higher peak may be due to sudden large catch of *Spathosternum* and *Oxya* in this month.

An attempt has been made to find out the relationship between the population of grasshoppers and the physical factors and also between some other parameters considered in this study. For this correlation coefficients and regression equations were done. From Table 3, it is clear that only the relative humidity shows a positive correlations (Column 3, Table 3) with the total populations and individual species populations, but even this is not significant. The other two factors (air and soil temperatures) show a negative correlation. Column 4 of Table 3 shows the regression values of above parameters. The correlation between the population of two grasslands shows a positive insignificant relationship. The population of male and female shows a

TABLE 2. Showing monthly fluctuations of adult Male, Female and Nymphal populations in two grasslands (in percentage).

Months	Bethuadohari grassland			Botanics grassland		
	Male	Female	Nymph	Male	Female	Nymph
M	—	1.77	0.21	0.43	0.43	0.43
J	1.07	0.48	—	0.75	0.43	0.43
J	0.54	—	0.91	1.88	—	4.62
A	0.88	—	6.18	2.96	—	5.05
S	0.7	0.48	5.00	1.61	0.38	3.01
O	1.13	1.72	0.21	1.83	4.08	1.99
N	2.36	0.7	0.51	2.53	1.72	0.64
D	0.97	0.05	1.88	1.72	1.29	1.83

positive correlation (significant at 5% level), but the correlation between adult and nymph population is negative and not significant. When relationship in between the species are calculated it is seen that there exists a positive correlation between them but this is not significant except between *Spathosternum*

and *Oxya* and between *Spathosternum* and *Atractomorpha*, which shows positive correlation and significant at 5% level. The impact of relative humidity, air and soil temperature on male, female and nymph population shows that the relative humidity is positively correlated with the male and nymph population

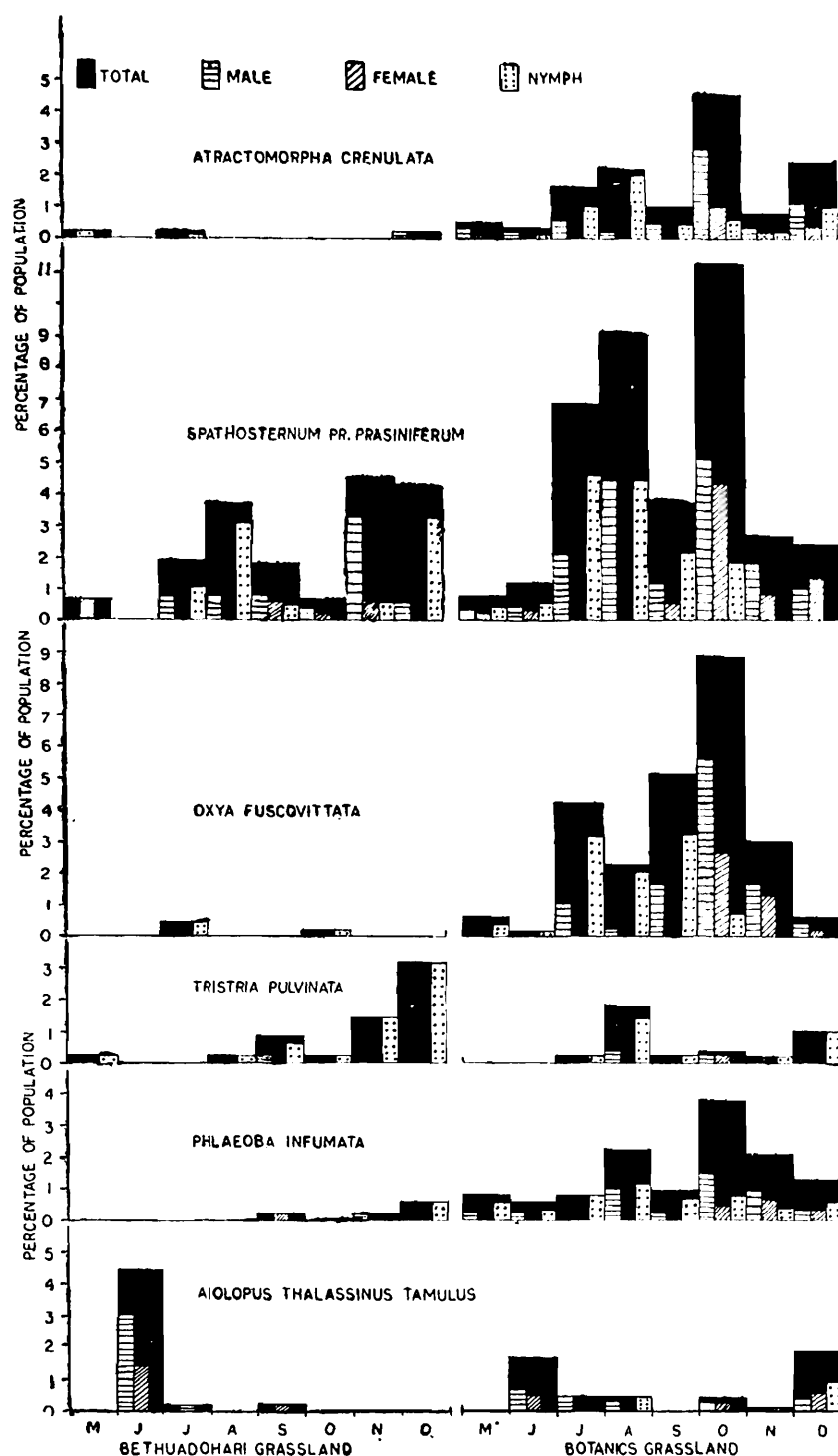


Fig. 2. Showing fluctuations of dominant grasshopper species per month in two grasslands.

and other two factors like air and soil temperature are negatively correlated. In case of female population relative humidity and soil temperature are negatively correlated and air temperature is positively correlated. This relationship is unique in case of female population in this study.

DISCUSSION

The present investigation is a part of a long term project on the ecology of grasshoppers and on ecological energetics in some grasslands of West Bengal.

The present observation exhibits two peaks during August and September in one site

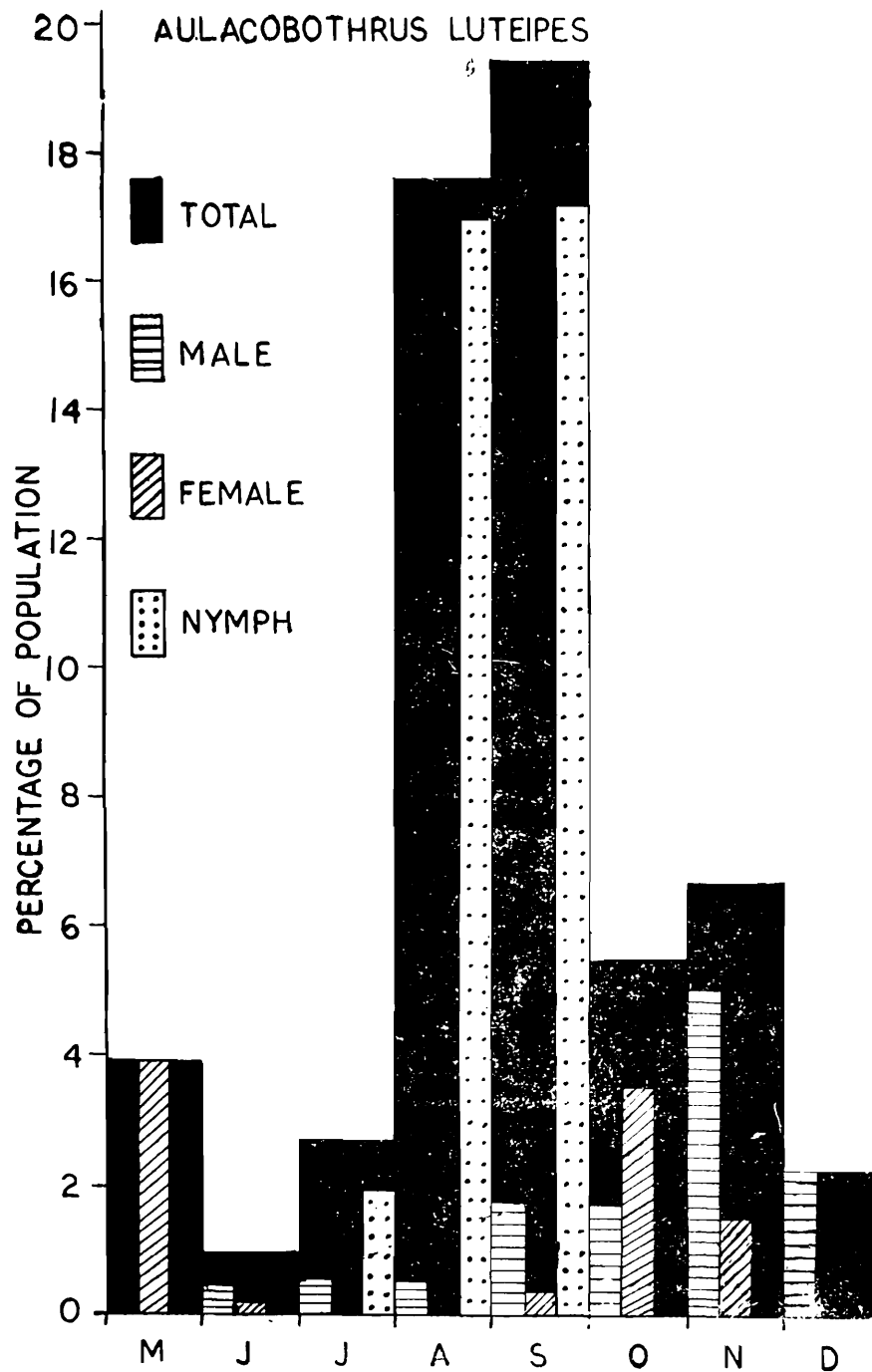


Fig. 3. Showing fluctuations of *Aulacobothrus luteipes* per month in Bethuadahari grassland.

TABLE 8. Showing relationship between grasshoppers population and different parameters.

Parameters	Mean	'r' value	Regression equation $Y = a + bx$
<i>Bethuadohari Reserve Forest</i>	57.25		
Y : <i>Total population</i>			
Air temp.	31.75	-0.2	$Y = 32.9 - 0.02 x$
Soil temp.	30.44	0.27	$Y = 28.15 + 0.04 x$
Relative humidity	77.13	0.38	$Y = 13.01 + 1.12 x$
Y : <i>Aulacobothrus</i> sp.	37.5		
Air temp.	31.75	0.05	$Y = 31.75 + 0.004 x$
Soil temp.	30.44	-0.05	$Y = 30.82 - 0.01 x$
R/H	77.13	0.5	$Y = 69.25 + 0.21 x$
Y : <i>Spathosternum</i> sp.	10.75		
Air temp.	31.75	-0.68	$Y = 28.85 - 0.27 x$
Soil temp.	26.38	-0.2	$Y = 25.84 - 0.05 x$
R/H	65.88	0.58	$Y = 61.02 + 1.98 x$
<i>BG/Botanicals</i>			
Y : <i>Total population</i>	101.75		
Air temp.	32.96	-0.29	$Y = 33.98 - 0.01 x$
Soil temp.	31.81	-0.03	$Y = 34.86 - 0.03 x$
R/H	71.5	0.29	$Y = 57.25 + 0.14 x$
Y : <i>Atractomorpha</i> sp.	14.25		
Air temp.	32.96	-0.45	$Y = 30.96 - 0.14 x$
Soil temp.	31.81	-0.61	$Y = 28.25 - 0.25 x$
R/H	71.5	0.08	$Y = 69.93 + 0.11 x$
Y : <i>Oxya</i> sp.	26.13		
Air temp.	32.96	-0.08	$Y = 37.93 - 0.01 x$
Soil temp.	31.81	-0.19	$Y = 32.86 - 0.04 x$
R/H	71.5	0.49	$Y = 63.66 + 0.3 x$
Y : <i>Phlaeoba</i> sp.	13.88		
Air temp.	32.96	-0.25	$Y = 34.76 - 0.13 x$
Soil temp.	31.81	-0.19	$Y = 33.2 - 1 x$
R/H	71.5	0.44	$Y = 60.95 + 0.76 x$
Y : <i>Spathosternum</i> sp.	38.75		
Air temp.	32.96	-0.18	$Y = 33.74 - 0.02 x$
Soil temp.	31.81	-0.31	$Y = 33.75 - 0.05 x$
R/H	71.5	0.43	$Y = 63.36 + 0.21 x$
<i>Correlation between population of two sites</i>			
Y : No. of specimen in Bethuadohari grassland	63.5		
No. of specimen in Botanical Garden Grassland	105.5	0.22	$Y = 70 + 0.56 x$

TABLE 8. Concluded.

Parameters	Mean	'r' value	Regression equation $Y = a + bx$
<i>Correlation between Male & female</i>			
Y : Total no. of male	61.00		
Total no. of female	31.00	0.78	$Y = -6.21 + 0.61 x$
<i>Correlation between Adult and Nymph Population</i>			
Y : Total no. of adult	98.98		
Total no. of Nymph	75.68	-0.17	$Y = 59.89 - 0.16 x$
<i>Correlation between Aulacobothrus sp. and Spathosternum sp. & others</i>			
Y : Total no. of Aulacobothrus sp.	37.5		
Total Spathosternum sp. population	38.75	0.17	$Y = 27.87 + 0.29 x$
Total Phlaeoba population	13.88	0.11	$Y = 12.75 + 0.08 x$
Total Oxya sy. population	26.13	0.21	$Y = 20.88 + 0.14 x$
Total Atractomorpha sp. population	14.25	0.03	$Y = 13.12 + 0.01 x$
<i>Correlation between Spathosternum sp. with others</i>			
Y : Total no. of Spathosternum sp.	38.75		
Total no. of Phlaeoba sp.	13.88	0.29	$Y = 11.94 + 0.05 x$
Total no. of Oxya sp.	26.13	0.77	$Y = -3.17 + 0.77 x$
Total no. of Atractomorpha sp.	14.25	0.78	$Y = 2.62 + 0.3 x$
<i>Correlation between Male population and physical factors</i>			
Y : No. of Male	61.13		
Air temp.	32.45	-0.2	$Y = 44.46 - 0.02 x$
Soil temp.	31.09	-0.48	$Y = 84.15 - 0.05 x$
R/H	74.31	0.39	$Y = 66.36 + 0.13 x$
<i>Correlation between Female population and physical factors</i>			
Y : No. of Female	31.5		
Air temp.	32.45	0.1	$Y = 32.13 + 0.01 x$
Soil temp.	31.13	-0.01	
R/H	74.31	-0.14	$Y = 76.2 - 0.06 x$
<i>Correlation between Nymph population and Physical factors</i>			
Y : No. of Nymph	76.63		
Air temp.	32.45	-0.3	$Y = 31.68 - 0.01 x$
Soil temp.	31.13	-0.27	$Y = 32.69 - 0.02 x$
R/H	74.31	0.44	$Y = 67.41 + 0.09 x$

* Significant at 5% level

and August and October in other site. It agrees with the observation of Dwivedi (1977) where he also obtained in a grassland of Madhya Pradesh early August and late September peaks. Little variation in the second plot may be due to climatological and vegetational differences of the two places. From the present study it is clear that the female population does not tolerate excessive humidity as is evidenced from Table 3. All the female population disappeared from both the field during July and August when, maximum relative humidity was present in the atmosphere. This inference is also supported by Statistical analysis (Table 3). Vegetation exerts a greater role in the distribution of grasshoppers. It is seen from the present investigations that *Aulacobothrus luteipes* is associated only with the grass *Dichanthium annulatum* (Table 1). It agrees with the observations of Bailey and Mukherjee (1976) in the case of *Melanoplus bivittatus*.

Dwivedi (1977) observed that the population density and climatic factors like temperature and relative humidity show a significant correlations. But in the present study these parameters are not statistically significant. The cause of this differences can not be explained at present unless more data are obtained. But it is clear that temperature and relative humidity exerts a notable influence upon the limits of population as is evidenced from Table 3.

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GALLS OF PEMPHIGINAE (HOMOPTERA : APHIDOIDEA) IN THE INDIAN REGION WITH DESCRIPTION OF A NEW SPECIES

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ABSTRACT

The present paper provides an account of gall aphids and aphid galls of the subfamily Pemphiginae in the Indian region. Moreover, host association, gall record and biological knowledge of such species in the region have also been included. A new gall forming species, *Kaltenbachiella carpinicola* infesting *Carpinus* sp, is described in this paper. A total of 27 species including 8 newly recorded one under this subfamily are known to produce galls in the area.

INTRODUCTION

Aphid galls are anatomically and histologically complex, formed mostly on the primary host-plants, in the course of heteroecious life cycle and association with true galls is regarded to be of primitive origin. Aphid galls may be covering galls, pouch galls, krebs galls and leaf fold or roll galls (Mani 1964). Amongst the members of Aphididae, species belonging to Pemphiginae are well known as gall makers ; of these, many species migrate to secondary hosts to complete the cycle (Table 1) while some may either become autoecious on primary host or may become restricted to a paracycle on secondary host and the situation in Indian region clearly indicates prevalence of the second condition ; out of more than 60 Pemphigids under 3

tribes known from Indian region, about 27 species are known to form galls. Many of these Pemphigid galls from Indian region have been described by Buckton (1896, 1897), Keiffer (1908), Das (1918), Gulamullah (1941), Mani (1973) and Habib and Ghani (1970) ; galls for eight species are reported here for the first time. So far, no key for identification of aphid species by their galls in the region is available. Several collection trips to Northwest and to Northeast India and Sikkim by the authors have enabled to prepare a key to the aphid species basing on the plant galls. The collection data for many of these species would indicate period of occurrence, while for the others, information have been incorporated from published literature,

TABLE—1
Host Association of Pemphiginae

Primary Host		Secondary Host
I. Tribe	Pemphigini	[mostly known from primary host in the region]
Sub Tribe	Pemphigina	
	<i>Populus</i>	Dicot Plants (Roots)
	(Galls)	
Sub Tribe	Prociphilina	
	Dicot Plants	Conifers (Roots)
	(Galls)	
II. Tribe	Eriosomatini	[mostly known from secondary hosts in the region]
	<i>Ulmus</i> (Galls)	Rosaceae
	<i>Carpinus</i> (Galls)	Graminae
III. Tribe	Fordini	[mostly known from secondary hosts in the region]
	<i>Pistacea</i> (Galls)	Graminae
	<i>Rhus</i>	
	<i>Ailanthus</i> (Galls)	?
	<i>Toona ciliata</i> (Galls)	? Graminae

TABLE—2
Aphid species on Poplar Galls

Aphid species	Host Plant	First record
1. <i>Epipemphigus imaicus</i> (Oholodkovsky) :	<i>Populus ciliata</i>	(Oholodkovsky, 1912)
2. <i>Pemphigus immunis</i> Buckton :	<i>Populus nigra</i>	(Buckton, 1897)
3. <i>Pemphigus mordvilkoii</i> Oholodkovsky :	<i>Populus ciliata</i>	(Oholodkovsky, 1912)
4. <i>Pemphigus nainitalensis</i> Oholodkovsky :	<i>Populus ciliata</i>	(Oholodkovsky, 1912)
5. <i>Pemphigus napaeus</i> Buckton :	<i>Populus euphratica</i>	(Buckton, 1897)
6. <i>Pemphigus siphunculatus</i> Hille Ris Lambers :	<i>Populus ciliata</i>	(Hille Ris Lambers, 1973)
7. <i>Pemphigus indicus</i> Keiffer :	Host indet	(Keiffer, 1908)
8. <i>Pemphigus spyrotheceae</i> Passerini :	<i>Populus nigra</i>	(Mathur & Sinch, 1959)
9. <i>Pemphigus ignotus</i> Habib & Ghani :	<i>Populus ciliata</i>	(Habib & Ghani 1970)
10. <i>Pemphigus venosus</i> Habib & Ghani :	<i>Populus ciliata</i>	(Habib & Ghani, 1975)
11. <i>Pemphigus vesicarius</i> Passerini :	<i>Populus</i> sp.	(Gulamullah, 1941)
12. <i>Pemphigus</i> sp. :	<i>Populus ciliata</i>	(New Record)

GALLS AND APHIDS

1. Tribe Pemphigini

A. On *Populus* spp.

Four species of Poplars, *alba*, *ciliata*, *euphratica* and *nigra* grow in the Himalaya (Indo-Pakistan region), but 6 of the 12 Pemphigids

species (Table 2) are known to form galls only on *Populus ciliata*, which is known to prevent soil erosion and is also used for match-industry (Habib & Ghani 1970). Further report of occurrence of four of these Poplar-aphids, after their first record of incidence,

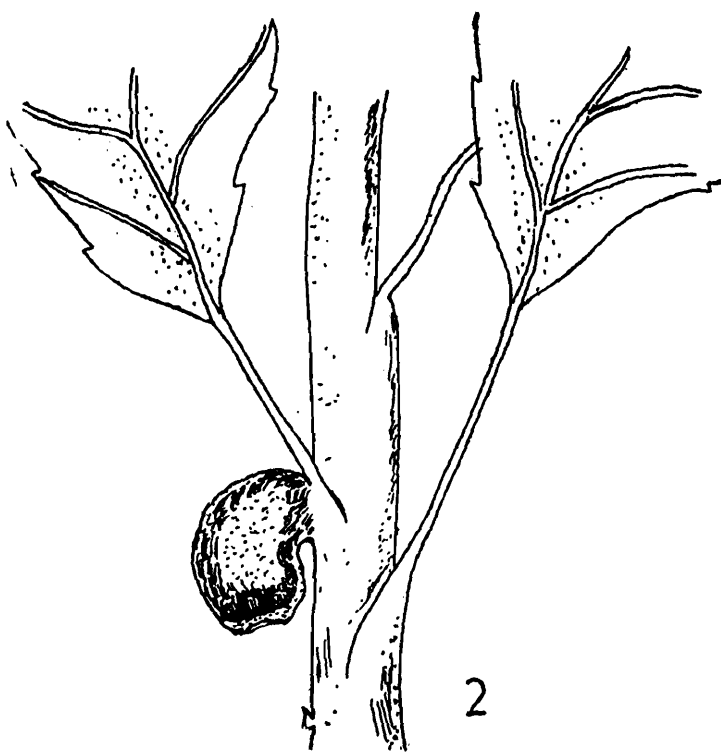
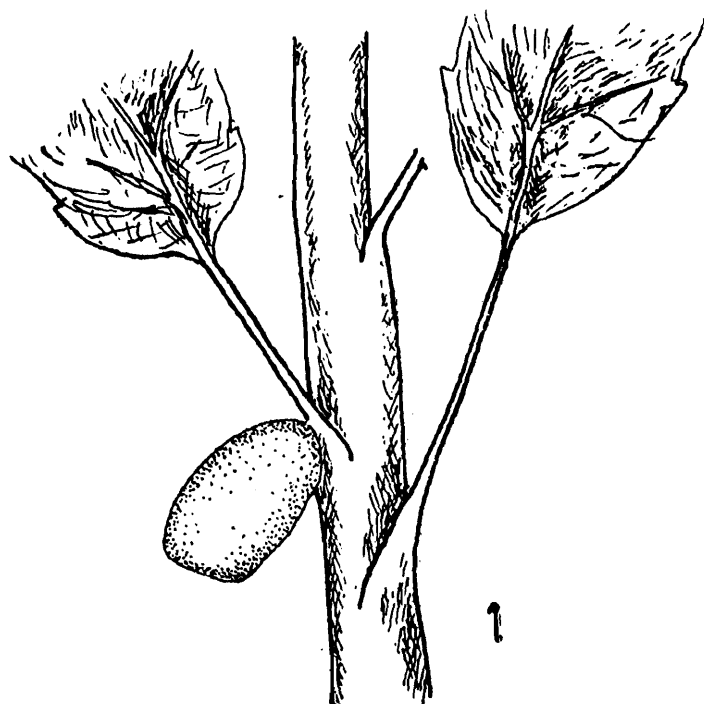
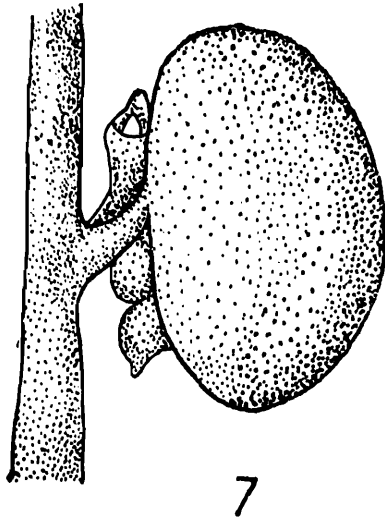


Fig. 1. Stem gall of *Pemphigus napeus* on *Populus* sp.
 Fig. 2. Stem gall of *Pemphigus mordvilko*i on *Populus* sp.
 Fig. 3. Stem gall of *Pemphigus naintalensis* on *Populus* sp.
 Fig. 6. Leaf gall of *Pemphigus indicus* on unidentified plant

is lacking (4, 7, 8, 11) and two species have only been recently recorded in Pakistan region (9,10) ; of these two, *venosus* is reported to form galls on twigs and branches (like

napaeus, *mordvilkoii*, *nainitalensis* and *siphunculatus*) and *ignotus* is reported to form leaf-galls, as in the cases of most of the other pemphigids. The key includes 6 of the



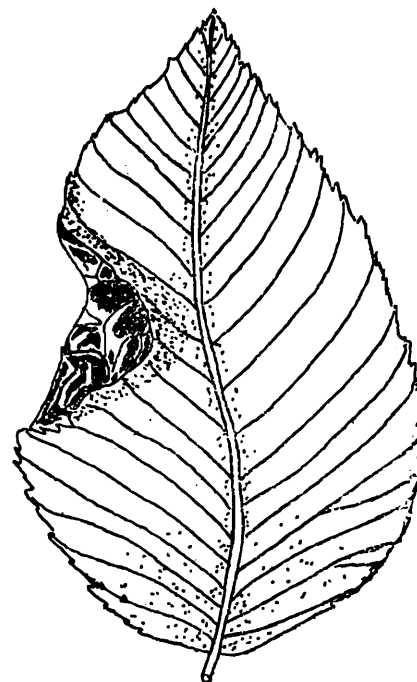
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Fig. 7. Leaf gall of *Pemphigus immunis* on *Populus* sp.

Fig. 8. Leaf gall of *Prociphilus alnifoliae caryae* on *Lonicera* sp.

Fig. 9. Leaf gall of *Thecabius affinis* on *Ranunculus* sp.

Fig. 10. Leaf gall of *Eriosoma ulmi* on *Ulmus* sp.

first seven species besides an unidentified *Pemphigus*, (no description of gall of *siphunculatus* is available) and excludes last 4 species, because of lack of sufficient report (8, 11 from Afghanistan) or description (9, 10 from Pakistan); however detailed description of galls of *spyrothecae* Passerini, and *vesicarius* Passerini are available in Roberti (1938).

Galls on *Populus* spp.

1. Closed galls, on stem. ... 2
On leaves. ... 4
2. Roundish or irregular, sessile, shining green, variegated with yellow or brown spots, distinctly veined, 25-75 mm, on *P. ciliata*, *P. nigra*; Darkot Pass in N. W. Himalaya (Fig. 1). ... *Pemphigus napaeus* Buckton.

Galls never veined as above ... 3

3. Subspherical or pyriform, sessile, usually, solitary, yellow or yellowish green, smooth walled, 10-30 mm in diameter with a large gall chamber. On *P. ciliata*; Kumaon Himalaya to Kashmir (Fig. 2). ... *Pemphigus mordvilkoii* Cholodkovsky

Subspherical, smooth, small, sessile, lateral, 1-2 per branch, 5-7 mm in diameter, much smaller than of *mordvilkoii* on *P. ciliata*; N. W. Himalaya (Fig. 3). ... *Pemphigus nainitalensis* Cholodkovsky

4. On dorsal surface, at leaf base, reddish green, cystolith patterned. On *Populus ciliata* (Fig. 4). ... *Pemphigus* sp.
Never on leaf base as above ... 5

5. Elongated finger like, reddish green, on dorsal surface of leaf, near midrib or on margin, chamber opens ventrally through a minute pore. On *P. ciliata*; Northwest Himalaya and Sikkim (Fig. 5) ... *Epipemphigus imaicus* (Cholodkovsky).

Never finger shaped as above; very large sac like or pyriform gall on branches, hard, smooth, with ostiole at apex, and corrugated at the edges; 25-50 mm long. On *P. euphratica*; Kashmir Himalaya (Fig. 7) ... *Pemphigus immunis* Buckton

B. On *Lonicera* sp.

Gall formed by folding of entire leaf blade, forming, somewhat elliptical, irregular shaped structure. On *Lonicera quingelocularis*; Himachal Pradesh, (Fig. 8) ... *Prociphilus alnifoliae caryae* Baker & Davidson

C. On *Syringa* sp.

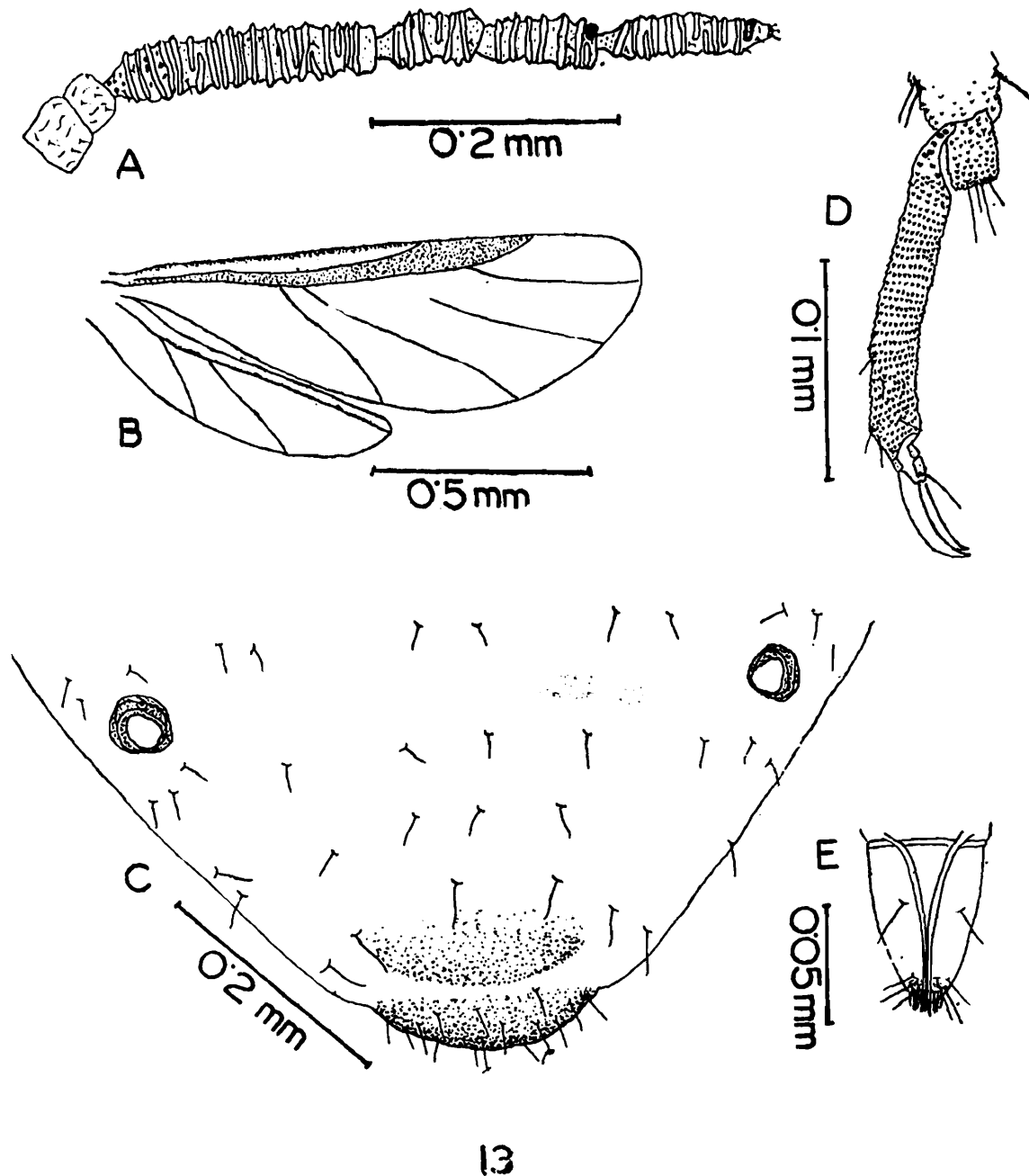
Gall hypophyllous, formed by simple leaf folding, appearing as a closed, marginal, tubular structure. On *Syringa emodi*; Uttar Pradesh ... *Prociphilus xylostei* (de Geer)

D. On *Ranunculus* sp.

Simple hypophyllous (rarely epiphyllous) leaf folding to form a closed tubular marginal gall; Uttar Pradesh (Fig. 9) ... *Thecabius affinis* (Kltb.)

