ESTIMATION OF POPULATION

Estimation of soil population, vertical distribution, pattern of distribution and morphometrical variation of *Tylenchorhynchus mashhoodi* and *Hoplolaimus indicus* recovered from six fields in two districts of West Bengal where sugarcane is cultivated in rotation and monoculture form the nucleus of the present investigation.

Results of the pilot experiment carried out in February 1990 to ascertain the nematode fauna of the above fields, revealed that only two plant parasitic species were of frequent occurrence. Other plant nematodes of sporadic abundance were *Meloidogyne* and *Helicotylenchus*. Hence it was decided to study the population characteristics of the above two frequently occurring species. The six fields from which samples were collected had the crop sequences as follows.

2. Jute-Garlic-Sugarcane-Sugarcane (Location : Bahiri-1).
3. Sugarcane-Sugarcane-Fallow-Jute-Fallow (Location : Bahiri-2).
4. Paddy-Fallow-Sugarcane-Sugarcane (Location : Bolpur-1).
5. Sugarcane-Sugarcane (Location : Bolpur-2).
6. Jute-Fallow-Sesame-Sugarcane-Sugarcane (Location : Jaugram).

Samples were collected from June 1990 to February 1993 when the fields had crops on them and lying fallow as well. Nematode numbers were estimated, their measurements were taken, data were analysed statistically and significance of different factors influencing population was found out. Studies made on different aspects of populations are enumerated in the following pages.
POPULATION DENSITY

*Tylenchorhynchus mashhoodi*

Population of *T. mashhoodi* was maximum under monoculture of sugarcane at the field at Bolpur-2 (1109 per 100 cm\(^3\) soil) and minimum under sesame in the field at Jaugram (43 per 100 cm\(^3\) soil) and under garlic in the field at Bahiri-1 (60 per 100 cm\(^3\) soil). The field at Bolpur-1 containing paddy supported 289 nematodes per 100 cm\(^3\) soil. No difference was observed between the population recovered from different jute fields (199 per 100 cm\(^3\) soil) and wheat at Bhedia (199 per 100 cm\(^3\) soil). *T. mashhoodi* increased at a faster rate during the earlier stage of crop growth and at maturity of the crop nematode numbers declined. Population also declined during successive periods of fallow.

*Hoplolaimus indicus*

Number of *H. indicus* was maximum under sugarcane at Bolpur-2 (500 nematodes per 100 cm\(^3\) soil) and minimum under sesame (23 per 100 cm\(^3\) soil) and garlic (39 per 100 cm\(^3\) soil). Unlike *T. mashhoodi*, population of *H. indicus* supported by paddy was poor (87 nematodes per 100 cm\(^3\) soil). As was observed for *T. mashhoodi* and *H. indicus* also showed the same trend of population reduction under the influence of fallow.

When nematode population of both the species recovered from all the six sugarcane fields were pooled and average calculated, it was observed that 100 cm\(^3\) soil contained 702 nematodes. Similarly, when nematode population of the two species concerned were pooled from all the jute fields, it was noticed that the crop contained 339 nematodes per 100 cm\(^3\)
soil. While soil containing wheat supported 335 nematodes per 100 cm$^3$ soil, more or less the same number were supported by jute and paddy supported a fewer more (337 nematodes per 100 cm$^3$ soil). Least number of nematodes, as already stated, was obtained from sesame and garlic (66 and 99 nematodes per 100 cm$^3$ soil).

In February 1991, the sugarcane field at Bolpur-2, the field containing the maximum number of nematodes, was divided and powdered corm of *Typhonium trilobatum* was applied. When samples were collected at harvest of sugarcane in January '92, it was observed that in the treated plots, there had been reduction of 82.5 per cent and 58.3 per cent in the populations of *T. mashhoodi* and *H. indicus* respectively. In other words, there had been, on an average, 70.4 per cent reduction in nematode density with a simultaneous increase in cane yield by 13.16 per cent.

