

Chapter 10

Population study of Earthworm *Pheretima* sp. (Oligochaeta: Megascolecidae) under the artificial condition

Introduction

The experimental population of earthworm *Pheretima* sp. (H-1) (Oligochaeta: Megascolecidae) was established under the artificial condition, originally to investigate the individual space distribution. The quadrat survey and some observations were made on this population. The spatial distribution of earthworms will be studied in later paper.

The main purpose of this chapter is the comparison of the population metabolism of *Pheretima* sp. (H-1) between the field condition and the artificial condition.

Study area

The experimental population was established on the clay sand area near the side of field study area in the experimental field of the department of science Kyushu University Fukuoka city Kyushu Japan. Clay sand was brought in from other regions several years ago, and have 50 cm depth layer. The vegetation on clay sand had been rare till Feb. 1970. Also, earthworms was nothing or rare till Feb. 1970. Seventy-two pieces of the straw bags of rice stem and leaf were put on the surface of clay sand area in February 1970. A piece of the straw bag was 0.9×1.8 . The covered area was $10.8 \times 10.8 \text{ m}^2$. A few number (2.65 m^{-2}) of *Pheretima* sp. (H-1) had distributed on the covered area of clay sand till July 8, 1970. More 72 piece of the straw bags were laid on the old straw bags on March 6, 1971. The old straw bags were weathered on clay sand for a year, and had become to be the decayed matter. The decayed matter was equivalent to 450 g dry wt. per square meter. The 1971-year population used the decayed matter laid on 1970 as food resource. The density of invading *Pheretima* sp.(H-1) was 20.54 m^{-2} on June 18, 1971. More 72 pieces of the straw bags were laid again on Feb. 10, 1972. The oldest mats laid in 1970 had disappeared and the old mats laid in 1971 had decayed till Feb. 1972. The 1972-year's population consumed the old mats laid in 1971. A gutter, 30 cm in depth and 30 cm in width, was dug along the covered area in April 1971 to prevent the migration of new comer. The survey of population change of experimental population was done in northern half of the covered area (Southern half of the covered area was used for the study on the spatial distribution of individuals).

Method

Ten points per samplings were chosen by using random number table. Cocoon collecting was made on Aug. 1971 by the method mentioned in earlier paper (Chapter 1). Earthworm sampling were made at monthly interval between Feb. to Aug. 1972. After peeling the upper piece of straw bag, quadrat frame, each of which was $25 \times 25 \text{ cm}^2$, were dug into one cm depth of the chosen area. Then, the earthworm inhabiting on the soil surface and in the wormcast were collected and counted. After that, the soil samples until 5 cm depth were dug up and the earthworm in clay sand of 5 cm

depth were collected. The collected earthworms were narcotized by adding alcohol, hold in formalin for a day and kept in 70 % alcohol. The body lengths and body widths of the preserved earthworm were measured. The weights of individuals were calculated by using the regression coefficient between the weight and the boy volume of *Pheretima* sp. (H-1). This regression was previously obtained in earlier paper (Chapter 1).

Decaying rate of the straw bag was determined on several times through quadrat study. Four samples of the decayed matter within quadrat frame were collected at every sampling. These were dried at 105 °C for 5 hr. and weighed.

Mass emergence of earthworms and dead bodies were frequently observed in the gutter and on the surface of the straw bags laid on clay sand. They were counted to determine the factors responsible for dispersion and mortality.

Result

1. Average weight of individual and population density

Figure 10-1 shows the average weight of individual and the population density. The density of cocoon belonging to *Pheretima* sp. (H-1) on the clay sand area was 137 m⁻² on Aug. 1971. A large number (94.4 m⁻²) of new individuals appeared on Feb. 3, 1972. The weight was 36 mg fresh wt. in average. The population attained to the maximum density of 105.6 m⁻² on Feb. 15, 1972. This value was equivalent to the maximum density of same species population in area D 1972 (Chapter 1). The population density decreased abruptly between April 29 and May 11, and between May 26 and June 15. The population on clay sand disappeared by July 28. The growth pattern of individuals on clay sand 1972 is similar to that in area D 1972. However, the maximum weight on the clay sand area was 1235 mg fresh wt. on June 15. This was far lower than that in area D 1972 (1610 mg fresh wt. on June 30) (Chapter 1).

2. Metabolism of the experimental population

Figure 10-1 shows also the biomass and respiration of the population. Respiration of the population was estimated by using the data on CO₂ expiration rates of *Pheretima* sp. (H-1) (Chapter 3).

