Earthworm Population in Deforested Lands in Hilly Area of Sumberjaya West Lampung

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ABSTRACT

Earthworm population in deforested lands in hilly area of Sumberjaya, west Lampung (S. Yusnaini, A.Niswati, M.A.S. Arif, M. Matsumoto and M. Nonaka): Earthworm is one of the most important soil animal while their activities are depending on a soil properties and climate. The deforestation of land into another function could changes the soil properties that could infact earthworm. Investigation the population and ecology of earthworm during the wet and dry season in the deforested soil at a hilly area Sumberjaya, west Lampung , South Sumatra, Indonesia was conducted. Soil samples and earthworm were collected from the top soils (0-10 cm), sub-soils (10-20 cm), and deeper soil (20-30 cm) in different land with the different vegetation after deforestation, i.e. Secondary forest, bush, alang-alang, and coffee plantation. The population and ecology of earthworm showed a close correlation with the seasonal trend. A great deal of adult type of earthworm were found in the top soil in the bush , however in dry season all of earthworm were living in a deeper layer of soil , and they were larva and juvenile type. Furthermore, a large amount of casts were produced by earthworms. The carbon contents in casts increased more quickly than in the native soil.

Keywords: Deforestation, Dry and Wet Seasons, Earthworm Casts, Ecology of Earthworms

INTRODUCTION

In a hilly area of west Lampung (southern Sumatra, Indonesia) intensive deforestation gave rise to a severe reduction in primary forest area up to 13% in 1990 (Syam et al., 1997). During the last 20 years, most of the primary forest was changed into cultivated land (mostly coffee plantations). The area taken up by coffee plantation was occurred for about 41% in the hilly area of west Lampung.

Deforestation in the tropical regions has long been considered to lead to the degradation of the soil properties related to soil fertility. Earthworm is one of the important organism in the soil that a susceptible to the faint changes of environmental, especially moisture, temperature and the amount of litter supply (Aoki, 1973).

The importance and function of earthworm had been recognized by Darwin (1881) and subsequently by many megadrilogists throughout the world. (Edwards, 1998; Brussand, 1993; Lee, 1985; Atlavinyte, 1982). However, some of the important problem remain unsolved. These include population, life cycle and ecology of earthworms under different land-use, vegetation, and seasonal change in tropical region. The deforestation in tropical regions has long been considered to lead to the

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degradation of soil properties related to soil fertility. In particular, there have been no comparative studies on the population and ecology of earthworm during dry and wet seasons in South East Asia.

The accurate information on earthworm ecology and population is very important for maintaining the sustainability of agricultural production. The use of this information can be directed toward maximizing beneficial effects and contributing to richness of the concerned lands. There have been some report on earthworms in tropical regions. Watanabe et al. (1984), reported the production of earthworm casting in the grassland and cultivated land in Thailand. Levelle et al. (1988) reported the population, species, and ecologies of native earthworms in the north neotropical, and Susilo et al. (1999) in the tropical regions. Yusnaini et al. (1998), described the role of earthworm on litter decomposition in areas of different land uses in tropical region. Furthermore, earthworm ecology and population during four seasons in neighboring apricot plantation and vegetable land in central Japan were reported by Matsumoto et al. (1999). Earthworms are probably the most important soil animal related to plant productivity because of their significant influence on soil physical, chemical and biological properties related to plant yields.

In this paper, we report the results of studying the seasonal variations in earthworm population and their ecologies in different land areas after deforestation in Lampung, south Sumatra, Indonesia.

MATERIALS AND METHODS

Study sites and survey methods

Location of study area; the study area, Sumber jaya , is located at the southen part of Bukit Ringgis mountain range (4 ^{0}55' S. to 5^0 10'S. and 104^0 19'E. to 104^0 34'E) in West Lampung, Lampung Province, South Sumatra. The elevation of the area ranged from 800 to 1000 m above sea level. Annual precipitation in Lampung is more than 1500 mm. However, the climate is divided into dry (from may to Oct.) and wet (from nov. to April), and heavy rain is concentrated in a very short period during the wet season. The surface soil of the lands were eroded by a heavy rainfall during this time.

The surveyed sites were secondary forest, deforested lands (i.e. bush, grasslands (alang-alang; *Imperata cylyndrica*), and coffee plantations). All of the sites were located within 500 m distances.

Collection of Earthworms and Measurement of Carbon contents in Wormcasts; Earthworms were taken using a quadrants of 25 x 25 cm and 30 cm deep soil monoliths that are divided into three layers; 0-10cm, 10-20cm and 20-30cm. In each sampling plot soil inside the quadrates were dug out in 0-10cm, 10-20cm and 20-30cm depth, spread on polyethylene sheet and than earthworm were collected by hand sorting. Five sampling points at each location were 5 m apart along a random transect. The survey had been conducted every month from April '97 to March '98. The earthworm casts were collected by hand from the quadrant (25 cm x 25 cm) surfaces in april. The casts were dried at room temperature for a few days. Soil chemical properties in soil and cast included pH (H_20), organic carbon content (Tyurin Methods) and total nitrogen (Kjeldhal methode) were measured.

