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COMPOSITION AND ECOLOGY OF A BEETLE (COLEOPTERA) COMMUNITY IN WEST BENGAL, INDIA

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(With 1 Text-figure and 8 Tables)

INTRODUCTION

Between January 1971 and August 1972 pit-fall traps were used to collect beetles attracted to various types of mammalian dung (Oppenheimer, 1977). As would be expected, many other organisms occurred in the traps from spiders and harvestmen (Oppenheimer and Tikader, 1976) to frogs and snakes.

This paper will present data for Coeloptera, with emphasis on beetles other than scarabaeoid dung beetles, which are treated in detail elsewhere (Oppenheimer, 1977, in prep.).

METHODS

The study was done in two villages, Burasanti and Nasibpur (E 88° 15′ and N 22° 50′), 40 km NNW of Calcutta, West Bengal, India. Trapping was done in tree-shrub (TS), bamboo (BB), banana (BN), and grassy (G) sites in each village. The villages were surrounded by extensive areas of agricultural fields.

The study spanned all of 1971, which was a wetter year than average, and the first 8 months of 1972, which was a drier year than average (Table 1). Temperatures were higher in 1972 because of delay in formation of the annual monsoon cloud cover.

The number of trap-days varied per month depending on the number of weeks in the month, the number of villages traps were set it, and the number of traps set at each site. A "trap-day" consisted of a single pit-fall trap set out between 1500 and 1600 hours and picked up the following day between 0900 and 1000. Between 17 January and 8 June 1971

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traps were set twice a week in the TS, BB and BN habitats in Nasibpur, and in the G habitat in Burasanti. Between 14 June 1971 and 26 February 1972 traps were set once a week in each of the four habitats in both villages. Starting with 3 March 1972 traps were set only once a week in the four Burasanti habitats. Trapping in the grass habitats was suspended in Nasibpur between 20 November and 17 December, and in Burasanti from 23 June 1972 till the end of the study.

TABLE 1. Weather data for Singur, Hooghly District West Bengal between January 1971 and August 1972

	1971						1972
	Jan-Feb	Mar-May	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug
Total rainfall (cm)	2.28	36.88	139.14	32.43	7 44*	4.42	75.71
Max. temp (°C)	25.9	34.4	32.3	32.5	24.2	39.0	36.9
Min. temp (°C)	15.6	21.7	26.4	19.6	14.2	22.8	26.6
Weather	cool-dry	hot-moist	hot-wet	mild-moist	cool-dry	hot-dry	hot-wet

*Jan & Feb 1972—7.44 cm

Initially six pit-fall traps were used in each habitat and each was baited with a different mammalian dung type : human (H), monkey-*Presbytis entellus* (M), dog-*Canis familiaris* (D), goat (G), cattle (C) and buffalo (B). Two additional traps (elephant dung and unbaited) were added as of 14 August 1971, for a total of eight traps. From 12 May 1972 to the end of the study two of the traps were baited with human dung and six traps were unbaited at each trapping site.

All beetles collected were pinned and labelled. Specimens were primarily deposited in the Zoological Survey of India, Calcutta, and in the U. S. Museum of Natural History, Washington, D. C.

Results

Over 16,000 specimens from at least 22 families, 73 genera and 207 species were ohtained from pit-fall traps during the study (Table 2). Though scarabs made up over 80% of the beetles in the collection, carabids contributed more genera and species. These two families, plus aphodids and tenebrionids, contributed 62% of the genera, 80% of the species and 99% of the beetles. The dominance of scarabs in the collection can be attributed to the use of baited traps. If one looks at just unbaited control traps (August 1971 to August 1972, n = 104 beetles) scarabs made up 17.3%, carabids 19.2%, and tenebrionids 40.4% (with aphodids they totaled 82.6% of the beetles). This differs significantly from the distribution in Table 2 ($p<.001$). However, the distribution of species from each family in the unbaited traps did not differ from that given in Table 2.

TABLE 2. Taxonomic and numerical composition of beetle collection between January 1971 and August 1972