E. On unidentified Plant

Irregular globose, lobed, with rugose surface, thick walled, with a large gall cavity, Eastern Himalaya (Fig. 6) ... *Pemphigus indicus* Keiffer



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Fig. 13. *Kaltenbechiella carpinicola* sp. nov., alate viviparous female ; A. antenna, B. wings, C. posterior part of abdomen, D. second joint of hind tarsus, E. ultimate rostral segment.

II. Tribe Eriosomatini

A. On *Ulmus* spp.

Four species of *Ulmus* are known to grow in Indian region between 1700-2000 m. of which *Ulmus villosa* and *wallichiana* appear to be more common. Eight species of Eriosomatini (of Pemphiginae) (Table 3) are

known to form galls on *Ulmus* in the region, of which five have been keyed below ; of the remaining species, no description of galls of *S. indica* Hille Ris Lambers and *T. polychaeta* Hille Ris Lambers is available ; galls of *lanuginosum* have been described from Europe by Hartig (1841).

Galls on *Ulmus* spp.

1. Simple leaf gall, without complex architecture, with a folding to form a closed tubular marginal hypophyllous structure. On *Ulmus montana* ; N. W. India. ... *Eriosoma phoenax* Mordvilko

Leaf gall, with complex architecture ...

2. Gall twisted, spiral, formed of leaf folding or epiphyllous
Gall bladder like ...

3. Large, epiphyllous, of various shape, ovoid, clavate, sometimes laterally compressed and lop sided with a short narrow neck, rugose, reddish brown, pubescent on inner wall ; On *Ulmus* sp. Afghanistan ...

Eriosoma lanuginosum (Hartig)

Galls spiral, twisted, never as above ...

4. Elliptical hard spiral gall with an elongate slit like opening on one side ; leaf margin ventrally folded. On *Ulmus wallichiana* ; N. W. India (Fig. 10) ---

Eriosoma ulmi (Linnaeus)

Gall with pouch or chamber, wall of which twisted clockwise and fringed to form a screwed—tubular gall ; on *Ulmus* sp., N. W. India (Fig. 11) ...

Eriosoma kashmiricum
I. K. Ghosh *et al*.

5. Reddish, conical bladder like, solitary, on dorsal leaf surface, on *Ulmus* sp. ; Kashmir (Fig. 10). ... *Tetraneura ulmi* Linnaeus

Epiphyllous, conical, short, bladder like, greenish not less than 4-5 on single leaf, on *Ulmus* sp. ; Uttar Pradesh (Fig. 12) ...

Tetraneura nigriabdominalis (Sasaki)

B. On *Carpinus* sp.

A new aphid species of *Kaltenbachiella* viz. *Kaltenbachiella carpinicola* sp. nov. has been collected from open galls on leaf blades, appearing as swollen cup-shaped pouch or cavity, surrounded by thick leaf tissue. Description of the new species is given below.



Fig. 14. Leaf gall of *Baizongia pistaciae* on *Pistacia* sp.

Kaltenbachiella carpinicola sp. nov. (Fig. 13)

Alate viviparous female : Body 2.23-2.55 mm. long with 0.89-1.24 mm. as maximum

TABLE—3
Aphid species in *Ulmus* Galls

Aphid species		Host Plant	First Record
1. <i>Eriosoma</i> (<i>Schizoneura</i>) <i>kashmiricum</i> L. K. Ghosh et. al.	—	<i>Ulmus</i> sp.	(L. K. Ghosh et. al. 1976)
2. <i>Eriosoma lanuginosum</i> (Harting)	—	<i>Ulmus</i> sp.	(Gulamullah, 1941)
3. <i>Eriosomae</i> (S.) <i>phaenax</i> Mordvilko	—	<i>Ulmus montana</i>	(New record)
4. <i>Eriosoma</i> (S.) <i>ulmi</i> Linnaeus	—	<i>Ulmus wallichiana</i>	(New record)
5. <i>Schizoneurella indica</i> H. R. L.	—	<i>Ulmus villosa</i>	(H. R. L. 1973)
6. <i>Tetraneura</i> (<i>Tetraneurella</i>) <i>nigriadominalis</i> (Sasaki)	—	<i>Ulmus</i> sp.	(New record)
7. <i>Tetraneura</i> (<i>Tetraneurella</i>) <i>polychaeta</i> H. R. L.	—	<i>Ulmus villosa</i>	(H. R. L. 1970)
8. <i>Tetraneura</i> (<i>Tetraneura</i>) <i>ulmi</i> (Linnaeus)	—	<i>Ulmus</i> sp.	(New record)

width. Head brown to blackish brown; vertex slightly rugose with many scattered wax pores and with 4 pairs of short hairs and a single hair placed laterad, with acute to acuminate apices, longest one about 11-14 μ long and about 0.50-0.66 times as long as the basal diameter of the antennal segment III; dorsal median suture present on posterior half of the head; lateral and median frontal prominence not developed. Eyes with indistinct ocular tubercles, median ocellus not viewed from the dorsal side. Antennae 6 segmented, brown to blackish brown, about 0.36-0.42 times as long as the body; segments I and II each with 4 short, pointed hairs; hairs on the flagellum sparse, acute, longest one on segment III about 7-11 μ and 0.45-0.50 times as long as the basal diameter of the segment; secondary rhinaria non-ciliated, annular, nearly encircling the width of the segments; segment III with 20-29, IV with 7-10, V with 10-13 and VI with 15-17 secondary rhinaria; primary rhinaria ciliated; processus terminalis about 0.14-0.18 times as long as the base of segment VI. Ultimate rostral segment about 0.54-0.62 times as long

as the second segment of hind tarsus, bearing 2-4 accessory hairs. Thorax blackish brown and with scattered wax pores particularly on mesothoracic lobes. Abdomen pale brown, tergum membranous, dorsal hairs thin with acuminate apices, mostly arranged in rows, anterior tergite with 10-12 hairs, usually with 1 pair of spinal, 1 pair of pleural, and 2-3 pair of marginals, longest hair on anterior tergites about 0.22-30 μ long and about 1.0-1.5 times as long as the basal diameter of antennal segment III; 7th tergite with 8-10 hairs and 8th with 6 hairs, longest one about 26-30 μ and 29-33 μ long and about 1.3-1.6 times and 1.3-1.7 times as long as the basal diameter of antennal segment III, respectively. Siphunculi black, sclerotized, ring like, about 0.029-0.044 mm in diameter. Cauda semilunar with 12-14 hairs. Subanal plate sclerotised slightly indented with 29-31 hairs. Subgenital plate with about 24 pairs of hairs in 2-3 rows on posterior margin. Ventral hairs stouter than dorsal hairs. Legs brown, femora stout scabrous, femoral hairs short and pointed, tibiae with long and fine hairs, longest hair on hind tibiae 23-26 μ long, 0.58-0.66 times

Measurements in mm :

Specimen No.	Length	Width	Antena	Antennal segments				urs.	ht ₂
				III	IV	V	VI		
1.	2.23	1.07	0.95	0.34	0.11	0.16	(0.16 ₊ 0.03)	0.09	0.16
2.	2.33	1.13	0.93	0.35	0.11	0.13	(0.16 ₊ 0.03)	0.09	0.16
3.	2.20	1.08	0.93	0.34	0.11	0.14	(0.16 ₊ 0.03)	0.09	0.16
4.	2.34	0.89	0.96	0.35	0.12	0.16	(0.17 ₊ 0.03)	0.09	0.15

(1. Holotype, 2-4, Paratypes, alate viviparae female, from *Carpinus* sp. Trijuginarayan, UTTAR PRADESH, INDIA, 5. 6. 1978. Coll. D. K. Bhattacharya).

as long as the diameter at the middle of hind tibiae; tarsi and anterior most portion of tibiae spinulose, spinules on tarsi arranged in rows. First tarsal segments with 4, 4, 5. Empodial hairs 23-30 μ long, 0.63-0.69 times as long as the claws. Forewing with media simple, veins little dusky.

Type material : Holotype; alate viviparous female from *Carpinus* sp. Trijuginarayan, INDIA : UTTAR PRADESH, 5. 6. 1978 (Coll. D. Bhattacharya).

Paratypes : 13 alate viviparous females and 3 alatoid nymphs, collection data as in the holotype.

Remarks : Four valid species of *Kaltenbachella* Schouteden 1906, are now recognised, viz. *elshotriae* (Shinji) from Japan and Sri Lanka, *japonica* Matsumura from Japan, *pallida* (Haliday) from Holarctic region and Africa, *ulmifusa* (Walsh & Riley) from U.S.A. The typical life cycle (e.g. *pallida*) involves alternation between galls of *Ulmus* spp., and roots of Labiatae but some like *japonica* Matsumura and perhaps also *elshotriae*

(Shinji) complete their life cycle on *Ulmus* and *Elshotzia*. The present collection from *Carpinus*, where these insects form galls, indicate the existence of yet another species, completely different in its host-association, from all other known species. The species, seems closest to North American *ulmifusa* but differs in much larger size of body, in ratio of body to antenna, ultimate rostral segment to second joint of hind tarsus and in having more number of secondary rhinaria etc.

The type materials are deposited in the Department of Zoology, University of Kalyani, except 4 paratypes which are with Fauna Unit, Zoological Survey of India, Calcutta.

III. Tribe Fordini

E. On *Pistacia* (Das 1918)

Elongate horn shaped, pod like leaf gall, may be twisted, straight or curved, green or pink, old galls remaining often on trees; may often be very long and contains hundreds of aphids, N. W. India (Fig. 14). ...

... *Baizongia pistaciae* (Linnaeus).

F. On *Ailanthus glandulosus* (Chowdhury et al.)

Petiole gall, elongate without specific shape with a single cavity. Himachal Pradesh.....

Kaburagia aillantii Chowdhury et al.

G. On *Toona ciliata* (new record)

Epiphyllous, leaf-folding, covering, brick-red, elliptical, pouch gall on the margin of leaf blade. Uttar Pradesh...*Forda orientalis*

George

MATERIAL EXAMINED FROM GALLS

-
- | | |
|---|---|
| 1. <i>Baizonga pistaciae</i> Linnaeus | : 8 alatae and nymphs, INDIA : U. P. : Dhakuri, 25. x. 1970. Coll. S. Chakrabarti. |
| 2. <i>Eriosoma ulmi</i> Riley | : 3 apterae, 4 alatae and nymphs ; INDIA : KASHMIR ; 22.v.1979. Coll. D. K. Bhattacharya. |
| 3. <i>Eriosoma kashmiricum</i> L. K. Ghosh et al. | : One aptera, many alatae and nymphs, INDIA : U. P. ; Ghangaria, 10. vi. 1978. Coll. S. Chakrabarti. |
| 4. <i>Eriosoma phoenax</i> Mordvilko | : Many apterae, 5 alatae and nymphs, INDIA : U. P. ; Bhowali, 24. v. 1969. Coll. S. Chakrabarti. |
| 5. <i>Epipemphigus imaicus</i> Chelodkovsky | : Many apterae, alatae and nymphs, INDIA : U. P. ; Mussoorie, 20. vi. 1975 Coll. S. Chakrabarti ; 21. vi. 1976 ; Coll. S. P. Maity ; HIMACHAL PRADESH ; Simla, 16. v. 1979. Coll. D. K. Bhattacharya. |
| 6. <i>Forda orientalis</i> George | : Many apterae, 7 alatae and nymphs, INDIA : U. P. ; New Forest, Dehradun, 21. vi. 1976, Mussoorie, 23. vi. 1976. Coll. S. Chakrabarti. |
| 7. <i>Kaburagia aillantii</i> Chowdhury et al. | : 4 alatae and nymphs, INDIA ; U. P. ; Sundardonga valley, 18.x. 1970. Coll. A. N. Chowdhuri. |
| 8. <i>Kaltenbechiella carpinicola</i> sp. nov. | : 6 alatae, INDIA : U. P. ; Trijuginarayan, 5. vi. 1978. Coll. D. K. Bhattacharya. |
| 9. <i>Pemphigus mordvilkoii</i> Chelodkovsky | : Many apterae, alatae and nymphs, INDIA : U. P. ; Mussoorie, 21. vi. 1976. 16, x. 1976, 19. x. 1976. Coll. S. P. Maity. |
| 10. <i>Pemphigus</i> sp. | : 2 apterae and nymphs, INDIA ; U. P. ; Ghangaria, 10. vi. 1978. Coll. S. Chakrabarti, Lanka 8. vi, 1980, Coll. D. K. Bhattacharya. |
| 11. <i>Prociphilus alnifoliae caryae</i> Baker & Davidson | : A alatae and nymphs, INDIA : HIMACHAL PRADESH Simla, 13. v. 1979. Coll. S. P. Maity. |
| 12. <i>Prociphilus xylostei</i> (de Geer) | : Many apterae and 10 alatae and nymphs, INDIA : U. P. ; Ghangaria, 13. vi. 1978. Coll. D. K. Bhattacharya. |
| 13. <i>Tetraneura ulmi</i> Linnaeus | : Many apterae, 4 alatae and nymphs, INDIA : KASHMIR, 22. v. 1979. Coll. D. K. Bhattacharya. |
| 14. <i>Tetraneura nioriabdominalis</i> (Sasaki) | : 2 apterae and nymphs, INDIA ; U. P. ; Ghangaria, 10. vi. 1978. Coll. D. K. Bhattacharya. |
| 15. <i>Thecabius affinis</i> Kaltenbaci | : 5 apterae and nymphs, INDIA ; U. P. ; Kedarnath, 3. vi. 1978. Coll. S. Chakrabarti. |
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GHOSH *et al*

PLATE IV

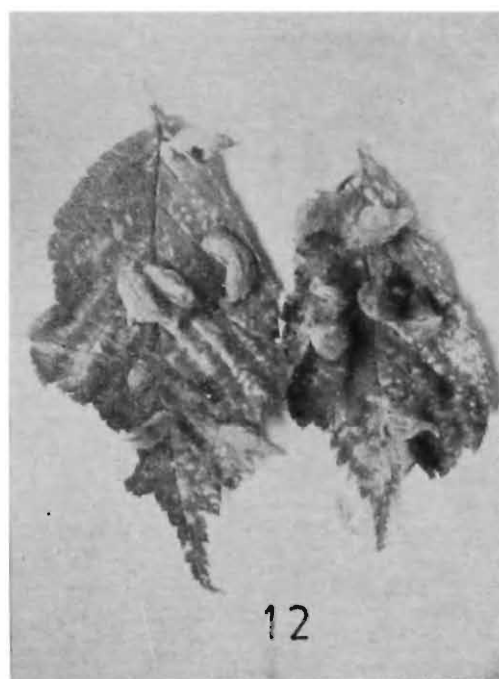
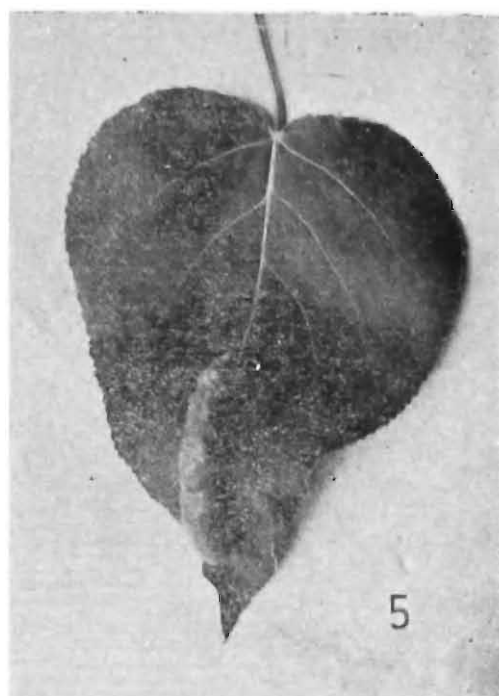
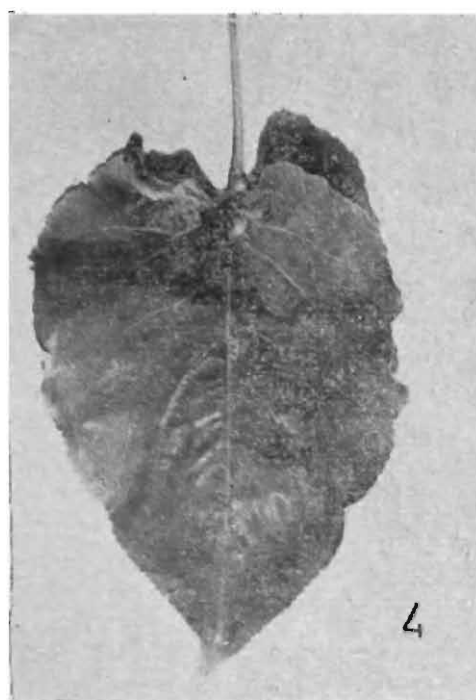


Fig. 4. Leaf gall of *Pemphigus* sp. on *Populus* sp.

Fig. 5. Leaf gall of *Epipemphigus imaicus* on *Populus* sp.

Fig. 11. Leaf gall of *Eriosoma kashmiricum* on *Ulmus* sp.

Fig. 12. Leaf gall of *Tetraneura nigriabdominalis* on *Ulmus* sp.

DISCUSSION

Schoutedon (1905) described a new genus and a species *Ceratopemphigus zehntneri*, from 'large foliate galls on undetermined shrubs', and opined that the 'shrub is possibly *Pistacia*'. Howard (1922) and Mani (1948) quoted from Schoutedon (op. cit.) ; Doncaster (1956) redescribed the species from another plant, *Brunfelsia uniflora* and did not mention anything about the galls. It is known that members of Pemphiginae have Poplar (Pemphigina) or Conifers (Prociphilina) as Primary host and have never been reported from *Pistacia* ; as such leaf gall on undetermined plant may not belong to *Pistacia* ; in case, *Brunfelsia* is recorded as secondary host, the genus and species could clearly be more closely correlated with *Prociphilus* (which has an array of primary hosts), as Doncaster (op. cit.) has already shown it taxonomically. But the question remains about the identity of the plant on which foliage gall were found.

Mani (1973) in his pioneering work on 'Plant Galls of India', listed four galls caused by unidentified aphids on *Ulmus wallichiana* (Gall No. 493), *Ulmus luevigata* (Gall 591), *Populus nigra* (Gall 590) and *Populus ciliata* (Gall 592) : All these must have been formed by some Pemphigids as no other aphid would form gall on Elms and Poplars ; the gall 493 may belong to a *Tetraneura* species, while gall 591 appear to be formed by *Schizoneura* species ; Mani, (op. cit.) also mentions a gall, i.e., 112, to be formed by *Schizoneura campestris* but no such species is known in Aphididae and this may refer to *Eriosoma* (S.) *ulmi*. Gall 590 on *P. nigra* and 592 on *P. ciliata* appear to be formed by some *Pemphigus* species (as it is, only two species *Pemphigus immunis* Buckton and *Pemphigus spyrotheceae* Passerini, are known from *P. nigra* and at

least 6 spp. are known from *P. ciliata*, (see Table 1).

It may be mentioned that *Dasia aedificator* (p. 320, Mani) on *Pistacia integerrima* and unknown aphid on *Pistacia khinjuk*, should both refer to *Baizongia pistaciae* (Linnaeus), as the galls described therein could only be formed by this aphid species.

Two galls on Rosaceae (Gall 422, 417) formed by unidentified aphids have been reported by Mani (op. cit.) which may be caused by some *Schizoneura* species (as secondary host) or even by *Brachycaudus* or some *Myzus* species, as often members these genera show preference for Rosaceae hosts.

The present paper outlines several aspects which need further investigation. Records of galls appear to be very few and from restricted collections localities ; as most of the plant species occurs in wide spread areas of temperate climate in North-west India, it is most likely that a more extensive survey of aphid-galls may reveal a better picture of occurrence of these galls and aphid species. This may also help to locate primary host of many of the other species, which have so far been reported only from secondary hosts ; new records of at least 8 species from plant-galls in this paper through recent surveys is noteworthy. Biological knowledge of many pemphigid species in the region remain far from complete and correlation of material from both primary (wherever existent) and secondary host could only solve the problem.

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A NEW GENUS AND A NEW SPECIES OF FLYING SQUIRREL (MAMMALIA :
RODENTIA : SCIURIDAE) FROM NORTHEASTERN INDIA

By

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ABSTRACT

A new genus and a new species of flying squirrel (Rodentia : Sciuridae) from Namdapha, Tirap District, Arunachal Pradesh, India, a proposed Biosphere Reserve in northeastern India, have been described.

This new genus is distinguished by having a combination of characters found in several separate genera and, so far known, is monotypic. The type species, also a new taxon, is characterized by its gorgeous red, white and gray colours on the dorsum and the ventrum being largely white.

INTRODUCTION

Recently, in course of a faunistic survey in Namdapha, Tirap District, Arunachal Pradesh, a proposed Biosphere Reserve area, during March-May 1981, a team headed by Dr. Shyamrup Biswas, Zoologist of the Zoological Survey of India, collected a unique flying squirrel. After critical examination, it was found to be an undescribed form belonging to a hitherto undescribed genus.

Since it will take some time to work out and report upon the entire collection, opportunity is taken to describe the new genus and the new species of this flying squirrel in the present communication.

All measurements are expressed in millimetres unless otherwise stated. Cranial measurements are taken after Ellerman (1963). Names of colours with initial capital letters are after Ridgway (1912).

SYSTEMATIC ACCOUNTS

Order RODENTIA

Family SCIURIDAE

Subfamily PETAURISTINAE

Genus **Biswamoyopterus***, new genus

DESCRIPTION

Size large, total length 1010 mm, head and body being 405 mm. Has a distinct inter-femoral membrane connecting the basal one third of the tail. The tail is cylindrical, not distichous. Pelage thick, soft and gorgeously coloured on the dorsum, the ventrum being largely white. Each ear conch; apparently denuded, has tufts of long hairs at the base, one at the anterior margin, one at the posterior margin and another on the dorsal part.

Cranially, it is characterized by large orbit, very large bulla, relatively shorter palate

* The generic name has been derived in honour of Dr. Biswamoy Biswas, Joint Director (Retired), Zoological Survey of India, who has been my mentor since last twenty years.

ending in line with the tooth row, deeply notched frontal depression, wider zygomatic width, and the zygomatic spring and muzzle giving an overall acute triangular outline to the skull in dorsal profile.

In dentition, it is characterized by the following features. The incisors are not pigmented with red although the white enamel is patchily stained with dark brown, and the upper incisors are feebly grooved on the inner margin (Plate V, Fig. C). Cheek teeth are brachydont but simplified and strongly cuspidate, lacking wrinkles and sculptures on enamel. Each molariform tooth is subtriangular in outline with the blunt apex on the lingual side. Both the upper premolars are functional. Pm^3 occupies the middle of the internal half of the tooth row. On the upper series Pm^4 is the largest tooth with three strong cusps, well separated from each other, are placed on the labial side and one strong cusp on the lingual side; another small cusp is present in the middle of the posterior transverse ridge. M^1 and M^2 are with two prominent cusps on the labial side and two on the lingual side, of which the postero-internal cusp is lowest; another feeble cusp is present on the posterior transverse ridge. M^3 strongly built and has a deep central valley with one major cusp on either side of it placed anteriorly; the margin of the tooth is sharply laminated, more prominently so on the posterior part. The transverse ridges on the molariform teeth are obliquely placed connecting the posterior cusp of the labial side with the anterior cusp of the lingual side. The lower M_3 is, however, the largest tooth in the combined upper and lower series. The lower molariform teeth are rhomboid in outline (Plate V, Fig. A, B).

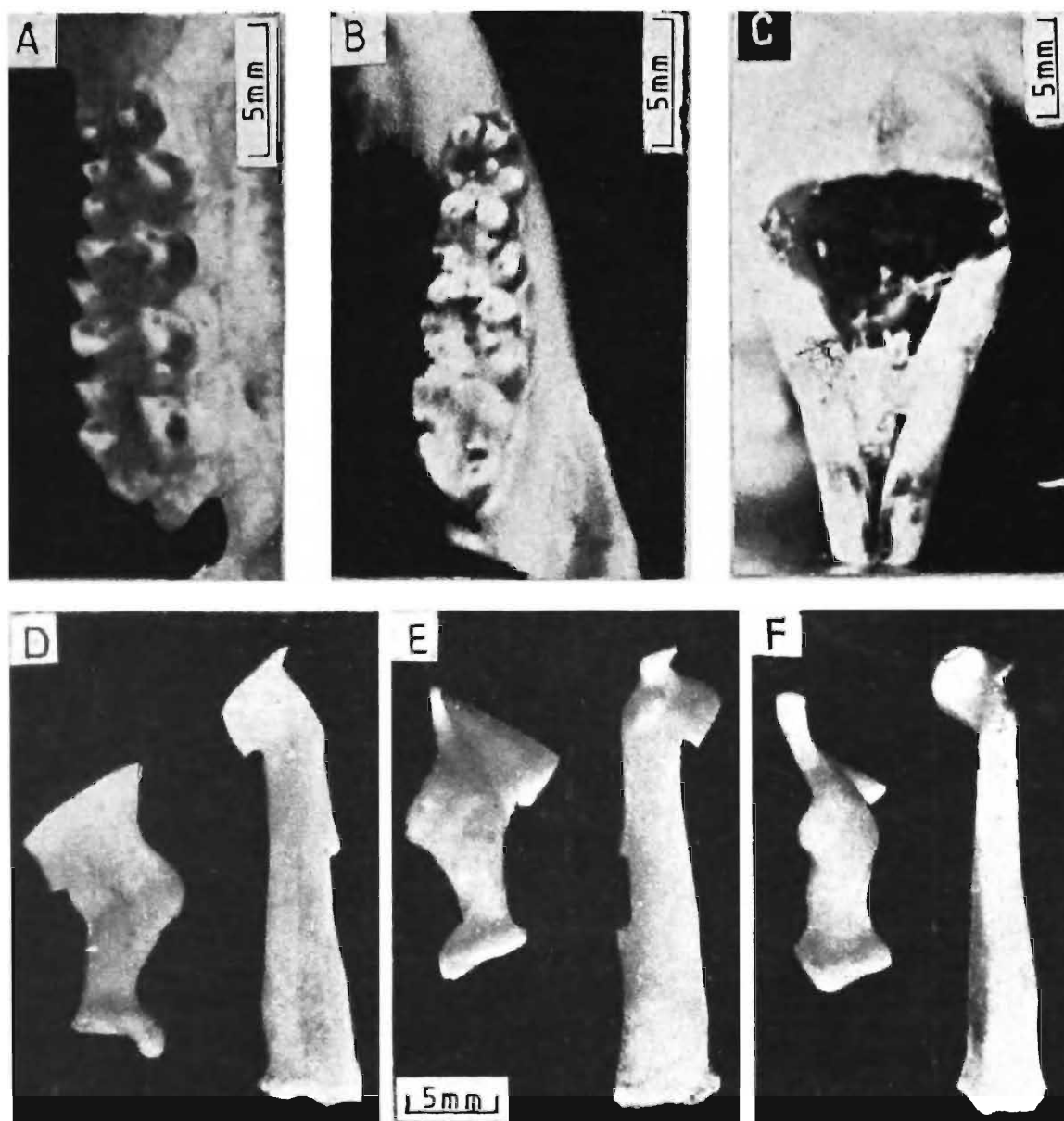
The baculum is strongly built; apex

hollowed and spatulated but is very short in length. The proximal part has a short but robust shaft and the distal apical part large, flattened and curved into a very wide spout, without any accessory structures (Plate V, Fig. D, E, F).

DISCUSSION

The new genus exhibits a combination of characters that are present in several distinct genera and are of much taxonomic values. In external features, it resembles the giant flying squirrels of the genus *Petaurista* Link, 1795, in its large size, cylindrical and non-distichous tail, and by the presence of a well developed interfemoral membrane. These characters are also found in *Aeretes* Allen, 1940 and *Aeromys* Robinson & Kloss, 1915. But, the present genus differs from those three genera by detailed taxonomic characters, externally by the presence of ear tufts and in dentition. Ear tufts are also found in *Belomys* Thomas, 1908 and *Trogopterus* Heude, 1898 but these two genera do not have any interfemoral membrane and their tail is not cylindrical but distichous.

In dentition, the new genus has the unique feature of its incisors being not pigmented with red as they are in all other known flying squirrels. The cheek teeth are brachydont but much simplified and strongly cuspidate. Enamel of the cheek teeth is not wrinkled or sculptured as found in the giant flying squirrels, specially, *Petaurista*. Simplified molariform teeth retained much of the basic *Sciurus*-type pattern, similar to *Hylopetes* Thomas, 1908 and *Aeromys*, but differ from them by upper Pm^4 being larger than M^1 as found in *Belomys* and *Trogopterus*. It differs from the last two genera who have compli-



- A. Upper tooth row (right side) of the Holotype of *Biswamoyopterus biswasi* Saha.
 B. Lower tooth row (right side) of the same.
 C. Upper incisors (in front view) of the same to show the unpigmented enamel although patchily stained and very feebly grooved inner margin of each tooth.
 D. Baculum of the Holotype of *Biswamoyopterus biswasi* Saha (left) compared with that of *Petaurista candidulus* Wroughton (right) in dorsal view.
 E. The same in ventral view.
 F. The same in lateral view (right side).



Dorsum of the Holotype of *Biswamoyopterus biswasi* Saha
(the dead animal before skinning).



Dorsum of the Holotype of *Biswamoyopterus biswasi* Saha
(the dead animal before skinning).

S. S. SAHA

PLATE VI C



Close up of the head region to show the ear tufts of Holotype of *Biswamoyopterus biswasi* Saha (the dead animal before skinning).

cated cheek teeth with much wrinkles and folds on enamel and also by other details.

The baculum of the new genus, at the first glance, appears similar to that of *Belomys* but the nature of curvature of the apical spatulate hook and absence of accessory structure it differs from that in *Belomys*.