RESULTS AND DISCUSSION

The soil pH in these areas was in the range it 4.4 to 5.3, which characterize the 'red Acid Soils' having very low biological production (Matsumoto, 2000). In general, soil animals do not live under soil with low pH value. However, we found many earthworms in this area. While there were considerable differences between the earthworm species based on the soil pH

values, these differences became overshadowed by the seasonal variations, the different biological characteristics of lands/vegetation and, the soil environments. The soils pH were 4.42 to 5.38 in top soil and 4.36 to 5.03 in sub soil. Yusnaini et al. (1998), found a well correlation between soil pH and earthworm population in Sumberjaya sites. These facts are very important to understands how to achieve sustainable biological farming production in tropical regions

In this area, the climate is divided into dry and wet seasons that affect the population and ecology of earthworm in the soils. The typical environmental factors and the soil zoological characteristics during dry and wet seasons in this area are shown in Table 1. The range of temperature of the soil (1-10cm) was relatively constant (21.8-22.3^{0}C) irrespective of sampling time. Soil temperature may be the most important factor in determining the composition and structure of earthworm communities. Lee (1985), suggested that the range of soil temperature within which earthworm can function is narrow, with upper lethal temperature being rather low (25-35 ^{0}C) and optimum temperatures is typically being lower for cool temperate species (10-20 ^{0}C) and for tropical and subtropical species (20-30^{0}C). In connection with soil temperature, the soil water content is a very important for earthworm. The water content in soil varied significantly between dry to wet season and the four sites surveyed in this area. The water content of soil in wet season much higher than in dry season. In dry season, the average water content of the soil is less than in wet season. However, there are often heavy rains for a short time, as shown for October in Table 1. Precipitation in this season provides favorable conditions for earthworm in the soil. The vertical distribution of earthworm is also affected by changes in soil conditions, such as temperature and moisture.

The environmental characteristics seemed to influence the seasonal variation of earthworm population and lifestyle. The number of earthworm was markedly different between dry and wet seasons. Earthworms were rarely detected in the upper soil layer in dry season (as seen by comparison of April and July) (Fig.1 & Fig 2). The average population of earthworm ranged from 4 to 60 ind/m2 in the upper soil layers of different vegetation. They were considered to move downward in relation to soil moisture. Earthworm were found in every site were small sized. Furthermore, we found a few cocoons below the shade of plants in the grasslands. Consequently, earthworms were observed in the dry season in the juvenile stage and survived in the deeper soil layers. These facts suggest that the small sized earthworm hatched one month before the present season. Therefore, the cuticle layer on the surface layer on the surface of freshly hatched earthworm's body is very thin and the clitellum is undeveloped. This makes difficult to move on the soil surface, so the earthworm live in aestivation as a small ball in a hole in the ground. These actions of aestivation were unavoidable due to the dried part of the body not being able to absorb H_2O from water saturated air and decreasing body water content inactivating the earthworms. It is possible that the cuticle of the adult body is made by the earthworm themselves biosynthetically from the food source to polysaccharides, protein, amino-hydrocarbon, and other organic substances. However, a freshly hatched earthworm does not have the ability to biosynthesize itself in this period. Therefore, they wait in a deeper soil layer until the wet season.

Table 1. Soil characteristic in upper layer in a hilly area of Sumberjaya

Soil Characteristic	Wet season		Dry season	
	January 1997	April 1997	July 1997	October 1997
Temperature (°C)	21.8	22.3	21.9	22.0
Water content (%)	55.5	59.5	35.6	36.5
Earthworms (ind. m^{-2})	61.3	169.0	13.7	38.5
Meso fauna (ind. 100 ml^{-1} soil)	7.24	5.03	2.75	4.38
Rainfall (mm)	160	170	65	85

In the wet seasons (from November to April), the earthworm population decreases with the increase in soil depth at every site. The number of earthworm increases remarkably in the upper soil layer under the vegetation of bushes and grasslands (alang – alang) in contrast to that of the coffee plantation (Fig. 2). The lower number of earthworm in coffee plantation probably because of the application of agrochemicals in the coffee plantation lands. The juvenile earthworm are often unable to burrow deeply in the soil and are affected more severely than the adults by chemicals.

It is known that large-sized (adult) earthworm are present in the wet season. In addition, they deposited a lot of earthworm casts on the soil surface in the vegetation of bush and alang –alang. In the wet season (April), the casts were collected by hand-sorting, and they amounted to about 2.5kg/m2 (dry wt.) on the soil surface. These actions of earthworms were very closely tied to the moisture and water content of the soils. The rate of cast production decreased in the dry season.

