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ON ECOLOGICAL FACTORS INFLUENCING THE ABUNDANCE OF *PORCELLIO LAEVIS* (LATREILLE) (ONISCOIDEA: PORCELLIONIDAE)

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A comprehensive report on the physico-chemical and biological factors affecting the abundance of *P. laevis* population in Delhi region is presented. Results regarding the diel periodicity and seasonal fluctuations of different faunal elements including predators and parasites in the vicinity of *P. laevis* are also discussed.

INTRODUCTION

Terrestrial isopods in Delhi are found to be dominated by *Porcellio laevis* (Latreille). They play significant role in the decomposition of organic matter and function as important first order link in the decomposer chain. The literature on the activity and abundance of foreign species of terrestrial isopods is plentiful (Miller, 1938; Waloff, 1941; Hatchett, 1947; Edney, 1954 & 1968; Cloudsley-Thompson, 1956 & 1969; Paris, 1963; Lokke, 1966; Kensley, 1974; Imafuku, 1976; Chelazzi & Ferrara, 1978 and Dubinsky *et al.*, 1979). The paucity of information on population regulations of an Indian terrestrial isopod in relation to the physico-chemical and biological factors of the habitat encouraged the present investigation in Indian tropics.

MATERIAL AND METHOD

Delhi being part of the tropics; has an area of 1500 Km^2, wedged within 28°12′—28°53′N and 76°50′—77°23′E and 150 metres above the sea level.

There is wide fluctuation of temperature, the highest being 46°C recorded during June, 1974 and the lowest 5°C noted in January, 1974. The air over Delhi is generally dry for most parts of the year with the relative humidity at its maximum in August and September and minimum in April and May. There is wide variation in total rainfall with the peaks reaching in July and September, A few winter and spring showers occur in December and February.

For sampling *P. laevis* population, a suitable site (Station-A) was selected within the Delhi University campus. It was situated amidst mulberry and neem trees which gave enough shade and a cooling effect to the entire area. Constant fall of leaves from these trees almost round the year resulted in rich deposition of litter. In order to determine the effect of physico—chemical factors operating on the soil on the abundance of *P. laevis*, population, an area of 5/15 m^2 was measured and samples were taken at random keeping 15 minutes time as a constant factor. Samples were collected from the top layers of the soil as well as from 2 to 5 cm below the surface. Animals from beneath the bricks and stones were removed with the help of a brush. Using standard methods, temperature reading of the atmosphere, soil surface and soil layer beneath were recorded and the relative humidity at the soil surface was noted. The pH, moisture and organic contents of the soil were analysed in the laboratory (Table I).

Table I. Mean surface temperature, % of moisture content and % of organic content of tha soil together with the number of *P. laevis* sampled at Station—A.

Year	Months	Temperature (°C)	Moisture content (%)	Organic content (%)	Number
	August	28.10	17.27	14.84	388
	September	27.10	13.61	17.12	531
1973	October	27.10	11.19	16.19	353
	November	23.60	8.[illegible]2	14.84	254
	December	19.50	8.90	11.01	239
	January	20.00	5.89	7.44	105
	February	20.00	5.90	7.06	53
	March	26.00	5.68	6.59	53
1974	April	27.00	3.10	6.30	25
	May	33.00	7.31	9.65	86
	June	33.60	8.08	9.80	71
	July	31.60	8.46	10.30	149

The diel periodic activity of *P. laevis* in the field was studied during the summer and monsoon periods of 1974 by recording the total number of actively moving animals at a time, during the course of a 24 hour period. A plot measuring 60x60 cm was selected and the estimates of isopod activity were obtained from the counts of individuals present in the plot. A hand counter was used to enumerate the animals in the plot. This number was counted 8 to 9 times during the period, and was a reliable index of activity. Measurements of atmospheric temperature, surface temperature and relative humidity on the soil surface were made with each observation. The data are presented in Table II.

