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Soil Microarthropods Associated with Mechanic Workshop Soil in Benin City, Edo State, Nigeria

[1]Iloba, B.N. and [2]Ekrakene, T.

[1]Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria.
[2]Department of Basic Science, Faculty of Pure and Applied Sciences, Benson Idahosa University, Benin City, Nigeria.

Abstract: An ecological study of soil microarthropods of a mechanic workshop was carried out in Benin City, Edo State, Nigeria to assess the soil microarthropods associated with the workshop in relation to the effect of petroleum and carbide wastes present. The experiment was undertaken for three months, there were two stations in the mechanical workshop, and one was contaminated with petroleum waste, while the other station was contaminated with carbide waste and a control adjacent to workshop. A total number of 268 soil microarthropods were found in all the studies, petroleum station has a total number of 54 but carbide waste station had a total number of 27. The presence of these contaminants reduced the soil microarthropod within workshop while the carbide had stronger effect on the soil microarthropod than the petroleum waste. The microarthropod populations collected were classified into two: Insecta and Acari, which were further, divided into 8 families. Soil pH, soil temperature, moisture content and total hydrocarbon were measured. Their abundance correlated positively with moisture content and total hydrocarbon in the mechanical workshop, Collembolans and acarina were most abundant. This suggest risk, to agricultural performance in areas polluted with these contaminants.

Key words: Soil Microarthropods, Mechanic Workshop, Soil, Benin City

INTRODUCTION

Arthropods are abundant in nature. They can be found in air, aquatic medium and on and below the soil. The arthropods that creep on and inside the soil are called soil microarthropods. They play a major role in essential natural processes, which determine nutrient recycling and water availability for agricultural productivity.

Soil microarthropods fall into three categories; the first consists of bacteria, fungi, protozoa and amoebae. The second groups include micro fauna tiny animals such as mites, collembolans and nematodes. The third class is macro fauna which comprise mainly of earthworm and insects.

The fungi and bacteria form a mutually beneficial relationship with plants, penetrating the roof cells without harmingg them. They also feed on dead cells sloughed from plant roots, as well as carbon compound that leak from roots, such as sugar, amino acids and organic acids. Fungi and bacteria also destroy pollutant such as nitrous oxide and methane and some pesticides.

The micro fauna includes mites, collembola and nematodes. They feed on organic matter, fungi, bacteria and some times each other. These organisms breakdown organic matter by acting on it, creating more surface area for fungi and bacteria to colonize.

The macro faunas are termites, earthworms, worms and so on. These macro fauna greatly modify the soil structure by their action, mainly through the creation of galleries open to the soil surface that break the bust and constitute preferential pathways for water in filtration, nitrogen availability and microbial activity.

Air is necessary for the respiration of soil fauna and flora. It also plays important role in chemical reactions and the respiration of organism results in carbon (iv) oxide content of the soil air in the surface being about ten times that of the atmosphere. Soil water is a vehicle for nutrient and is necessary for biological and chemical reaction in the soil. The main nutrient cycles in the soil are linked with the activity and cycles of the soil life, for example; organic matter decomposition, production of organic acid and nitrogen fixation.

Decomposition is the physical breakdown and biochemical transformation by saprophytic fungi and bacteria of complex organic molecules of dead materials into simpler organic and inorganic molecules

Corresponding Author: Ekrakene, T., Department of basic science, faculty of pure and applied sciences, Benson Idahosa University, Benin City, Nigeria.
Email: taidi_e@yahoo.com

which may be again by other organism[1], results in nutrients such as nitrogen, phosphorus and sulphur becoming available for uptake by other organisms.

This investigation aims at knowing the microarthropods associated with mechanic workshop and the effects of petroleum and carbide on soil microathropods since they constitute major wastes in mechanic workshop. Soil is not only a full time home to millions of small animals but is also a temporary escape from elements for many others, a huge number of beetles, flies and moth lay their eggs in the soil and have their larval live there. In addition to these are earthworms and collembolans which are important in shifting and mixing of the soil[2].

Soil invertebrates are ecologically important in terms of soil structure, nutrient cycling and as food for wide life. They are however sensitive to soil contaminants due to their intimate contact with and consumption of contaminated soil. Soil micro fauna are important indicator of reclamation activities in recovery soil habitat since they respond quickly to change in chemical and physical properties of habitat[3]. Contamination of soil from petroleum hydrocarbons is wide spread in motor mechanic workshop.

Classification of oil contamination of soil can be acute or chronic[4]. The acute type is isolated event that occur in a short time period as spills from tanks or pipes. The chronic type is a release of over an extended period such as leakages from tanks or pipes of vehicle direct to the soil surface. This chronic release usually occurs in mechanical workshop.