This new genus like *Aeromys*, abridges the giant flying squirrels and the smaller flying squirrels. To the former by presence of inter-femoral membrane and non-distichous, cylindrical tail and with the latter by much simplified brachydont molariform teeth retaining much of the basic *Sciurus*-type pattern and also by presence of ear tufts as found in some smaller flying squirrels.

The new genus *Biswamoyopterus* Saha, so far known, is monotypic and represented by the type species which is also a new species described below.

Biswamoyopterus biswasi*, new species

DESCRIPTION

Colouration : body above, in general, Morocco Red grizzled with white, a conspicuous blob of Pale Violet Gray present on the top of crown ; patagium glossy Mehgony Red ; particoloured tail beyond interfemoral membrane proximally Pale Smoky Gray, changing distally to Vinaceous Rufous, then to Hay's Russet and finally to Clove Brown near tip, the proximal gray part is also washed with red ; muzzle mostly Vinaceous Rufous changing to a broad ring of Mehgony Red around eyes ; a narrow black line forms the nasal bridge ; hands and feet darker than body ; ear tuft on posterior margin silvery white but that of anterior margin basally

white and changing to Morocco Red distally, some all silvery white hairs are also mixed up with those bicoloured hairs, tufts on dorsal base of the ear Morocco Red and extending to middle of the neck from each side ; neck region otherwise coloured Mehgony Red ; some silvery white hairs are scattered over forehead and cheeks ; forehead is washed with red because of the hairs of that region being faintly tipped with red ; lower cheeks mixed gray and white. Body below is white with hairs having Pearly Gray bases ; patagium below washed with faint Orange-Rufous ; interfemoral membrane with a band of Pale Morocco Red near margin, the margin is also grizzled with gray and white, more so near tail root ; underarm Mehgony Red, intensified distally ; underfeet Morocco Red near ankles ; a black line running from each side of propatagium extends to wrist and margin of the palm, this also extending over dorsal side of manus, particularly to fingers ; margins of soles of feet black ; lateral margin of patagium and scrotal sac Vinaceous Slate grizzled with silvery white ; distal end of scrotal sac adorned with long hairs which are tipped Vinaceous Rufous ; chin dusky with a spot of Clove Brown below lower lip. (Plate VI, Figs. A, B).

Each hair on dorsum is banded with gray basally and red distally, but pattern is different in different region. Each body hair is coloured Vinaceous Slate and Smoky Gray on basal onethird and red on remaining part. White hairs that produce grizzled effect are basally gray, middle part white and finely tipped with black. Hairs on loin and outer part of patagium Orange Cinnamon on base and red on distal part. Underwool coloured intense

* The species name has been derived after the collector of the Holotype, Dr. Shyamrup Biswas, Zoologist, Zoological Survey of India, the Leader of the Namdapha Expedition, 1981.

cinnamon. Each hair on proximal twothird of tail banded by various shades of colours from base to tip and arranged in the following manner : Vinaceous Slate (20%), Pale Smoky Gray (next 40%), Orange Cinnamon (15%), Vinaceous Rufous (10%) and the remaining free end (5%) being Hay's Russet to Clove Brown ; in similar fashion, each hair on distal onethird of tail Orange Cinnamon (10%), Pale Smoky Gray (next 30%), Orange Cinnamon again (5%) and the rest (55%) grading from Hay's Russet to Clove Brown. Intensity of gray on tail decreases with the increase of russet and brown from proximal to distal region.

Cranial features are characterized by the following : very large orbit (33.9% of occipitonasal length), bulla enlarged and inflated (21.4%), large palatal foramina (8.84%), foramen magnum much enlarged, frontal depression very deeply notched, zygomatic arch much wide (65.6%), interparietal well demarcated, fronto-parietal ridge strong anteriorly and confluent with posterior rim of postorbital process, the latter is more flat and broad, transverse flank of squamosal that contributes to zygomatic arch is flat, broad and convex anteriorly, occipital plane much convex, peroccipital process very short and closely inclined to tympanic bulla, the latter being very large and approaching each other anteriorly resulting narrowed anterior part of basioccipital and posterior part of basisphenoid, intermaxillary foramen conspicuously large.

Short and robust baculum has a dumbbell-shaped twisted proximal shaft and widely expanded and upturned distal apical part, the latter is very broad and curved, and projecting from the left hand side like a spout of jug ; apical part is subequal to shaft in length.

Type Material : *Holotype* one male ; skin, skull and baculum, deposited in the National Zoological Collection, Zoological Survey of India, Calcutta, Z.S.I. Reg. No. 20705, collected by Shyamrup Biswas on 27 Apr. 1981.

Type Locality : Deban, (alt. c. 350 metre), 26 km east of Miao, Namdapha, Tirap District, Arunachal Pradesh, India.

Measurements of the Holotype : External : head and body 405, tail 605, hindfoot 78 (with claws 83), ear 46, greatest patagial expanse 760, interfemoral membrane connects 186 of tail length from roct.

Cranial : occipitonasal 72.4, condylobasal 70.1, palate 34.7, diastema 15.7, palatal foramina 6.4, bulla 15.5, upper tooth row 15.5, nasal 20.9, orbit 24.6, frontal length 28.6, least interorbital width 19, greatest zygomatic width 47.5 ; upper teeth : Pm^s 2.4, Pm^4 4.4, M^1 3.6, M^2 3.6, M^3 3.4 ; lower teeth : Pm^4 2.9, M_1 3.4, M_2 3.4, M_3 4.4.

Baculum : total length 16.7, shaft length 11.5, width of apical hook 6.8.

DISCUSSION

This new species, which may be called the Namdapha Flying Squirrel, is a beautifully coloured animal with gorgeous fur. In brilliance of coat colour, it approximates to some species of the genus *Petaurista*, specially to *Petaurista taylori* Thomas.

The Holotype was collected at early hours of evening (at 20.15 hrs) from a lofty Nahar tree (*Mesua ferrea*). Another species of flying squirrel, namely, *Petaurista candidulus* Wroughton, fairly common in that terrain, was also found foraging near by. The range of this new species, so far known, is only in the catchment area of the Noa Dihing River, particularly on the western slope of the Patkai Range in Namdapha area. Its extraordinary

characters as well as its range of distribution are of important academic interest, particularly in regard to its bearing on the phylogeny of flying squirrels and zoogeography of the region.

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FURTHER STUDY ON THE ASPECTS OF POPULATION FLUCTUATIONS OF PHLEBOTOMID SANDFLIES (DIPTERA : PHLEBOTOMIDAE) IN NORTH BIHAR

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ABSTRACT

This paper deals with the continued study of numerical fluctuation of populations of phlebotomid sandflies of Darbhanga, Sitamarhi, Samastipur and Muzaffarpur districts of North Bihar for two more years, i.e., from November 1979 to September 1981. A total number of 14,587 flies belonging to *Phlebotomus argentipes* Annandale and Brunetti, *Phlebotomus papatasi* Scopoli and *Sergentomyia babu* (Annandale) were collected, the increase and decrease of their populations are discussed in relation to abiotic factors, and the cause for the spurt in population is also discussed.

INTRODUCTION

In the earlier paper (1981), I had given in detail the significance of the study, a brief description of the nature of the terrain along with a map showing the collection localities, an account of the different kinds of houses of North Bihar, the mode of collection of phlebotomid sandflies, a graphical representation of the flies collected, their seasonal abundance for one year, etc. The present paper deals with the continuation of this study for two more years, i.e., from November 1979 to September 1981, and regular bimonthly collections of flies were made per man hour from all the same eleven localities—three each from Muzaffarpur (Chapralasgipur, Sipahapur and Pirocha), Sitamarhi (Gotbavadevpur, Sakanbavadevpur and Thumma) and Samastipur (Tajpur, Adharpur and Shambu Patti) districts and two from Darbhanga (Derhar and Khansi Simidi) district.

RESULTS

A total number of 14,587 flies belonging to *Phlebotomus papatasi* Scopoli, *P. argentipes* Annandale and Brunetti and *Sergentomyia babu* (Annandale) were collected from Darbhanga, Sitamarhi, Samastipur and Muzaffarpur districts (Table I-VIII). It can be seen from the tables that as in the first year *P. papatasi* is the predominant species followed by *S. babu* and *P. argentipes*. In cases of *P. papatasi* and *S. babu* the females outnumbered the males whereas in *P. argentipes* both sexes are almost equal in number (total number of females 256, total number of males 250). However, in the first year study (1978-79) in the case of *P. argentipes* it was observed that the females were lesser (48) than the males (82). Overall analysis shows that the total population contains 87.34% *P. papatasi*, 2.43% *P. argentipes* and 10.23% *S. babu* in 1979-80, and 84.88% *P. papatasi*, 4.44% *P. argentipes* and 10.68% *S. babu* in 1980-81, the only notable

TABLE I.—*Phlebotomid sandflies collected per man hour from indoors in Darbhanga District from November 1979 to September 1980 along with climatological data*

	Nov. 79			Jan. 80			March 80			May 80			July 80			Sept. 80			Total	% of the grand total
Name of species	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	33	81	114	1	—	1	22	68	90	83	138	221	187	322	509	147	309	456	1391	82.36
<i>P. argentipes</i>	7	8	15	—	—	—	3	—	3	—	—	—	4	2	6	12	21	33	57	3.37
<i>S. babu</i>	12	23	35	1	1	2	10	13	23	24	26	50	38	56	94	15	22	37	241	14.27
Grand total	52	112	164	2	1	3	35	81	116	107	164	271	229	380	609	174	352	526	1689	100.00
Temp. Mean maxi °C	29.7			23.6			32.2			35.0			33.6			32.6				
Temp. Mean mini °C	18.7			12.5			19.8			26.1			27.9			27.1				
Mean monthly rainfall (mm)	2.6			0.1			0.8			4.8			13.8			5.5				
Mean monthly humidity (%) at 17.30	70.4			70.4			52.8			63.8			82.7			81.3				
Mean wind velocity (Km. p. h) at 08.30	0.0			0.3			0.8			2.7			1.4			1.3				

TABLE II.—*Phlebotomid sandflies collected per manhour from indoors in Darbhanga District from November 1980 to September 1981 along with climatological data*

	Nov. 80			Jan. 81			March 81			May 81			July 81			Sept. 81			Total	% of the grand total
Name of species	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	16	52	68	—	—	—	18	25	43	67	140	207	184	306	490	162	317	479	1287	71.86
<i>P. argentipes</i>	46	70	116	—	—	—	22	13	35	6	14	20	15	11	26	5	—	5	202	11.28
<i>S. babu</i>	7	12	19	—	—	—	26	37	63	21	41	62	43	68	111	19	28	47	302	16.86
Grand total	69	134	203	—	—	—	66	75	141	94	195	289	242	385	627	186	345	531	1791	100.00
Temp. mean maxi °C	26.5			16.7			27.3			33.8			28.5			29.8				
Temp. mean mini °C	20.0			8.6			18.7			24.6			25.6			25.6				
Mean monthly rainfall (mm)	0.0			0.6			1.2			1.7			20.2			7.1				
Mean monthly humidity (%) at 17.30	63.3			72.8			45.3			62.1			81.9			78.2				
Mean wind velocity (Km. p. h) at 08.30	0.0			0.3			1.3			2.0			1.8			3.3				

TABLE III.—*Phlebotomid sandflies collected per man hour from indoors in Sitamarhi District from November 1979 to September 1980 along with climatological data*

Name of species	Nov. 79			Jan. 80			March 80			May 80			July 80			Sept. 80			Total	% of the grand total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	65	160	225	—	—	—	152	142	294	198	294	492	382	473	855	276	364	640	2506	87.26
<i>P. argentipes</i>	2	1	3	—	—	—	1	3	4	1	2	3	3	1	4	14	17	31	45	1.57
<i>S. babu</i>	16	19	35	—	—	—	27	32	59	27	33	60	36	78	114	22	31	53	321	11.18
Grand total	83	180	263	—	—	—	180	177	357	226	329	555	421	552	973	312	412	724	2872	100.01
Temp. mean maxi °C	29.7			23.6			32.2			35.0			33.6			32.3				
Temp. mean mini °C	18.7			12.5			19.8			26.1			27.9			27.1				
Mean monthly rainfall (mm)	2.6			0.1			0.8			4.8			13.8			5.5				
Mean monthly humidity (%) at 17.30	70.4			70.4			52.8			63.8			82.7			81.3				
Mean wind velocity (Km. p. h) at 08.30	0.0			0.3			0.8			2.7			1.4			1.3				

TABLE IV.—*Phlebotomid sandflies collected per man hour from indoors in Sitamarhi District from November 1980 to September 1981 along with climatological data*

Name of species	Nov. 80			Jan. 80			March 81			May 81			July 81			Sept. 81			Total	% of the grand total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	45	115	160	—	—	—	105	91	196	217	291	508	407	529	936	338	474	812	2612	86.49
<i>P. argentipes</i>	3	3	6	—	—	—	9	7	16	7	7	14	21	14	35	4	1	5	76	2.52
<i>S. babu</i>	28	41	69	—	1	1	29	34	63	20	26	46	35	59	94	22	37	59	332	10.99
Grand total	76	159	235	—	1	1	143	132	275	244	324	568	463	602	1065	364	512	876	3020	100.00
Temp. mean maxi °C	26.5			16.7			27.3			33.8			38.5			29.8				
Temp. mean mini °C	20.0			8.6			18.7			24.6			25.6			25.6				
Mean monthly rainfall (MM)	0.0			0.6			1.2			1.7			20.2			7.1				
Mean monthly humidity (%) at 17.30	63.3			72.8			45.3			62.8			81.9			78.2				
Mean wind velocity (Km. p. h) at 08.30	0.0			0.3			1.3			2.0			1.8			3.3				

TABLE V.—*Phlebotomid sandflies collected per man hour from indoors in Samastipur District from November 1979 to September 1980 along with climatological data*

Name of species	Nov. 79			Jan. 80			March 80			May 80			July 80			Sept. 80			Total	% of the grand total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	22	37	59	—	—	—	11	19	30	43	52	95	76	133	209	78	124	202	595	81.84
<i>P. argentipes</i>	2	4	6	—	—	—	5	3	8	2	11	13	6	8	14	9	9	18	59	8.12
<i>S. babu</i>	2	3	5	—	—	—	4	6	10	7	7	14	12	16	28	3	13	16	73	10.04
Grand total	26	44	70	—	—	—	20	28	48	52	70	122	94	157	251	90	146	236	727	100.00
Temp. mean maxi °C	29.3			23.0			31.2			34.6			32.3			32.7				
Temp. mean mini °C	17.9			8.9			14.7			21.5			25.5			25.2				
Mean monthly rainfall (mm)	2.9			0.1			0.5			2.7			15.4			5.7				
Mean monthly humidity (%) at 17.30	79.7			69.7			47.9			73.6			83.4			79.9				
Mean wind velocity (Km. p. h) at 08.30	0.6			1.3			2.4			3.6			2.5			2.5				

TABLE VI.—*Phlebotomid sandflies collected per man hour from indoors in Samastipur District from November 1980 to September 1981 along with climatological data*

Name of species	Nov. 80			Jan. 81			March 81			May 81			July 81			Sept. 81			Total	% of the grand total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	29	54	83	—	—	—	14	27	41	37	49	86	88	163	251	91	148	239	700	85.89
<i>P. argentipes</i>	3	4	7	—	—	—	2	1	3	—	—	—	9	7	16	8	3	11	37	4.54
<i>S. babu</i>	—	4	4	—	—	—	2	8	10	7	4	11	9	21	30	7	16	23	78	9.57
Grand total	32	62	94	—	—	—	18	36	54	44	53	97	106	191	297	106	167	273	815	100.00
Temp. mean maxi °C	31.4			22.3			28.6			35.0			33.2			33.5				
Temp. mean mini °C	21.9			10.2			17.0			23.1			27.3			28.5				
Mean monthly rainfall (mm)	0.0			0.8			1.3			1.8			17.5			6.5				
Mean monthly humidity (%) at 17.30	71.6			75.1			48.9			61.3			83.8			81.3				
Mean wind velocity (Km. p. h) at 08.30	0.4			1.4			1.9			3.3			2.5			5.8				

TABLE VII.—*Phlebotomid sandflies collected per man hour from indoors in Muzaffarpur District from November 1979 to September 1980 along with climatological data*

Name of species	Nov. 79			Jan. 80			March 80			May 80			July 80			Sept. 80			Total	% of the grand total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	63	92	155	1	—	1	47	91	138	105	156	261	228	385	613	192	296	488	1656	94.57
<i>P. argentipes</i>	—	—	—	—	—	—	2	—	2	—	2	2	1	1	2	3	1	4	10	0.57
<i>S. babu</i>	3	5	8	—	2	2	4	7	11	9	11	20	13	20	33	3	8	11	85	4.85
Grand total	66	97	163	1	2	3	53	98	151	114	169	283	242	406	648	198	305	503	1751	99.99
Temp. mean maxi °C	29.3			23.0			31.2			34.6			32.3			32.7				
Temp. mean mini °C	17.9			8.9			14.7			21.5			25.5			25.2				
Mean monthly rainfall (mm.)	2.9			0.1			0.5			2.7			15.4			5.7				
Mean monthly humidity (%) at 17.30	79.7			69.7			47.9			73.6			83.4			79.9				
Mean wind velocity (Km. p. h) at 08.30	0.6			1.3			2.4			3.6			2.5			2.5				

TABLE VIII.—*Phlebotomid sandflies collected per man hour from indoors in Muzaffarpur District from November 1980 to September 1981 along with climatological data*

Name of species	Nov. 80			Jan. 80			March 81			May 81			July 81			Sept. 81			Total	% of the grand total
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
<i>P. papatasi</i>	80	135	215	—	—	—	73	126	199	143	201	344	224	356	580	173	297	470	1808	94.07
<i>P. argentipes</i>	—	—	—	—	—	—	5	1	6	1	—	1	4	3	7	3	3	6	20	1.04
<i>S. babu</i>	5	11	16	—	—	—	11	4	15	7	12	19	11	19	30	6	8	14	94	4.89
Grand total	85	146	231	—	—	—	89	131	220	151	213	364	239	378	617	182	308	490	1922	100.00
Temp. mean maxi °C	31.4			22.3			28.6			35.0			33.2			33.5				
Temp. mean mini °C	21.9			10.2			17.0			23.1			27.3			28.5				
Mean monthly rainfall (mm)	0.0			0.8			1.3			1.8			17.5			6.5				
Mean monthly humidity (%) at 17.30	71.6			75.1			48.9			61.3			83.8			81.3				
Mean wind velocity (Km. p. h) at 08.30	0.4			1.4			1.9			3.3			2.5			5.8				

TABLE IX.—*Relationship between sandflies and variables (temperature, rainfall and humidity)*

	Correlation coefficient between number of sandflies and variables	Regression line of number of sandflies (Y) on variables (X) $Y = a + bx$
<i>Darbhanga District</i>		
<i>P. papatasi</i>		
Temperature	0.6131**	$Y = -601.16 + 31.43 x$
Humidity	0.7942*	$Y = -641.39 + 12.94 x$
<i>S. babu</i>		
Rainfall	0.8423*	$Y = 28.38 + 4.16 x$
<i>Samastipur District</i>		
<i>P. papatasi</i>		
Temperature	0.8084*	$Y = -463.64 + 21.75 x$
Rainfall	0.8193*	$Y = 63.91 + 11.73 x$
Humidity	0.7777*	$Y = -215.53 + 4.85 x$
<i>P. argentipes</i>		
Temperature	0.7421*	$Y = -19.63 + 1.12 x$
Rainfall	0.6293**	$Y = 7.85 + 0.50 x$
Humidity	0.6599**	$Y = -5.94 + 0.23 x$
<i>S. babu</i>		
Temperature	0.6576**	$Y = -36.13 + 1.88 x$
Rainfall	0.9179*	$Y = 8.61 + 1.28 x$
<i>Sitamarhi District</i>		
<i>P. papatasi</i>		
Humidity	0.6353**	$Y = -1548.89 + 32.92 x$
<i>Muzaffarpur District</i>		
<i>P. papatasi</i>		
Temperature	0.8643*	$Y = -685.76 + 38.20 x$
Rainfall	0.8621*	$Y = 169.76 + 28.73 x$
<i>S. babu</i>		
Temperature	0.6886**	$Y = -20.40 + 1.4 x$
Rainfall	0.8284*	$Y = 9.39 + 1.28 x$

*Significant at 1% level.

**Significant at 5% level.

variation being the increase in the population of *P. argentipes* in the third year of the study.

Relationship between sandfly population and climatological factors: Data pertaining to climatological factors and population density

of sandflies were subjected to statistical analysis for finding out regression correlation and dependence of the number of sandflies (Y) on each variable (temperature, rainfall and humidity) considered here (Table IX).

It has been found that in Darbhanga district the population of *P. papatasi* has shown significant correlation with temperature and humidity, and *S. babu* with rainfall; in Samastipur district the population of *P. papatasi* and *P. argentipes* with temperature, rainfall and humidity, and *S. babu* with temperature and rainfall; in Sitamarhi *P. papatasi* with humidity; and in Muzaffarpur *P. papatasi* and *S. babu* with temperature and rainfall.

Regression line were obtained by pooling together the data obtained during two years. The combined regression lines drawn along with respective scattered diagrams are shown in figures 5-20.

SEASONAL ABUNDANCE

The incidence of sandflies is similar to that of first year study, in extreme winter the flies are practically absent and their peak season in monsoon, i.e., from July to October. In summer the population is comparatively lower than in the monsoon. The number of flies caught per man hour varies from 0 in January to 437 in July 1981. As in the first year, sandfly activity is maximum in Sitamarhi district.

DISCUSSION

The pattern of seasonal abundance of *P. papatasi*, *P. argentipes* and *S. babu* for two years is similar to that of the first year. As pointed out in my earlier paper (1981), it is to be ascertained whether *P. argentipes* or *P. papatasi* is the vector of kala-azar in North Bihar or both of them are vectors side by side.

The application of insecticides was slowed down by the beginning of 1980 due to the decrease in the number of cases of kala-azar,

consequent to which there is a sudden increase in the fly activity. There is 30.47% increase in the number of flies in the second year and only a slight increase (7.23%) in the third year from the preceding year thus showing that the fly activity is more or less steady in the absence of systematic application of insecticides. Consequent to the spurt in fly activity we are sitting on a 'live volcano' which can erupt at any moment causing another outbreak of the dreaded kala-azar.

ADDITIONAL OBSERVATIONS

It has been found that the flies prefer moderately dirty or shabby corners to the extremely dirty or clean corners of the rooms. It may be due to the thick cobweb (on the contrary a little cobweb helps their resting) or a thick coat of dust present in the dirty corners which makes their resting difficult as they get entangled in the cobweb or their body gets covered with dust. Similarly the flies detest the extremely clean corners of the rooms, the reason of which is difficult to understand, perhaps it may be due to their difficulty in resting for longer periods on smooth surfaces.

Sandflies have been found hanging on the cobweb, which the collector may mistake for dead ones. When disturbed they dart and hang themselves again in cobweb, if available. While using the aspirator, if it is not sucked in with force, often the flies cling on to the surface and may escape as soon as the suction is over.

As mentioned in the earlier paper, flies are seldom found in brick-walled houses. Curiously enough, on two occasions from this type of houses also considerable number of flies have been collected during the peak season. The favourite resting places of the

flies are the dark corners of mud-walled houses, but in a few cases they have been found to occur in abundance in open rooms

with three or even two walls. Generally the flies are scarce or absent in cooking rooms because of the heat and smoke but exceptio-

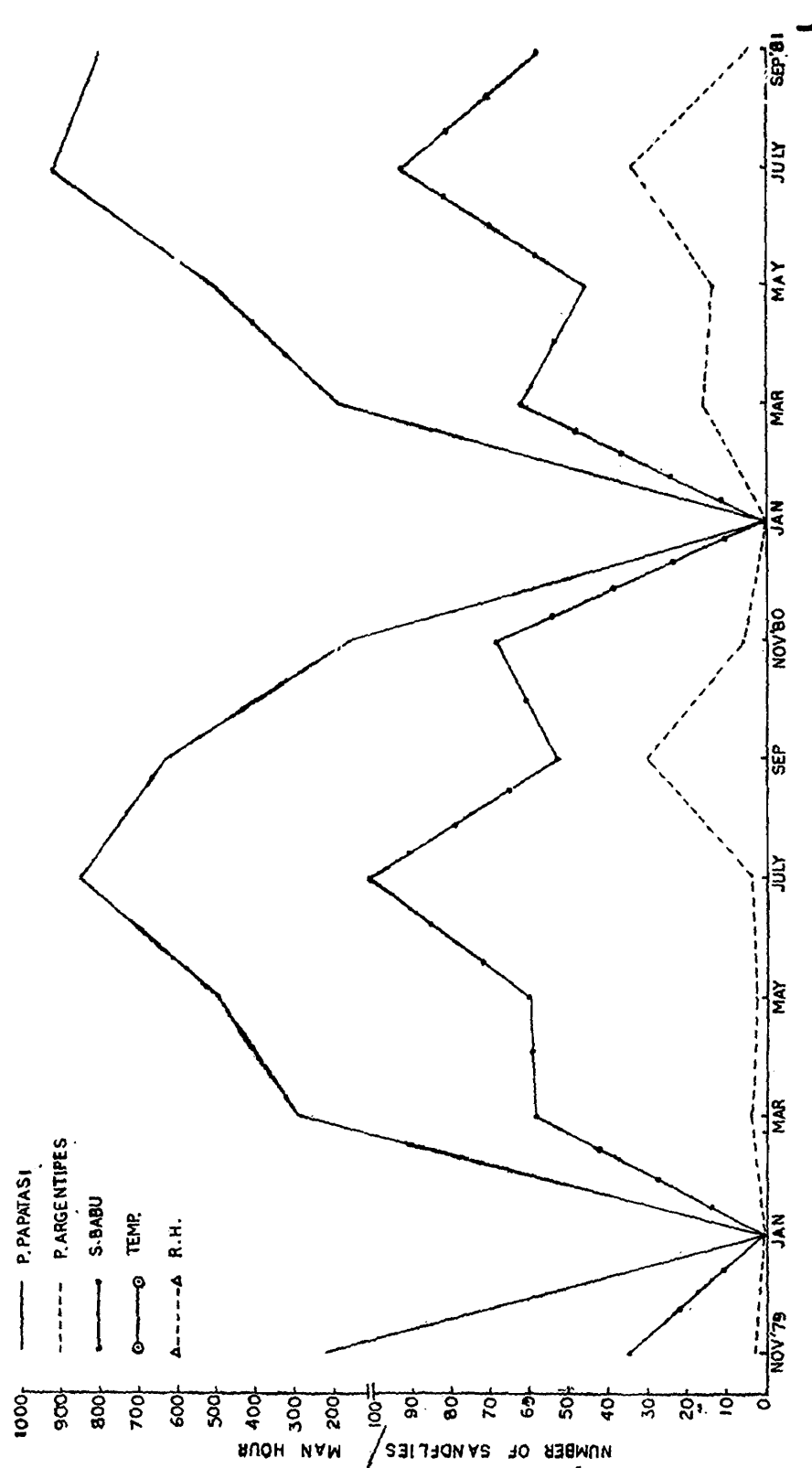
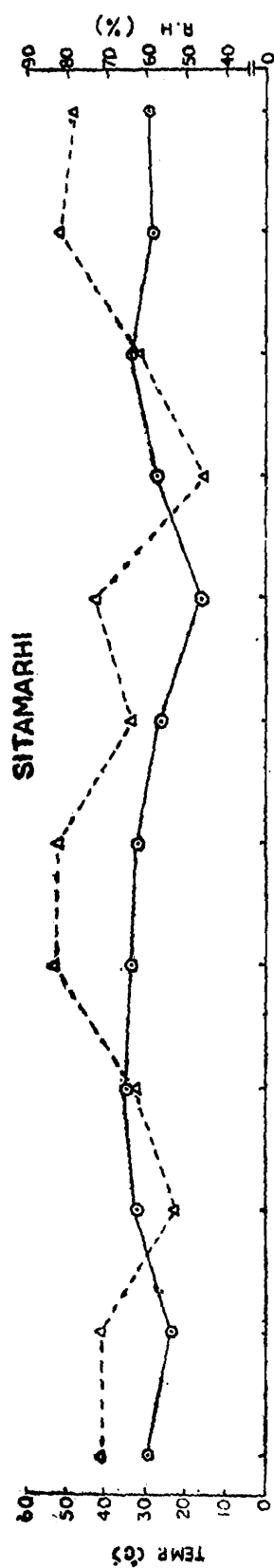


Fig. 1. Bimonthly fluctuation of sandfly population in relation to temperature and relative humidity in Darbhanga District.

nally in the peak periods they may be seen on the walls opposite to hearth, even while the cooking is on.

On the whole it can be summarised that the flies are found in the dark corners of the mud-walled houses. At the same time

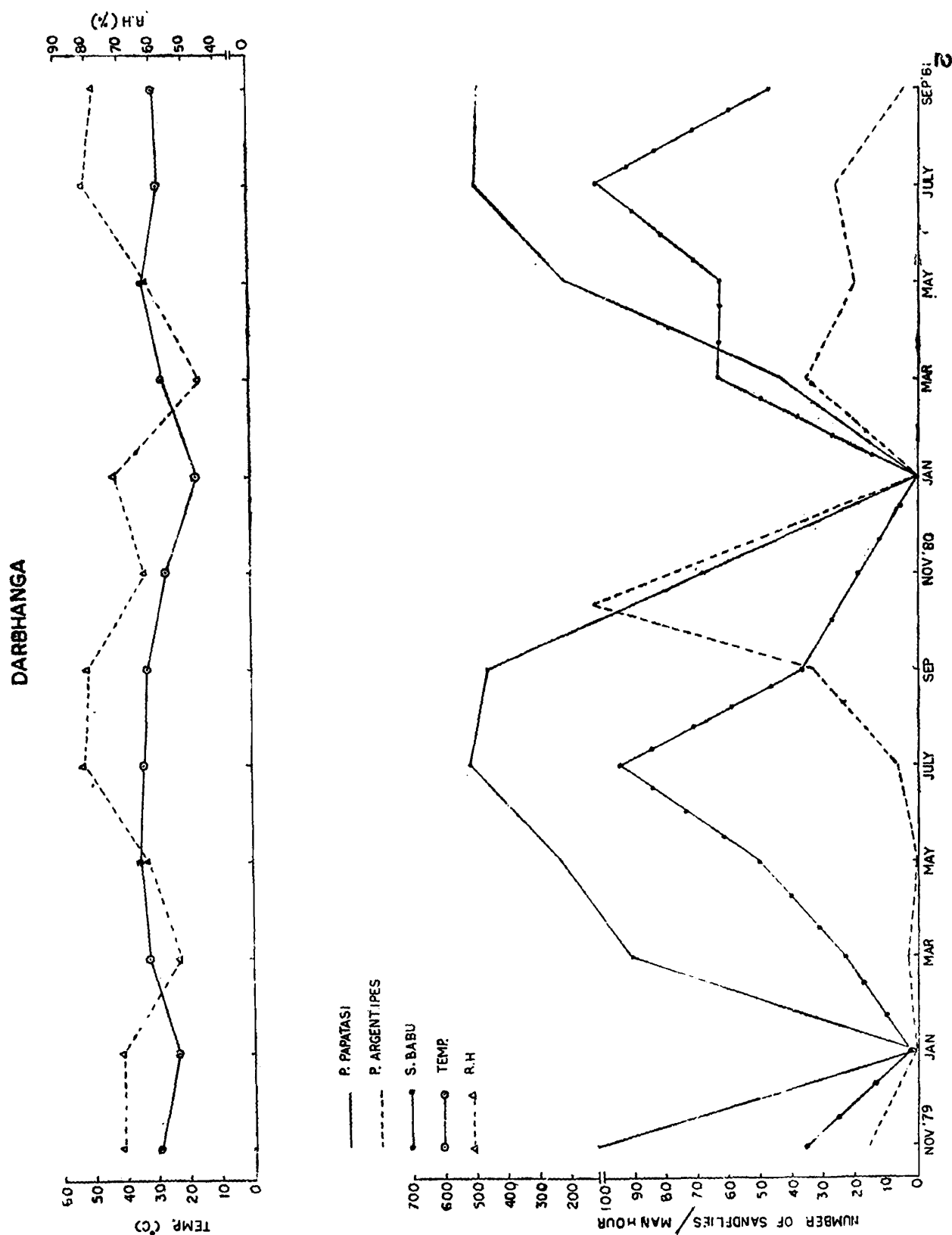


Fig. 2. Bimonthly fluctuation of sandfly population in relation to temperature and relative humidity in Sitamarhi District.

some of the microhabitats which cannot be explained are : (1) in one corner of a room the flies may be abundant whereas in the other corners only sparsely present or absent ;

and (2) in houses possessing apparently similar habitats their occurrence varies from sparse to abundance.