Suborder / Super family	Family (Code)	Number of Genera	Number of Species	Individuals No.	Individuals %
Adephaga					
Caraboidea	Carabidae (A)	26+	67	614	3.8
Polyphaga					
Hydrophiloidea	Hydrophilidae (B)	2	2	35	.2
Histeroidea	Histeridae (C)	4	4	67	.4
Staphylinoidea	Staphylinidae (D)	2	2	5	<.1
Scarabaeoidea	Scarabaeidae (E)	9	53	13,435	83.0
	Aphodiidae (F)	2	25	1,373	8.5
Byrrhoidae	Byrrhidae (G)	1	1	1	<.1
Elateroidea	Elateridae (H)	3	6	18	.1
Dermestoidea	Dermestidae (I)	1	1	1	<.1
Bostrychoidea	Ptinidae (J)	1	1	2	<.1
Cucujoidea					
Clavicornia	Nitidulidae (K)	1	1	2	<.1
	Erotylidae (L)	1	1	1	<.1
	Coccinellidae (M)	1	1	5	<.1
	Endomychidae (N)	1	1	2	<.1
Heteromera	Colydiidae (O)	1	1	1	<.1
	Tenebrionidae (P)	8	20	536	3.3
	Anthicidae (Q)	1	1	1	<.1
Chrysomeloidea	Cerambycidae (R)	1	1	1	<.1
	Chrysomelidae (S)	3	10	23	.1
Curculionoidea	Anthribidae (T)	1 ?	2	20	.1
	Curculionidae (U)	2 ?	5 ?	39	.2
Unidentified	Unidentified (V)	1 ?	1 ?	10	<.1
Total		73+	207	16,192	100.0

The number of species contributed by each family varied with season, and to some extent by habitat (Table 3). Tenebrionids accounted for one-quarter of the species during the winter months, but only a tenth of the species in the total study. Carabids accounted for over 30% of the species during the monsoon months of June to August and in the total study. Scarabs accounted for an average of 39% of the

TABLE 3. Distribution of species across families by seasons, habitats, and study (in percent)

	1971		Seasons			1972		Habitats				Total
	J-F	M-M	J-A	S-N	D-F	M-M	J-A	TS	BB	BN	G	Study
Scarabaeidae	30	39	35	24	30	39	43	30	31	31	25	26
Aphodiidae	9	16	16	14	11	11	6	15	17	15	15	12
Histeridae	2	3	1	5	3	8	2	1	3	4	2	2
Hydrophilidae	0	1	2	1	0	0	0	0	0	2	2	1
Carabidae	23	29	34	29	17	16	32	31	28	22	35	32
Tenebrionidae	26	12	3	11	23	16	9	13	7	11	10	10
Misc. families	9	16	8	16	17	11	9	11	15	16	12	17
Total no. of												
species	43	90	97	85	66	38	47	88	108	109	117	207
families	8	14	12	14	13	9	9	13	17	15	15	22
trap-days	255	672	672	816	808	416	368	1033	1034	1032	908	4007

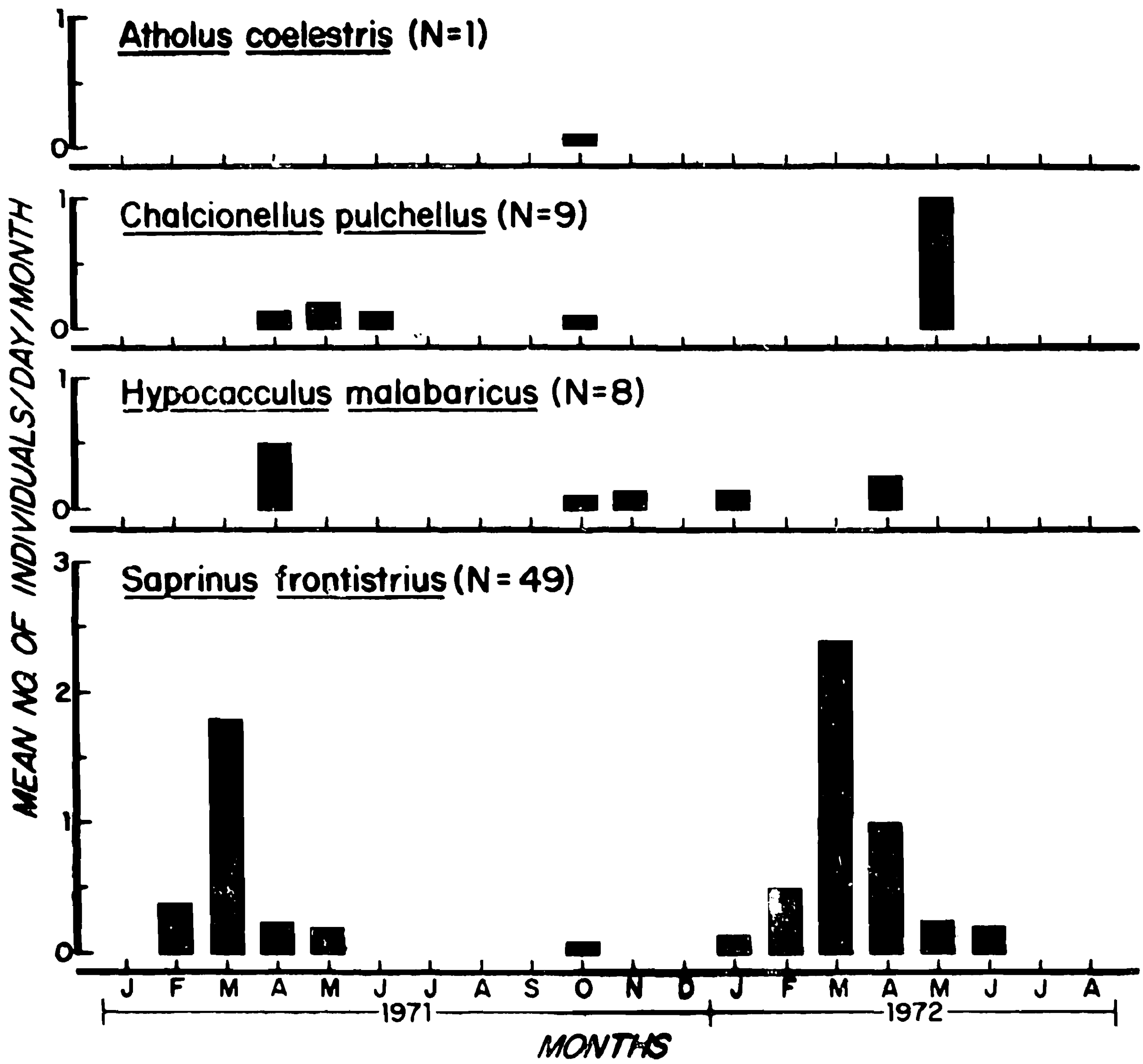
species from March to August, though they accounted for only 26% of the species in the total study. The total number of species caught per season increased with the number of trap-days per season ($r^2=.782$, $n=7$, $p<.05$) ; but such a correlation did not hold for any single family. The number of carabid species increased as the number of species of other families increased ($r^2=.818$, $n=7$, $p<.05$). More species occurred in the grass habitat than in the other three habitats despite the smaller number of trap-days there, though this difference was not significant.