There is no doubt that contamination of soils would affect the soil fauna thereby influencing decomposition, release of nutrients as well as their availability for plant growth. Arthropods can increase decomposition rates by 2 to 100 times, in the presence of bacteria and fungi but the increased decomposition would be absent if bacteria and fungi are lacking[5]. Acari and collembolan are by far the two most important groups of micro arthropods in the soil and they account for 95% of the soil arthropod fauna[6].

Harsh soil condition prompt soil arthropods to move downward below 10cm from soil surface[7,8]. The death of some soil microarthropods is inevitable as a result of oxygen shortage and immobilization of nutrients[9].

MATERIALS AND METHODS

Study Area and Sampling: This investigation was carried out in mechanic workshop in Benin City, Southern Nigeria.

Benin City is located in the Rainforest belt of the humid tropic and has two distinct seasons; the rainy (wet) and dry seasons. The dry season last from November to March and the rainy season from April to October.

The sampling exercise was carried out in the months of May, June and July, 2006. The study sites from where samples were collected and analyzed were monitored at an interval of two weeks throughout the duration of the research.

At the workshop were two designated sites marked X_1 and X_2. X_1 was polluted with petroleum product (oils) while station X_2 was polluted with carbide, and a station X located adjacent to the workshop served as the control.

The three designated sites were all of the same soil type (sandy loamy) and well drained.

Collection of Samples and Extraction: Sampling was done fortnightly from 6pm – 7pm and five samples were collected from all stations. In the collection of samples from different stations, the split core sampler was used to collect 50g soil samples, from a depth of 10cm from all the stations. Sampling was done twice a month. Every fortnight, the split core sampler was pushed into the soil by applying pressure on the handle with both hands. The split core was pushed into about 10cm from the topsoil, twisted and brought out, the cover was opened, and samples are placed in black cellophane bags and labeled. These samples were then taken for onward extraction.

The extraction methods were designed to suit, size, behavior and structural patterns shown by the microarthropods[10]. Berlese Tullgren Funnel extractor was used as it is described the best method for extracting soil micro arthropods with an efficiency of about 90%[11]. The soil samples were placed on the sieve-mesh at the top of each funnel and the organisms were collected in containers with 70% alcohol after 24 hours.

Sorting and Preservation: After the microarthropods were extracted and collected, they were then sorted. This was done under a binocular dissecting microscope and individual species were removed from the lot by suction using a sucking pipette and placed in a glass specimen bottle containing 70% alcohol.

Preparation of Slide: As a result of the microscopic nature of many of the arthropods, they were not readily identified unless they are mounted on a slide after sorting with Canada balsam in xylene and examined at high magnification with a compound microscope under phase contract illumination.

Measurements of Parameters: The various parameters that were monitored and measured include soil $_pH$, soil moisture content, air and soil temperature.

Soil $_pH$: Twenty-gram (20g) of air dry soil from each station was put in a 50ml beaker and 20ml of distilled water was added and allowed to stand for 30 minutes. The mixture was stirred occasionally with a glassrod. Then the electrodes of the $_pH$ meter were inserted into the partly settled suspension during measurement, and readings of soil $_pH$ were taken fortnightly.

Soil Total Hydrocarbon Content (THC): The spectrophotometer method without slica gel was used. Twenty gram (20g) of soil sample from stations X_1 X_2 and X was placed in a fifty gram (50g) conical flask. Thirty (30ml) of normal xylene was added and the mixture shaken for 5 minutes and allowed to standard for 20 minutes. Then the mixture was filtered and collected in a clean beaker. Spectrophotometer analysis was carried out. An absorbance of liquid extract read at a wavelength of 425mm using xylene as blank sample. Finally, concentrations were extrapolated form a prepared calibrated curve against corresponding absorbance. Soil total hydrocarbon content (THC) was measured fortnightly.

Soil Moisture Content: Fifty gram (50g) of soil samples were taken from the stations and left in an oven for 24 hours at a constant temperature of 100^{0}C, then samples were weighed again and again until contant temperature is maintained and the moisture content thus calculated.

$$\text{Soil moisture content \%} = \frac{\text{loss in weight}}{\text{Initial weight}} \times \frac{100}{1}$$

Soil Moisture Was Taken Biweekly:

Soil Temperature: Temperatures reading were taken in the evening (6pm) each sampling day with mercury in glass thermometer. This was done by digging a small hole (10cm depth) and the thermometer was placed in it and covered. Readings in ^{0}C were taken after 5 minutes.