The biomass and respiration were 0.37 mg dry wt. m⁻² (7.820 KJ m⁻²) and 0.092 KJ m⁻² on February 2. The biomass attained to the maximum of 4.352 g dry wt. m⁻² (91.969 KJ m⁻²) on March 26. Also, the respiration showed the maximum of 3.423 KJ m⁻²d⁻¹ on June 15, respectively. The average biomass in growing season was 1.72 g dry wt. m⁻² (36.388 KJ m⁻²). The net production was 6.368 g dry wt. m⁻² (134.575 KJ m⁻²). Total respiration was 263.885 KJ m⁻². The ecological important ratios were R/A = 0.662, P/B = 3.702, and P/B_{max} = 1.463.

Figure 10-2 shows the disappearance rate of the decayed straw bags. The decayed part of the straw bag made from leaf and stem of *Oryza sativa* L. was same matter to the food used for cultivation. Then, the resource utilization rate of earthworms on clay sand area is same to the food

consumption rate of the cultivated individuals (Chapter 4). The food consumption rate (g dry wt. $m^{-2}d^{-1}$) are shown in same figure.

The weight of the decayed straw bags laid on Feb. 1971 was 450 g dry wt. m^{-2} on Feb. 1972. All matter disappeared by June 1972. The litter feeder on clay sand was, only, *Pheretima* sp. (H-1). Then, the disappearance of the decayed matter was mainly due to the feeding activity of the population of *Pheretima* sp. (H-1). The estimated cumulative food consumption attained to 450 g dry wt. m^{-2} by early May. This mean that the population after early May would obtained the food resource from the decayed wormcast.

3. Dispersing earthworm and dead earthworms

Figure 10-3 shows the numbers of migrating earthworms and of dead bodies. Many of the migrating earthworm and the dead bodies were observed frequently on fine days after rain in May and June. The occurrence of mass emergence of earthworms was coincided with the disappearance of the decayed straw bags. These mean that food shortage condition is a factor for mass emergence of earthworms on fine days after rain. After the occurrence of mass emergence, the population density decreased rapidly.

4. Aggregation degree of the experimental population

The ratio of mean crowding to mean density (\bar{m} / \bar{m}) and the mean crowding (\bar{m}) were calculated from the frequency distribution of number on quadrat study. The calculation method and the contents of these indices were mentioned in Chapter 8. Figure 10-3 shows the change of mean crowding and the ratio of mean crowding to mean density. The \bar{m} / \bar{m} and the \bar{m} value took a high value in May. After, these pass the lowest value in June and took a high value in July again. The lower and lowest value of two indices in May and June was due to the dispersion of earthworms in these month.

The seasonal change in the values was a similar to those of the population of same species in area D 1972. However, the values were far lower in the clay sand population than in the area D population. Namely, the value of \bar{m} / \bar{m} changed between 5.0 and 8.0, and the values of \bar{m} changed between 0.92 and 2.0, and, respectively on clay sand area. (In area D 1972, the value of \bar{m} / \bar{m} changed between 5.0 and 10.0, and the values of \bar{m} changed between 1.25 and 3.6, respectively.) It seems that the differences in the aggregated degree of individuals depend on the difference of the complexity of each habitat. In clay sand area, soil surface was smooth with clay sand, and the wormcast on clay sand area was crashed by the heavy weight of the straw mat cover containing large amount of water. Then, the thickness of earthworm's wormcast has few differences with the point on clay sand area. Thus, the linear relation between number of individuals and thickness of wormcast was not detected on clay sand area. The other side, the soil surface of area D was covered with the plant of various species, and the thickness of wormcast and of A_0 horizon has large differences with the point on area D (chapter 8).

Conclusion

Maximum weight of individuals, and biomass, annual production and total assimilation of population, these were far lower in the experimental population on clay sand area 1972 than in the field population on area D 1972. The resource supply on clay sand area was less than half of the annual production of the above ground vegetation in area D 1972 (Chapter 1). The difference in bio-economic items between two populations may be due to the difference in the quantity of the food resource between each habitat.

The population on clay sand area 1972 showed the more dispersed distribution of individuals than the field population on area D 1972. In area D, the soil surface was covered by various plant species and the thickness of wormcast was different with spot within area. Otherwise, the clay sand makes a surface smooth and was covered by the straw bags over the area. The thickness of wormcast was uniform over the area of clay sand after May 1972. The difference in distribution pattern between two populations may be due to the difference in the uniformity of the environmental condition between two habitats.

Summary

1) The experimental population of *Pheretima* sp. (H-1) was established on the clay sand area in the experimental field of Kyushu University.

2) Maximum weight of individuals, and biomass, annual production and total assimilation of population, these were far lower in the experimental population than in the field population. The difference in bio-economic items between two populations may be due to the difference in the quantity of the food resource between each habitat. The experimental population showed the more dispersed distribution of individuals than the distribution pattern of the field population. The difference in distribution pattern between two populations may be due to the difference in the uniformity of the environmental condition between two habitats.