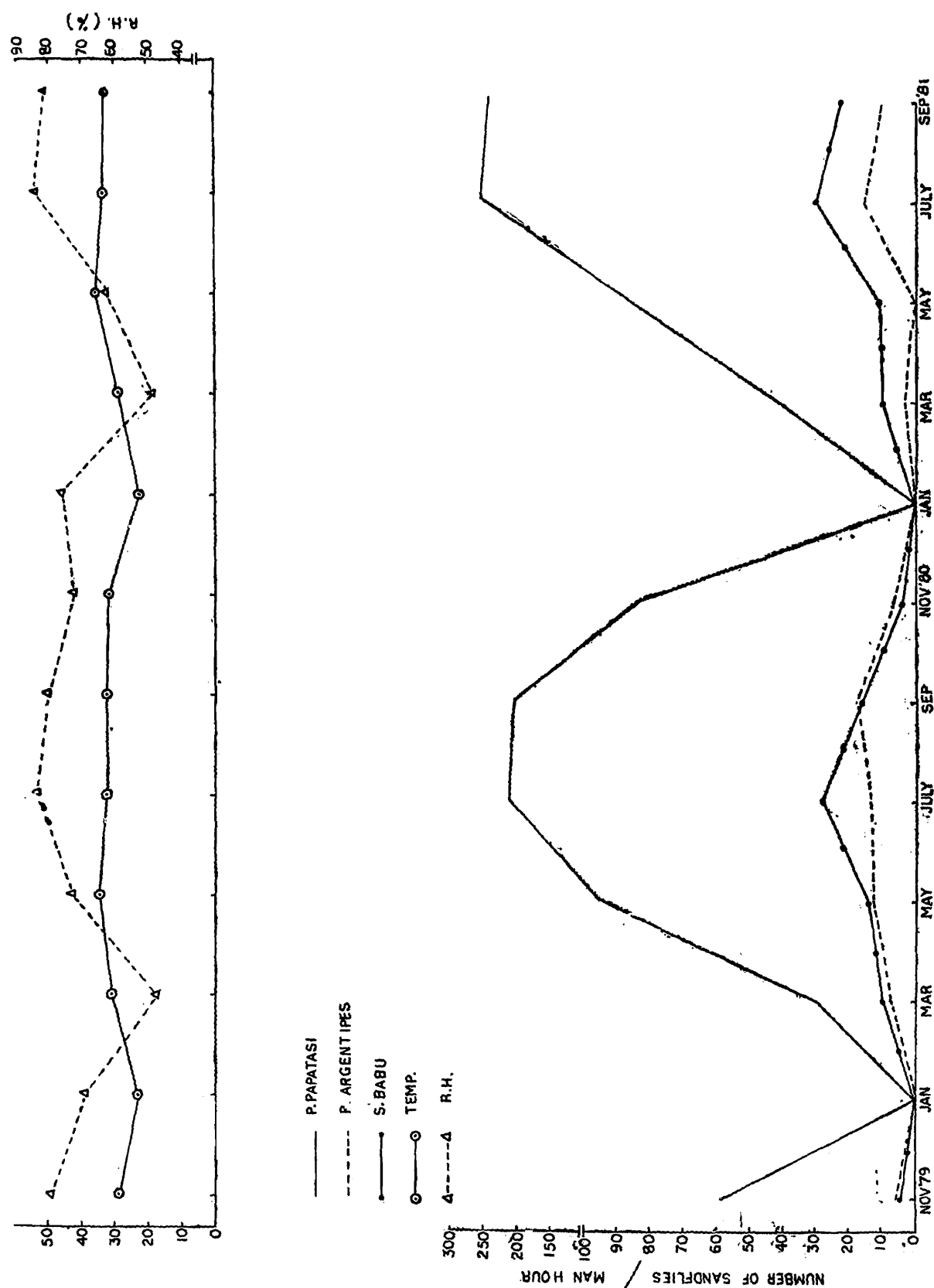


Fig. 3. Bimonthly fluctuation of sandfly population in relation to temperature and relative humidity in Samastipur District.

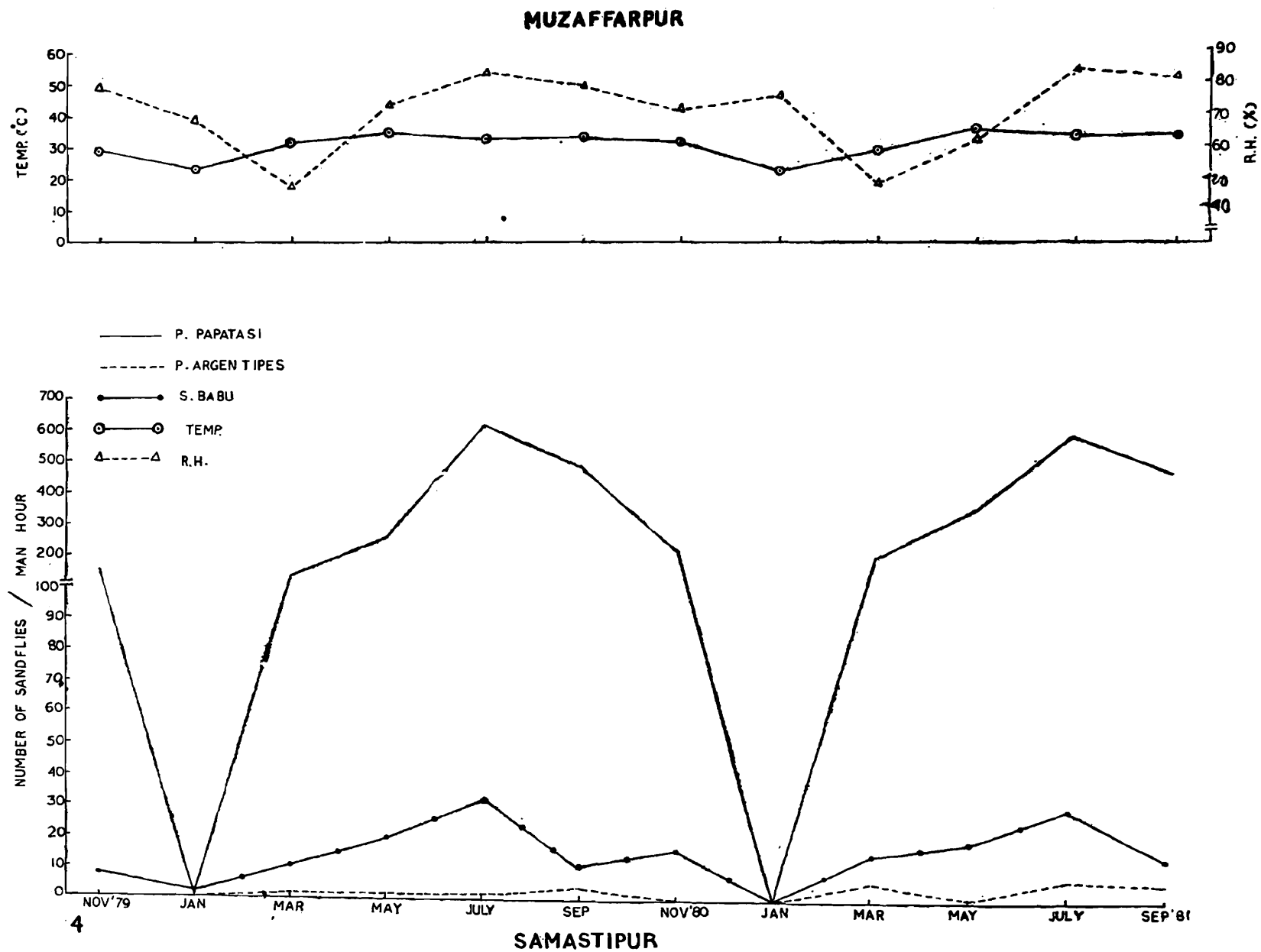


Fig. 4. Bimonthly fluctuation of sandfly population in relation to temperature and relative humidity in Muzaffarpur District.

DARBHANGA

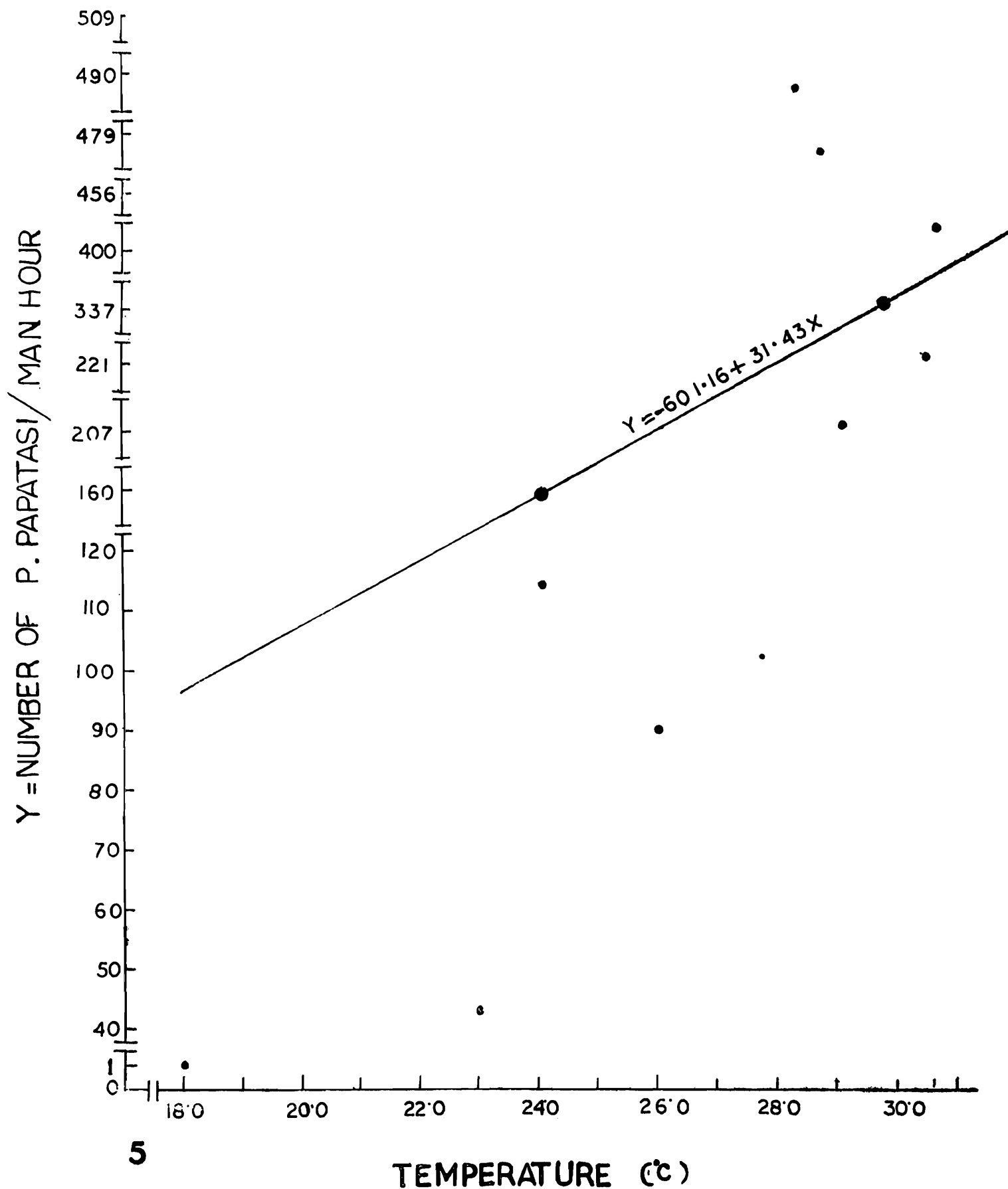


Fig. 5. Regression line with scattered diagram of *P. papatasi* (per manhour) on temperature (°C), in Darbhanga District.

DARBHANGA

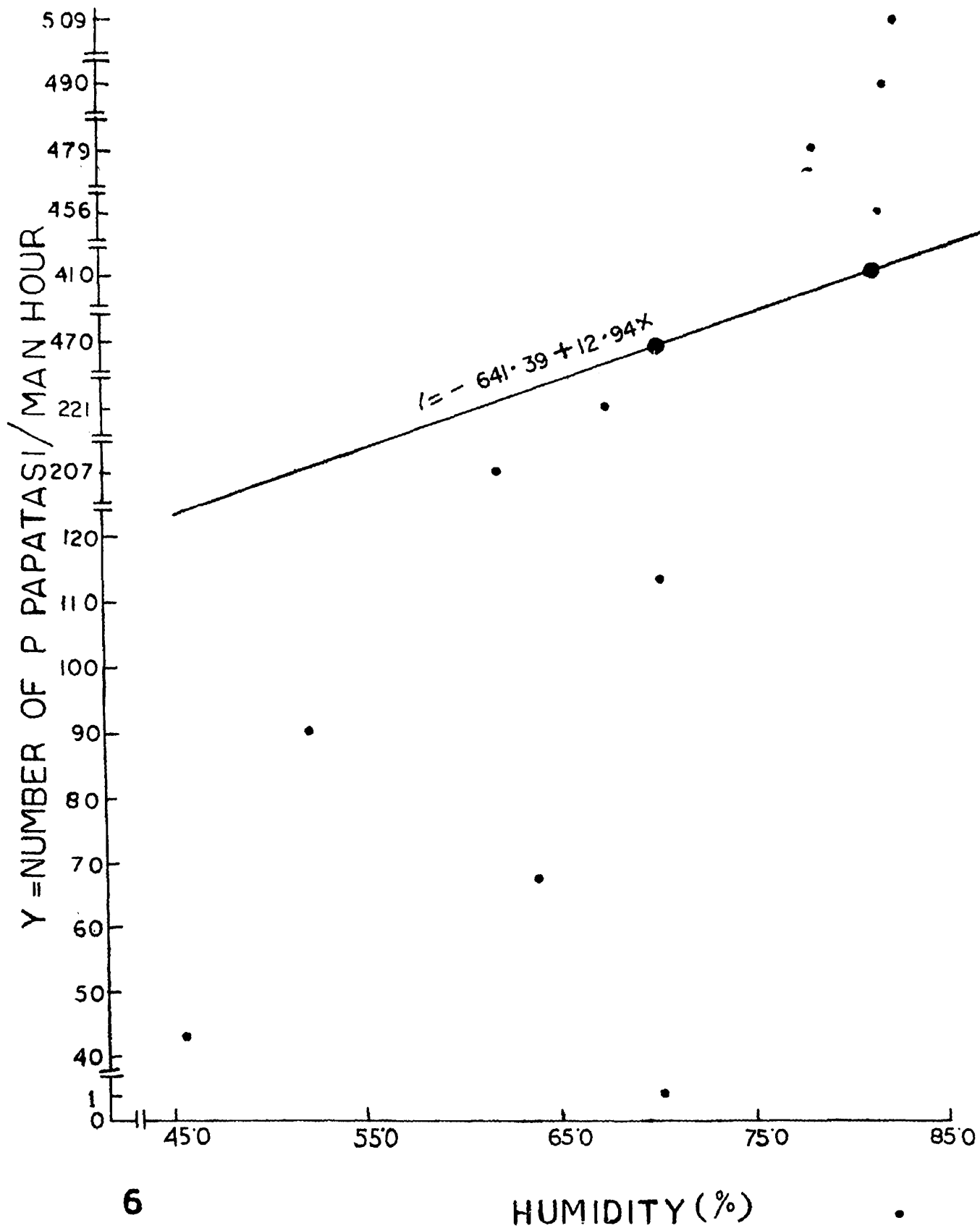


Fig. 6. Regression line with scattered diagram of *P. papatasi* (per manhour) on humidity (R/H) in Darbhanga District.

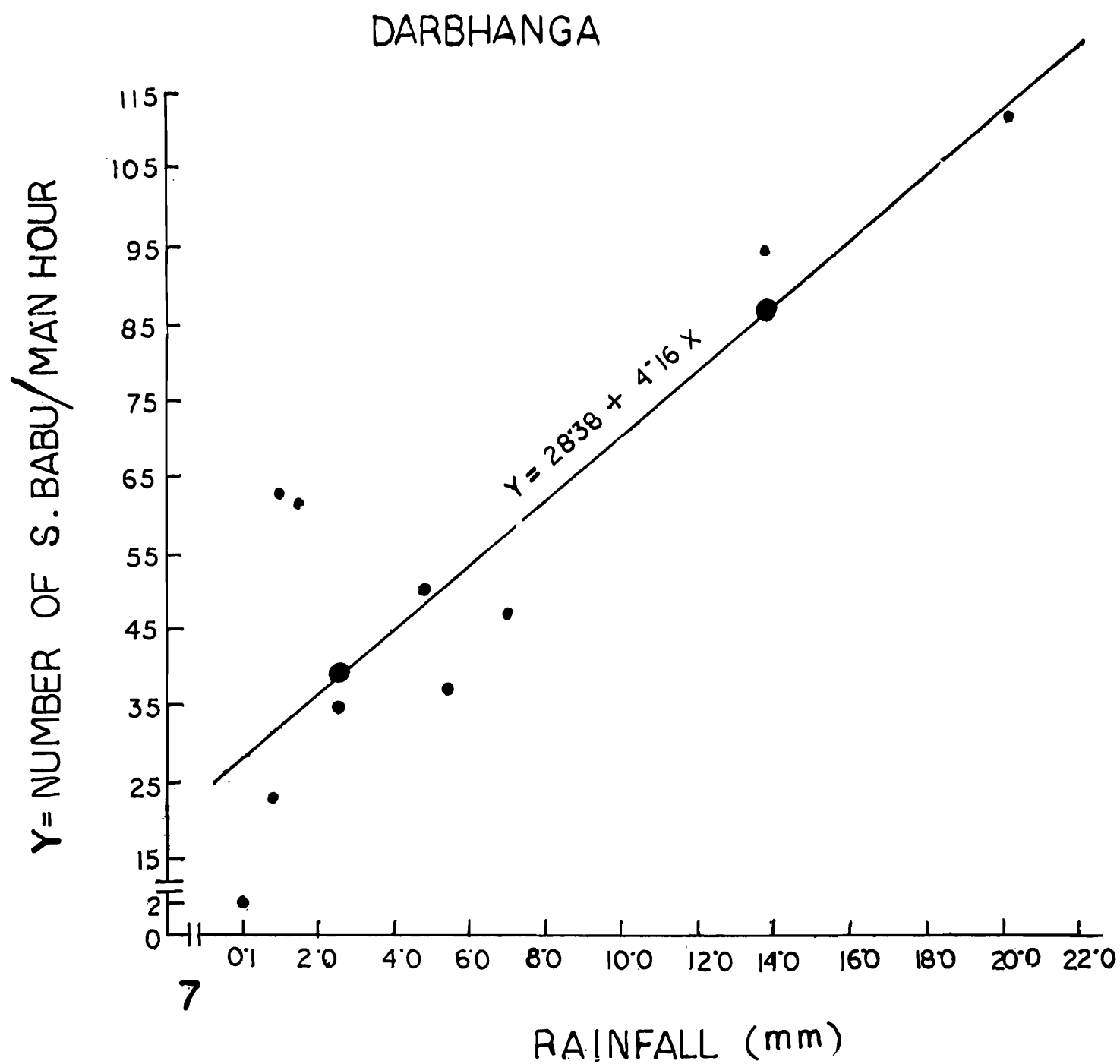


Fig. 7. Regression line with scattered diagram of *S. babu* (per manhour) on rainfall (mm) in Darbhanga District.

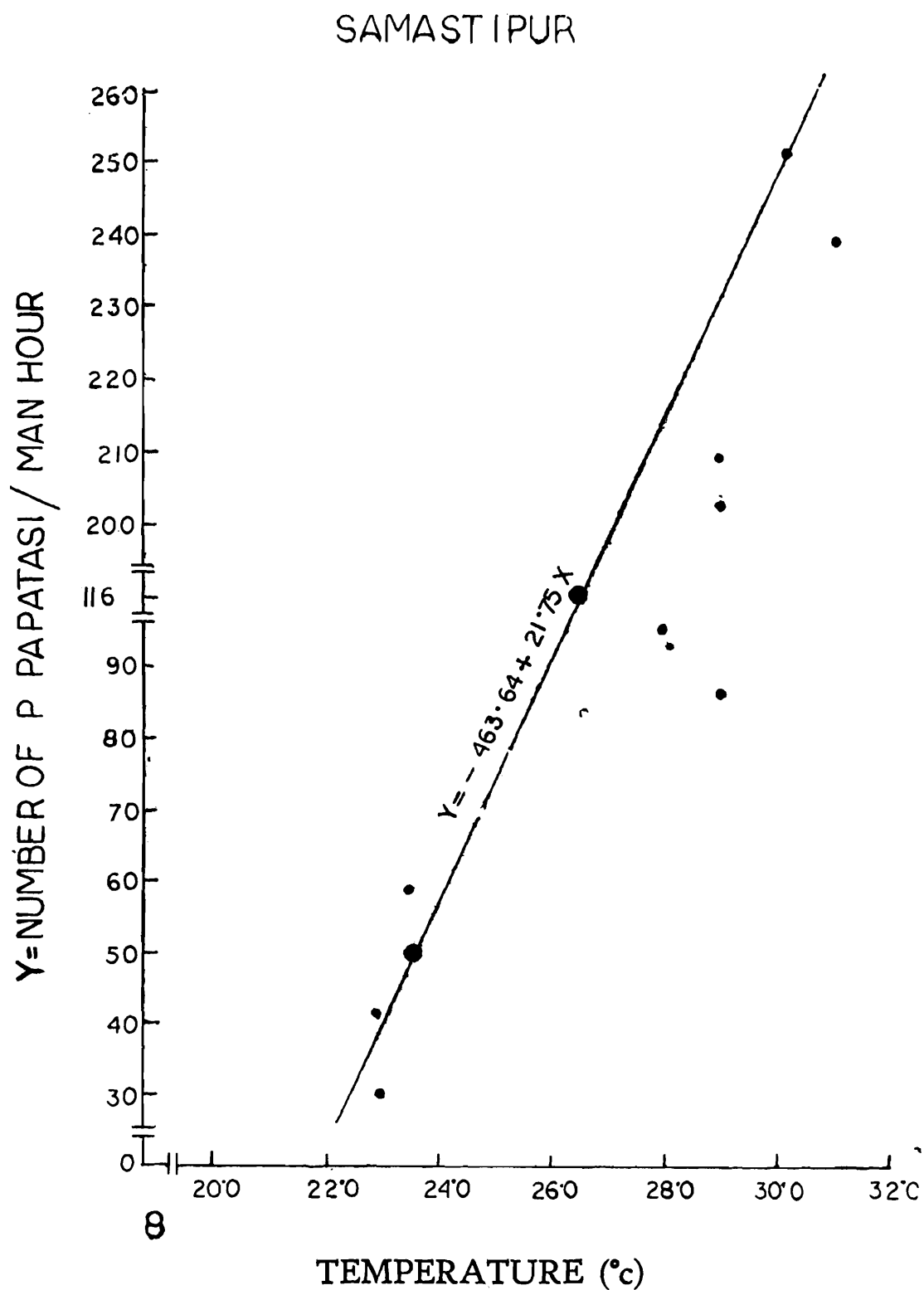


Fig. 8. Regression line with scattered diagram of *P. papatasi* (per manhour) on temperature (°C) in Samastipur District.

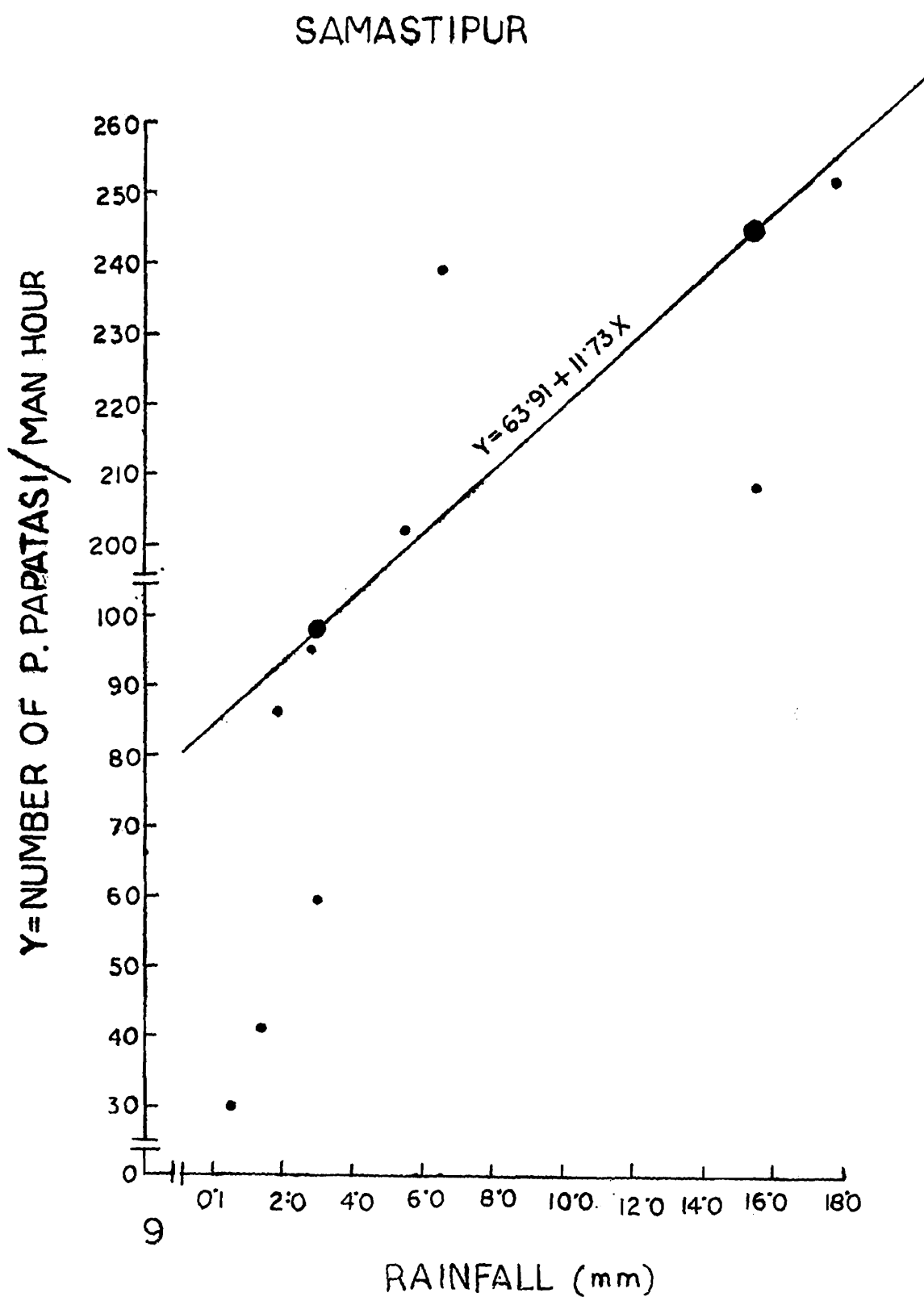


Fig. 9. Regression line with scattered diagram of *P. papatasi* (per manhour) on rainfall (mm) in Samastipur District.

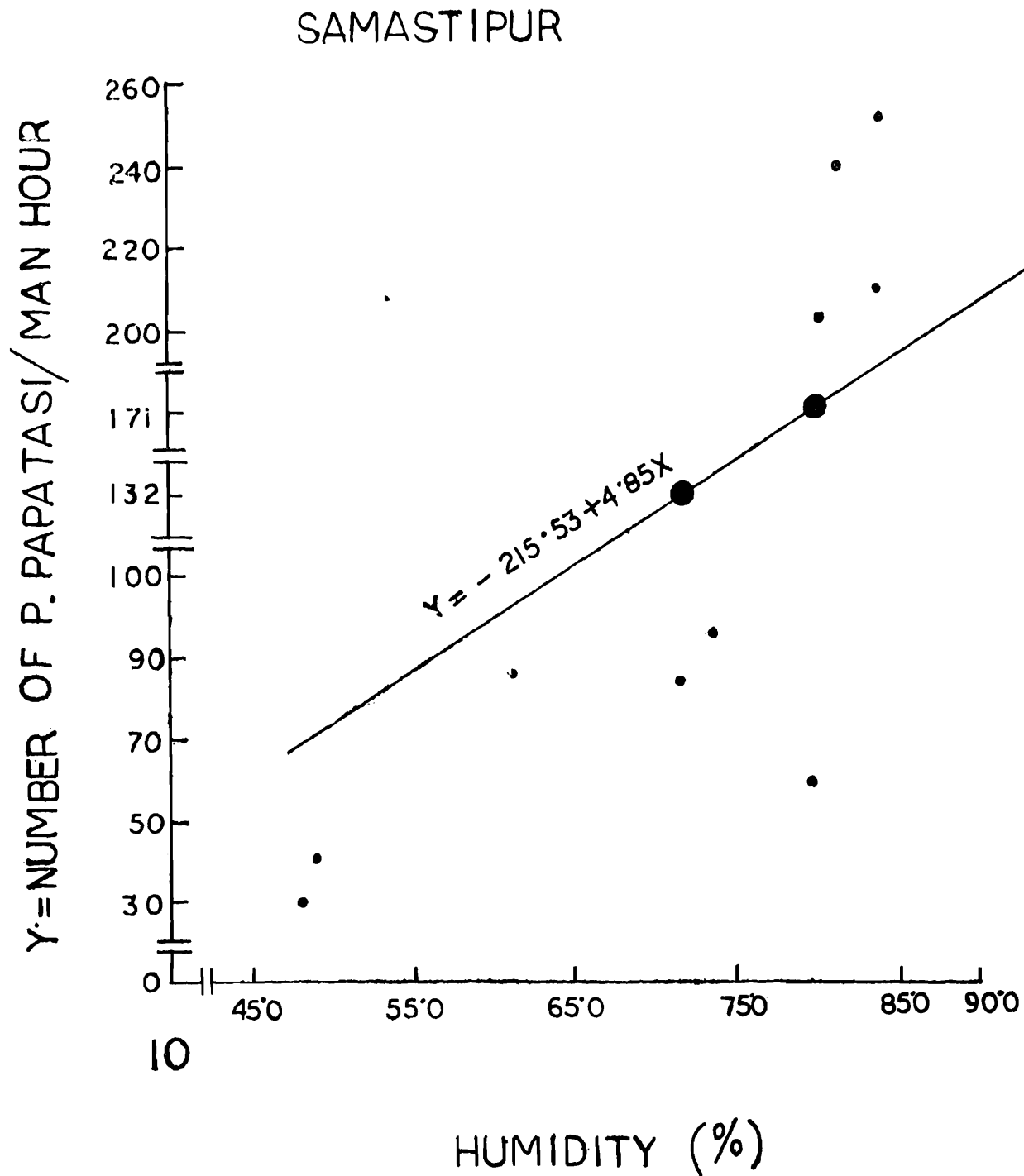


Fig. 10. Regression line with scattered diagram of *P. papatasi* (per manhour) on humidity (R/H) in Samastipur District.