Table II. *P. laevis* : Total number of active animals observed during a 24 hour period at Station – A.
Area of Plot : 60 × 60 cm

Time in Hours I.S.T.[1]	Temperature (°C)	Relative humidity (%)	Total number of *P. laevis* observed
	SUMMER SEASON (Date of Survey : 12 & 13 April, 1974)		
21.30	A[2]—30.0; S[3]—25.5	48	17
00 30	A —29.0; S —24.0	50	16
3.30	A —27.0; S —25.0	58	33
6 30	A —26.0; S —25.0	55	21
9.30	A —31.0; S —26.0	54	19
12 30	A —39.0; S —26.0	44	12
15.30	A —36.0; S —27.0	44	15
18.30	A —31.0; S —26.0	54	16
21.30	A —30.5; S —26.0	50	18
	MONSOON SEASON (Date of Survey : 2 & 3 July, 1974)		
22.00	A —31.0; S —28.5	78	69
1.00	A —29.0; S —29.5	72	68
4.00	A —31.0; S —30.0	72	42
7.15	A —29.0; S —30.0	70	48
10.10	A —32.0; S —31.0	68	32
13.10	A —33.0; S —31.0	70	30
16.00	A —33.0; S —32.5	70	16
19.30	A —32.0; S —31.0	70	20
21.30	A —31.0; S —29.0	72	44

[1] Indian Standard Time,
[2] Atmospheric temperature
[3] Soil temperature

Extraction of soil organisms associated with *P. laevis* population was carried out from July, 1973 to March, 1974. The soil samples taken from the upper layer upto a depth of 1 to 2 cm and a volume of approximately 150 g of soil taken from it was used for the extraction of soil animals. Modified Berles Tullgren funnel was employed for the extraction of soil micro-arthropods and macro-organism sorted and were counted. The microclimatic conditions such as temperature, relative humidity, moisture and organic contents of the soil surface were also studied. The monthly data obtained on the faunal composition are pooled and are presented on seasonal basis in Table III. Sampling was discontinued during summer (April, May and June) since they disappeared in toto owing to the extreme dry conditions, prevailing on the soil surface. Extensive field observations were also carried out to locate the predators of *P. laevis* in the wild. The suspected predators were subsequently trapped, dissected and their guts were analysed.

OBSERVATIONS

Physico-chemical factors

Short term and long term changes in weather determined the distribution and abundance of *P. laevis*. The ecological factors such as temperature, moisture and organic contents of the soil together with the total number of *P. laevis* collected at station-A are presented in Table I.

The range of temperature favourable to *P. laevis* was related to the prevailing temperatures in the places where the animals usually lined. It was observed that temperature alone did not play an important part in determining their abundace (Table I). The correlation coefficient of 0.071 between the mean temperature of the soil and the total number of *P. laevis* collected during different months of study was found to be insignificant. But the nocturnal activities of the animals on the soil surface were very much influenced by temperature. Thus on warmer periods, most of them took shelter during the day time and came out in large numbers only at night. The preferred temperature of these animals ranged between 19.5°C and 33.1°C. When other parameters were in their tolerable ranges these animals showed a quick acclimation to high and low temperatures, though they did not survive beyond 42°C which can be considered as the lethal temperature.

To avoid desiccation, *P. laevis* restricted their activities to permanent humid conditions. Moisture thus appears a prime factor to influence the distribution and abundance of these animals (Table I). The high correlation coefficient of 0.772 between the moisture content of the abundance of these animals during different months of study was fonnd to be significant at 1% level.

The organic content of the soil is largely colloidal and hence regarded as the humus. The humus content varied between 6.3% and 17.12% (Table I). In those regions where the soil had a high organic content, the aggregation of *P. laevis* was maximum whereas in regions of low humus content the population was poor and scattered. *P. laevis* also preferred slightly alkaline soil. They showed a tendency to avoid abodes with acidic soils. The preferred range of pH for these animals was between 7.2 and 8.2.