The number of beetles obtained from the pit-fall traps per trap-day varied during the study (Table 4). The smallest number of beetles was caught in January 1971 and April 1972, which were dry months, and the largest number was caught in the months of June 1971 and August 1972, which were wet months. The number of beetles caught actually increased with the increase in total monthly rainfall up to the point where the water table reached or rose above the soil surface, as occurred in August 1971. This relationship between abundance and rainfall was apparent in both 1971 ($r^2=0.699$, $n=11$, $p<.02$) and 1972 ($r^2=0.928$, $n=8$, $p<.001$). This increase in abundance with increase in rainfall occurred in scarabs ($r^2=.807$, $n=19$, $p<.001$), aphodids ($r^2=.659$, $n=18$, $p<.005$, months with over 47 cm of rainfall omitted), hydrophilids ($r^2=.764$, $n=18$, $p<.001$) and carabids ($r^2=.888$, $n=18$, $p<.001$). Tenebrionids were most abundant during the cool dry months and increased in abundance with a decrease in temperature ($r^2=-.896$, $n=20, p<.001$) and rainfall ($r^2=-.595$, $n=20, p<.01$) ; multiple regression on temperature (y) and rainfall (x) was $R^2=0.90$ ($n=20$, $z=78.07-0.23x-$

TABLE 4. Monthly catch of beetles of several families caught during 4007 pit-fall trap-days between January 1971 and August 1972 (mean number of beetles per trap-days × 100)

Beetle	1971												1972								
families	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Mean
Scarabaeidae	9	42	130	383	963	1290	863	222	245	359	185	20	15	123	79	21	70	161	804	1090	353.7
Aphodiidae	0	5	2	32	97	234	105	18	2	34	13	7	5	7	1	1	3	11	105	52	36.7
Histeridae	0	2	8	4	2	1	0	0	0	1	<1	0	1	2	8	4	1	1	0	0	1.8
Hydrophilidae	0	0	0	0	1	5	5	2	2	1	0	0	0	0	0	1	0	0	0	0	0.9
Carabidae	2	7	2	9	35	47	80	27	12	14	7	4	1	5	4	1	3	9	19	9	14.9
Tenebrionidae	29	28	19	2	2	1	0	1	<1	5	36	35	37	23	16	6	2	3	0	0	12.3
Misc. families	0	4	6	2	5	8	1	1	2	5	8	3	3	2	6	2	2	9	2	2	3.7
Total beetles	39	88	168	431	1106	1586	1053	272	262	419	250	69	62	162	114	35	82	193	930	1152	423.7
No. of trap days	66	189	240	192	240	192	192	288	256	320	240	296	256	256	160	128	128	152	96	120	4007

2. 31y). Histerids were most abundant during warm dry months, and showed no association with rainfail ($r^2=-.360$, $n=19$, n. s.) or temperature ($r^2=.056$, $n=20$, n. s.) ; this is emphasized by their consistent pattern of abundance in both years (Table 4), despite weather differences (Table 1). *S. frontistrius* peaked in March, *H. malabaricus* in April and *C. pulchellus* in May of both years (Text-fig 1). All three of these species occurred in October at a very low level, which indicated it was a suitable but nonoptimum time for them. October was the only month in which *A. coelestris* appeared.