**VERTICAL DISTRIBUTION**

*Tylenerhynchus mashhoodi*

*T. mashhoodi* preferred to inhabit the soil depth of 0-10 centimetre. Under jute, nearly 79 per cent of the population was recovered from this layer and the rest 21 per cent abounded the 10-20 centimetre soil layer. Under paddy, nearly 75 per cent of the nematode species was recovered from 0-10 centimetre soil layer and the remaining 25 per cent was recovered from 10-20 centimetre depth. Under wheat, 71 per cent of the population was recovered from 0-10 centimetre depth while the rest 29 per cent was obtained from the 10-20 centimetre layer. Distribution of the nematode species in relation to depth was more or
less the same for the rest three crops viz. garlic, sesame and sugarcane.

Maximum concentration of *T. mashhoodi* was observed in the 5-10 centimetre soil layer which contained, on an average, one and half times the numbers than the topmost layer viz. 0-5 centimetre depth. The deeper layers viz. 10-15 centimetre and 15-20 centimetre soil depths contained respectively a little more than 18 and 8 per cent of the total population. In other words, the deepest layer contained less than half the numbers than that of the next top layer (Tables 18A to D, 19, 20, 21, 22 and 23A to F).

**Hoplolaimus indicus**

Distribution of *H. indicus* was restricted, under jute, in the 5-15 centimetre soil layer wherefrom more than 68 per cent of the population recovered. The top layer i.e. 0-5 and the deepest layer 15-20 centimetre, each contained, on an average, about 15 per cent of the population. Distribution of the nematode species under paddy, wheat and garlic was more or less the same as was observed for jute. The difference between the topmost layer and deepest layer was not great for these crops so far as distribution of *H. indicus* is concerned. However, under sesame this difference was noticeable, the deepest layer containing a few more nematodes. Same was true for sugarcane also, the crop containing a few more nematodes in the deepest layer compared with the topmost layer. Like garlic, sesame and sugarcane both contained a little more than 67 per cent of the total population in the 5-15 centimetre layer.
When all the six fields under crops were taken into account, it was observed that the topmost layer 0-5 centimetre contained 15 per cent, 5-10 centimetre layer contained 27 per cent, 10-15 centimetre layer contained 40 per cent and the deepest layer viz. 15-20 centimetre depth contained 18 per cent of the population. Thus, the preferred zone of habitation of *H. indicus* seems to be 5-15 centimetre soil layer under the crops studied.

**PATTERN OF DISTRIBUTION**

*Tylenchorhynchus mashhoodi*

When Taylor's Power Law (Taylor, 1961) was applied to study the pattern of distribution of the nematode species, it was observed that *T. mashhoodi* showed least aggregation in the sugarcane fields at Bolpur-1, Bolpur-2 and Bahiri-2. In these fields, nematode population was comparatively higher and $b$ values were around 1.0 (Tables 38, 40 and 42). Sugarcane fields at Bhedia, Bahiri-1 and Jaugram contained comparatively lesser number of *T. mashhoodi* consequently $b$ values became higher (Tables 32, 34 and 36). Thus, it seems that nematode density has a bearing on the nature of aggregation of the species.

*Hoplolaimus indicus*

Like *T. mashhoodi*, *H. indicus* showed least aggregation in the sugarcane fields at Bolpur-1, Bolpur-2 and Bahiri-2 giving a $b$ value around 1.0 (Tables 38, 40 and 42). Higher $b$ values were obtained for the
sugarcane fields at Bhedia, Bahiri-1 and Jaugram where nematode density was comparatively lower (Tables 32, 34 and 36).

MORPHOMETRIC STUDIES

Body length

Mean body length of Tylenchorhynchus mashhoodi varied between 580 and 650 μm in females and between 565 and 620 μm in the males under the influence of different hosts. This character presented a wide range of variability, coefficient of variation (C.V.) values ranging from 6.4 to 11.8 (Table 43). Individuals recovered from sugarcane were longest and those obtained from sesame were shortest.