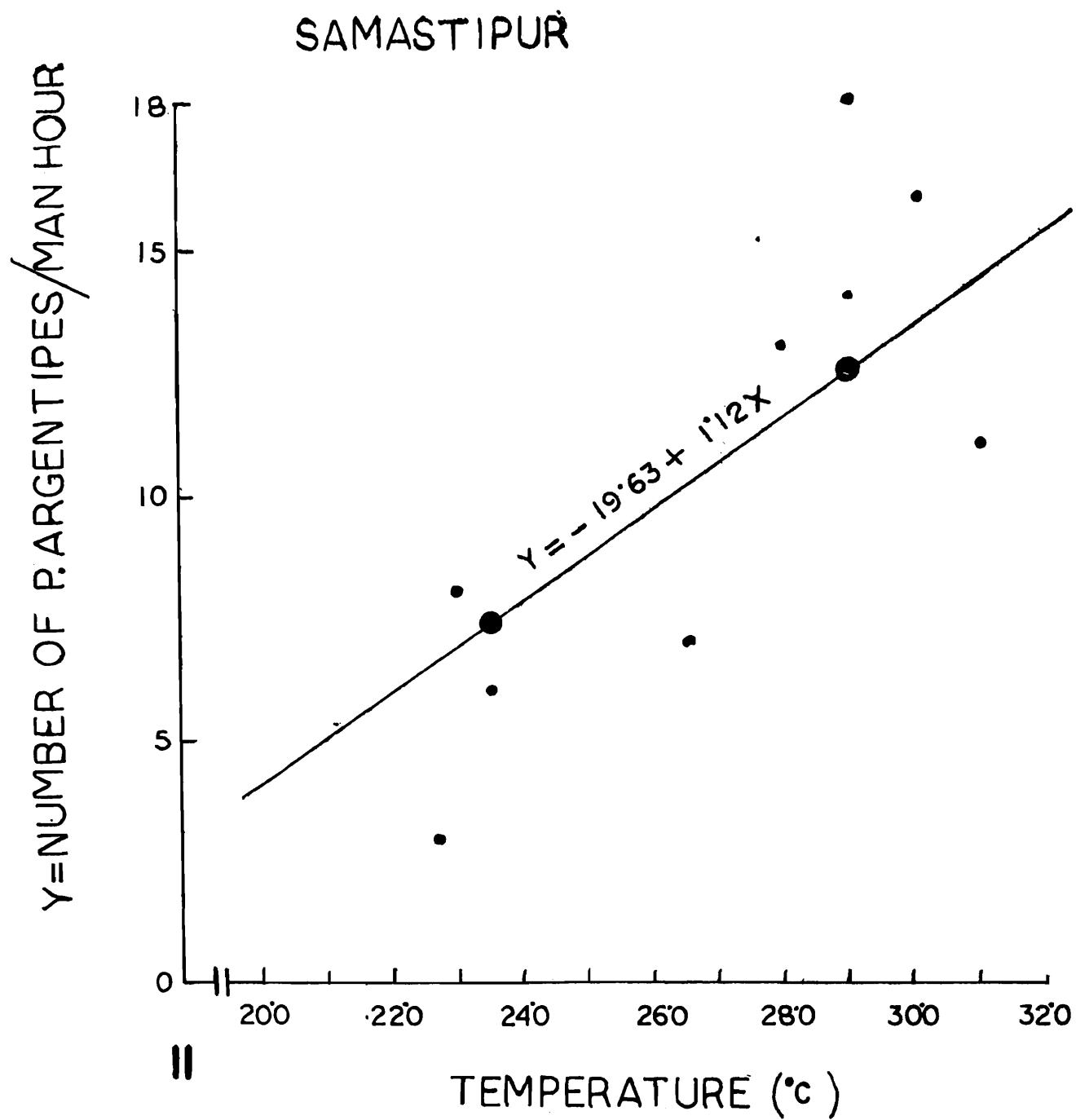


Fig. 11. Regression line with scattered diagram of *P. argentipes* (per manhour) on temperature (°C) in Samastipur District.

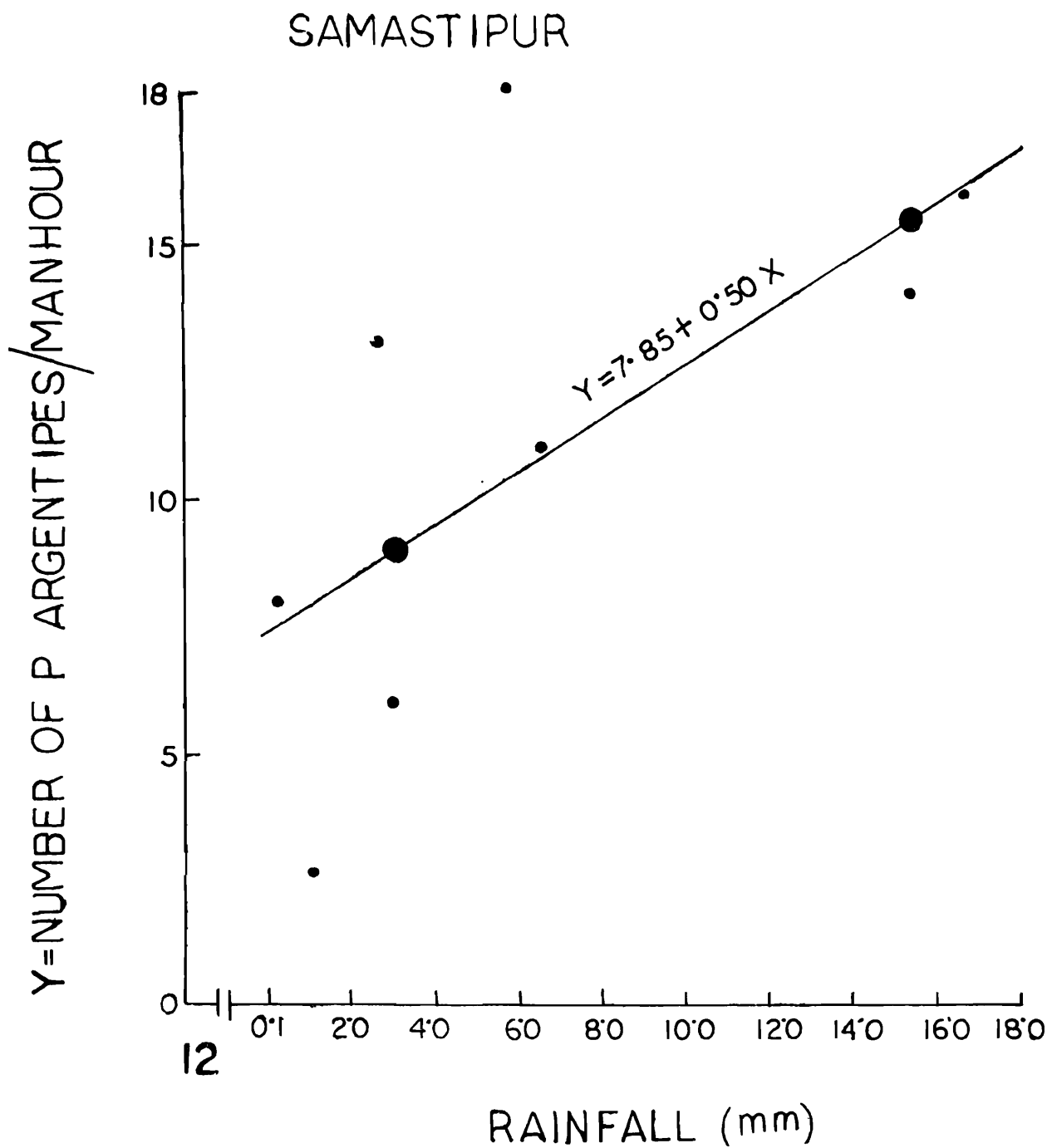


Fig. 12. Regression line with scattered diagram of *P. argentipes* (per manhour) on rainfall (mm) in Samastipur District.

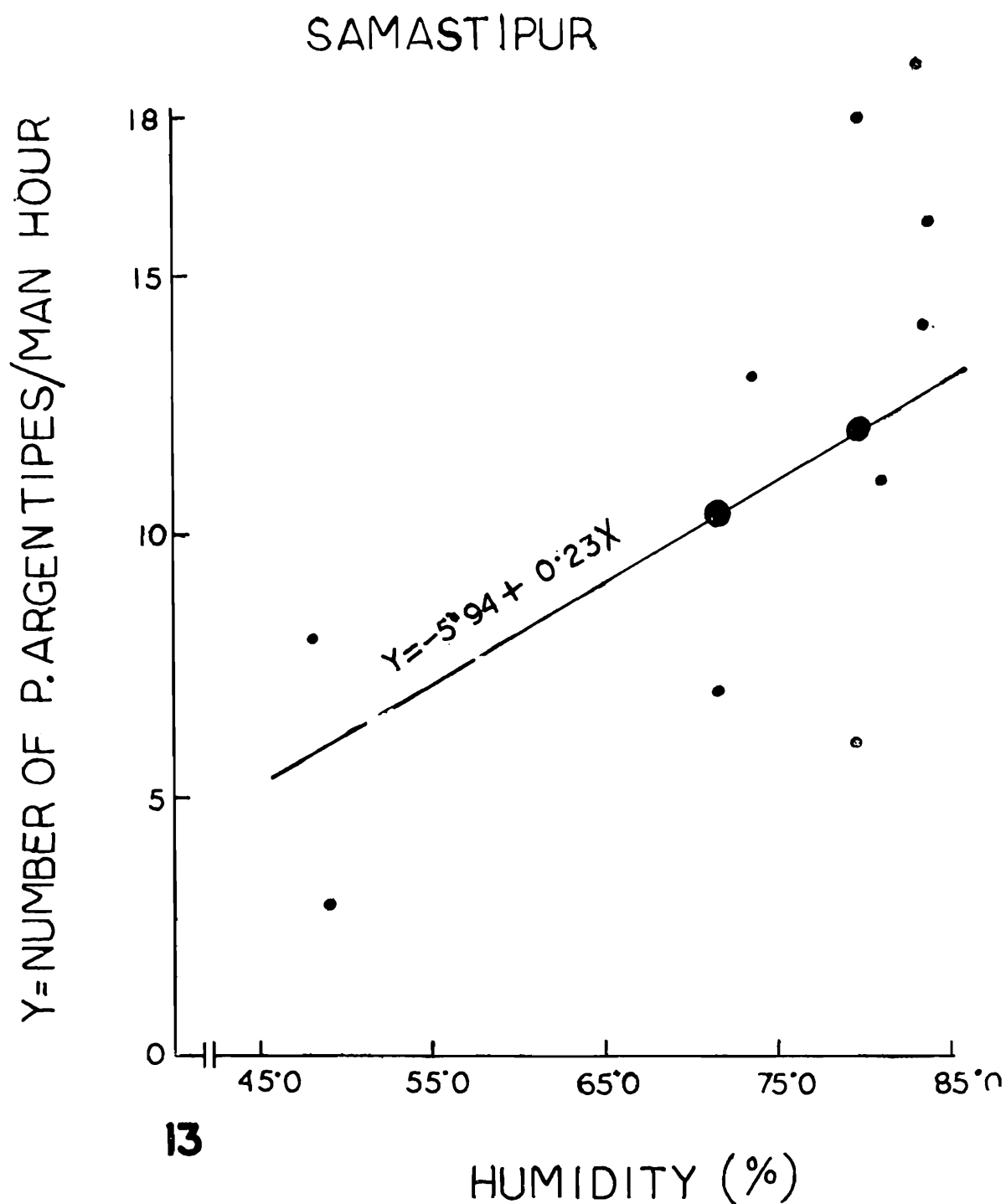


Fig. 13. Regression line with scattered diagram of *P. argentipes* (per manhour) on humidity (R/H) in Samastipur District.

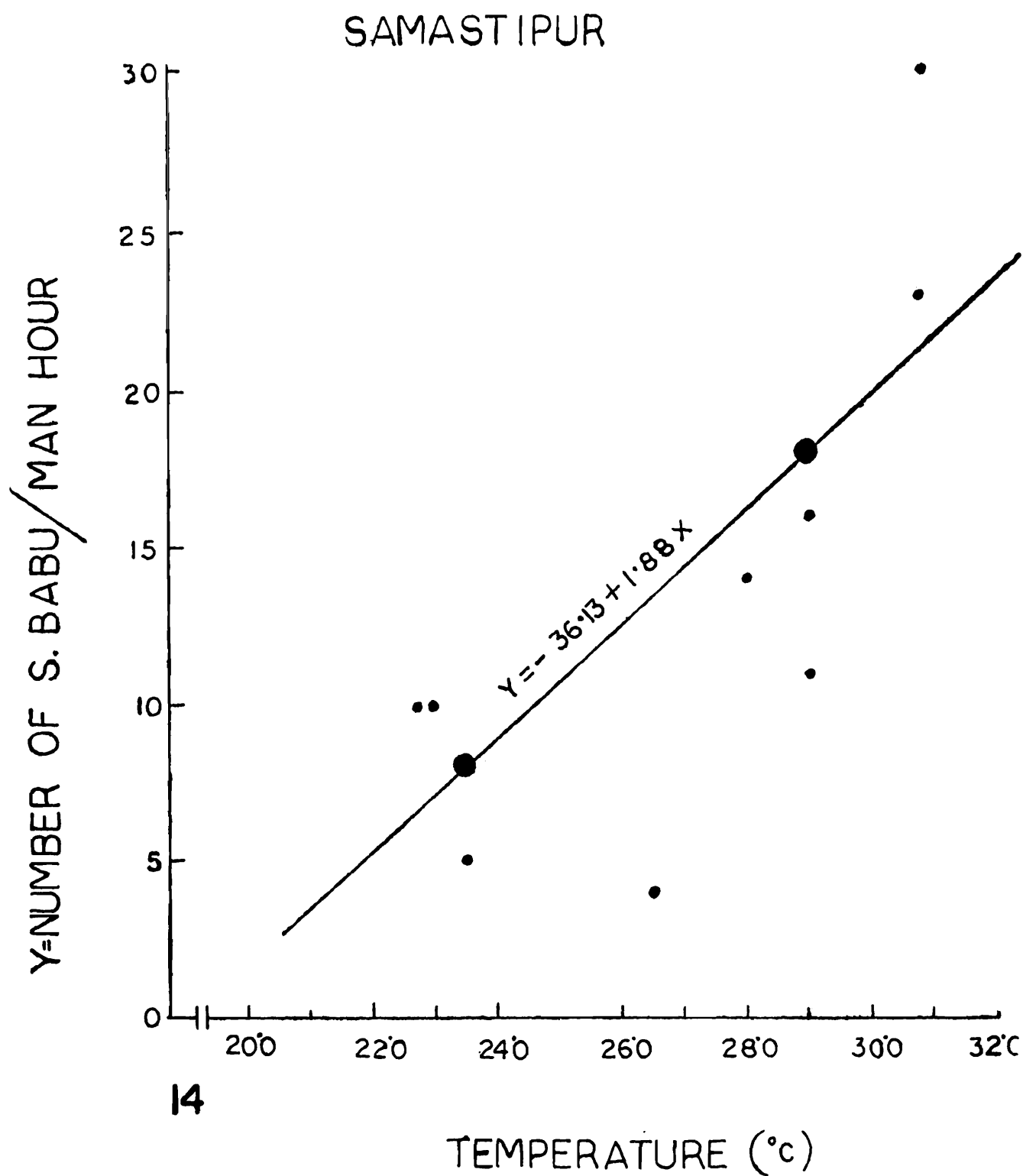


Fig. 14. Regression line with scattered diagram of *S. babu* (per manhour) on temperature (°C) in Samastipur District.

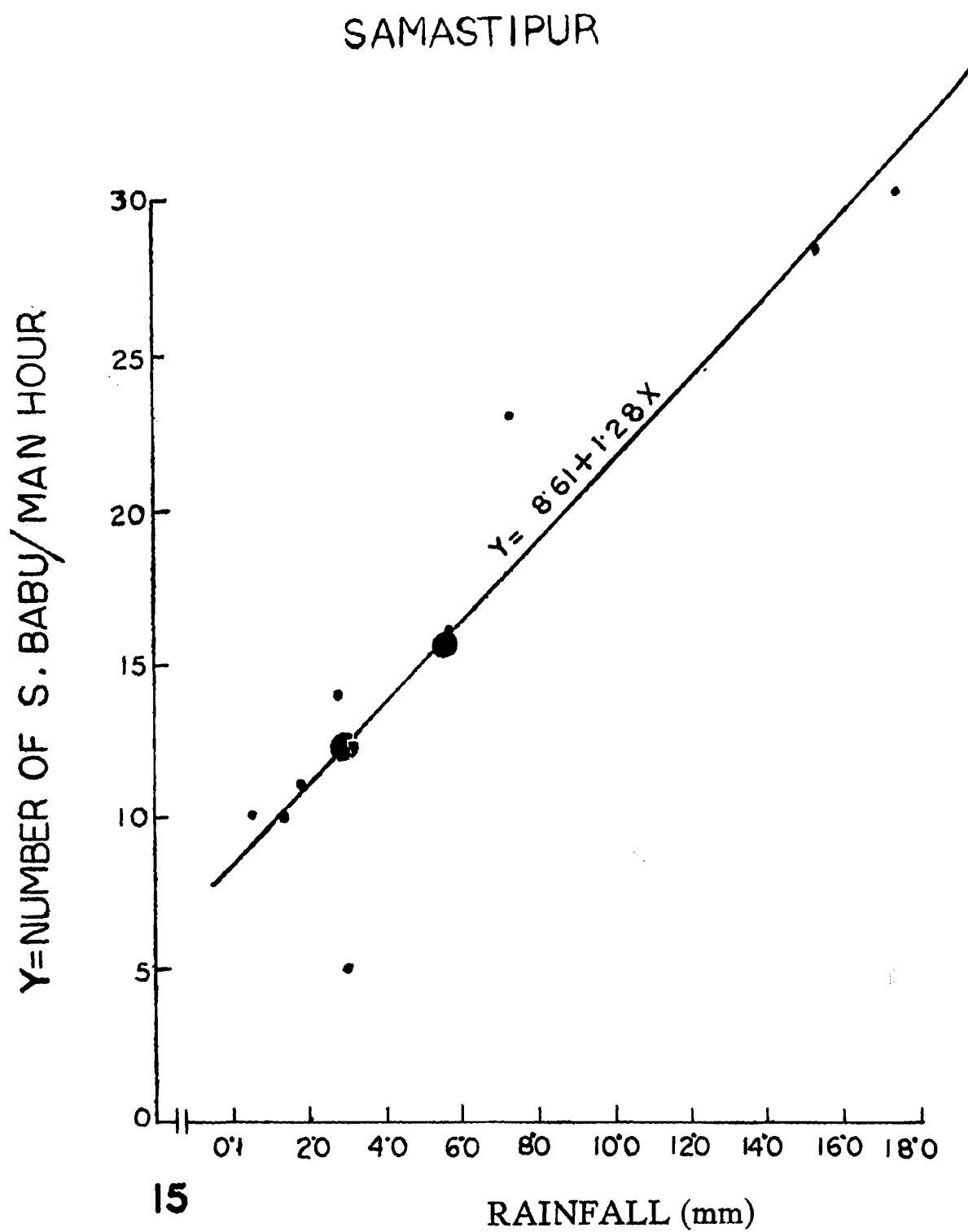


Fig. 15. Regression line with scattered diagram of *S. babu* (per manhour) on rainfall (mm) in Samastipur District.

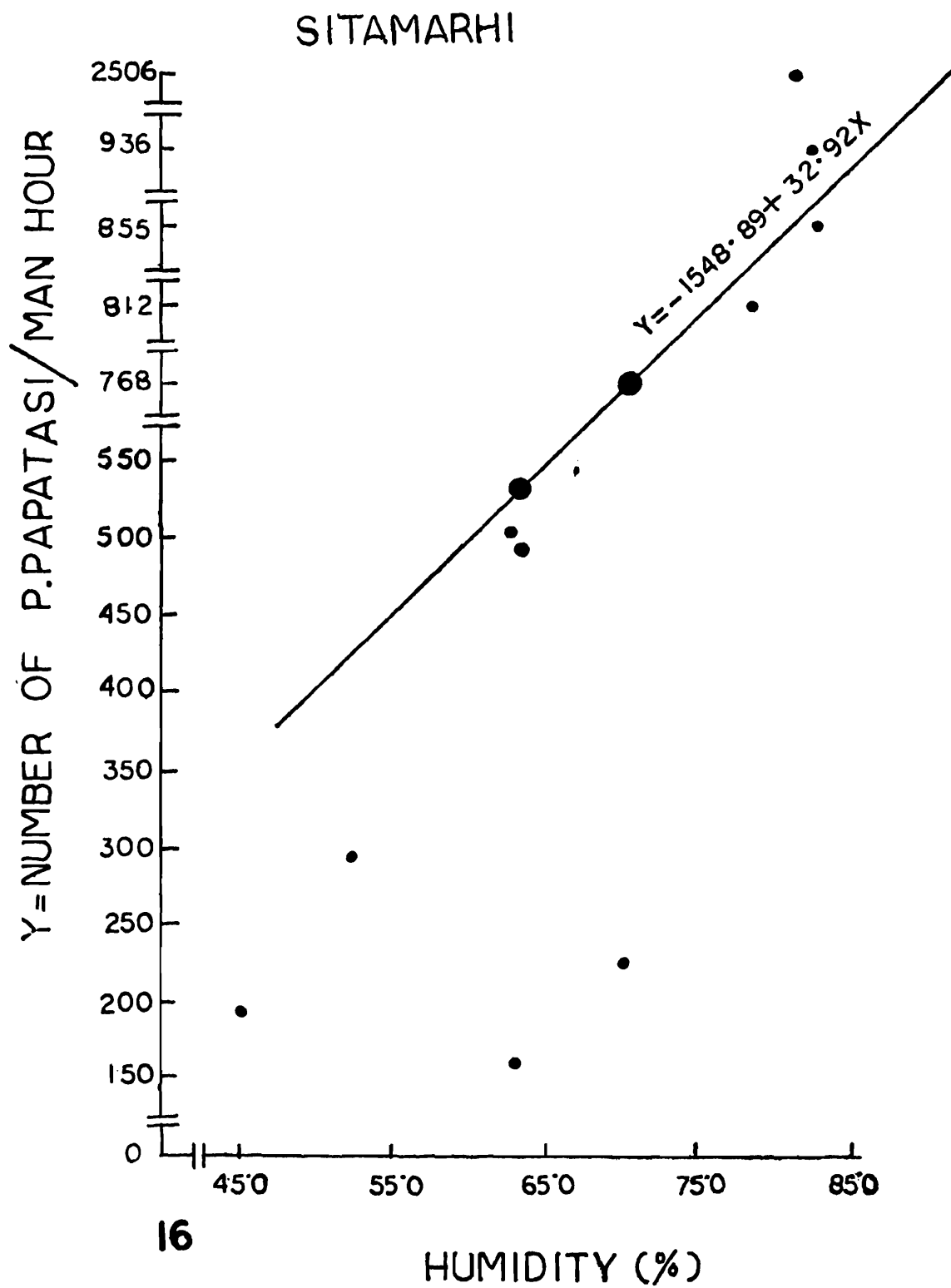


Fig. 16. Regression line with scattered diagram of *P. papatasi* (per manhour) on humidity (R/H) in Sitamarhi District,

MUZAFFARPUR

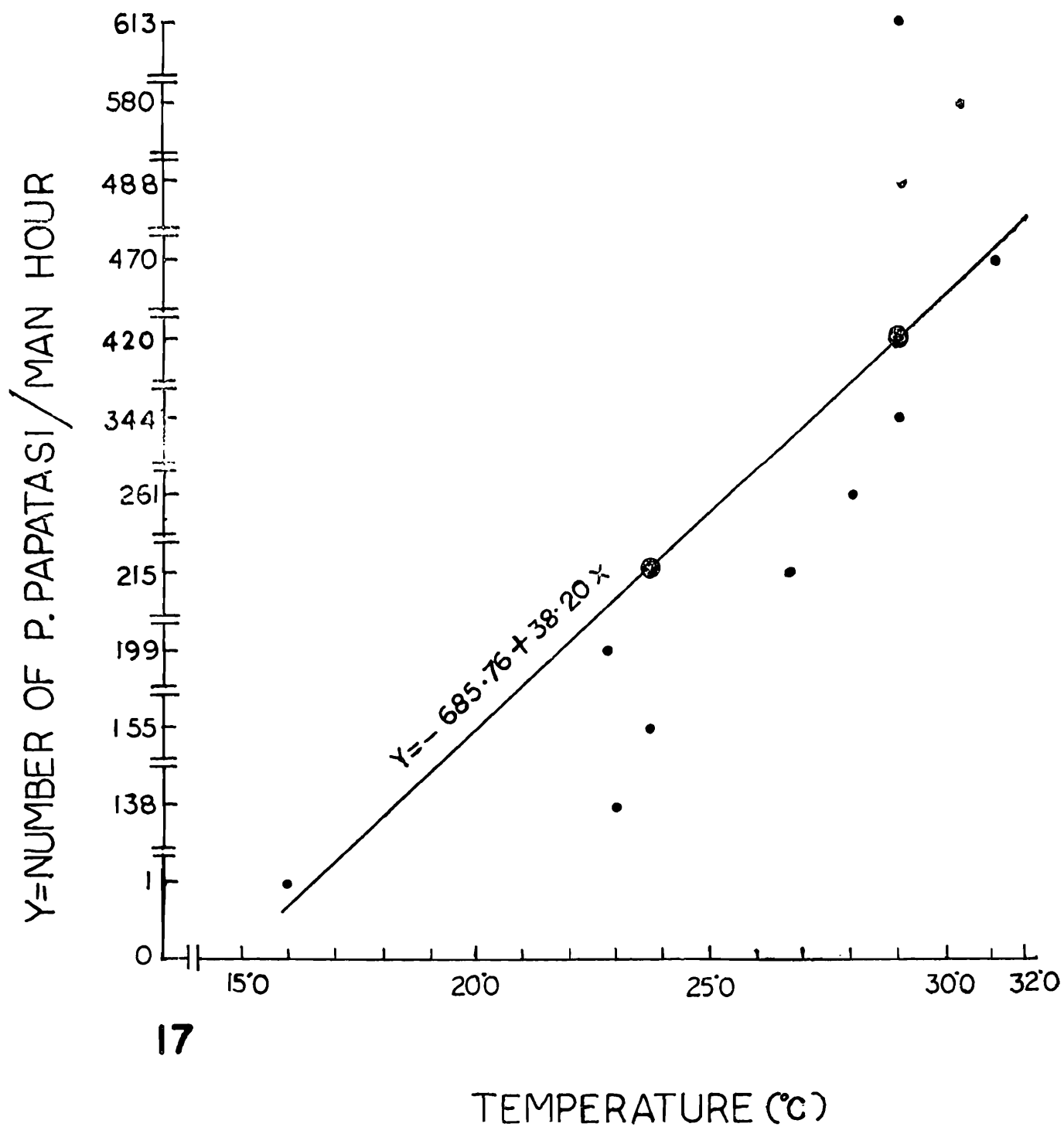


Fig. 17. Regression line with scattered diagram of *P. papatasi* (per manhour) on temperature (°C) in Muzaffarpur District,

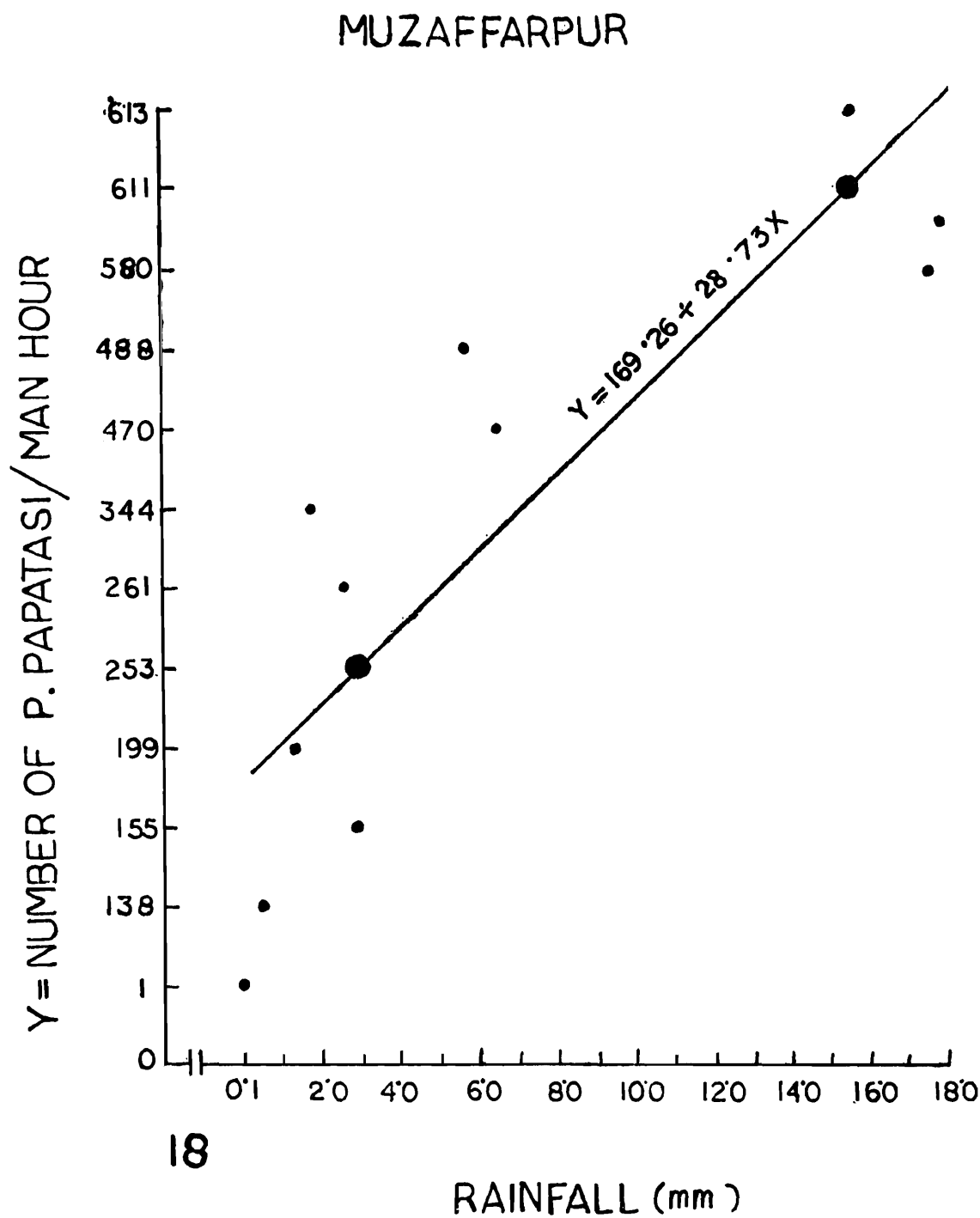


Fig. 18. Regression line with scattered diagram of *P. papatasi* (per manhour) on rainfall (mm) in Muzaffarpur District.

