

Chapter 2

Ecological feature and feeding habit of Pheretima group (Oligochaeta: Megascolecidae)

Introduction

Various litter dwellers have mutually different adaptability for different vegetations. The litter dweller and the soil dweller segregate the habitat concerning the depth of the soil inhabited. It seems that each species is mutually different of the feeding habit, the body size besides the life history and the body form, etc. These features of each species may be significant factors for their distribution and or their biomass.

The purpose of this chapter is the investigation on the feeding habit and eco-morphological features of several species of Pheretima. Besides, the distribution and biomass of Pheretima species is discussed in relation to the vegetation types of their habitat.

Method

1. Distribution of earthworm in a grass field

The ecological distribution of earthworm that is relating to vegetation type was investigated in the experimental field of the Department of biology Kyushu University. The maps on the ecological distributions of earthworm were constructed from the results of the population studies in the experimental field (Chapter 1). The flora maps on this field were made on Feb. 29 and July 24, 1972. The ignition loss weights and particle compositions of habitat soil were measured. 24 points were chosen at an interval of three meter over the area. Two soil samples of 30 mm³ were sampled at each point on Feb. 25, 1972. One series (24 samples) was used for the measurement of the ignition loss weight of soil. The soil sample was dried during one week in the room temperature, and dried for 24 hours at 60 °C. Afterwards, these were weighed. These were burned out by electric furnace at 600 °C for five hours and were weighed. The ignition loss weight of soil is represented by the percentage of the weight of the dried soil to the weight of the burned out soil. That is, the content of the organism in the soil is shown by the difference of two measurement values. Another samples were used for the particle size analysis of soil. The thickness of A₀ horizon layer was measured over the experimental field with scale, cutting the soil surface with shovel, on early August 1972.

2. Eco-morphological feature and behavior of Pheretima

The body size, body forms and behavior of earthworms may be related to their distributions and their abundance. A characteristic feature of the genera of Pheretima is the presence of intestinal coeca on the wall of intestine. There was a large difference in the developmental degree of the intestinal coeca among species. Such a difference seems to be correlated to the difference of feeding habit.

Seven species of Pheretima group: *Pheretima s. schmardae* (Horst), *Pheretima* sp. (H-1), *Pheretima vittata* (Goto et Hatai), *Pheretima irregularis* (Goto et Hatai) Ohfuchi, *Pheretima* sp.

(M-3), *Pheretima heterochaeta* (Kinberg) and *Pheretima micronaria* (Goto et Hatai) were investigated for the eco-morphological comparison. These are an abundant species in the suburb of Fukuoka city Kyushu (Chapter 1). The informations on weight, body length and body width were obtained from the data on the matured individuals collected in the population study (Sugi and Tanaka 1978 b, Chapter 1). The observations on the inhabiting layer and on the mobility, of earthworm were made at the sampling times for the population studies (Sugi and Tanaka 1978 a, b, chapter 1). The morphological observation on intestinal coeca was made on 30-50 specimens, per a species, of the matured individuals reserved in 70 % alcohol.

3. Composition of gut content

The feeding habit may be another feature relating to their distribution and to their abundance. The knowledge on the composition of gut content will clarify the feeding habit of animals in their habitats.

Seven species of *Pheretima* mentioned in above were studied on the composition of gut content. The specimen preserved in 75% alcohol was used to analyze the composition of gut content.

The specimens of *Ph. schmardae*, *Pheretima* sp. (H-1), *Ph. vittata*, *Ph. irregularis*, *Pheretima* sp. (M-3), *Ph. heterochaeta* and *Ph. micronaria* were obtained from the reserved samples of the pre-matured and matured individuals collected in area H, area H and area D, area H and area D, area K, IBP Minamata area, area D and area G, and area H, respectively. The situation and environment of the areas were described in chapter one. The specimens were thawed and smears made of material removed from gut. Gut smears were prepared by dispersing the gut samples in a few drop of alcohol on a slide. The larger volume gut smears than about 100 m³ were divided into some slides. The smears mounted in alcohol were examined through a binocular at 60 magnification, initially a slide glass being placed on a white plate with reflect light, and an estimate of the abundance of humus components made. Material in which intact cell were regularly arranged, varying from yellow to brown in color, was distinguished as raw humus as opposed to amorphous humus which was brown or black, including material in an advanced state of decay. Moreover, raw humus were distinguished between large humus (H1) and small humus (H2), with the length of materials being longer than or shorter than 5 mm. Next, smears were examined through a binocular at 60 magnification, a slide glass being placed on a black plate with reflect light, and an estimate made of the amount of mineral present. Each component was recorded as most abundant (+++), abundant (++) , present (+) or absent (-).