Diel Periodicity in Activity : During the summer of 1974, the first recording was done at 21.30 hrs (12/13, April) and subsequent observations were made after an interval of 3 hrs (Table II). It was a warm and clear night with 30°C atmospheric temperature. The highest relative humidity was 58% at 3.30 hrs with maximum number of individuals counted (33) Between 3.30 and 9.30 hrs these animals remained active but with the rise in temperature and decreased relative humidity during the day compelled these animals to take shelter and the minimum number of animals (12 to 15) was recorded between 12.30 and 15.30 hrs.

During the monsoon of 1974, *P. laevis* population was mostly located near the soil surface at all times. Observations made during 2nd/3rd July, 1974 showed higher number of individuals at all hrs compared to summer, 1974 (Table II). The maximum relative humidity recorded was 78% at 22.00 hrs and the minimum at 10 10 hrs (68%). Maximum activity was also recorded during the cool night hrs and thereafter, the number of actively crawling individuals on the surface decreased by dawn and remained low during the day. The general pattern of activity was similar to that of summer season except that their numbers did not reduce drastically from the surface during the day. Thus monsoon appears to be better and favourable period for *P. laevis* activity.

Biological factors

Faunal Composition : The community structure was studied in which *P. laevis* also lived during the period July, 1973 to March, 1974 with a view to know the principal faunal components. During the whole period of survey, the temperature and relative humidity were in their optimal ranges for the maximum activity of soil fauna. Thus the temperature ranged from the mean value of 21°C during the winter of 27°C during the monsoon, and the relative humidity on the soil surface was above 55% during the whole period of survey. Moisture content on the other hand varied from 8.62% during the winter to 16.49% during the monsoon whereas the maximum value of organic matter was recorded during the winter season (12.76%) and the minimum during the spring (5.84%).

Most of the animals which formed members of the soil community were mites belonging to the suborders of Cryptostigmata, Astigmata, Prostigmata and Mesostigmata (Table III). Mesostigmata and Cryptostigmata were numerically most abundant forming more than 50% of the total number of mites collected during different seasons. Prostigmata was low in numbers though they are known for their ability to establish in dry soils with a high mineral content. The collembola formed a sizable section of the soil fauna. They were dominant and showed percentages of relative abundance varying from 50.95% during the autumn to 69 23% during the monsoon (Table III). Other members of the soil community which were numerically less abundant were earthworms, millipedes, centipedes, insects and their larvae and slugs.

Predators and Parasites : The most common predator of *P. laevis* observed in the field was *Suncus murinus*. Other predators were *Calotes versicolor, Acridotheres tristis*, *Copsychus saularis* and *Saxicoloides fulicata*. Laboratory trials were also made with these animals and they readily ate *P. laevis*. Feeding trials made with centipedes, spiders and beetles gave negative results similar to early observations made by Paris (1963) who tried to feed the same animals with the isopod, *Armadillidium vulgare* in California.

P. laevis collected from the field were examined in the laboratory for parasites and their cysts. None were seen to be parasitized. But often the gut content showed nematodes similar to free-living ones of the soil. These must have gained entry into the gut through the food and cannot be considered as parasites. In laboratory cultures, heavy fungal attack often increased mortality but such fungal infections were rare in the field.

DISCUSSION

Different ecological factors regulate *P. laevis* population along with the availability of shelter sites. Thus the prevailing regional climatic conditions provide the basis of long term regulation of their numbers. Observations on the mircroclimatic conditions which regulate the activity and abundance of *P laevis* population in Delhi showed that more than temperature, other factors such as moisture and organic matter of the soil have greater influence on their abundance. The behaviour and distribution of these isopods in Delhi during different months is determined primarily by moisture of soil and this of course is related to the survivorship and natality as well. Similar observations were made on *A. vulgare* populations at California by Paris (1963). Though majority of *P. laevis* avoid desiccation by vertical migration, a small proportion of individuals die owing to

Table III. Faunal composition of the soil community at Station—A
*Group Index : 1) Mesostigmata 2) Prostigmata
3) Astigmata 4) Cryptostigmata
5) Collembola 5) Other associates