Text-fig. 1. Monthly distribution of four species of histerids between January 1971 and August 1972 (total number caught in parentheses). Note that each species had its peak activity in a different month and that the pattern is the same in both years.

More beetles occurred per trap day in the bamboo habitat than in the other three habitats, and the least occurred in the grass habitat (Table 5). Scarabs and aphodids were most abundant in the bamboo habitats, whereas hydrophilids and carabids were most abundant in the grass habitats, and tenebrionids in the banana groves.

TABLE 5. Habitat and trap abundance of several beetle families caught between January 1971 and April 1972 (mean number of beetles per trap-day × 100)

Beetle families	Habitats				Mean	Probability*	Traps and bait type						Mean	Probability*
	Tree-shrub	Bamboo	Banana	Grass			Human	Monkey	Dog	Goat	Cattle	Buffalo		
Scarabaeidae	258	589	281	115	310.8	<.001	979	349	454	211	131	76	366.7	<.001
Aphodiidae	16	61	36	23	34.0	<.001	61	62	10	58	26	19	39.3	<.001
Histeridae	1	3	2	1	1.8	<.001	6	<1	2	1	1	1	1.8	<.001
Hydrophilidae	0	0	<1	4	1.0	<.001	1	1	2	1	1	1	1.2	>.100
Carabidae	8	8	22	28	16.5	<.001	19	18	21	14	18	18	18.0	>.500
Tenebrionidae	17	3	28	12	15.0	<.001	14	12	15	13	17	15	14.3	>.700
Misc. families	2	6	3	4	3.8	—	6	4	4	3	2	3	3.7	—
Total beetles	302	669	371	186	382.0	<.001	1086	446	508	302	196	133	445.5	<.001
No. of trap days	889	888	890	844			498	495	496	496	497	497		

*Chi-square test done on actual number caught with expected values assumed equal

Traps baited with human feces attracted the largest number of beetles, whereas those baited with cattle and buffalo dung attracted the smallest number (Table 5). Scarab, aphodid, and histerid families followed this pattern, whereas hydrophilid, carabid and tenebrionid families occurred with essentially equal frequency in all traps. An exception were two carabid (A) species (Table 6) : *P. catoirai* was most abundant on dog dung (46%, $p<.005$) and *A.* nr *pallipes* was more abundant on human and buffalo dung than on monkey and goat dung ($p<.01$). The two species of hydrophilids (B) were slightly more abundant on dog dung (Table 6), but this was not significant. Only one species of histerid (C), *S. frontistrius*, was abundant enough for selectivity to be detectable ; it occurred primarily in the bamboo habitat (Table 7) and was attracted most frequently to human dung (Table 6). The other three species of histerids showed different patterns.

TABLE 6. Distribution of non-dung beetle species (between January 1971 and April 1972), which showed selectivity for dung type or might be expected to show selectivity (mean # beetles per trap-day x 500)

Family Code*	Species	Dung type H	M	D	G	C	B	Total
A.	*Pheropsophus catoirai*	8	1	19	4	3	6	41
	Abacetus nr pallipes	36	19	25	15	24	31	150
B.	*Coelostoma* sp.	4	3	10	4	0	3	24
	Sphaeridium sp.	4	4	12	4	4	6	34
C.	*Saprinus frontistrius*	25	1	5	7	2	2	42
	Hypocacculus malabaricus	2	0	1	0	1	3	7
	Chalcionellus pulchellus	1	1	2	0	1	0	5
	Atholus coelestris	0	0	0	0	1	0	1
D.	*Anotylus foetidus*	1	0	0	0	0	0	1
	Philonthus sp.	0	1	0	0	0	0	1
	Zyras sp.	2	0	1	0	0	1	4

*See Table 2

As seen in the histerids in terms of dung selectivity (Table 6), where one species accounted for 76% of the beetles, the ecological distribution patterns for the families presented above were established by one or a few species that were represented by a large number of individuals (Table 7). Four of the 67 carabid species accounted for 52% of the carabid beetles, and five of the 20 tenebrionid species accounted for 83% of the tenebrionid beetles. Similar dominance of a few species

TABLE 7. Mean number of beetles per trap day (x 1000) for each season and habitat for all non-scarabaeoid species and non-coprophagous scarabs collected between January 1971 and August 1972 (based on 4007 pit-fall trap days)