Result

1. The micro habitat distribution of earthworm

Figure 2-1 shows the flora maps in the experimental field. A part of the experimental field (area D) was covered densely by the dicotyledon such as *Vicia hirsuta* Koch, *Artemisia vulgaris* L. var. *indica* Maxim., *Solidago altissima* L. and *Medicago denticulata* Willd.. The remained part of the

experimental field (area G) was covered with the monocotyledon such as *Imperata cylindrica* Beauv., *Cyperus rotundus* L. and *Carex* spp. in sparsely. The ignition loss weight, the particle size and the thickness of A₀ horizon are summarized in two maps (Fig. 2-2). The characters of substratum were different with each vegetation types. In the soil of Area D, the organic was rich, the ratio of fine particle was high and the density was low. The A₀ horizon in area D was thick. On the other hand, in the soil of area G, the organic material was poor, the ratio of coarse sand was high and the soil density was high. The A₀ horizon in area G was thin.

There were drawn a map (1/300 scale) of the experimental field showing the distribution of earthworm species (Fig. 2-3 a,b). The distribution of *Pheretima* sp. (H-1) which is the litter dweller is corresponding to the distribution of the dicotyledon and the distribution of *Ph. vittata* and *Ph. schmardae* were restricted within the area D, the soil surface of which were covered with the dicotyledon. *Ph. heterochaeta* was scattered over the experimental field regardless of vegetation type. As mentioned, the area covered by the dicotyledon (area D) had plenty ground flora and thick A₀ horizon, and the area covered by monocotyledon (area G) had not. These results may mean that *Pheretima* sp. (H-1), *Ph. vittata* and *Ph. schmardae* require a plenty flora and thick A₀ horizon for their distribution, and *Ph. heterochaeta* can live in either condition.

2. Body size, body form and other ecological feature of *Pheretima* species

Table 2-1 represents the body size and body form of seven species of earthworm, such as the weight, body length, body width and the ratio of body length to body width. The weight, the body length and the body width in the table are the arithmetic average value for all of the matured individuals collected. It seems that the ratio of the body length to the body width shows earthworm's body form.

Ph. schmardae was found in litter layer and its mobility was active. This species had the small ratio of body length to body width showing a plumply body form, and had a small body size (474 mg fresh wt). This species showed an active action as like spring. *Pheretima* sp. (H-1) and *Pheretima vittata*, both were found in litter layer, and had a similar body form. They showed a similar movement to *Ph. schmardae*. The weight of *Pheretima* sp. (H-1) was 1922 mg, and that of *Ph. vittata* was 6006 mg fresh wt. These weights were equivalent to 3 times and 10 times of that of *Ph. schmardae*, respectively. *Ph. irregularis* was found in litter layer. The weight was 2206 mg fresh wt. The body size and mobility of *Ph. irregularis* was almost same to those of *Pheretima* sp. (H-1). *Pheretima* sp. (M-3) was inhabited in the litter layer of evergreen forest of mountain site with *Pheretima sieboldi* (Horst) (Sugi and Tanaka 1978 a, b). This species was active in mobility. This species had the smaller weight (1434 mg fresh wt) than those of other litter dweller *Pheretima* except *Ph. schmardae*. *Pheretima* sp. (M-3) had the large ratio of body length to body width showing the slender body form. *Ph. heterochaeta* and *Ph. micronaria* were found in deeper soil layer. Both had a small body size (799 mg fresh wt in *Ph. heterochaeta* and 564 mg fresh wt in *Ph. micronaria*). They

had a large value of the ratio of body length to body width showing a slender body form. Particularly, the ratio of *Ph. heterochaeta* was the largest one among seven *Pheretima* species. They were sluggish in mobility.