Like T. mashhoodi, H. indicus presented a wide range of variation in body length. It varied between 1070 and 1170 μm in females under the influence of host crops. In males, body length varied from 1073 to 1182 μm under different crops. Sugarcane supported longer individuals and sesame the shortest ones. Those recovered from jute, wheat and paddy were of medium length. Body length in the individuals recovered from garlic and sesame did not differ appreciably. Values of coefficient variation fluctuated from 15.9 to 19.0.

GBW

Body width like body length differed under different hosts in Tylenchorhynchus mashhoodi. Mean body width fluctuated between 19 and 25 μm in females and 16 and 21 μm in males. In other words, males were
relatively slender than the females. Sugarcane supported wider individuals and garlic and sesame the slender ones; paddy, jute and wheat supporting the medium sized ones. Values of coefficient of variation fluctuated between 8.5 and 11.0.

In *Hoplolaimus indicus*, body width did not show marked differences between the two sexes except for those recovered from sugarcane. Individuals recovered from this host were widest and those recovered from paddy, garlic and sesame were slender. While, maximum width was 44 μm (male recovered from sugarcane), the minimum was 36 μm (both male and females recovered from garlic and sesame) (Table 44).

'a' ratio

Mean 'a' values fluctuated between 26 and 31 in the females and between 30 and 36 in the males of *Tylenchorhynchus mashhoodi*. In general, males had higher 'a' values than females and females recovered from sugarcane field had lowest 'a' values. This indicates that males were slender than the females and individuals recovered from wheat, garlic and sesame were slender since they had comparatively higher 'a' ratio. C.V. values ranged between 4.0 and 8.0 (Table 43).

Mean 'a' values in *Hoplolaimus indicus* varied from 27 to 30. Females recovered from sugarcane and jute and males recovered from wheat and paddy, exhibited greater variations, since, values of coefficient of variation were greater in these case, 'a' ratio in individuals recovered from sugarcane was lowest while the same was highest in the individuals
recovererd from paddy, garlic and sesame (Table 44).

**SL**

*Styel length in Tylenchorhynchus mashhoodi* varied from 17 to 20\(\mu m\) in the females and from 16 to 20\(\mu m\) in the males. Whereas, there was noticeable difference in this character in the two sexes, hosts crop appeared to exert an influence on this character. Individuals recovered from sugarcane, paddy and jute had longer styel than those recovered from wheat, garlic and sesame. However, differences in styel length as observed was rather small. Values of co-efficient of variation ranged between 5.0 and 10.0 (Table 43).

Like *T. mashhoodi*, *Hoplolaimus indicus* also exhibited small differences in the mean styel length in the two sexes. Females of this species had an average styel length between 35 and 38\(\mu m\) and the males had styel length between 31 and 34\(\mu m\). Males, in general, had smaller styel than the females. Coefficient of variation ranged between 5.0 and 7.1 (Table 44).

**LOJ**

Mean length from the anterior end up to the oesophago-intestinal junction in *Tylenchorhynchus mashhoodi* was maximum among the individuals recovered from sugarcane and minimum among the individuals recovered from garlic and sesame. It fluctuated between 110 and 125\(\mu m\) for the females and between 107 and 122\(\mu m\) for the males. Effect of host crop in influencing this length is quite apparent. Coefficient of variation varied between 3.5 and 5.2 (Table 43).
Mean length from the anterior end up to oesophageal gland overlapping the intestine (LGO) was maximum in the females recovered from sugarcane and minimum among the individuals in the same sex recovered from sesame. The length varied between 158 and 182 \( \mu \text{m} \) in the females and from 160 \( \mu \text{m} \) to 178 \( \mu \text{m} \) in the males. Coefficient of variation varied between 12.0 and 17.2 (Table 44).