Family Code* and subfamily	Genus and species	Seasons and number of trap days J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	Habitats & # trap days TS 1053	BB 1034	BN 1032	G 908	Total # of beetles
A. Bembidiini													
	Bembidion sp.	4	—	—	—	—	—	—	—	—	—	1	1
	Elaphropus politus Motch.	—	10	19	5	1	—	3	—	4	12	11	26
	Elaphropus sp.	—	—	3	—	—	—	—	—	—	—	2	2
	E. klugi Nietn.	—	1	—	1	—	—	—	—	—	—	2	2
Brachinini													
	Mastax sp.	—	—	4	—	—	—	—	1	—	2	—	3
	Pheropsophus catoirai Dej	12	28	15	7	4	—	11	1	3	35	6	45
	P. bimaculatus L.	—	3	—	—	—	—	—	—	2	—	—	2
	P. sobrinus Dej var. *hilaris* F.	—	—	—	1	—	—	—	—	—	—	1	1
Chalaenini													
	Callistomimus chalcocephalus Wied.	—	1	3	—	—	—	—	—	3	—	—	3
	Chlaeninus quadriplagiatus Chaud.	—	—	3	18	4	—	—	2	—	—	20	20
	Chlaenius chlorodynus Dej	—	6	3	—	—	—	—	—	3	—	3	6
	C. cyaniceps Bates	—	—	1	7	—	—	5	6	1	—	2	9
	C. hamifera Chaud.	4	—	—	—	—	—	—	—	—	—	1	1
	C. poecilinus Bates	—	—	6	—	—	—	—	—	3	—	1	4
	C. xanthospilus Wied.	—	1	—	—	—	—	—	1	—	—	—	1
	Chlaenius sp. #2	4	—	—	—	—	—	—	—	1	—	—	1
	Chlaenius sp. #3	—	—	4	1	—	—	—	3	1	—	—	4

TABLE 7. (*Continued*)

	J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total # of beetles
Cicindelini												
Cicindela nr *corticata*	—	—	3	—	—	—	—	—	2	—	—	2
Harpalini												
Amblystomus bivittatus Andr.	8	3	4	1	—	—	—	1	1	1	5	8
Amblystomus sp. #24	—	1	1	—	—	—	—	—	—	1	1	2
Amblystomus sp. #25	—	—	1	—	—	—	—	—	—	1	—	1
Dioryche sp.	—	6	1	10	2	—	—	1	—	11	6	17
Egadroma sp. #1	—	—	—	—	—	—	3	—	1	—	—	1
Egadroma sp. #2	—	—	—	—	—	—	16	—	—	—	6	9
Egadroma sp. #3	4	—	—	—	—	—	3	—	—	1	1	2
Egadroma sp. #4	—	—	—	—	1	—	3	—	—	1	1	2
Egadroma misc.	—	1	—	1	1	—	3	—	—	3	1	4
Euryaptus sp.	—	—	3	—	—	—	—	—	2	—	—	2
Species #34	—	1	3	1	—	—	—	2	—	1	1	4
Lebiini												
Apristus sp.	—	12	—	1	—	7	14	1	1	5	11	17
Apristus sp. #2	—	7	7	1	—	5	8	1	1	1	14	16
Apristus (?) sp. #4	—	—	—	1	—	—	—	—	—	—	1	1
Licinini												
Diplocheila laevigata Bates	—	1	1	—	—	2	—	3	—	—	—	3
D. latifrons Dej	—	—	3	—	—	—	—	—	—	1	1	2

TABLE 7. (*Continued*)

	J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total # of beetles
Masoreini												
Aephnidius adelioides Macl.	—	—	—	—	1	—	—	—	—	—	1	1
A. opaculus Zimm.	4	1	—	4	7	—	—	2	—	6	3	11
Caphora humilis Schm.-Goeb.	8	—	—	—	5	—	—	1	1	—	4	6
Tetragonoderus notaphioides Mots	4	—	—	1	2	7	—	1	—	2	4	7
Tetragonoderus sp.	—	—	—	—	1	2	—	2	—	—	—	2
Tetragonoderus (?) sp.	4	—	—	—	—	—	—	1	—	—	—	1
Oodini												
Simons nigriceps Wied.	—	1	7	—	—	—	16	5	2	2	3	12
Panagaenini												
Dischissus sp. #1	—	8	12	4	—	—	—	9	4	—	—	13
Dischissus sp. #2	—	—	4	—	—	—	—	—	—	3	—	3
Pterostichini												
Abacetus atratus Dej	—	1	—	—	—	—	—	—	—	1	—	1
Abacetus nr *antiquus*	—	4	100	9	—	—	—	2	4	4	74	77
Abacetus nr *pallipes*	—	25	186	12	—	—	—	5	10	92	46	152
Abacetus (?) sp. #35	—	—	1	—	—	—	—	—	1	—	—	1
Abacetus (?) sp. #36	—	—	—	1	—	—	—	1	—	—	—	1
Caelostomous nr *inermis* Bates	—	1	—	—	—	—	—	—	—	—	1	1
Lesticus sp.	—	—	4	—	—	—	—	—	3	—	—	3
Trigonotoma indica Brullé	—	3	—	—	—	—	—	1	1	—	—	2

