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Since the classical observations of Darwin (1881) on the role of earthworms, some new and controversial aspects have come to light, It is the purpose of this paper to review them in brief and to describe results of certain experiments devised to study its role with reference to some important soil factors.

While a majority agree in attributing a beneficial role to this animal there are a few who think otherwise (Grant, 1955; Agarwal *et al*, 1958). According to Grant (1955), benefical effects on crop yields observed by inoculating the living earthworms are to some extent, due to the decomposition of worms which have died during the experiment and hence, are temporary. Other arguments can be summed up as follows : (*i*) Beneficial effects displayed by earthworms can be produced equally well by artificial fertilizers ; and (*ii*) large earthworm population is the effect rather than the cause of soil fertility. Agarwal *et al* (1958) in India, observed that some species of *Allolobophora* rendered the soil unproductive by secretion of a colourless waxy fluid and made it cloddy.

The concensus of opinion, however, is in favour of earthworms. Their role as soil builders led to their being used in reclaiming flooded areas. In more advanced countries earthworm farms capable of an output of 500,000 worms a day are in operation. Contemporary work indicatesthat the major effects of earthworms on soil are : (1) improvement of soil structure (Hopp and Hopkins, 1946 ; Evans, 1948 ; Nijhavan and Kanwar, 1952 ; Zicsi, 1954), (2) favourable change in soil pH (Puh, 1941 ; Finck, 1952 ; Nye, 1955 ; Baltzer, 1955), (3) increases in mineral nutrients (Puh, 19.1 ; Lunt and Jacobson, 1944 ; Hopp and Slater, 1949 ; Needham, 1957 ; Barley, 1959*b* ; Bhat *et al*, 1960), (4) increases in availability of nutrients (Puh, 1941 ; Lunt and Jacobson, 1944 ; Barley, 1959*b*) and (5) transport of sub-soil to the upper cultivable soil surface, thus counteracting the ravages of soil erosion.

Microbiological studies on the earthworm gut by Bhat and his School (Khambata and Bhat, 1957 ; Bhat *et al*, 1960) have brought to light their ability or otherwise to communicate certain pathogens. They have also proved that earthworm intestines are devoid of nitrifying bacteria, though harbouring the nitrogen fixing *Azotobactor chroococcum*. Kuhnelt (1948) maintains that plant residues must first pass through several animals before they can be made available to micro organisms, which in turn, transform them to forms acceptable to higher plants. Jacks (1955) also observes that soil animals like earthworms are more importan than micro-organisms in this respect.

The present investigation concentrated on changes produced in certain factors like total nitrogen, organic matter, and calcium carbonate, in passing through the gut of a single worm, namely, *Pheretima posthuma*, maintained as a sub-culture. The experiments were repeated with different animals of the same species. Main cultures were maintained in culture boxes according to the technique described by Tembe and Dubash (1959) which provided the stock for subcultures.

MATERIAL AND METHODS

To the unintitiated all worms look alike, but in reality they show great difference in their physiological make up which is perhaps the main reason for the contradictory observations that have been recorded in the past. The mode of excretion, the distrbution of nephridia, presence or absence of calciferous glands and other features determine a particular species. Each worm used was carefully examined for the distinguishing characters of the species. The casting of *P. posthuma* have a pellet like appearence, varying from 1/20th to 1/10th of an inch in length. Unlike some other spp. this animal voids casting on the surface and hence becomes suitable for the type of investigation described here.

Barley (1959*a*) employed a pot culture method in studying the castings of *Allolobophora caliginosa.* An earthen plate method, a modification on that of Barley (1959*a*) was devised, whereby pure cultures could be obtained and castings eollected without any contamination from ohter worms. 100 gms. of soil, free from manure, was passed through a 30 mesh B. S. sieve and mixed with shredded leaves and straw and then put in shallow culture plates 8″ in diameter. A small hole is bored in the bottom and then plugged with absorbent cotton, so as to prevent excess drainage. 25 ml. of distilled water was sprayed uniformly over the soil surface and the leaves and straw allowed to decompose for 72 hours. The earthworms were previously fed on wet filter paper for 48 hours, in order to clear their gut of any soil present (Barley, 1959*a*). They were than weighed quickly on a Mettler balance and distributed one per plate. The plates were covered with polythene to prevent excess of evaporation. After 24 hours the worms were removed, washed, wiped dry and re-weighed. The castings were separated from the soil and their moisture content, total nitrogen, organic matter and calcium carbonate determined along with that of the culture soil. The total nitrogen was determined by the micro-Kjeldahl method (Strouts *et ul*, 1955) organic matter by the Walkley–Black method (Jackson, 1955) and calcium carbonate with the Collin's Calcimeter.