'b' ratio

Mean 'b' values fluctuated within a small range for both the sexes in *Tylenchorhynchus mashhoodi*. Not much variation was observed for this ratio in either sex. While the maximum value was 5.4, the minimum was 5.1. Since the body length and neck length increased proportionately, 'b' values could not show any greater degree of variation. Coefficient of variation ranged between 2.0 and 4.0 (Table 43).

'b' ratio

Mean b' value for *Hoplolaimus indicus* varied between 6.4 and 6.8 in the females and between 6.5 and 6.8 in the males. In other words, this ratio did not show any greater degree of variation probably because of the fact that body length and neck length had been proportionately in this species. Coefficient of variation ranged between 8.8 and 9.7 (Table 44).
EXP %

Like stylet length in *T. mashhoodi*, excretory pore percentage did not differ widely between two sexes though effect of host crop was somewhat noticeable. Mean excretory pore percentage value in the female ranged between 14 and 15 and in the male the same varied from 14 to 16. Coefficient of variation ranged between 5.0 and 7.6 (Table 43).

Mean values of excretory pore percentage for *H. indicus* female varied between 9.4 and 9.5 and in case of male, the variation observed was between 8.3 and 8.9. Unlike *T. mashhoodi*, this character in *H. indicus* exhibited some difference between the two sexes. Values being comparatively smaller for the males. Coefficient of variation ranged in between 5.0 and 7.5 (Table 44).

TL

Mean tail length varied from 53 to 58 μm in the female and from 52 to 60 μm in the male of *T. mashhoodi*. Individuals recovered from sugarcane had longest tail while those recovered from garlic and sesame had the shortest. Not much difference in tail length was observed between the two sexes. Coefficient of variation ranged from 9.0 to 11.0 (Table 43).

Like *T. mashhoodi*, *H. indicus* showed smaller ranges of variation in the mean tail length between the two sexes. Tail length in the females ranged from 28 to 31 μm while in the males it ranged from 25 to 28 μm. Males recovered from garlic and sesame had shortest tails and females recovered from paddy, sugarcane, jute, garlic and sesame had longer tails. C.V. ranged from 15.0 to 17.5 (Table 44).
'C' ratio

Mean value of 'C' ratio fluctuated between 10 and 11 for both the sexes of Tylenchorhynchus mashhoodi. Since, in general, longer individuals of this species had longer tails. 'C' ratio could not show greater fluctuations. C.V. ranged between 2.0 and 7.0 (Table 43).

Hoplolaimus indicus showed somewhat greater degree of variability in the mean 'c' ratio. In the females, its value fluctuated between 36 and 41 and in the males the same varied between 41 and 45. Moreover, increase in body length and tail length had been consistent so far as hosts are concerned. In other words, increase/decrease in body length and tail length had not always been proportionate in this species. C.V. ranged between 9.0 and 19.1 (Table 44).

V% Position of vulva in relation to body length (expressed in percentage) did not vary to any greater extent in either species. While in T. mashhoodi, it varied from 57 to 60 per cent, in H. indicus, it did so from 56 to 58 per cent. Vulval position was slightly posterior for T. mashhoodi females recovered from paddy, garlic and sesame. C.V. values for T. mashhoodi ranged between 2.0 and 4.0 (Table 43), and for H. indicus it varied between 3.1 and 3.7 (Table 44).

T % Like V%, length of testis did not show any greater variation in either species studied. Mean testis length (expressed in percentage) varied from 32 to 40 in the males of T. mashhoodi and from 42 to 45 in
H. indicus. In other words, variation in testis length in the former species have been greater compared with latter. In both the species individuals recovered from sugarcane had longer testis and those recovered from garlic and sesame had relatively shorter testis. C.V. values ranged between 7.0 and 12.0 for Tylenchorhynchus mashhoodi (Table 43) and from 3.5 to 4.1 in case of Hoplolaimus indicus (Table 44).