TABLE 7. (*Continued*)

		J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total # of beetles
	Scaritini												
	Clivina "attenuata" Herbst spp. ?	—	12	12	1	—	—	8	1	1	3	17	20
	C. "sagittaria" Bates spp. ?	—	19	49	10	—	—	11	16	14	16	11	58
	Clivina sp. #3	—	—	—	1	—	—	—	—	1	—	—	1
	Unknown subfamily												
	Species #20	—	—	1	—	—	—	—	—	1	—	—	1
	Species #21	—	—	—	1	—	—	—	—	—	—	1	1
	Specics #22	—	—	1	—	—	—	—	—	—	—	1	
	Galerita orientalis Sch. Gobb (?)	—	4	3	2	—	—	3	4	3	1	—	8
	Species #52 to 60 (lost in mail)	—	—	4	—	—	5	11	1	3	2	3	9
B.	*Coelostoma* sp.	—	4	22	7	—	—	—	—	—	1	26	25
	Sphaeridium sp.	—	—	15	—	—	—	—	—	—	2	9	10
C.	*Saprinus frontistrius* Mars	12	33	—	1	6	41	3	10	23	12	3	49
	Hypocacculus malabaricus Reicht	—	6	—	2	1	2	—	—	7	1	—	8
	Chalcionellus pulchellus (Fab.)	—	4	1	1	—	10	—	—	1	5	3	9
	Atholus coelestris (Mars)	—	—	—	1	—	—	—	—	—	1	—	1
D.	*A. foetidus* (Cameron)	—	—	—	—	—	—	3	1	—	—	—	1
	Philonthus sp.	4	—	—	—	—	—	—	—	—	1	—	1
	Zyras sp.	12	—	1	—	—	—	—	1	3	—	—	4
E.	Non-coprophagous												
	Apogonia sp.	—	1	—	—	—	—	—	1	—	—	—	1
	Autoserica sp.	—	3	—	—	—	—	—	2	—	—	—	2

TABLE 7. (*Continued*)

		J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total # of beetles
	Shizonycha sp.	1	—	—	—	—	—	—	—	—	1	—	1
	unidentified spp.	—	1	6	1	—	7	3	—	—	3	8	10
G.	*Byrrhus murinus* (F.) ?	—	—	—	1	—	—	—	—	—	—	1	1
H.	*Cardiophorus* sp. #1	—	—	—	1	—	—	—	—	—	1	—	1
	Cardiophorus sp. #2	—	—	—	2	—	—	—	—	—	2	—	2
	Conoderus sp. (?)	4	—	—	—	—	—	—	—	—	1	—	1
	Drasterius sp. #1	—	1	—	13	—	—	—	1	1	—	11	12
	Drasterius sp. #2	—	1	—	—	—	—	—	—	—	—	1	1
	Drasterius (?) sp.	—	—	1	—	—	—	—	—	—	—	1	1
I.	*Evorinea indica* (Arrow)	—	1	—	—	—	—	—	—	1	—	—	1
J.	*Gibbium psylloides* (Czenpinski)	—	—	—	—	2	3	—	—	1	1	—	2
K.	*Carpophilus* sp.	—	—	—	1	1	—	—	1	—	—	1	2
L.	*Amblyopus* sp.	—	—	—	—	—	—	3	—	1	—	—	1
M.	unidentified sp.	—	1	1	1	2	—	—	—	2	1	2	5
N.	*Beccaria cardoni* Gorh.	—	—	—	—	2	—	—	1	—	1	—	2
O.	unidentified sp.	—	1	—	—	—	—	—	—	1	—	—	1
P.	*Caedius indicus* Fairmaire	12	3	3	15	162	63	5	1	—	153	21	178
	Gonocephalum bilineatum Walker	75	3	—	11	32	10	3	20	6	25	9	61
	G. birmanicum Kaszab	—	—	—	—	1	—	—	—	—	1	—	1
	G. "hoffmanseggi"	4	—	—	5	16	2	—	—	—	12	8	19
	G. minisculum Fairmaire	—	1	—	—	—	—	—	—	—	1	—	1

TABLE 7. (*Continued*)