3. Composition of gut content

Table 2-2 represents the composition of gut content. There was a significant preponderance of large particle raw humus in *Ph. vittata*, of small particle of raw humus in *Pheretima* sp. (H-1), of small particle of raw humus and organic rich material in *Ph. irregularis*, of organic rich material in *Ph. schmardae* and *Pheretima* sp. (M-3), and of organic rich soil and mineral material in *Ph. micronaria* and *Ph. heterochaeta*. No change was found in the relative abundance of each fraction during the passage of the material consumed through the alimental canal. Fungal hyphae were frequently found in the alimental canal of two litter dwellers, *Pheretima* sp. (H-1) and *Ph. vittata*. Plant grains having 2-3 mm diameter were sometime found in the intestine of *Ph. vittata*. The raw humus in the intestine of *Ph. vittata* and *Pheretima* sp. (H-1) were consisted by the decayed matter of above ground vegetation. Then, Raw humus which derives from the ground vegetation seems a main food resource of *Ph. vittata* and *Pheretima* sp. (H-1). The small raw humus in the intestine of *Ph. irregularis* were nearly less than 2 mm of tree leaves litter and major part of gut content of this species were organic rich material. Then, the well decomposed organic matter may be a main food resource of *Ph. irregularis*. Also, In the intestine of *Pheretima* sp. (M-3), the well decomposed matter was most and Raw humus or mineral matter was rare. The decayed matters of plant root were sometimes found in the intestine of *Ph. heterochaeta* and *Ph. micronaria*. However, the majority of Raw humus in the intestine of these soil dwellers was the well decayed matter of above ground vegetation.

The difference was seen by the composition ratio of the gut content of same species population between different Habitat. The gut content of *A. vittaus* in Area H was composed of a higher ratio by large size Raw humus compared with the gut content of *A. vittaus* in Area D. Mainly the decayed matter from monocotyledon composed the large raw humus in the intestine of *Ph. vittata* in area D. Otherwise, the large raw humus in the intestine of same species in area H were composed by the decayed matter from the leaves of trees besides monocotyledon. There was no significant difference in gut composition between three populations of *Pheretima* sp. (H-1): area H 1968, in area D June 1971 and May 1972. However, organic rich soil was more abundant in the gut content of *Pheretima* sp. (H-1) in July, 1972 in Area D than that of the previous three populations. This problem will be discussed in later paper, in relation to the resource utilization intensity of animals. There was no significant difference in the composition in the gut content of *Ph. heterochaeta* between area D and area G.

As mentioned in earlier, a characteristic feature of the genera of *Pheretima* in Japan is the presence of relatively complex intestinal coeca. The degree of the development of this organ is

different according to the species. The finger shaped projection (secondary coeca) of the organ was 8 pairs in *Ph. vittata*, 6-7 pairs in *Pheretima* sp. (H-1), 6 pairs in *Ph. irregularis* and 5 pairs in *Ph. schmardae*. The intestinal coeca of *Pheretima* sp. (M-3), *Ph. micronaria* and *Ph. heterochaeta* is simple being conical form in shape. *Ph. sieboldi* had a most complex intestinal coeca, among *Pheretima* group found in Japan (Ohfuchi 1947). There is no difference in the degree of the development of the organ within 40 individuals of same species.

Kobayashi (1938) reported that most individuals of *Pheretima hilgendorfi* collected in Korea showed 8 pairs of secondary coeca. However, same species collected by present author in the suburb of Fukuoka City Kyushu Japan was 6 pairs of secondary coeca (Sugi unpublished). Also, he reported that *Ph. vittata* in Korea showed 5 pairs of secondary coeca. However, *A. vittata* collected in Fukuoka City has secondary coeca of eight pairs (Table 2-3). So, there may be some difference in the developmental degree of intestinal coeca of individuals within a species between different habitats.

Intestinal coeca's development degree corresponded to the decomposition extent of food resource which each species had taken well. Namely, the species having a more complicated intestinal coeca consumed rawer humus. The intestinal coeca exists in front of the intestine. Therefore, I think as follows. The intestinal coeca of *Pheretima* is taking part in the digestion from the food material.