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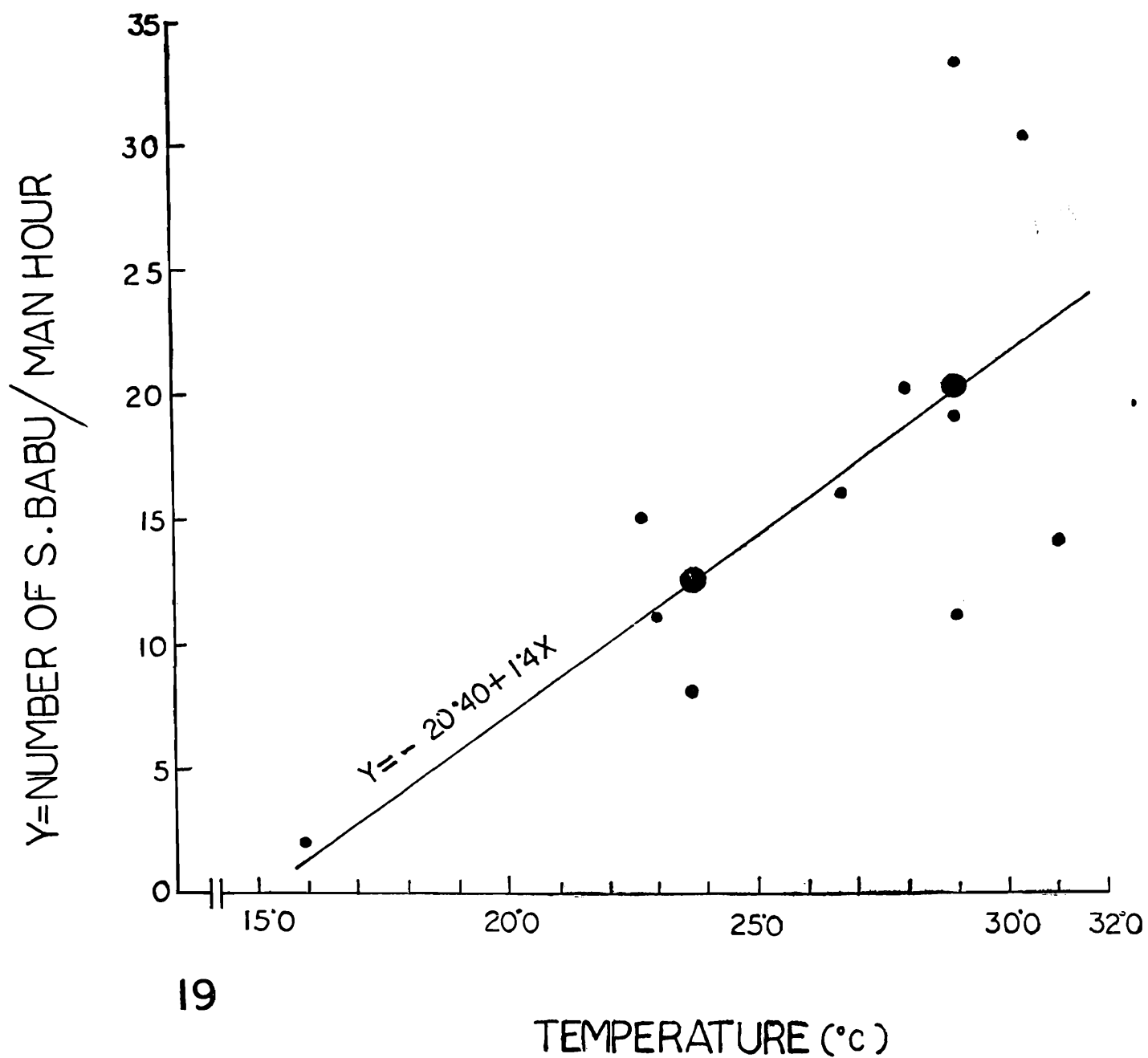


Fig. 19. Regression line with scattered diagram of *S. babu* (per manhour) on temperature (°C) in Muzaffarpur District.

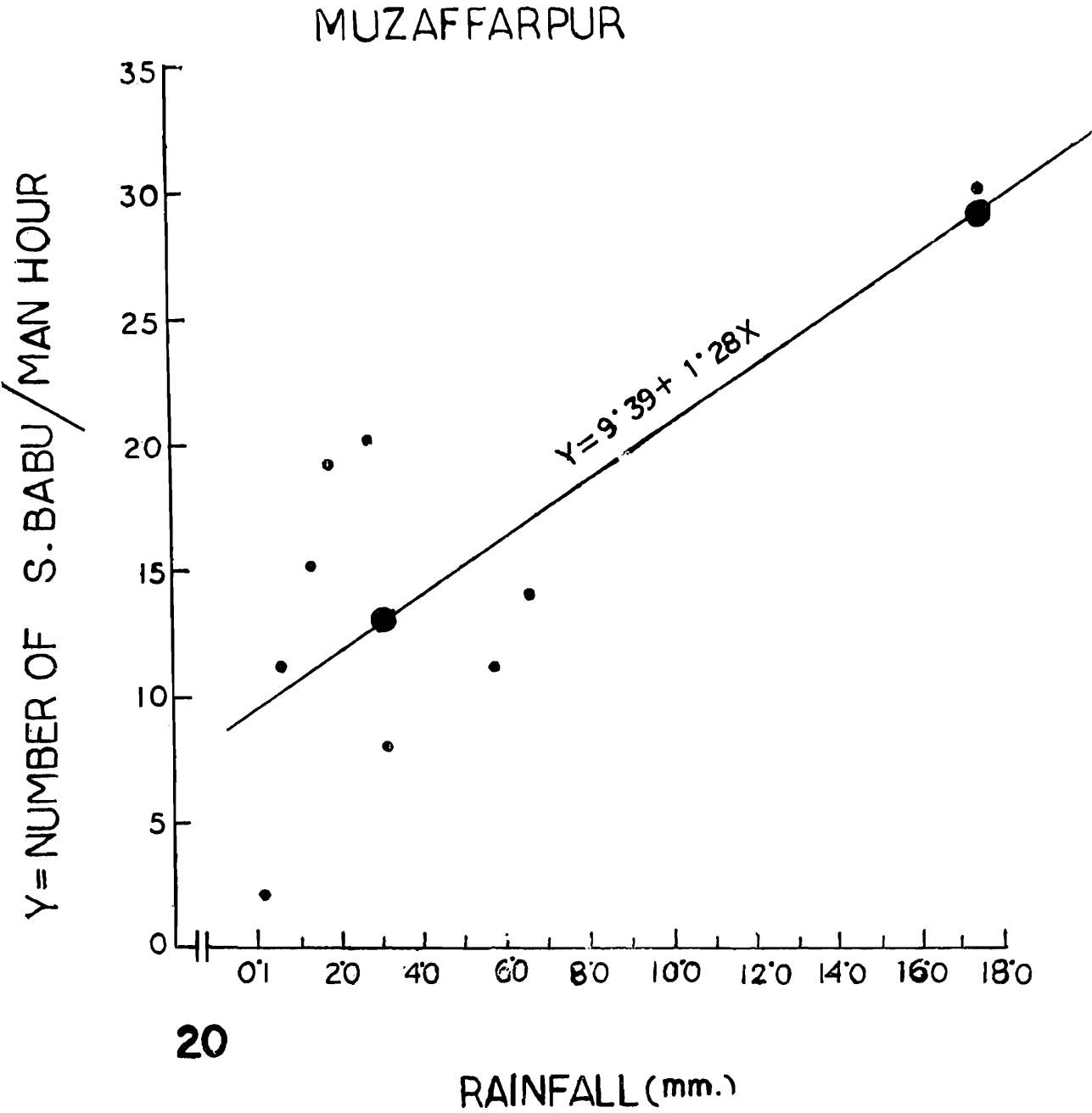


Fig. 20. Regression line with scattered diagram of *S. babu* (per manhour) on rainfall (mm) in Muzaffarpur District.

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A. K. Sanyal for statistical analysis of the data.

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SOME OBSERVATIONS ON ORB-WEAVING MECHANISM OF INDIAN ARANEID SPIDERS

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ABSTRACT

Orb-weaving mechanism of Indian Araneid spiders are given with full illustrations and their two types of primary web-building operations and pattern of orb-weaving of some genera of the family Araneidae (=Argiopidae) have been discussed.

INTRODUCTION

The first thing which strikes our mind by the name of spider, is its spinning habit. Among spiders araneids are unique because of their peculiar habit to construct the orb-webs having geometrical precision. Their finished product of web is a masterpiece of their craftsmanship. The webs mainly serve as trapping nets to capture their prey, often camouflage the spiders from their prey and predators. The threads of webs are nothing but the secretion of silk glands, present inside the abdomen. The silk secretion which is a kind of protein, solidifies as soon as it comes in contact with the air. The secretion of silk gland comes out from the minute microscopic spigots present on the mound of spinnerets. There are very little work on this subject in our country. Only Dugdale (1969) and Tikader (1961, 1966 and 1978) have published some observations of spiders and their biology and protective device of orb-weaving spiders from India. Levi (1978) and Kullmann (1975) have also published some observations of orb-weaving spiders from America and West Germany respectively. In this paper we have given our observations of orb-weaving technique of

araneid spiders with illustrations, and also discussed the pattern of orb-weaving of different genera of spiders of the family Araneidae (=Argiopidae).

ORB-WEAVING MECHANISM

Orb-weaving spiders are of various kinds, so their modes of web-building also different to some extent. Primarily two types of operations are seen. One, the bridge line along with the outer frameworks are constructed first. By this way the orb-webs are either vertical or horizontal in position with the adjacent supporting objects. The other type, where after formation of bridge line a V-shaped two radii are formed from a second thread just below the upper bridge line, and the other radii along with outer frames are constructed. But in both the types the operations are a little bit variable according to the availability of adjacent supporting objects. After formation of all radii, the spider constructs the non-viscid spiral thread from centre to periphery which later replaced by viscid spiral thread from periphery to centre.

Here the two types of web-building operations have been discussed ;

In the first instance the spider *Gasteracantha mammosa* C. L. Koch (= *G. brevispina*) pays out silk from its spinnerets to the wind from at a point A until the free end of the thread gets entangled to an end B on the shrub (Fig. 1). From A the spider goes over to the point B and sticking the end firmly there. The spider then walks back and forth along the line to strengthen it by laying more silk on it. Thus the bridge line A-B is established (Fig. 2). From A the spider proceeds upto the middle of the bridge line, i.e., C, from where it drops down a thread over a weed below and fixes the thread at D on the weed (Fig. 3). From this point the spider continues the thread and carrying it loose by one of its hind legs not to be entangled on the supporting weeds on which it walks, and goes over the weeds upto a stump E of the shrub where it entangles the line. Now, it climbs up along the branch from E by trailing the thread and attaches it to the point A (Figs. 4, 5). Thus D-E and E-A outer frameworks have been formed.

Then the spider crosses the bridge without any trailing thread upto B and from there it drops down on the weed below by a dragline thread and fixes it at the point F on the weed, thus B-F is formed (Fig. 6). From the point F the spider crawls down along the weed with a thread to form F-D (Fig. 7). In this way a pentagonal framework is built with the bridge line A-B and outer four boundary lines B-F, F-D, D-E, E-A, the line C-D, which passes from the middle of the bridge line C as a diameter through the centre of the entire space upto the middle of the opposite boundaries of the future web.

After this, the spider starts to construct the radial threads through a point on the already formed diameter C-D, which will

be the centre or hub at the future web. In anticipation to this operation, it crawls upto a point G on D-C. At G the spider attaches a thread and trailing it loose behind proceeds upto C and from there it goes a little distance towards B and at point H entangles the line tight and makes the radius GH (Fig. 8). From H point the spider moves a few centimetres further towards B and at the point I fixes a fresh thread and trailing it loose comes back to G alongwith the radius HG and by pulling tight the thread at G the spider makes IG radius (Fig. 9).

Next, the spider spins a new thread from G and trailing the line loose descends down to D and turns towards E, at J it fixes the thread tight and thus the radial thread GJ is formed (Fig. 10). From J, the spider moves a little away towards E upto the point K, where it fixes a new thread and carrying the thread upto G via JG and attaches it to G. In this way another radial thread KG is formed.

The spider repeats the operation to construct the radial threads in pair, are laid alternately on the right and left until the required radii are formed which are sufficient to hold the future web (Fig. 11).

After completion of all radii, the spider moves to the centre of the web and gives attention to some extent to give sufficient support to the radial threads, so it spins a few turn of spiral thread immediately outside the hub. This small spiral around the hub is called attachment zone (Fig. 12), and it is, ofcourse, before the spider starts a temporary non-viscid spiral. Because of this attachment zone, the radial threads are getting the uniform tension.

Once the hub and the attachment zone are completed, the spider starts to weave a spiral from the end of the attachment zone

and continuing to the periphery in an anti-clockwise direction (Fig. 13), with turns as far as the spider can stretch. The thread of this temporary spiral is coarse and non-viscid and its function is to hold the radial threads for subsequent operations.

When the temporary spiral is completed, the spider reverses its direction, rolls up the old one and puts down the new, finer and more closely interspaced viscid silk which is elastic too (Fig. 14). This viscid spiral is weaving in a clockwise direction with measured action and uniform speed. In spinning the viscid thread the spider fastens it to a radius and then moves on pulling out the thread from the spinnerets, but before the thread is fastened to another radius the spider takes hold of it with the claws of one hind leg, and straightening this leg pulls out from the spinnerets; the spinnerets are then applied to the next radius and the thread fastened in place. After this the spider takes away its hind leg and the thread contracts to the length of the space between the two subsequent radii.

The viscid spiral does not cover entirely upto the hub but leave a space between the viscid spiral and the attachment zone called free zone (Fig. 15). By following the above mentioned modes of operation to construct the web, the final product gets a "geometrical precision" which reveals the highest achievement of the craftsmanship of orb-weaving spiders (Fig. 15).

In the second instance the young *Araneus* spider starts to weave its web at the beginning of dark in the evening. At point A on a tree branch it fixes a thread and then crawls along the branch in an inverted position by trailing behind the thread carefully and attaches at the points X, Y, Z and finally at B (Fig. 16).

From B the spider returns to A carrying behind a loose thread which it fixes to A. Thus an upper bridge line A-B is established (Fig. 17).

Soon after this the spider drops down by a thread upto a level of a small plant below (Fig. 18) to reach to the plant the spider dangles to and fro, and as soon as it gets the plant, fixes the thread on any of the branches firmly. Through this oscillation and also with the help of wind it reaches to the plant (Fig. 19). Thus A-C is formed, and along this A-C the spider climbs back to A and then towards B upto D, the mid-point of A-B. At the point D the spider cuts the thread and attaches the spinnerets to the cut end, and makes the thread A-B longer by rotating itself. Thus a V-shaped structure of thread is formed (Fig. 20). From the bent point of V the spider drops down by a thread forming a Y and attaches the end of the thread at C (Fig. 21).

The spider then fixes a thread at C and trailing it behind and climbs upto B following the way C-D-B. At B the thread is hauled tight and fixed (Fig. 22). Thus a boundary line of the framework at future orb-web C-B is formed. From B the spider moves down a little distance towards D and fixes a thread there at E. The spider then trailing loose a thread, goes upto F via D, a little below of A where the thread is pulled tight and fixed. Thus the upper boundary line E-F is formed after removing the original bridge line A-B (Fig. 23).

From F the spider moves a few distance towards E and at G fixes a thread, and by holding it carefully not to be entangled to any pre-existing thread the spider moves upto D via F. At D the thread fixes tight. Thus the radial thread GD is formed. Then from D the spider trailing a thread upto H via C, and

the thread is pulled and fixed tightly at H. In this way another spoke DH is formed (Fig. 24). The spider then moves to the point J and attaches a thread there and return to D via H to fix a thread to form the spoke JD (Fig. 25). By following the same procedure all other spokes or radial threads at the future orb-web are formed, one or two to the right alternating with one or two to the left (Fig. 26).

Next to this, the spider starts the subsequent phases to complete the orb-web, so the attachment zone and non-viscid spirals are formed after leaving the free zone as stated in the first case (Fig. 27). Then the non-viscid spiral is removed by closer meshed viscid spiral, weaving clockwise from periphery to the centre (Fig. 28). In this way the orb-web in vertical plane is constructed by *Araneus* spiders.

DIFFERENT FEATURES OF A TYPICAL ORB-WEB

The bridge line (A) as in the text-fig. 29 is a line which is spun by a spider between the two supporting objects. Foundation lines (B) are outer framework lines spun subsequently after establishment of bridge line, with different supporting objects. After construction of outer framework the spider spins the radial threads (C) in the open space of the framework, each intersecting the hub or the web-centre (D). Thus after formation of the hub the spider spins a few turn of spiral thread, just adjacent to the hub, which gives more strength to the radial threads, called the attachment zone (E). At the end the spider spins the viscid, elastic spiral thread (F) from periphery to the centre in a clockwise direction by leaving an area of less width called free zone (G). The viscid spiral thread removes the non-viscid spiral thread which is spun

from the centre to the periphery in an anti-clockwise direction.

NET ELEMENT OR THREAD

Generally large orb-weavers produce thicker threads. Within one species of spider, the diameter of the thread also changes with age. The thread thickness of an adult large orb-weaver is 0.010 mm. to 0.012 mm. per individual thread. The thread produced by *Nephila* is the strongest among spider's thread. The strong webs of *Nephila*, matted and twisted, are used by South Sea Islanders for various kinds of bags and fish nets. (Kullmann, 1975).

As a spider walks around, it usually emits a double or even quadruple thread—this is called "dragline". This dragline serves as a safety line so that in the face of danger the spider can let itself fall without losing contact to the last attachment disk to which it can return by climbing up the thread.

THE MESH OF THE ORB-WEBS

The mesh is the geometrical elements of the web. It is formed by the joining together the threads and knots of the close lines.

Accordingly, they are only of four kinds found in orb-webs. The Trapezoid mesh (Fig. 30) as found in general orb-webs. The Square mesh (Fig. 31) which is constructed in the sheet of the orb-web made by *Cyrtophora*. The Rectangular mesh (Fig. 32) constructed by *Nephila*, and the rest one is Irregular mesh (Fig. 33) which is also found in the hub of the orb-web of some araneids.

NET-SUPPORT

Orb-webs are suspended by one or more pairs of threads or thread bundles from objects close to it, such as grass, leaves,

branches, ropes, stones and spanned between them. On one side it consists of objects found ready to hand such as grass, leaves, branches, fence wire, stones, walls etc. and on the other hand, at adjusting elements such as foundation lines and anchoring threads (Figs. 34, 35). They transmit the forces to the net supports such as branches (Fig. 36). External net supports such as blades of grass (Fig. 37) or wall or building corners (Fig. 38) are known. However, internal net supports, particularly blades of grass, may also be observed (Fig. 39). If the net supports are very elastic, as in case of very long suspension threads or very flexible grass (Fig. 40), their elastic-constructive behaviour is an essential help for trapping the prey.

SPECIAL FEATURES IN ORB-WEBS OF ARANEID SPIDERS IN DIFFERENT GENERA

The spiders of *Gasteracantha* weave some small fussy silk balls along the viscid spiral, which are afterwards entangled with debris to form rounded mass of waste products of their body size. So it is very difficult to locate the spider in exact position in the web (Fig. 41). This is also a kind of protective device. The young *Gasteracantha* may make a stabilimentum where as adults do not (Levi, 1978).

In the genera *Argiope* and *Cyclosa*, the orb-webs are commonly provided with stabilimentum. It is a zigzag ribbon like structure across the hub. It consists of large number of minute threads resembling a swathing band and spun from the small spigots of the acini-form glands.

In the webs of *Argiope*, the stabilimentum is X-marked across the hub (Fig. 42). It is always more elaborate in young than in adults. Despite its names the ribbon like white bands

do not function in support of the web, so it is seen the webs of largest females often lack of stabilimentum. The stabilimentum may obscure the out-line of the spider, which does not have a retreat but hangs in the centre of the web (Levi, 1968). It is not periodically replaced as the viscid silk. Since the decorative stabilimentum is found in diverse groups, sometimes only in the webs of immature, it may have different functions in different webs (Levi, 1978).

In the orb-webs of *Cyclosa*, the stabilimentum is generally a small one, placed just above and below the hub. *Cyclosa insulana* does not spin stabilimentum in the webs but the female spider fastens her egg-sacs in a series which extends across the web from the hub to the upper margin looks like a dead twigs or debris in a row in the web. The spider hangs in the web in a small gap at the centre between the upper half and the lower half of the structure (Fig. 43). This band of egg-sacs and the spider are of the same grey colour, so it is very difficult to find out the spider in the web, *C. mulmeinensis* constructs horizontal web without any stabilimentum. The spider waits in the hub for prey and the female fastens its egg-sacs in the webs at a side.

Some orb-weavers wait away from the web in a retreat which is directly connected with the hub by thread called trap-line. This retreat is made up of leaves fastened together with silk, a little away above or a side of the web (Fig. 44). When any insect gets trapped in the web, the disturbance caused on the web is communicated to the spider waiting in the retreat, and the spider rushes to get the prey. These retreats or nests are commonly found in the spiders—*Araneus mitifica*, *Neoscona*

rumpfi, *N. mukerjii*, *Parawixia dehaanii*, *Zygeilla* sp. etc.

Zygeilla builds the orb-web, in which characteristically one sector remains free of viscid spiral threads (Fig. 45). There is one radius leading through this open sector to the retreat of the spider as a trap-line. Their webs are renewed almost everyday.

In case of *Gea*, the orb-web occasionally has a sector missing from the lower half, compare with the web of *Zygeilla* where the sector is missing from the upper half. *Gea* constructs the web close to the ground in low vegetation and not having any stabilimentum.

In some genera, as in *Meta*, *Leucauge*, *Gasteracantha*, the hub is open. This open hub facilitates the spider to move from one face to the other. The hub of *Neoscona* is not fully open but crossed by only one or two threads (Fig. 46), unlike webs made by *Araneus* where the hub is meshed (Fig. 47). *Neoscona* sits in the hub with the tip of the abdomen pushed through the open space of the hub.

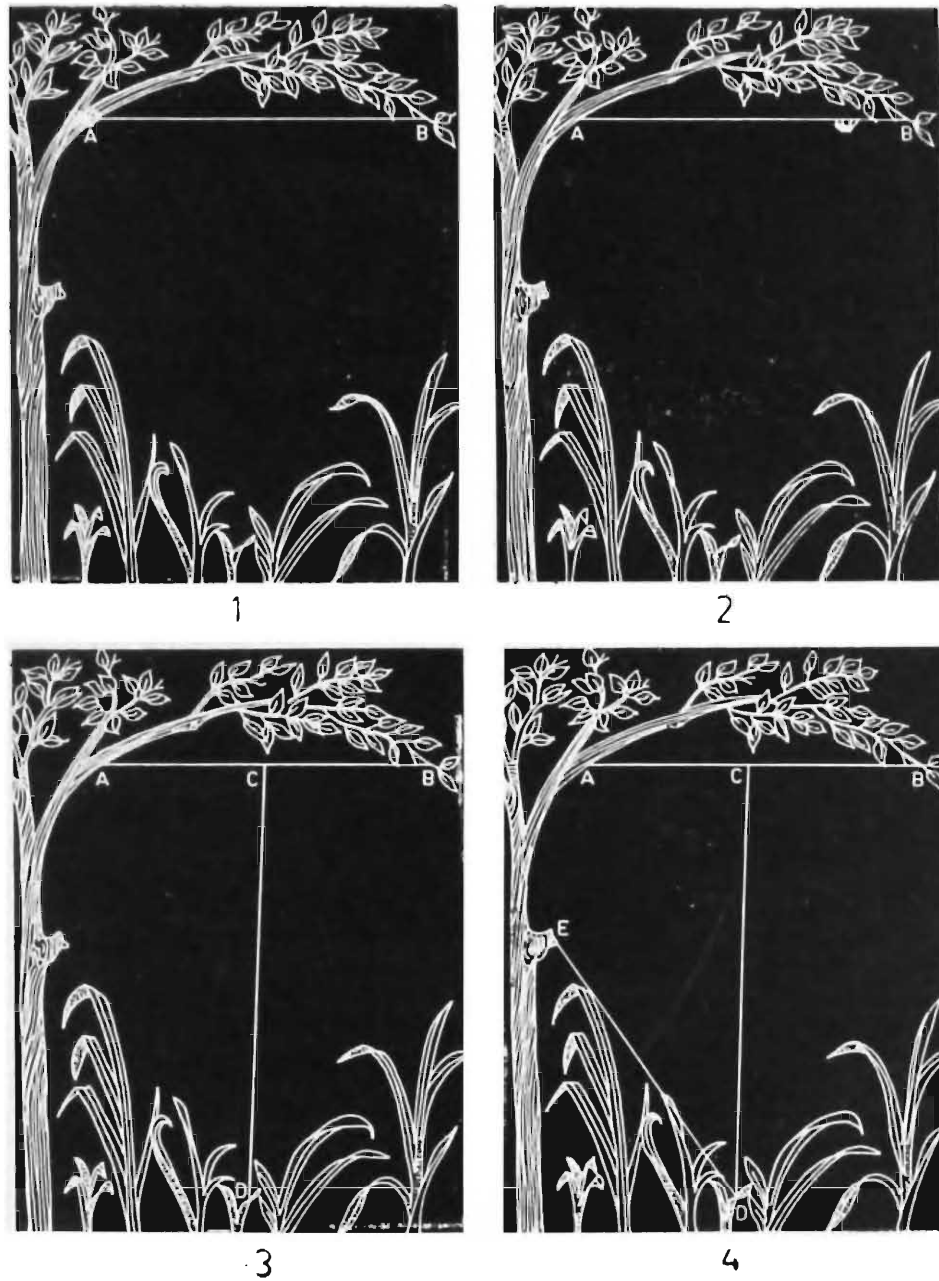
Leucauge builds the web in horizontal plane in low bushes during day time. Very quickly they construct their webs, which are devoid of retreats. The spider hangs at the centre upside down posture. Almost everyday they build their nets after removing the old one.

Nephila makes a huge web, nearly one metre or more in diameter, in shaded woods. The webs are different in number of respects from the others in the family. The radii are pulled out at their direct course to give a notched appearance (Fig. 48) and the viscid spiral is of yellowish in colour rather than white. The silk of *Nephila* is the strongest natural fibre known (Levi, 1968). The strong

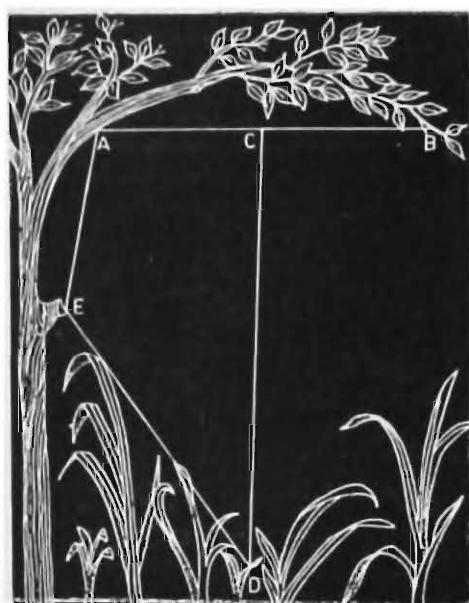
webs of *Nephila*, matted and twisted, are used by South Sea Islanders for various kinds of bags and fish nets. Unlike other orb-weavers, the *Nephila* makes use of the same web for a long period replacing only the viscid lines. The webs of young *Nephila* are complete orbs but the adults construct incomplete webs in the upper side. *N. maculata* is having an orb-web with a barrier web in the lower side.

Larinia makes the orb-web in the low bushes without any retreat. It does not rest in the centre of the web but on the vegetation to the side in day time. At night it sits in the hub only.

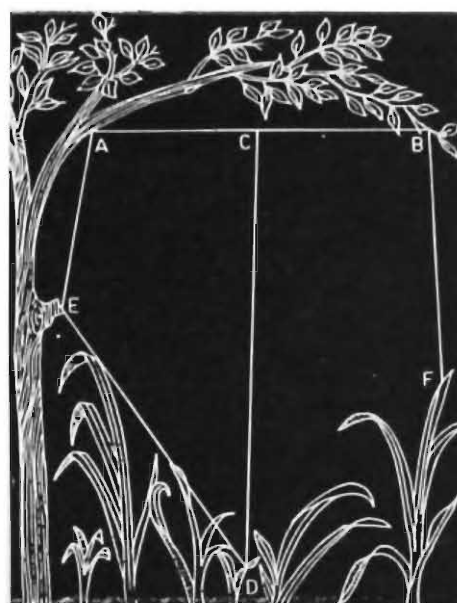
Members of the genus *Cyrtophora* produce the most unusual webs, thus perhaps the most specialised one. They make horizontal dome shaped webs with a barrier-web above and below (Fig. 49). The webs are devoid of viscid silk which is a specialised character since sticky threads are found in almost all araneids. The mesh of the web, which takes several nights to build, is so extraordinarily small that it can be said that it is a derived character. The webs of *Cyrtophora* are the best example of highest achievement of technical masterpiece among the spiders. *C. cicatrosa*, *C. citricola*, live in large colonies that span huge areas with contiguous barrier webs. These spiders make very few catches but since new webs are not constructed frequently, little energy is spent. The moths or other insects fly against the barrier web, tumble down to the domed horizontal orb-web, and are pulled through by the spider from below the web. The threads of the orb are not viscid and thus the rain water does not affect them, so no need to replace them frequently. It is observed that *Cyrtophora* takes 4-5 nights to complete its web (Kullmann, 1975).



Figs. 1-4. Orb-weaving mechanism of *Gastelacantha mammosa*
C. L. Koch.