The casts were rich in organic carbon, which were made up with the fragmentation and breakdown of the plant residues by the eating action of earthworms. Sampling of worm casts was conducted in April 1997 from these sites. The carbon content in the earthworm casts were analyzed by Tyurin methods. Carbon content in earthworm casts were about 10-30% higher than those in the upper-layer soils (native soils) (Fig. 3). It is well known that organic materials are mixed with soil minerals by the deposition of earthworm digested casts. Therefore, in a field with a large number of earthworms, the soil structure can provide ample 0_2 for increased microbial activity (Willems, 1996). The importance of earthworm activity in a low – input agro-ecosystem has been recognized in some tropical soils (Pashanasi, 1996). As soil animals, earthworm spend their entire life cycle within the soil. By burrowing, casting, feeding and propagating they directly or indirectly influence the soil physical and chemical properties in many ways and establish the basis for the propagation of other organism (microorganisms, other group of soil fauna) and especially plants in a tropical region (Matsumoto 2000).

CONCLUSION

The populations and ecologies of earthworms in a tropical region were very different due to seasonal change. The pattern of high earthworm abundance and biomass were found in the wet season. In the dry season, earthworms moved to a deeper soil layer, and these were young, small-sized and endogeic types.

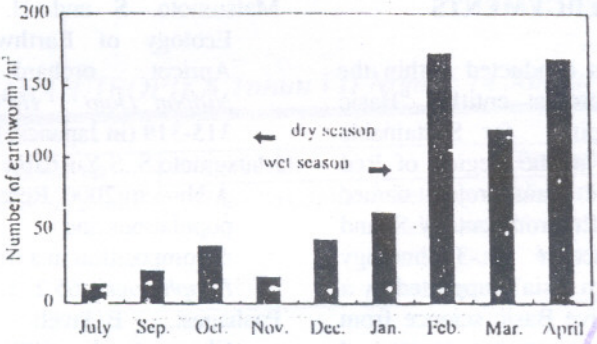

Fig. 1 Seasonal variation in the average number of earthworms in all the test sites at Sumberjaya Area

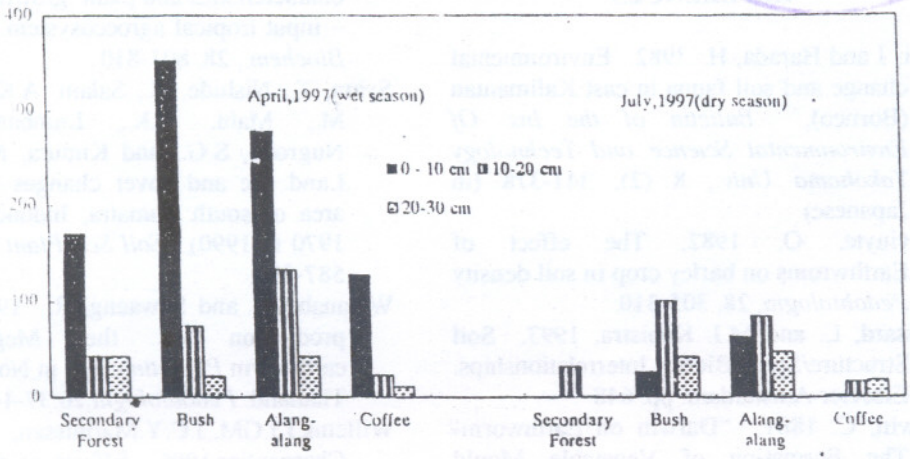

Fig. 2 Change in the number of earthworms with soil depth

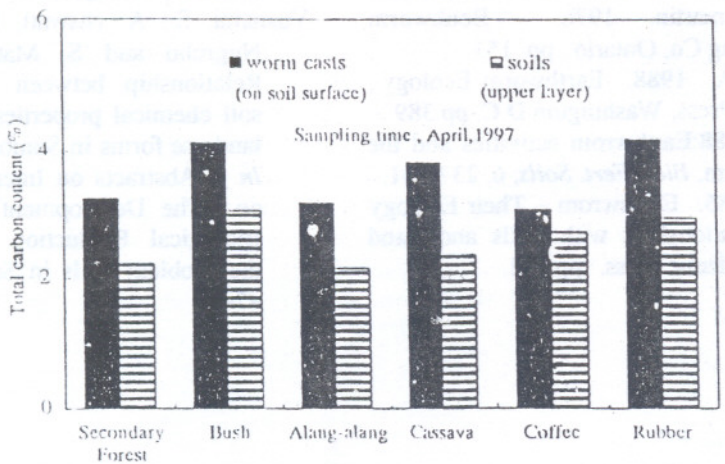

Fig. 3 Total carbon content in earthworm casts and upper layer soils

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