Discussion

1. Ecological feature of *Pheretima* group relating to their distribution

There was large difference in body size, body form and mobility between soil dwellers and litter dwellers. The soil dweller has a small body, and has a long and slender body form compared with the litter dweller. Still, *Ph. schmardae* exceptionally has a small body, and *Pheretima* sp.(M-3) has an exceptionally slight body form. The soil dweller can roll the coil better compared with the litter dweller. Soil dwellers were sluggish compared with the behavior of litter dwellers. These features of the soil dweller show that these species can dive in deeper soil layer. Particularly, the slenderest body form of *Ph. heterochaeta* means the most adaptability for living in deeper soil. This is a reason for the distribution of *Ph. heterochaeta* in the experimental field regardless of the type of vegetation (Fig. 2-2 and Fig. 2-3 a,b). Lavelle (1973) showed that the deeper soil dweller have the larger ratio of body length to body width in Acanthodridae and Eudrilidae earthworm in Lamto savanna. This phenomenon might be a common in several earthworm communities. *Ph. schmardae*, *Pheretima* sp. (H-1) and *Ph. vittata* were are found in the litter layer through the growing period. They were exposed to drought and high temperature in their habitat. These species have large weight in general, show an active movement, and these feature mean that the thick A₀ horizon and the good soil texture near soil surface were essential for their distribution. This may be a reason for the distribution of these litter dweller *Pheretima* to restrict within the area covered by dicotyledon (area D), where A₀ horizon was thicker, soil density was smaller and litter layer was thicker than those of

the area covered by monocotyledon (area G) (Fig. 2-2 and Fig. 2-3 a, b). Nordstrom and Rundgren (1974) said that surface living species were absent in some exposed biotopes with high soil surface temperature. Also, Phillipson et al (1976) said that the litter dwellers (epigees) although affected in their distribution by litter standing crop are more significantly associated with soil depth and the moisture regime of the soil. Each of the above mentioned litter dwellers showed different adaptability to vegetation type (Chapter 1). *Ph. schmardae*, *Pheretima* sp. (H-1) and *Ph. vittata* are all litter dweller, and these are found in same region area D and Area H. However, each species showed different adaptability for the type of vegetation. *Ph. schmardae* had the smallest weight and the most thin body wall, which induced a fragility of this animal to dryness. These characters of *Ph. schmardae* may be a reason for this species to be found abundantly in wetter habitat such as compost and the surrounding of rice field (Chapter 1). *Ph. vittata* have larger weight and thicker body wall and perhaps larger migrating ability, compared with those of other litter dweller. That is, *A. vittata* is more excellent than other litter dwellers concerning the evasion ability to the high temperature and dryness. This may be a reason for some individuals of *Ph. vittata* to survive after summer in area H (Chapter 1). Another litter dweller *Pheretima*: *Ph. irregularis* had same weight and same body forms to those of *Pheretima* sp. (H-1). *Ph. irregularis* is survived till late in the autumn though most individuals of *Pheretima* sp. (H-1) disappears before late summer (chapter one). The difference in life time between two species may be due to the difference in habitat condition of each species (Chapter 1). *Pheretima* sp. (M-3) had relatively small body size and slender body forms compared with those of other litter dweller except *Ph. schmardae*. The smaller body and slender body forms of *Pheretima* sp. (M-3) seems to be related to their hibernating behavior in winter month. This species hibernate in deeper layer 30-40 cm depth (Sugi and Tanaka 1978 b). It is very interest that another mountain species: *Pheretima sieboldi* has the largest body size among all earthworm species in Japan. This species have the similar life history to *Pheretima* sp. (M-3). The weight of the pre matured individuals of *Ph. sieboldi* in Nov. before hibernation attained to 12-14 g fresh wt and their body widths exceed one cm. Also, this species showed a mysterious hibernating behavior that they migrate to the dry bottom of a dingle on rainy days in late November to hibernate in the soil or under stones until April of the next year (Sugi and Tanaka 1978 a). The mysterious hibernating behavior of *Ph. sieboldi* may be related to their body size and body width which is unsuitable for creeping into solid and deeper soil on mountain slope in hibernating months.