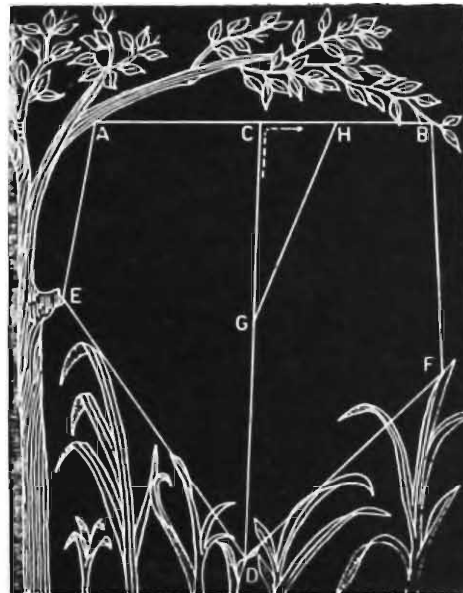
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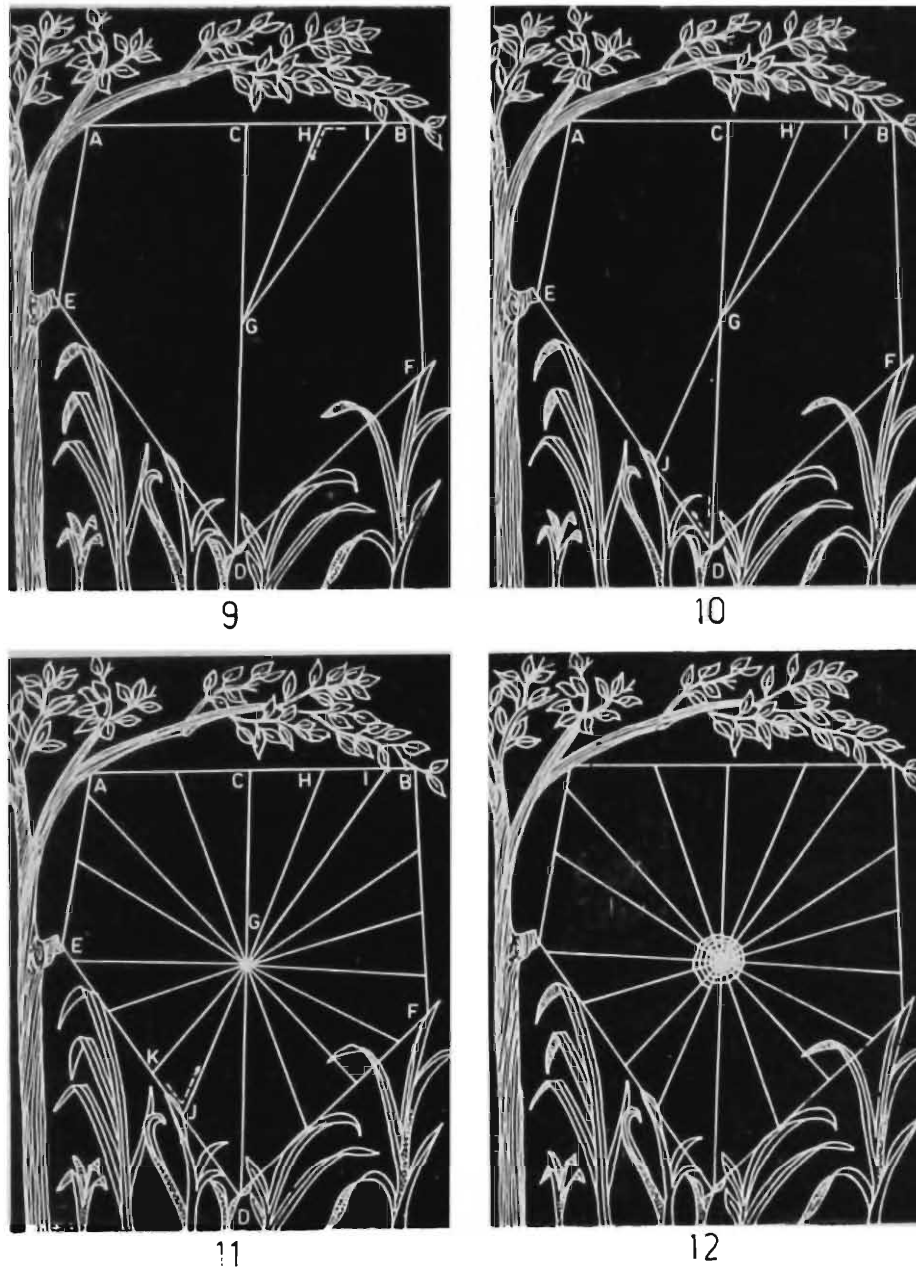


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Figs. 5-8. Orb-weaving mechanism of *Gasteracantha mammosa*
C. L. Koch.



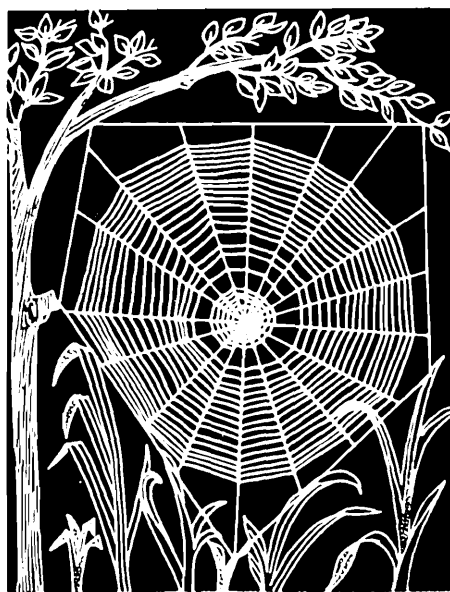
Figs. 9-12. Orb-weaving mechanism of *Gasteracantha mammosa*
Q. L. Koch.



13

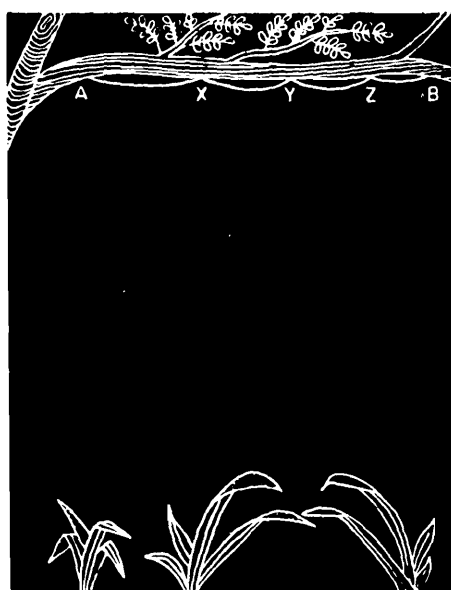


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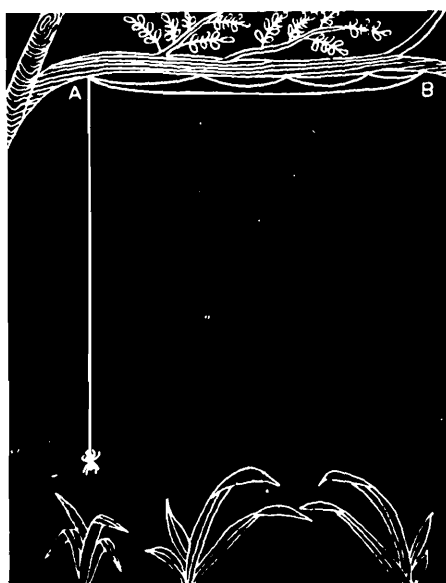
Figs. 13-15. Orb-weaving mechanism of *Gasteracantha mammosa*
C. L. Koch.



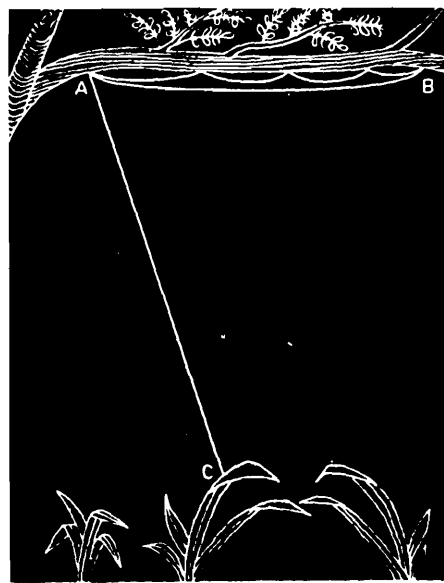
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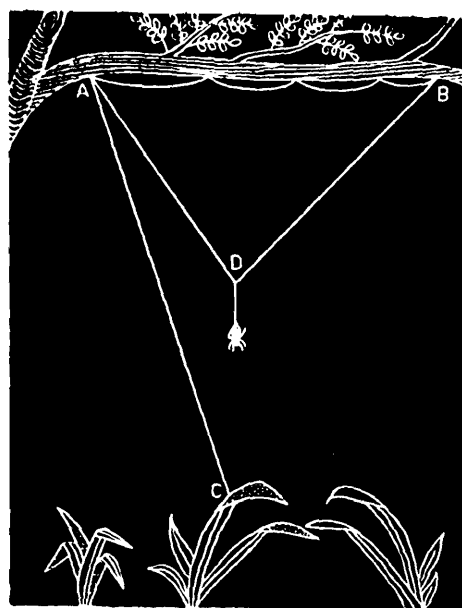


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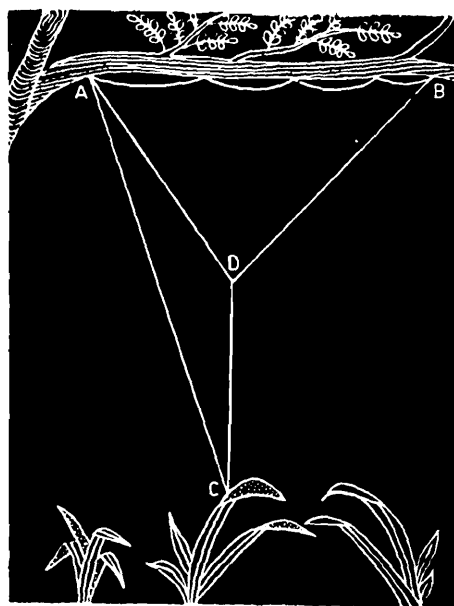


19

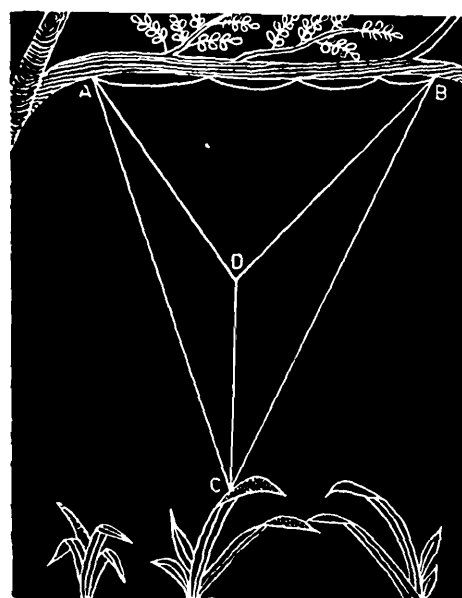
Figs. 16-19. Orb-weaving mechanism of young *Araneus* spider.



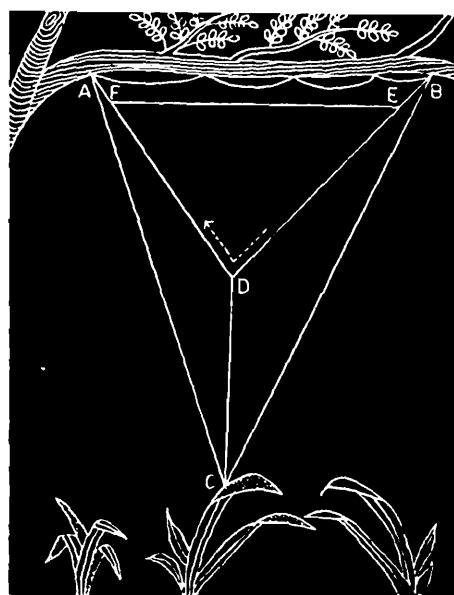
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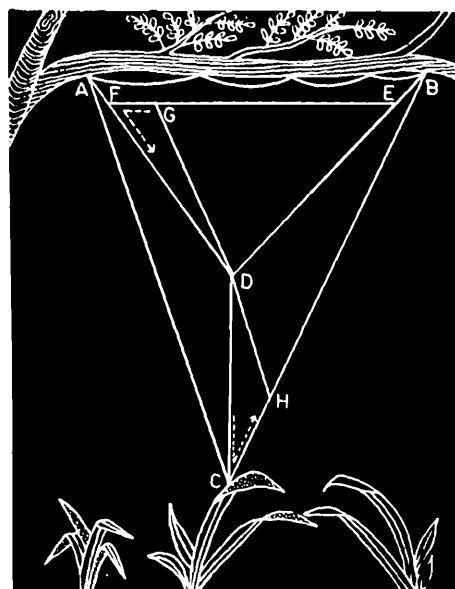


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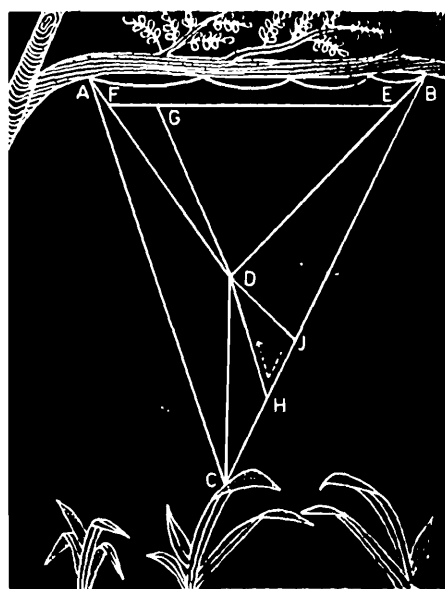


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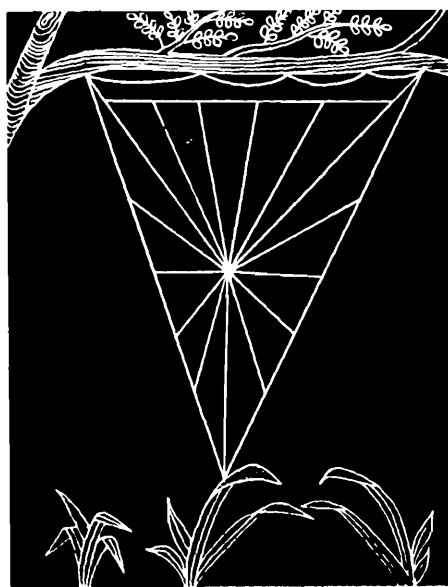
Figs. 20-23. Orb-weaving mechanism of young *Araneus* spider.



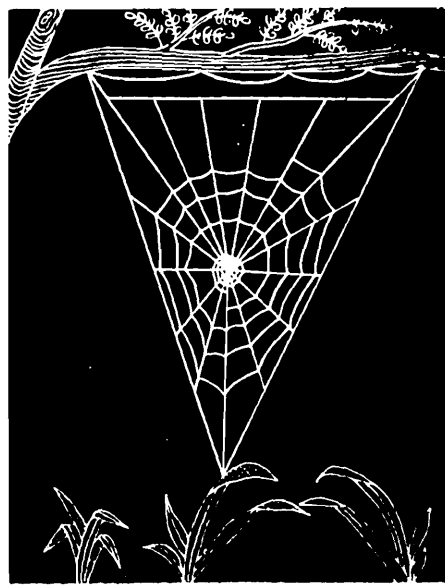
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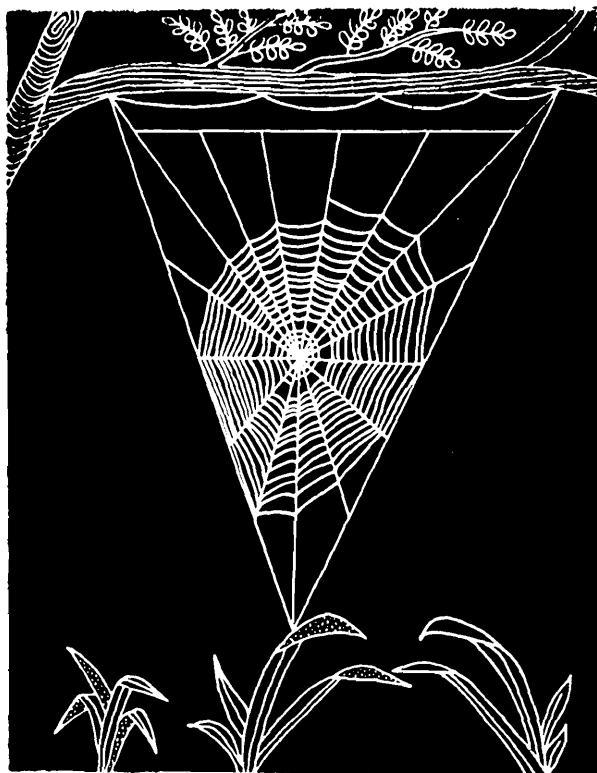


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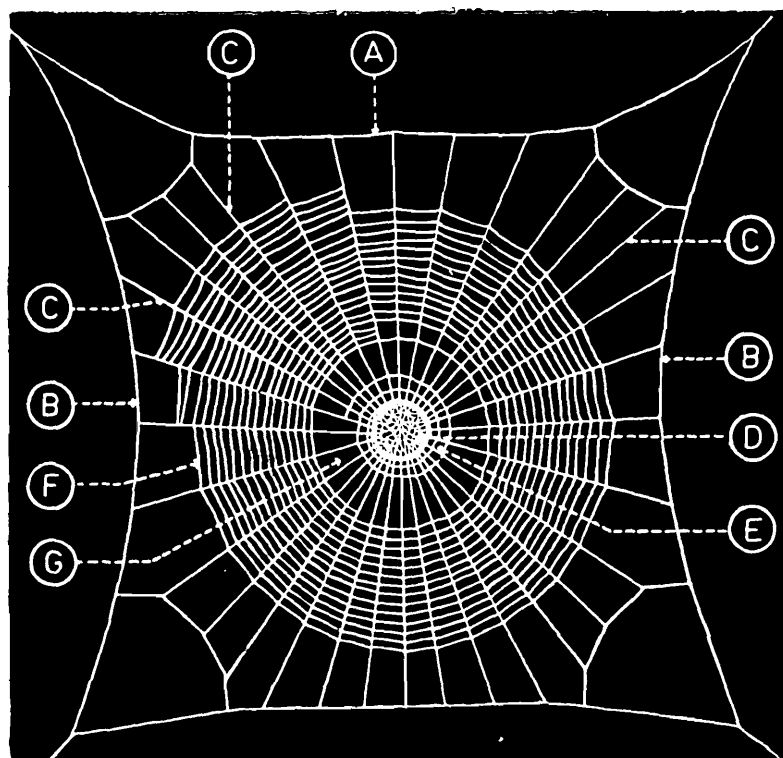
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Figs. 24-27. Orb-weaving mechanism of young *Araneus* spider.



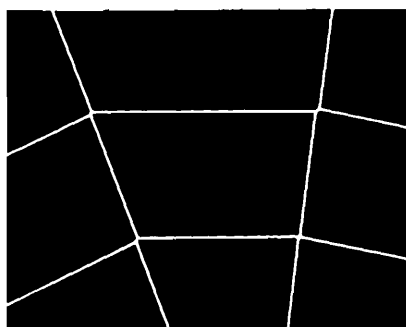
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Fig. 28. Orb-weaving mechanism of young *Araneus* spider.

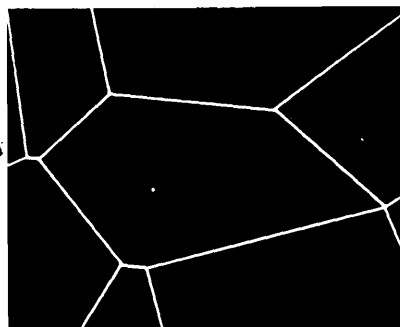


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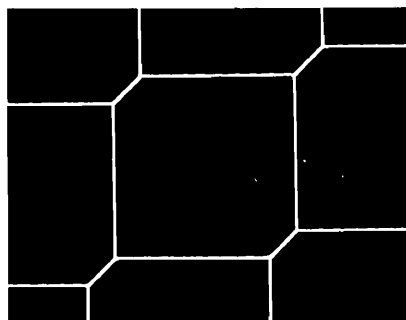
Fig. 29. Different parts of a typical orb-web.



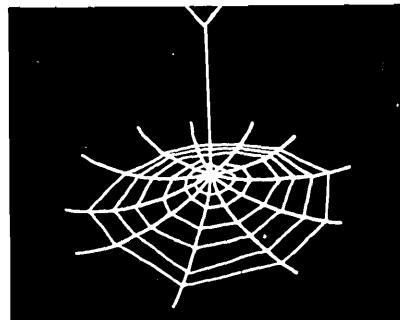
30



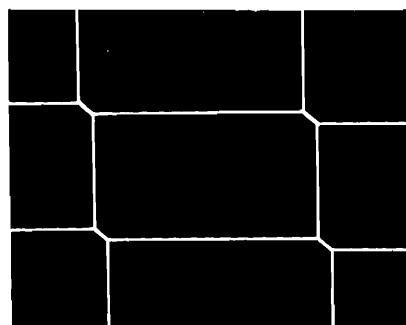
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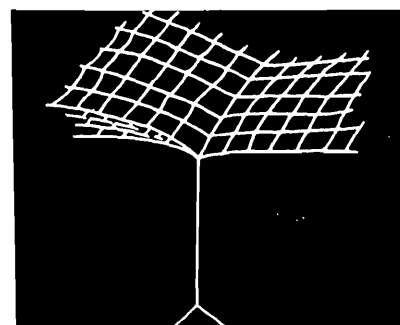
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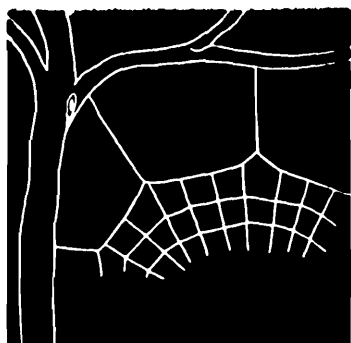
32



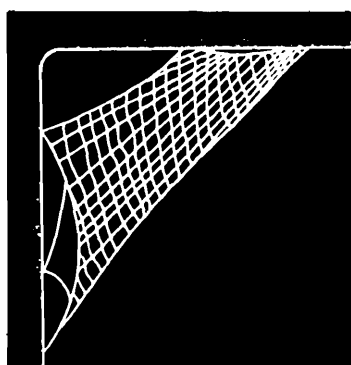
35

Fig. 30. Trapezoid mesh.
Fig. 31. Square mesh.
Fig. 32. Rectangular mesh,

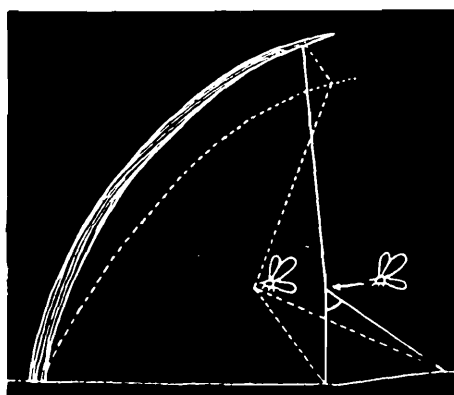
Fig. 33. Irregular mesh.
Fig. 34. Anchoring threads.
Fig. 35. Anchoring threads.



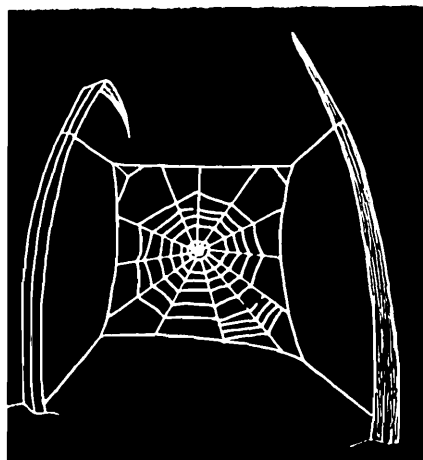
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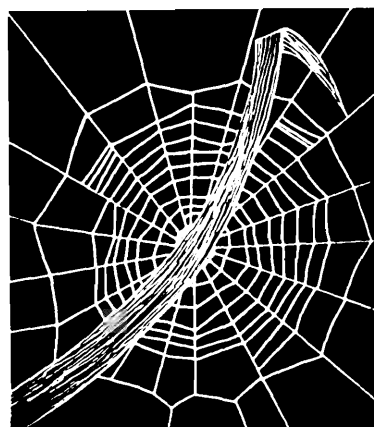
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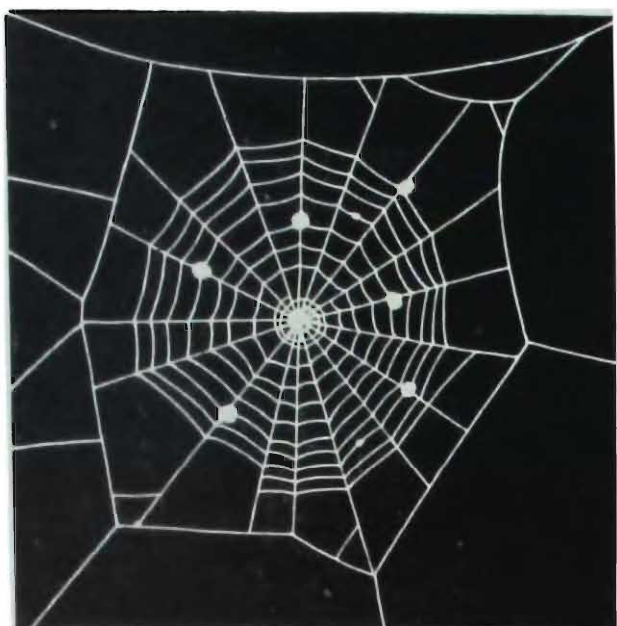


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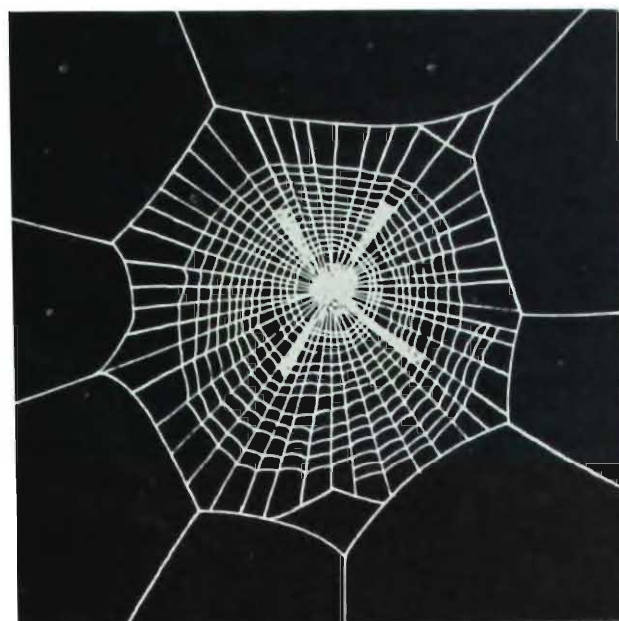
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- Fig. 36. Tree branches.
 Fig. 37. Blades of grass.
 Fig. 38. Building corners.
 Fig. 39. Blade of grass as internal net-support.
 Fig. 40. Very flexible grass,



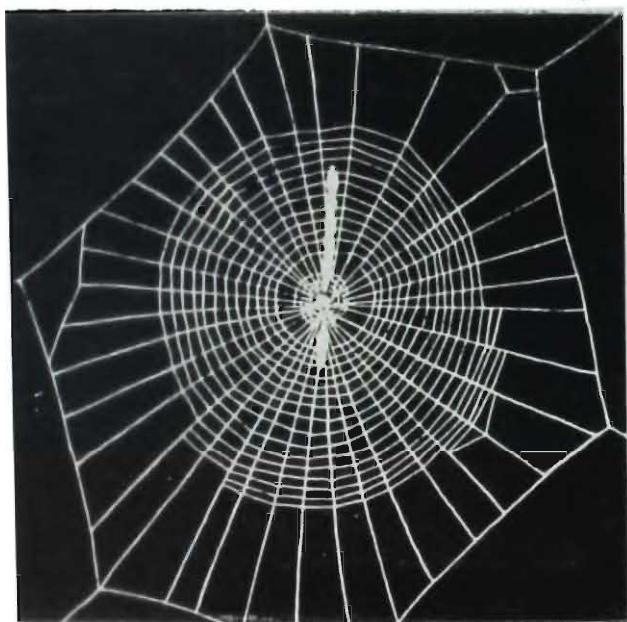
41

Fig. 41. Orb-web of *Gasteracantha* with fuzzy silk balls.



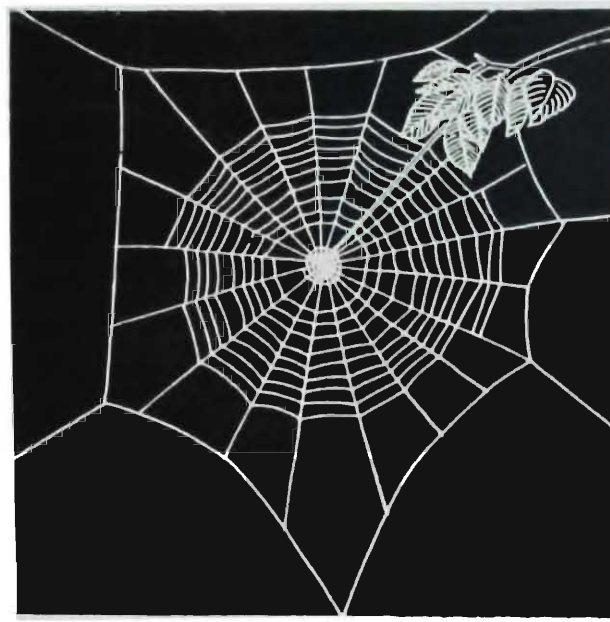
42

Fig. 42. Orb-web of *Argiope*, provided with X-shaped stabilimentum.



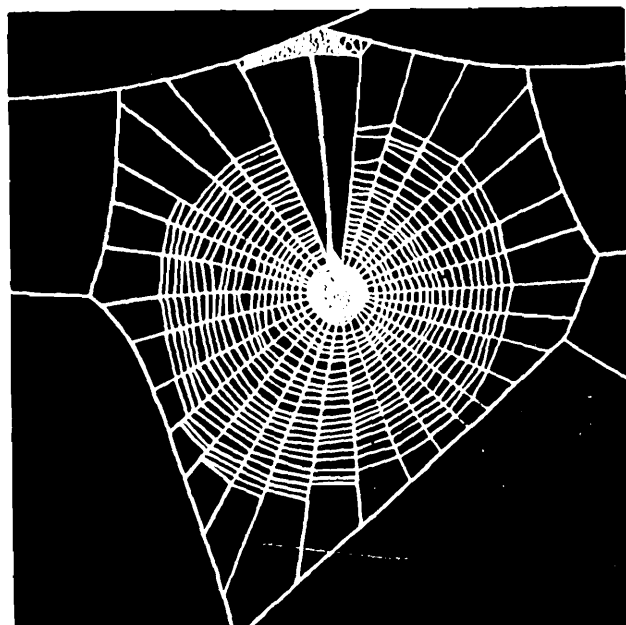
43

Fig. 43. Orb-web of *Cyclosa insulana* (Costa).