		J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 903	Total # of beetles
	G. oculare Kaszab	—	1	—	10	—	—	—	—	1	—	9	9
	G. spinicolle Fairmaire	4	—	—	—	1	—	—	—	1	1	—	2
	G. subspinosum Fairmaire	—	—	—	1	4	—	—	3	1	—	—	4
	G. szekessyi Kaszab	94	24	—	28	21	—	—	68	4	6	—	80
	G. tuberculatum Hope	8	7	1	43	50	10	—	35	9	8	37	87
	G. vagum Steven	31	3	1	7	2	—	3	1	—	2	19	20
	G. sp. aff. *crassepunctum* Kaszab	—	—	—	1	10	2	—	4	2	3	1	10
	Heterotarsus sp.	—	1	—	—	—	—	—	—	—	—	1	1
	Leichenum canaliculatum Fab.	—	—	—	—	1	—	—	—	—	—	1	1
	Mesomorphus latiusculus chatanay	—	4	—	—	5	—	—	7	—	—	—	7
	M. villiger Blanchard	4	—	—	—	10	—	5	2	—	—	10	11
	Pocadiopsis marginicollis Fairmaire	8	9	—	—	—	—	—	8	—	—	—	8
	Scleron ferrugineum Fab.	31	22	—	—	12	—	—	2	—	29	1	33
	S. reitteri Gebien	8	—	—	—	1	—	—	—	—	2	1	3
	unidentified sp. #18	—	—	—	—	—	2	—	—	1	—	—	1
Q.	*Anthicus* sp.	—	1	—	—	—	—	—	—	—	—	1	1
R.	*Dorysthene* sp.	—	—	—	—	—	—	3	—	1	—	—	1
S.	*Chaetocnema* sp. #1	—	7	4	—	—	—	—	1	4	2	1	8
	Chaetocnema sp. #2	—	3	—	—	—	—	—	—	—	2	—	2
	Haltica coerulea Oliv. ?	—	3	—	—	—	—	—	—	—	—	2	2
	unidentified spp. 5, 6, 8-14	—	1	3	1	6	5	—	—	5	5	1	11
T.	unidentified sp. #1	—	6	—	12	2	—	—	—	1	13	2	16
	unidentified sp. #2	—	—	—	2	1	—	3	1	1	1	1	4

TABLE 7. (*Concluded*)

		J-F 255	M-M 672	J-A 672	S-N 816	D-F 808	M-M 416	J-A 368	TS 1033	BB 1034	BN 1032	G 908	Total # of beetles
U.	*Cosmopolites sardidus* Germ.	—	1	—	4	4	—	—	1	—	6	—	7
	unidentified sp. #1	—	—	—	1	—	—	—	—	1	—	—	1
	" " sp. #3	—	—	—	—	—	14	27	2	—	14	—	16
	" " sp. #4 group	1	3	1	2	4	—	—	3	2	2	2	9
	" " sp. #5 group	—	3	1	1	1	—	—	—	4	2	—	6
V.	unidentified sp.	—	—	10	1	1	2	—	1	5	1	3	10

*See Table 2 for family code.

also occurred in the scarab (5 spp=76% of the beetles) and aphodid (2 spp=74% of the beetles) families.

In addition to the species that occurred in the systematic pit-fall trapping (Table 7), other species were obtained in infrequent sporadic collections by hand. Three staphylinid species were found on fresh monkey (langur) dung collected in a nearby village on 20 February 1971 : *Anotylus cameroni* (Scheerpeltz), *A. latiusculus* (Kraatz), and *Tinotus* sp. One species of tenebrionid, *Cossyphus depressus* Olivier, was collected at a incandescent light at night on 8 November 1971.

Discussion

The number of individuals caught per family was distorted by the use of bait at the traps. Scarabs and some of the other dung seeking beetles were attracted to the traps by odor of the bait, and may have been drawn in from a much larger area than, for example, carabids who, if drawn to the traps, would have been attracted visually by the activity of other insects. However, the composition in terms of number of species per family seemed to be unaffected by baiting. The community as seen here was primarily made up of ground active species, as only pit-fall traps were used. Comparison can thus be made with other studies that used baited pit-fall traps, and thus were looking at the same segment of the beetle community.

The composition of four such communities are presented here for comparison (Table 8). Two of the studies used only cattle dung (Hanski and Koskela, 1977 ; Merritt and Anderson, 1977), one used dung from six species of ungulates, including cattle (Hafez, 1939), and one used decomposing fish and fruit (Pirone and Sullivan, 1981).

In the current study carabid spacies made up a much larger proportion of the community and staphylinid species a much smaller proportion than occurred in the other studies (Kolmogorov-Smirnov, $p < .001$). These two families are primarily predaceous and may in part compete for similar resources, though this does not explain why such a shift should occur in West Bengal. There may be a gradual change in community composition with change in latitude. Staphylinids and hydrophilids seem to make up a larger proportion of the species at higher latitudes, whereas scarabs and tenebrionids seem to contribute larger proportions of species at lower latitudes (Table 8). This trend was only significant for staphylinids ($r^2=.880$, $n=5$, $p < .05$), and this was brought about primarily by its low representation in the West Bengal collection. In the other studies baited traps were usually set out for 2 or more days, whereas in this study they were out for less than 24 hrs. In Egypt