The color on the body surface is different little by little according to the species. Namely, the color on body surface in live were yellow green in *Ph. schmardae*, dark reddish brown with yellow band in *Ph. vittata*, deep black purple in *Pheretima* sp. (M-3) together with *Ph. sieboldi*, light purplish brown in *Ph. micronaria*, and light gray brown in *Ph. heterochaeta*. The color on the body surface may be related to the distribution of each species. However, the relation could not be considered enough. Moreover, the numbers of pair of spermatial pore were four in soil dweller

Pheretima, and two in litter dweller Pheretima except three pair of *Ph. sieboldi*. This difference may be related to the copulation behavior of each species in their habitats. However, the detail was unknown.

2. Feeding habitat of Pheretima group in relation to their abundance

Ph. schmardae, *Pheretima* sp. (H-1) and *Ph. vittata* were found in the areas, the surface of which was covered by dicotyledon (area D and area H). These were litter dweller Pheretima. However, there was large difference in food preference between these species. Main component of the gut content of *Ph. schmardae* was organic rich matter in spite of raw humus of other litter dwellers. *Ph. schmardae* was a small size species compared with other litter dwellers (Table 2-2). *Ph. schmardae* was very abundant in the meadow around the rice field though the biomass of *Ph. schmardae* in Area D and Area H was few (6.65 g fresh wt m⁻² in area D and 1.88 g fresh wt m⁻² in area H, see Chapter 1). These results may mean that *Ph. schmardae* has the favor of food different from other litter dwellers, and the main habitat is compost and field around the rice field, then, *Ph. schmardae* only accomplishes just minor part as decomposer in an old grass field. There was significant difference in the component of gut content between two remained litter dwellers: *Pheretima* sp. (H-1) and *Ph. vittata*. The intestine of earlier species filled up with smaller raw humus, and that of later species was filled up with larger raw humus. This difference means that *Pheretima* sp. (H-1) prefer more decayed matter and *Ph. vittata* prefer un-decayed matter. The difference in the preference for food between two species seems to be related to the difference in the maximum biomass of each species in area D and area H. The maximum biomass of *Pheretima* sp. (H-1) was 122.96 g fresh wt m⁻² in area D and 43.95 g fresh wt m⁻² in area H. Otherwise, the maximum biomass of *Ph. vittata* was 24.91 g fresh wt m⁻² in area D and 29.24 g fresh wt in m⁻² area H (Chapter 1). Vegetation in Area D is composed by dicotyledon, The litter which derives from dicotyledon decomposes easily, and is the best for the food of *Pheretima* sp. (H-1). On the other hand, the half of Area H is covered with the deciduous tree and the litter does not decompose easily. Therefore, the litter is more effective as the food of *Ph. vittata* (Chapter 1).

Ph. irregularis and *Pheretima* sp. (M-3), both were a foresty species. Although there were abundantly litter supply in forest, most gut contents of forest species were the well decomposed matter for *Ph. irregularis* and *Pheretima* sp. (M-3). Still, the author had the observation that the intestine of *Ph. sieboldi* collected in IBP Minamata area was full of the litter of the tree (Sugi unpublished). These results show that many earthworm are physiological unable fully exploit the tree leaves as food and able exploit the well decomposed matter in foresty habitat, but only *Pheretima sieboldi*, which have the most complex intestinal coeca among japanese Pheretima, can exploit the newly litter of tree leaves. The un-palatability of tree leaves litter may be most important limiting factor, which regulated the biomass of foresty litter dwellers at low level: 10.55 g fresh wt m⁻² of *Ph. irregularis* in area K 1968, and 16.8 g fresh wt m⁻² of *Pheretima* sp. (M-3) in IBP

Minamata, (See Sugi and Tanaka 1978 b and Chapter 1).