Results are summarised in Tables I and II.

RESULTS

TABLE I

Faecation data of *Pheretima posthuma*

Plate No.	Wt. of worm before culturing. Grams	Wt. of worm after culturing. Grams	Wt. of air dry casting. Grams	Wt. of oven dry casting. Grams	Faecation as muliple of body weight. Times.
1	0·8791	0·8650	6·6150	5·1742	8·26
2	0·7083	0·7153	7·3483	6·8743	10·49
3	0·9470	0·9500	8·0783	7·5399	8·96
4	0·8769	0·9648	6·5100	6·1006	8·12
5	0·6897	0·7210	5·2386	4·9059	8·66
6	0·8020	0·7946	4·9893	4·6992	6·42
Mean	0·8188	0·8350	6·4630	5·8783	8·81

TABLE II

Comparative data of soil and castings

No.	% moisture		% total nitrogen		% org. matter		% $CaCO_3$	
	Soil	Casting	Soil	Casting	Soil	Casting	Soil	Casteng
1	6·3	6·6	0·154	0·160	3·269	3·92	0·280	0·36
2	6·4	6·6	0·154	0·160	3·269	3·92	0·283	0·358
3	6·3	6·7	0·154	1·159	3·269	3·92	0·281	0·357
4	6·2	6·5	0 154	0·160				
5	6·2	6·5	0·150	0·162				
6	6·2	6·5	0·154	0·160				
Mean	6·26	6·56	0·153	0·1601	3·269	3 92	0 282	0·356

DISCUSSION

Several workers observed with species other than *Pheretima posthuma*, that an average growing animal defaecated castings equal or exceeding its own body weight in 24 hours (Hopp and Hopkins, 1946 ; Barrett, 1955 ; Barley, 1959*a*). Evans and Guild (1947) estimated the total amount of castings of a field as ranging from 7 to 11 tons/acre/year. Working separately on Rotahmsted permanent pasture soil, Evans (1948) found the amount of casting varying from 1 to 25 tons/acre/year. Roy (1958), estimated total amount of casting in Baranagore, Calcutta and Giridih, Bihar as ranging from 9 to 89 tons and 0·30 to 2·04 tons respectively per acre per year. Thus there are wide variations in the estimtes.

The resuts in Table I indicate that the amount of defaecation appaoximates eight times the body weight *P. posthuma*, in a period of 24 hours, under the conditions specified above. This high rate of defaecation has not hitherto been recorded. Guild (1955) observes that the amount of defaecation depends upon size, species complex and on the type of soil. Barley (1959*a*) considers that the age of the worm may also account for their rate of defaecation.

The increases in moisture content, total nitrogen, percentage of organic matter and calcium carbonate were statistically signifinant. The increase of total nitrogen is comparatively less than increases in the other factors studied. Barley (1959*b*) also observed a small increase of organic nitrogen in the castings but they were found to contain more available nitrogen than the soil. The increases in organic matter and calcium carbonate content of castings relative to soil were considerablc (Table II). Increase in organic matter has been reported by several other workers (Puh, 1941 ; Lunt and Jacobson, 1944 ; Nijhavan and Kanwar, 1952 ; Hasan *et al*, 1956). The augmentation of calcium carbonate in the castings of *P. posthuma* may be due to concentration rather than active secretion, since this species can at best be said to possess only by rudiments of calciferous glands (Bhal, 1936). Further work with other species having well developed claciferous glands will be taken up later. No conclusion can be drawn at present with regards to the change of weight of earthworms during the course of experiment.

The increases reported here within a short period of 24 hours, indicate the extent of progressive changes which may be occurraing in the soil through the years. Moreover the technique adopted avoids the errors due to increases produced by dead and decaying worms.

Comparative work on additional aspects of the castings *P. posthuma* and other related species of worms is in progress.

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