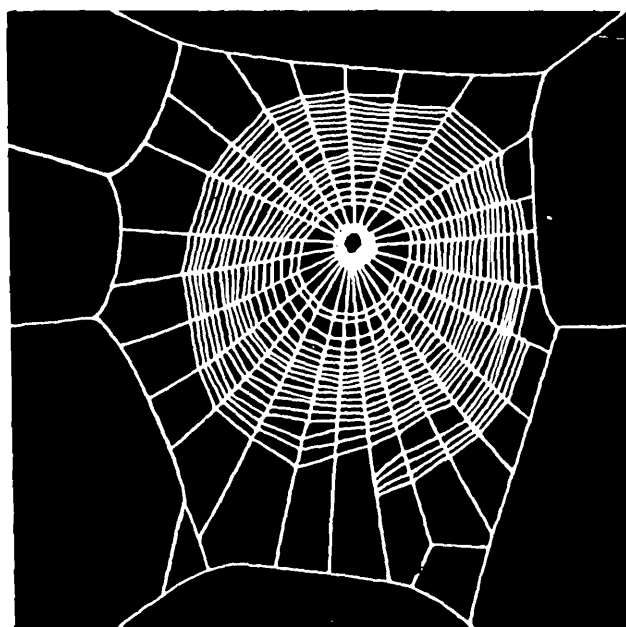


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Fig. 44. Orb-web of an araneid spider with retreat.

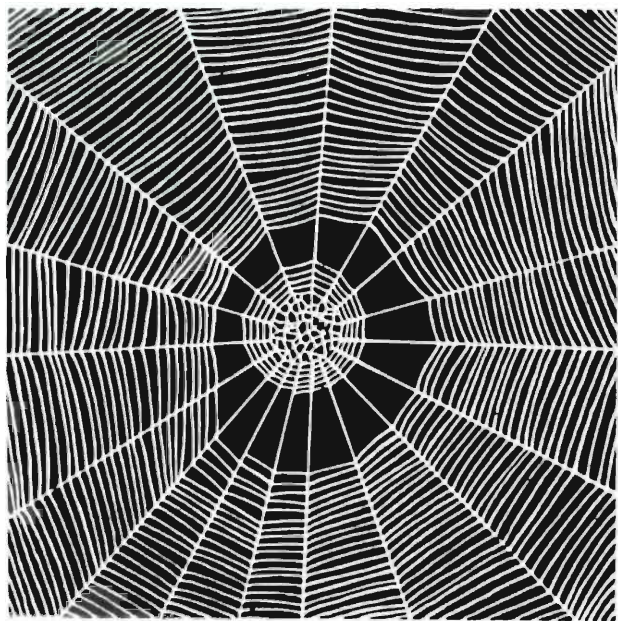


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Fig. 45. Orb-web of *Zygeilla*.

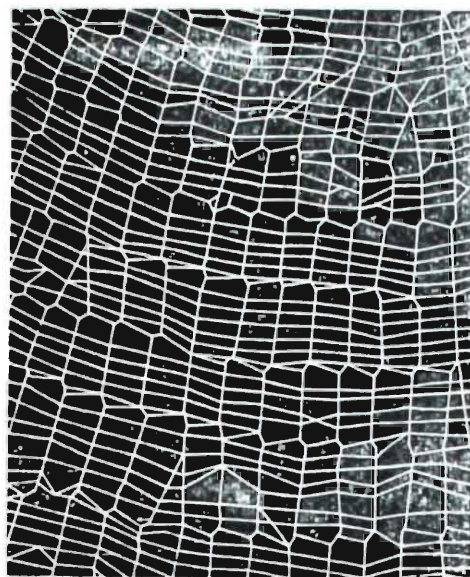
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Fig. 46. Orb-web of *Neoscona*.



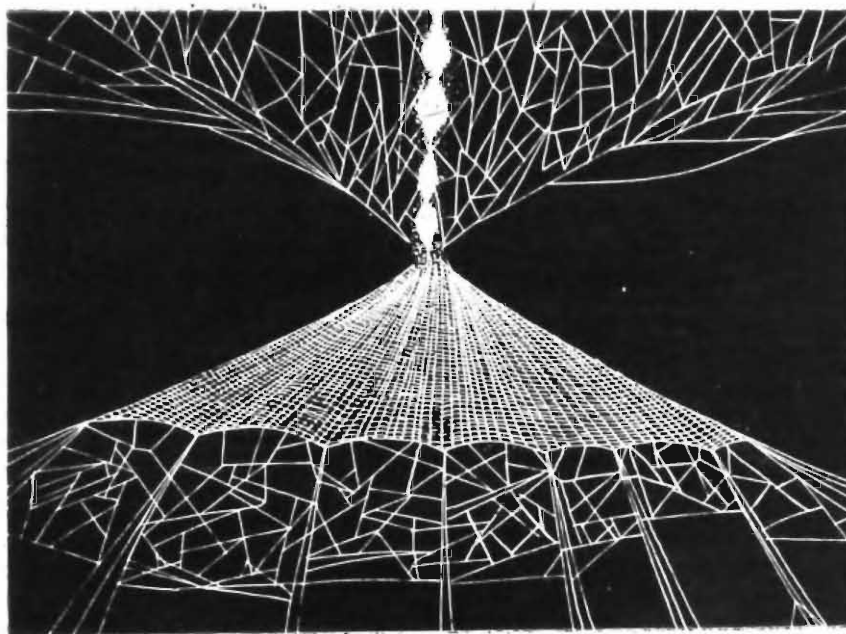
47

Fig. 47. Orb-web of *Araneus*.



48

Fig. 48. Part of the orb-web of *Nephila*.



49

Fig. 49. Horizontal dome shaped web of *Cyrtophora citricola* (Forsk.) with a barrier web above and below.

ACKNOWLEDGEMENTS

We are thankful to Dr. T. N. Anantha-krishnan, former Director, Zoological Survey of India for providing facilities and encouragement for undertaking this ecological studies on Indian araneid spiders. The illustrations used in this paper are prepared by Shri P. W. Garde and Shri D. J. Kamble, Artists of the Western Regional Station, Poona, to whom our thanks are due.

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FIRST RECORD OF *STIGMATOGOBIOUS DURBANENSIS* (PISCES :
GOBIIDAE) FROM INDIAN WATERS

The gobioid, *Stigmatogobius durbanensis* (Barnard) is known so far only from its type locality in the western Indian ocean (Smith, 1960). Recently, the author discovered four well-preserved specimens of this rather rare gobioid from the Orissa coast. The present communication reports the occurrence of this gobioid for the first time in Indian waters thereby extending its range to the central Indian ocean.

The genus *Stigmatogobius* Bleeker is represented by 21 species in the Indo-Pacific region. Of these, nine species including the present one are known from Indian waters : *S. sadanundio* (Hamilton), *S. poicilosoma* (Bleeker), *S. hoevenii* (Bleeker), *S. oligactis* (Bleeker), *S. roemeri* Weber, *S. minima* (Hora), *S. durbanensis* (Barnard), *S. yanamensis* Visweswara Rao and *S. micrognathus* Visweswara Rao.

A brief description of *Stigmatogobius durbanensis* is given below.

Stigmatogobius durbanensis* (Barnard)

(Plate VIII)

Gobius durbanensis Barnard, 1927, *Ann. S. Afr. Mus.*, 21 : 815. (type locality : Durban Bay).

Stigmatogobius durbanensis : Smith, 1960, *Ichthyol. Bull. Rhodes Univ.*, (18) : 306.

Material : 4 specimens, 16-27 mm. standard length ; Orissa coast, no further data ; Z. S. I. Regd. No. F 7651/2.

Description : D₁ VI, D₂ I, 7 ; A I, 7 ; V I, 5 ; P 15-16 ; C 16 (segmented rays) ; scales : lat. sr. 36-38, tr. sr. 10-11, pred. sr. 15-16.

Body elongated, somewhat compressed posteriorly ; head depressed. Depth of body 18.4-20.3%, length of head 27.7-30.0%, both in standard length. Predorsal distance 38.8-42.5%, preanal distance 56.2-61.1%, preventral distance 34.4-37.5% in standard length. Eye 25.3-29.1%, snout 26.6-29.1% in head length. Maxilla extending to vertical from mid-eye to posterior margin of eye, 40.9-46.6% in head length. Anterior nostril tubular. Tip of tongue rounded. Teeth in jaws multiserial, close-set, outer rows somewhat enlarged ; in lower jaw, outer row extends to half of jaw length ; no canines. Only nasal sensory canal-pores present. Scales ctenoid, on nape and operculum weakly ctenoid, on breast and belly cycloid. Head scaled above behind eyes, the foremost scale a large unpaired one in the median line. Preoperculum naked, operculum scaled in the upper part. Caudal fin rounded, shorter than head.

Colour, in alcohol : yellowish brown, with faint irregular cross-bands. Dorsal fins with brownish spots arranged in two longitudinal rows ; caudal fin also spotted.

Remarks : The present specimens agree well with the original description of the species but have a lesser number (10-11 vs. 12) of scales in the transverse series.

* While the manuscript of this communication was in press, the author received the paper of Hoesé & Winterbottom (1979, *Occ. Pap. Life Sci. R. Ont. Mus.*, (31) : 4) wherein *durbanensis* is placed in the genus *Mugilogobius* Smitt. 1899.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India, and Dr. K. C. Jayaram, Deputy Director for their kind encouragements. I wish to express my deep sense of gratitude to Dr. P. K. Talwar, Superintending Zoologist for kindly critically going through the manuscript. The photograph of the

specimen was taken by the departmental photographer, Shri Kanchan De.

REFERENCE

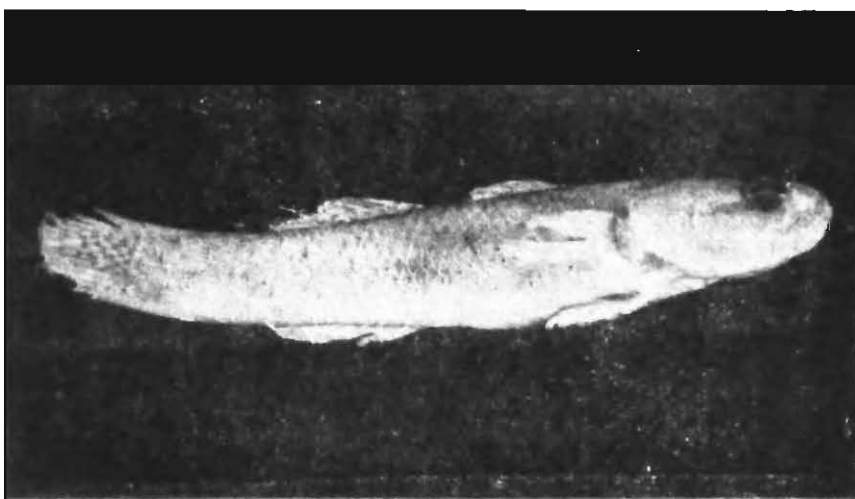
SMITH, J. L. B. 1960. Fishes of the family Gobiidae in South Africa. *Ichthyol. Bull. Rhodes Univ.*, (18) : 299-314.

*Zoological Survey of India,
Calcutta.*

T. K. CHATTERJEE

CHATTERJEE

PLATE VII



Stigmatogobius durbanensis (Barnard), specimen (ZSI F 7651/2, 27 mm S. L.) from Orissa coast, India.

Bull. zool. Surv. India, 4 (3) : 387-388, 1981

ON THE RANGE EXTENSION OF THE CARIDEAN SHRIMP *CONCHODYTES*
TRIDACNAE PETERS IN ASSOCIATION WITH THE BIVALVE *TRIDACNA*
TRIDACNA LINNEAUS IN THE MINICOY ATOLL, LAKSHADWEEP¹

While surveying the Lakshadweep group of Islands, one of the authors (A. M.) came across a caridean shrimp *Conchodytes tridacnae* Peters (Plate VIII, Figs. 1 & 2) ensconced within the mantle cavity of a giant bivalve *Tridacna tridacna* Linn. (Plate VIII, Fig. 3) from the coral bed of Minicoy atoll (Between Lat. 8°15' N and 8°20' N and Long. 73°0'E and 73°05'E), the southern most atoll in Lakshadweep, Arabian Sea.

Material : One example. (♂), Minicoy atoll, 14.7mm in length, B. P. Halder & A. Misra, 11.12.1979, Reg. No. C 2533/2.

The present note reports the southward extension of the range of distribution of the shrimp within the Lakshadweep group of islands. From the published reports, it reveals that the species is widely distributed in the Indo-Pacific region and is confined to the insular regions *viz.*, Andamans and Lakshadweep group of islands in India.

The earliest report of the occurrence of this shrimp (as *Pontonia* sp.) within the mantle cavity of clam (*Tridacna* sp.) from the Indian waters, Cherbanian reef, the northern most open reef in Lakshadweep, is by Alcock (1902). Pearson (1905) erected the new genus *Conchodytes* for *Pontonia*. Kemp (1922) determined the shrimp of Cherbanian reef collected by Investigator, Octo. 1891 as *Conchodytes*

tridacnae Peters and mentioned the extension of the range of distribution of this species to Port-Blair, Andamans, Indian Ocean. The first report of the association of this species with a holothurian host, off Cinque Island, South Andamans, is by Chopra (1937). The study of Nagabhusanam & Rao (1972) on the marine fauna of Minicoy atoll, Lakshadweep, reports the occurrence of the bivalve but not the shrimp.

The exact relationship of the shrimp with the host is not studied in detail. But from the observations, so far, made, it appears that the host provides not only a safe shelter but also sufficient food and oxygen through its activity. In turn, the benefit gained by the host through this association is apparently nil.

Concluding, it may be stated that future collections and observations from the mainland as well as the islands in the Indian region, should focus sufficient light on the nature of relationship existing between the associating partners.

ACKNOWLEDGEMENT

We are grateful to the Director, Zoological Survey of India, Calcutta, for the laboratory facilities and Shri G. Ramakrishna, retired scientist, Zoological Survey of India for going

through the manuscripts and offering valuable suggestions in the preparation of this report.

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*Zoological Survey of India,
Calcutta*

A. MISRA AND S. S. GHATAK



Fig.1



Fig.2



Fig. 3

Figs. 1 & 2. *Conchodytes tridacnae*. (1) Dorsal view ; (2) Ventral view. Fig. 3. *Tridacna tridacna*, shell opened

Bull. zool. Surv. India, 4 (3) : 389, 1981

FIRST RECORD OF THE RUFIOUS HORSESHOE BAT, *RHINOLOPHUS ROUXI*
ROUXI TEMMINCK [CHIROPTERA : RHINOLOPHIDAE] FROM BURMA.

While studying some specimens of the genus *Rhinolophus* present in the collection of the Zoological Survey of India, a male specimen (Reg. No. 12726) collected from Toungoo, Burma in January, 1927 was identified as *Rhinolophus rouxi rouxi* Temminck.

According to extant literature (Ellerman and Morrison-Scott 1966 and Sinha 1973) this bat is hitherto known from Sri Lanka, peninsular India extending north to Nepal, the easternmost limit being Darjeeling Dist., West Bengal. This would, therefore, constitute not only its first authentic record from Burma but also extends its range of distribution for eastwards.

The measurements (in mm) taken from alcohol preserved specimen are as follows :

External : Length of ear 20 ; length of noseleaf 11.5 ; width of horseshoe 8 ; length

of forearm 46.2 ; length of tail 23.7 ; length of tibia 20.7 ; length of foot and claw 10.8.

Skull : Total length 21.8 ; condylobasal length 19.4 ; interorbital width 2.6 ; zygomatic width 11.7 ; length of upper tooth row 8.5 ; width across caniness 5.9 ; length of lower tooth row 9.8 ; mandibular length 15.

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J. P. LAL

Bull. zool. Surv. India, 4 (3) : 391-393, 1981

ON THE TEREDINID BORERS OF MANGROVES OF CAMORTA ISLAND, NICOBAR, INDIA

Considerable damage is caused to marine installations and timbers by teredinid borers (Teredinidae : Bivalvia : Mollusca) and have been investigated in detail from different coastal waters of the Indian mainland (see Turner, 1966 a & b ; Subba Rao, 1968 ; Nair and Saraswati, 1971 ; Purushotham and Satyanarayana Rao, 1971 ; Nair and Dharmaraj, 1980) as well as Andaman Islands (see Karande, 1978 ; Das and Dev Roy, 1980 ; Tiwari *et al*, 1980). Studies on this group of wood borers are very much essential in order to have an understanding of their incidence and activity in different aquatic biotypes particularly in view of our increasing mariculture necessitating installation of numerous wooden structures. Moreover it has also been found that each geographical location is having its own set of dominant borers and assemblage of less important ones (Nair, 1968 ; Nair and Dharmaraj, 1979). So, teredinids of Nicobar waters need special attention as barring two reports on the occurrence of *Nausitora dunlopei* Wright (Rajagopal and Daniel, 1972 ; Tiwari *et al*, *op. cit.*) no information on this group from Nicobar Islands are available till date. The said species has been recorded from Galathea river, Great Nicobar and mangrove zones of Car Nicobar, the southernmost and northernmost Islands of the Nicobar group respectively.

During the course of a recent survey three species of teredinid borers, namely, *Bactronophorus thoracites* (Gould), *Dicyathifer manni* (Wright), *Lyrodus pedicellatus* (Quatrefages) have been collected from the mangrove areas of Camorta Island, Nicobar lying between 08°03'-08°15'N and 93°27'-93°34' E. Thus all these three species constitute the first record from Nicobar waters.

Family TEREDINIDAE

***Bactronophorus thoracites* (Gould)**

Material : 5 exs., Camorta Is., coll. M. Sil ; 6. VIII. 80 & 8. VIII. 80.

Remarks : Among the teredinid borers collected in camorta island this species was found to be most dominant attacking the dried up stems of the mangrove, *Rhizophora apiculata*. It is one of the longest borer and the maximum length of our collected materials from this island was 50 cm.

Distribution : In India this species has so far been reported from Sundarbans, Mahanadi estuary, Visakhapatnam, Vellar-coleroom estuary (Porto Novo), Bombay and South Andaman. For detailed distribution outside India see Das and Dev Roy (*op. cit.*).

***Dicyathifer manni* (Wright)**

Material : 2 exs., Camorta Is ; coll. M. Sil ; 8. VIII. 80.

Remarks : This species was found to infest dead stumps and stilt roots of the mangrove. Our collected materials are 8 cm. and 9.5 cm. in length.

Distribution : This species is having world-wide distribution in tropical and temperate seas. In India it has been reported from Sundarbans, Mahanadi estuary, Visakhapatnam, Madras harbour, Pulicat Lake, Cochin, Bombay, South and Middle Andamans.

Lyrodus pedicellatus (Quatrefages)

Material : 2 exs., Camorta Is ; coll. M. Sil ; 8. VIII. 80.

Remarks : It has also been found to attack the dead stumps and stilt roots of the mangrove. Length of the specimens examined 9 cm and 10.2 cm.

Distribution : World-wide in tropical and temperate seas. In India this species has been recorded from Mahanadi estuary, Visakhapatnam, Madras, Pamban, Tondi and Adirampatnam, Tuticorin, Kayamkulam, Cochin, Mangalore, Karwar, Panaji, Ratnagiri, Bombay, Daman, Veraval, Okha, Kandla and South Andaman.

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SILUROID FISHES OF INDIA, BURMA AND CEYLON. 24. THE SYSTEMATIC STATUS OF *ARIUS SATPARANUS* CHAUDHURI (ARIIDAE : SILURIFORMES)

Chaudhuri (1916) described *Arius satparanus* from a single example 210 mm long (probably SL)*, collected from the channel between Satpara and Barnikuda (Chilka Lake, Orissa), ZSI Regd. No F 8784/1. He differentiated his species from *Arius arius* (Hamilton) and *A. maculatus* (Thunberg) and also from all the other known species of this genus in its having a single oval patch of sparsely arranged globular teeth on either side of the posterior extremity of the palate. He did not compare it with *A. tenuispinis* Day, 1877, convinced as he was that *tenuispinis* belonged to the genus *Hemipimelodus* (palate teeth absent) as indicated by Day 1877.

Chandy (1954) published a description of *Tachysurus* (= *Arius*) *tenuispinis* based on the topotype specimens and contended that there are two distinct pear shaped patches of globular teeth placed far back almost at the posterior extremity of the buccal cavity. However, she included *T.* (= *Arius*) *satparanus* (Chaudhuri) in her catalogue without any comment. Misra (1976) placed *tenuispinis* under the genus *Hemipimelodus* following Day and he considered *A. satparanus* as a distinct species. Talwar (1976) examined the holotype of *A. tenuispinis* Day (original

of pl. 107, fig. 5, 280 mm in SL, registered as *Hemipimelodus tenuispinis* in the National Zoological Collections of ZSI, Regd. No. 482) and demonstrated the species as having two pear shaped teeth patches on the palate. He concluded thereby that *tenuispinis* cannot be placed under the genus *Hemipimelodus* confirming Chandy's (1954) earlier contention. In respect of *A. satparanus* Chaudhuri, he considered it as most closely related to *A. tenuispinis* Day and distinguished the two species on the presence or absence of dorsal tubercles and the nature of the dorsal and pectoral spines.

During the course of our studies on the fishes of the family Ariidae, we have examined and compared the holotypes of *A. tenuispinis* Day (280 mm. SL, ZSI, Regd. No 482) and *A. satparanus* Chaudhuri (200 mm in SL, ZSI, Regd. No. F 8784/1). We have also examined more than 150 fresh specimens of *A. tenuispinis* collected from various localities of east and west coasts of India, besides other 'non-typical material preserved in the collections of ZSI, Calcutta. The size range of the specimens of *A. tenuispinis* examined by us is also wide (80 to 415 mm in SL) which

* The preserved holotype of *A. satparanus* is 200 mm in SL measured by us, however, Chaudhuri (1916) measured the same as 210 mm. Probably this difference of 10 mm may be attributable due to a different standards adopted by Chaudhuri,

covers the size of the holotype (200 mm in SL) of *A. satparanus* Chaudhuri.

As stated earlier, Chaudhuri (1916) did not compare *A. satparanus* with the already described species *A. tenuispinis* Day, presumably because he was convinced that the latter species did not belong to the genus *Arius*. The morphometric proportions for six characters given by Chaudhuri for *A. satparanus* are compared with the same features derived from the samples of *A. tenuispinis* (Table 1)

collected by us. Further, 23 morphometric and meristic characters of *A. tenuispinis* are analysed statistically and compared with those of *A. satparanus* so as to have a perspective picture of the intraspecific range of variation in respect of each character (Table 2).

From the above analysis it is seen that there is hardly any character which distinguishes *A. satparanus* from *A. tenuispinis*. All the 23 major taxonomic characters of the former species intergrade completely with

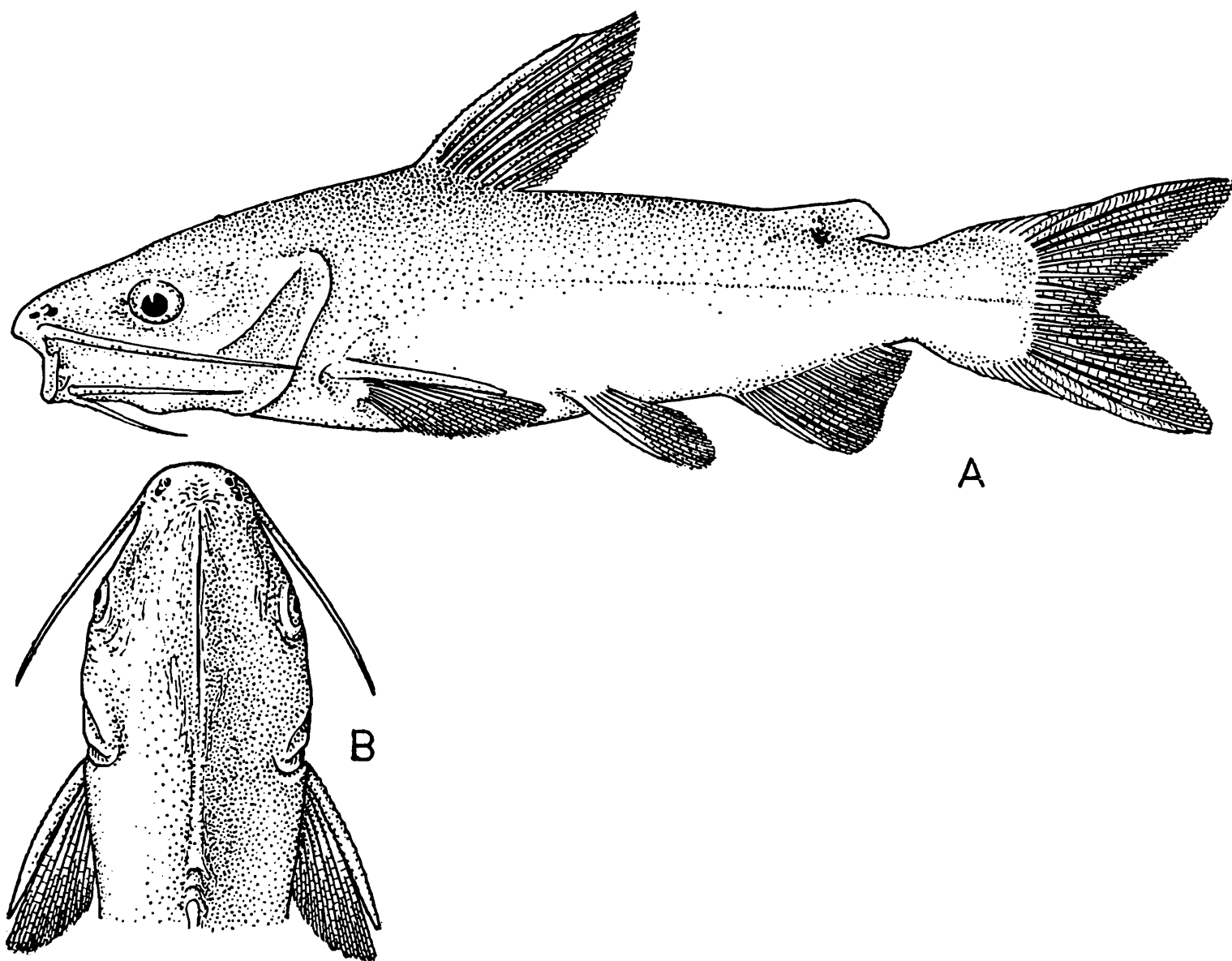


Fig. 1a. Lateral view of *Arius satparanus*, after Chaudhuri, 1916.

1b. Dorsal view of the head region of *A. satparanus*, after Chaudhuri, 1916.

that of the latter (Table 2). The morphological features considered by Talwar (1976) such as the dorsal tubercles and nature of the dorsal and pectoral spines are also not very helpful in distinguishing the two species when a series of large examples of all size groups are examined. Moreover it may be noted that there are no dorsal tubercles in the holotype of *A. satparanus* barring a few granulations on the occipital process which is very much similar to that of *A. tenuispinis*. It is also of

interest to note that subsequent to Chaudhuri (1916), *A. satparanus* has not been recorded from Chilka Lake or any where else and no example has been so far identified by any ichthyologist as *A. satparanus*.

In view of the above reasons we relegate *A. satparanus* Chaudhuri (1916) as a junior synonym of *A. tenuispinis* Day (1877).

We are thankful to the Director, Zoological Survey of India, for facilities.

TABLE—1

Showing the various morphometric characters in *A. satparanus* (after Chaudhuri)
vs. in the samples of *A. tenuispinis*.

As percentage of Standard length	<i>Arius satparanus</i>	<i>Arius tenuispinis</i>	
	(after Chaudhuri)	Range	Mean
1. Length of head	28.6	27.02-33.24	29.5913
2. Depth of body	20.00	16.66-23.33	20.6230
3. Length of snout	12.00	9.35-14.68	12.7321
4. Diameter of Eye	4.76	3.65- 5.76	4.3542
5. Length of pectoral fin	19.00	16.39-21.85	18.6291
6. Length of ventral fin	14.3	12.95-18.23	15.4512

TABLE—2

Biometric comparison of various taxonomic characters in the type specimens of *A. satparanus* Chaudhuri from Chilka Lake vs. sample means of 150 specimens of *A. tenuispinis* Day from different localities of east and west coast of India

150 specimens of <i>A. tenuispinis</i> Day				Type specimen of <i>A. satparanus</i> Chaudhuri			
	Range	$\bar{X}$	S	X	$\bar{X} - X$	t	p
LH/TL%	22.18-28.60	24.1316	1.5211				
HB/TL%	13.10-18.94	17.1800	1.2721				
LH/SL%	27.02-33.24	29.5913	1.4718	30.00	-0.4087	-0.2745	80%
HB/SL%	16.66-23.33	20.6230	1.0452	22.00	-1.377	-1.3023	20%
PDL/SL%	37.57-44.88	40.5830	1.2275	40.00	0.583	0.4695	60-70%
PAL/SL%	65.10-74.88	70.7618	2.2145	68.25	2.5118	1.1212	20-30%
PPL/SL%	23.35-30.98	27.0720	1.7871	30.00	-2.9298	-1.6196	10%
WDF/WAF%	52.38-75.00	61.1797	5.3731	58.62	2.5597	0.4713	60-70%
WH/LH%	59.63-71.62	66.5188	3.3731	65.83	0.6888	0.2009	80-90%
HH/LH%	51.16-60.00	55.8555	3.0645	58.33	-2.4745	-0.7992	40-50%
LS/LH%	32.53-39.70	36.51674	1.6110	35.83	0.6867	0.4193	70%

TABLE—2. Concluded.

150 specimens of <i>A. tenuispinis</i> Day				Type specimen of <i>A. sataparanus</i> Chaudhuri			
	Range	$\bar{X}$	S	$\bar{X}$	$\bar{X}-x$	t	p
ED/LH%	12.50-17.64	15.4134	1.1514	16.66	-1.2466	-1.0759	30%
INW/LH%	13.68-19.11	16.2041	1.1271	16.66	-0.4559	-0.3599	70%
IOW/LH%	43.55-53.70	50.9695	2.5706	55.83	-4.8605	-1.8704	10%
ED/LS%	32.35-47.62	42.2586	3.1125	46.51	-4.2514	-1.3508	20%
INW/LS%	38.46-55.55	44.5311	3.8001	46.51	-1.9789	-0.5152	60%
INW/WS%	40.91-62.79	49.5476	5.1681	50.00	-0.4524	-0.0865	More than 99%
ED/IOW%	25.80-39.86	30.6939	2.2450	29.85	0.8439	0.37129	70%
WPMT/ LPMT%	20.00-37.50	25.6848	3.9990	28.83	-3.1452	-0.7379	40-50%
HCPD/ LOPD%	41.34-68.00	55.2386	4.7068	57.14	-1.9014	-0.3999	70%
PFR	10.00-12.00	11.2325	0.5272	11.00	0.2325	0.4360	70%
AFR	17.00-19.00	17.9534	0.5324	18.00	-0.0466	-0.0865	More than 99%
GR	12.00-15.00	13.5348	0.6672	14.00	-0.4652	-0.6892	50%

AFR : anal fin ray counts ; ED : eye diameter ; GR : Gill raker ; HB : height of body ; HCPD : height of caudal peduncle ; HH : height of head ; INW : inter-nostril width ; IOW : inter-orbital width ; LCPD : length of caudal peduncle ; LH : Length of head ; LPMT : length of premaxillary band of teeth ; LS : length of snout ; P : observed probabilities for confidence intervals given in Simpson *et al.* (1960), Appendix Tab. II, for the corresponding calculated 't' value, PAL : pre-anal length ; PDL : predorsal length ; PFR : pectoral fin ray counts ; PPL : pre-pectoral length ; S : standard deviation of the sample mean ; SL : standard length ; TL : total length ; WAF : width of anal fin base ; WDF : width of dorsal fin base ; WH : width of head ; WPMT : width of premaxillary band of teeth ; $\bar{X}$: arithmetic mean of the various observation ; X : single observation.

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