Soil dweller, *Ph. heterochaeta* and *Ph. micronaria* consumed organic rich soil and mineral soil. This result shows that these soil dwellers were soil feeder. The biomass of the soil dweller in the forest is very small. However, the biomass of *Ph. heterochaeta* in the meadow is very large. The tendency that the biomass of the soil dweller is more abundant than that of the forest in the meadow is similar to the case of the litter dweller. It is interested that, the ground vegetation in area D is more abundant than area G. However, there is no difference in the composition of the gut content of *Ph. heterochaeta* in two areas. In addition, the maximum biomass of this species was larger in area G (60.51 g fresh wt m⁻²) than in area D (34.39 g fresh wt m⁻²) (Chapter 1). This result seem to be explained as that *Ph. heterochaeta* in area D could utilize only the refuge food resource of litter dwellers *Pheretima* sp. (H-1) and *Ph. vittata*, and that in area G could dominate the more quantity of resource.

3. Habitat, feeding habit and life history of Pheretima group

In above section, the ecological feature and feeding habit of *Pheretima* group were studied in relation to their life history, their habitat preference and their abundance. The acid tolerance of earthworm may be related to their ecological feature and their abundance as pointed out by many authors (Ljungstrom et al 1973, Nordstrom and Rundgren 1974 and Phillipson et al 1978). Pearce (1972 a, b) suggested that the difference in calciferous gland activity of Lumbricidae could be related to difference in the nature of the material consumed by each Lumbricidae species and this organ function principally in the elimination of excess calcium absorbed from the diet. Calcium balance seems to be important also for *Pheretima* group. However, the genera of *Pheretima* in Japan lack the well-developed calciferous gland. However, this problem is unsettled.

Table 2-3 summarizes the body size, body form, feeding habit and other characters of seven species of *Pheretima* studied, together with those of *Pheretima sieboldi*. The life history and the distribution areas of every species are shown in same table (Chapter1). *Ph. schmardae*, *Pheretima* sp. (H-1), *Ph. vittata* and *Ph. irregularis*, All are litter dwellers. They have almost resembled life history and were found in same areas. However, each species have different preference to vegetation types, different body size and different feeding habit. *Pheretima* sp. (H-1) and *Ph. irregularis* have same body size and body form, but have different distribution area and different feeding habit with each other. Next, *Ph. sieboldi* and *Pheretima* sp. (M-3), both are litter dwellers, have same life history and same distribution area, but there are large difference in body size, feeding habit between two species. *Ph. heterochaeta* and *Ph. micronaria*, both have different habitat preference, although both have same ecological feature and same feeding habit with each other. The above mentioned results show that *Pheretima* species in Japan have different niche with each other, along three axes such as time (life history), habitat (morphological feature relating to the distribution), and food (feeding habit relating to the distribution and abundance). Lavelle (1983) said

that earthworm communities are separated into ecological niches by various vertical and horizontal distributions, alimental specialization and species sizes. Many among the factors enumerated by Lavelle (1983) are equally true in *Pheretima* communities (Table 2-3). However, the way of niche separation of earthworm in southwest Japan seems to be very different in another earthworm. Lumbricid in Europe fall into main two eco-physiological groups: Epigeic and Endogeic. Epigeic live in surface organic horizons, ingest little mineral material, and were small body size. Otherwise, Endogeic live predominantly in mineral soil and were large body size. The division is not absolute “anesic” feed on plant remains drawn from the surface into its burrows and it also ingest soil (Satchell 1967, Bouche 1977 cited by Satchell 1980). Satchell (1980) interpreted the contrasting behavior, morphology and physiology of these two groups as r worms (epigeic) and K worms (anesic and most endogeic) in the concept of r-K strategies. Lavelle (1983) made a factorial analysis on 42 earthworm communities in diverse temperature and tropical environment, and said that temperature difference related to latitude was the main factor explaining 31 % of the calculated variance, and the ecological amplitude of the earthworm community change toward the tropics as the population occupy the deeper soil, exploiting the humic reserves and depending less on surface litter. And he concluded that vertical distribution and size distribution were better distinguished in tropical regions whereas temperate area have greater horizontal and temporal separation and greater alimentary specialization. Southwest Japan near 33 N situated between temperate and tropical zone in the Lavelle's figure (1983). From his figure, it is expected that the dominant type of earthworm in southwest Japan was anesic or endogeic. However, the earthworm in southwest Japan lacks anesic fauna, and the dominant type in there was litter dweller of *Pheretima* group. These *Pheretima* live in litter layer 0-4 cm, and ingest mainly litter and well decayed organic matter and less mineral soil. These features show “Epigeic” of litter dweller *Pheretima*. However, “Epigeic *Pheretima*” is in contrast to “Epigeic Lumbricid” in body size and life history. The weight of Epigeic *Pheretima* ranged from 1.2 to 30 g fresh wt in average of the matured individuals of every species (Table 2-3), which were equivalent to several fold of “Epigeic Lumbricid”. Secondary, the cocoon production of Epigeic *Pheretima* were less than 3 in field and less than 2 in pathogenesis of the culture condition, against 42-100 per a individuals per a day in culture condition, of “Epigeic Lumbricid” (Evans and guild 1947, Satchell 1967) and the form of survivor ship curve of “Epigeic *Pheretima*” belong to Type I or II against Type III of “epigeic Lumbricid” (Chapter 1, Satchell 1980). The third difference is in the age composition of populations. “Epigeic *Pheretima*” populations were composed by only one generation and all species of “epigeic *Pheretima*” attained to matured stage in the relatively shorter period of warm and wetter season of June, against the complex age composition with several generation in “epigeic Lumbricid” population (Evans guild 1947, Satchell 1967, Chapter 1). In relation to this, it is very interested that dominant species of “epigeic *Pheretima*” changed in different habitats (Chapter 1). This means that every “epigeic *Pheretima*” species specialized their