**Seasons	*Group index	Total individuals sampled	Mean number per sample	% of relative abundance
	1	117	29.25	11.25
	2	61	15.25	5.87
	3	49	12.25	4.71
Monsoon	4	49	12.25	4.71
	5	720	180.00	69.23
	6	44	11.00	4.23
	1	204	51.00	25.85
	2	8	2.00	1.01
	3	22	5.50	2.79
Autumn	4	92	23.00	11.66
	5	402	100.50	50.95
	6	61	15.25	7.74
	1	95	47.50	17.72
	2	5	2.50	0.93
	3	22	11.00	4.10
Winter	4	27	13.50	5.04
	5	370	135.00	69.04
	6	17	8.50	3.17
	1	290	72.50	15.38
	2	29	7.25	1.54
	3	58	14.50	3.08
Spring	4	183	45.75	9.71
	5	1280	320.00	67.90
	6	45	11.25	2.39

**Seasons : Monsoon—July, August, September
Autumn—October, November
Winter—December, January
Spring—February, March
Summer—April, May, June

exposure during the dry summer period. The ability of terrestrial isopods to live in a relatively dry environment depend primarily on behavioural mechanisms which enable them to avoid the rigors typical of terrestrial habitats and this fact is related to the evolutionary process which enable these isopods from an aquatic habitat to invade the terrestrial environment (Edney, 1954 & 1960).

The diel periodic behaviour of *P. laevis* population during the summer and monsoon seasons shows that they are active at night and early morning hours when the atmospheric temperature and humidity factors are more favourable. Thus they show a strong preference for early morning hours when illumination is less, humidity on the ground layer is high and the temperature is low. This is a common feature for almost all terrestrial isopods. Breymeyer & Brazozowska (1970) also made similar observations while studying the diurnal changes in the intensity of penetration of the isopod, *Trachelipus rathkei* into the substratum. Paris (1963) studying *A. vulgare,* also observed maximum activities of isopods during hours of darkness. But moisture availability is the primary factor which decides the distribution and abundance of *P. laevis* population in a particular region. Cloudsley-Thompson (1952 & 1956) observed that the degree of nocturnal activity of the terrestrial isopod, *Oniscus asellus* is correlated with its ability to withstand water loss by transpiration.

An estimation of the soil mites indicate that numerically Mescstigmata and Cryptostigmata emerge as the most dominant group where *P. laevis* is found. Wood (1971) and Wallwork (1972) also made similar observations on the soil mites of Australian and Californian regions respectively. The predominance of Collembola over mites in the present study is partly a reflection of the greater ability of the former to establish relatively larger populations in the litter layer.

The chief predators of *P. laevis* in the field are the common shrew, the garden lizard and the birds like myna, magpie robin and Indian robin. Sutton (1970) observed that woodlice in the field are preyed upon by a number of invertebrates and he singled out the shrew, *Sorex araneus* as the most voracious feeder of these animals. Paris (1963) observed predation on *A. vulgare* by lizards, salamanders, beetles and birds but found that predation plays only a minor role in the regulation of these animals in the habitat. Brereton (1957) while studying *Porcellio scaber* population in England observed a high mortality rate among young ones in the laboratory which he explained as being caused by cannibalistic adults and stated that cannibalism is a self regulating mechanism in natural populations. Although it is refuted by Paris (1963) who considers cannibalism as a negligible mortality factor which is true as far as *P. laevis* is concerned.

Even though no parasites could be located in *P. laevis* during the present study, terrestrial isopods in general are known to be hosts of several tachnid parasites belonging to Diptera. Thus Thompson (1934) listed *P. scaber*, *O. asellus*, *M. pruinosus* and *A vulgare* are hosts in which these parasites occur and found *P. scaber* to be the most frequently parasitized woodlouse. Acanthocephalan parasites from *A. vulgare* have been reported by Thompson (1934) and from *Porcellionides pruinosus* by Menon *et al.* (1970).

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