(Hafez, 1939) and Finland (Koskela, 1972) staphylinids reached their greatest abundance in terms of numbers of beetles after the third or fourth day, when the number of dipteran larvae was high (Hafez, 1939). However, in terms of species the Finish study showed that 71 species occurred by end of the first day and that the number of staphylinid

TABLE 8. Percent of species contributed by each family to the overall collection (all families presented that contributed at least 5% of the species to a collection)

Families	Location	Finland[1]	New York[2]	California[3]	Egypt[4]	West Bengal[5]
	N. latitude	61°	41°	40°	30°	22°
	Rainfall (cm)	—	112	61	—	145
Carabidae		2.8	10.6	0	1.9	32.4
Hydrophilidae		8.9	.5+*	13.9	5.6	1.0
Histeridae		2.2	7.8	5.6	9.3	1.9
Staphylinidae		74.9	28.4	61.1	31.5	1.0
Scarabaeidae		0	7.8	0	16.7	25.6
Aphodiidae (+Geotropidae)		10.6	0	16.7	20.4	12.1
Nitidulidae		0	11.0	0	3.7	.5
Tenebrionidae		0	0	0	3.7	9.7
Other families		.6	33.9	2.7	7.2	15.8
Total number of :	families	6	33	5	12	22
	species	179	218+	36+	54	207
	beetles	62,500	19,992	?	?	16,192

1. Hanski and Koskela (1977). 2. Pirone and Sullivan (1981). 3. Merritt and Anderson (1977). 4. Hafez (1939). 5. This study.

*Species were unidentified, but beetles made up 7.1% of the collection.

species on the dung remained essentially the same for the next 9 days (see Table 3 in Koskela, 1972). Thus the staphylinid species present in the West Bengal community should have been adequately sampled despite the shorter trap period.

Tenebrionids occupy the same microhabitats (under stones, leaf litter, etc.) that carabids do, but in the United States they occur in more arid regions than do carabids (Borror and Delong, 1954, p. 377). In West Bengal these two families were most abundant in the open habitats, but tenebrionids were most abundant during the dry cool months and carabids during the wet hot months. During cold winters, as in Quebec, adult carabids hibernate in the soil (Larochelle, 1974) and thus would not appear in traps. These two families had similar population sizes as indicated by the number of individuals caught, but carabids were represented by three times as many genera and species.

This suggests that either carabids exploit a much wider niche space as a family, or that each species is more specialized and occupies a narrower niche than do tenebrionids. Since carabids prey on other insects (Hengeveld, 1980) and were most abundant when other insect species were most numerous in the traps, it seems likely that greater food specialization may explain why carabids were represented by more species than were tenebrionids.

In addition to the possible change in community compositon with latitude discussed above, it appears that the environmental cues the species are sensitive to change with latitude. In France, at 48°N latitude, seasonal change in carabid activity was positively correlated with temperature for most species ; a correlation between activity and rainfall was lacking (Benest and Cancela da Fonseca, 1980). In this study carabid activity was positively correlated with monthly rainfall and not with mean monthly temperature. Of the six families tested only tenebrionid activity showed a correlation with temperature, but it was also correlated at a lower level of significance with rainfall. Histerid activity lacked correlation with either rainfall or temperature. They seemed most sensitive to competition, at least with related species, as indicated by their activity across months. Interspecific competition may explain the activity patterns of other species in the study, but more information would be needed about their feeding habits.

Histerids, scarabs and aphodids were primarily attracted to traps baited with human dung, which was the most abundant dung type available (Oppenheimer, 1977) and which probably attracted the greatest number of prey for the histerid. The carabids, tenebrionids and hydrophilids, as family groups, seemed to be falling into the traps at random as they occurred in all traps equally, including the unbaited trap.

Summary

Eight pit-fall traps were set one day a week in each of four different habitats between January 1971 and August 1972, in two villages 40 km NNW of Calcutta in West Bengal, India. Seven traps were baited with mammalian dung and one trap was unbaited. Twenty-one identified families, 73 genera and 207 species were represented in the 16, 192 beetles trapped. Carabibs accounted for 36% of the genera, 32% of the species, but only 4% of the individuals. Scarab dung beetles accounted for 12% of the genera, 26% of the species, and 83% of the individuals. Aphodids made up 12% of the species and 8% of the individuals. The abundance of these three families, and that of hydrophilids, was posi-

tively correlated with rainfall. Tenebrionids accounted for 11% of the genera, 10% of the species, and 3% of the individuals ; their abundance was negatively correlated with rainfall and temperature. The remaining families, including histerids and staphylinids, each made up less than 1% of the beetlies. Scarabs and aphodids were most abundant on human dung and in bamboo groves. Hydrophilids and carabids were most abundant in grass habitats, and tenebrionids in banana groves ; all three families occurred with equal frequency in all traps. Detailed information is included for all species, except scarabs and aphodids.

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