life history to the environmental condition of habitat. Otherwise, soil dweller (“endogeic”) *Pheretima* have relatively small body size compared with the weight of “epigeic *Pheretima*” and they occupy the position of dominant in the areas refused by “epigeic *Pheretima*” and could utilized the resource and the season refused by “epigeic *Pheretima*” (Chapter 1). As seen in above, the principal of the organization of *Pheretima* communities were very different to that of Lumbricid communities.

Dominant group in the earthworm community of south west Japan were litter dweller (epigeic) *Pheretima*, and in there, soil dweller (endogeic) *Pheretima* occupied the vacant niche. The flourish of epigeic *Pheretima* in south west Japan must be an important factor for the lacking of anesic fauna in this region. Now, there are no fully interpretation on the reason why “epigeic” earthworms occupy the dominant in earthworm communities of southwest Japan.

Summary

1) Ecological distribution of earthworm was investigated in the experimental field of the Department of biology Kyushu University, which was composed by two vegetation type. Litter dwellers: *Ph. schmardae*, *Pheretima* sp. (H-1), *Ph. vittata* distributed within the area having a plenty ground flora, thick A₀ horizon. On the other hand, Soil dwellers: *Ph. heterochaeta* distributed in whole area, regardless vegetation type and habitat structure near soil surface.

2) Some eco-morphological feature such as body size, body form mobility and the developmental degree of intestinal coeca, and feeding habit were investigated on seven representative *Pheretima* species: *Ph. schmardae*, *Pheretima* sp. (H-1), *Ph. vittata*, *Ph. irregularis*, *Pheretima* sp. (M-3), *Ph. heterochaeta* and *Ph. micronaria*.

3) Soil dweller: *Ph. heterochaeta* and *Ph. micronaria* had in a small body size and slender body form, and showed a sluggish mobility compared with those of litter dwellers. Among litter dwellers, *Ph. schmardae* had the smallest body size, and *Pheretima* sp. (M-3) had the slenderest body form. It was discussed that the eco-morphological feature of each species were largely reflected on their life history, their hibernating behavior and distributions, in relation to the structure of their habitats.

4) There was large difference between every species in the gut material. The main component of gut material were large particle of raw humus in *Ph. vittata*, of small particle of raw humus in *Pheretima* sp. (H-1), of small particle of raw humus and organic rich material in *Ph. irregularis*, of organic rich material in *Ph. schmardae* and *Pheretima* sp. (M-3), and or organic rich soil and mineral material in *Ph. micronaria* and *Ph. heterochaeta*. There were observed a linear relation between the decayed degree of gut material and the developmental degree of intestinal coeca, of each species. The feeding habit of each species was discussed in relation to the quantity and quality of the food resource presenting in their habitats.

5) It was discussed that *Pheretima* species found in suburb of Fukuoka city had a different niche with each other, along three axes: life history, habitat preference and food preference.

Reference

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