Identification of Samples: Species identification was done in the Department of Animal and Environmental Biology, University of Benin by the use of identification keys, past works and Internet.

RESULTS AND DISCUSSIONS

Hundred of species of soil micro arthropods may inhabit a square of foot soil. Many are hardly visible to the naked eye. Their intricate relationship with ecosystem and role played by individual species remain fundamental in ecosystem balance. The balance abundance is determined by four major factors and these are availability of resource materials that is organic matter, the macro and micro climatic disposition and degree of disturbance (stressed) that is directed at them[12].

The result showed relationship between occurrence and abundance of microarthropods with variation in physio-chemical factors.

The soil $_pH$ and soil temperature fluctuated slightly with soil $_pH$ dropping slightly from May to June and slightly increasing from June to July. The soil temperature was relatively constant between May and June but decreased slightly from June to July as indicated in Tables 1 and 2.

Soil pH had acidic values and these correlate positively with all micro arthropod groups in all station. This could be as a result of the dilution potential of water with increasing moisture content, activities of micro organism and micro arthropod[13]. The soil temperature was low since the experiment was carried out during the rainy season. Positive correlation was shown between moisture and micro arthropod group because of increase in rainfall. The parameter discussed above does not show any significant difference across the station and so may have little effect on the organisms.

The soil moisture content (THC) showed a different pattern compared to other parameters. The petroleum treated site recorded an increase in THC from May to July, with July having 94.06%. The THC value however decreased from June to July in carbide treated station.

The soil microarthropod at the control were more than those found in areas polluted with petroleum and carbide because the animals may have moved below 10 cm into the soil in order to avoid harsh conditions. This agreed with earlier findings[7,8]. The number of soil microarthropod found in the control x for the three months was 187 which out numbered the petroleum and carbide stations put together. The abundance of soil microarthropods dwelling in the petroleum waste station is more than those dwelling in carbide station. This is because, the interaction of soil microarthropod with petroleum waste will lead to loss of petroleum waste due to microbial metabolism and generations of intermediate metabolism on the petroleum waste. Whereas, in the case of carbide the soil microarthropod cannot metabolize it. So, there is no loss of carbide.

The soil microarthropods dwelling in the control site are more than those found in the mechanic workshop. The presence of these contaminants affects soil microarthropod due to contact with and consumption of contaminated soil. The contaminants immobilize nutrients and also affect the soil structure and lead to reduction of the soil oxygen level and soil water. This can lead to the death of some of these soil microarthropods[9].

Table 1: The monthly abundance samples of soil microarthropod group in station X_1 in response to petroleum product with physiochemical reading.

GROUP	MONTH					
	May		June		July	
	A	Control (X)	A	Control (X)	A	Control (X)
Collembolans	9	45	10	53	11	55
Isopterans	-	-	-	-	-	-
Coleopterans	3	-	5	-	7	-
Hymenopterans	2	1	3	1	1	-
Acarina	1	10	1	9	1	10
Thysanoptera	-	1	-	1	-	1
Means soil $_pH$	6.26	6.27	5.9	6.0	6.26	6.0
Mean soil temperature (^0C)	30.1	30.0	30.0	29.0	28.9	28.7
Moisture content (%)	15.82	15.9	16.2	22.6	21.8	22.8
Total Hydrocarbon Content THC (ppm)	21.62	0.06	33.0	0.08	94.6	<

Note: < means below the detection limit of the machine

Table 2: The monthly abundance samples of soil microarthropod group in station X_2 in response to carbide waste with physiochemical reading.

GROUP	MONTH					
	May		June		July	
	A	Control (X)	A	Control (X)	A	Control (X)
Collembolans	4	45	4	53	5	55
Isopterans	-	-	-	-	-	-
Coleopterans	-	-	-	-	-	-
Hymenopterans	1	1	1	1	1	-
Acarina	3	10	2	9	3	10
Thysanoptera	1	1	2	1	1	1
Means soil $_pH$	6.26	6.27	5.9	6.0	6.26	6.0
Mean soil temperature (^0C)	30.1	30.0	30.0	29.0	28.9	28.7
Moisture content (%)	15.82	15.9	16.2	22.6	21.8	22.8
Total Hydrocarbon Content THC (ppm)	1.62	0.06	7.18	0.08	0.24	<

Note: < means below the detection limit of the machine

Table 3: Number of Soil Microarthropod

Group	Petroleum Station	Carbide Station	Control Filling Station
Collembolans	30	13	153
Coleopterans	15	-	-
Hymenoptera	6	3	2
Acarina	3	7	29
Thysanoptera	-	4	3
Total	54	27	187

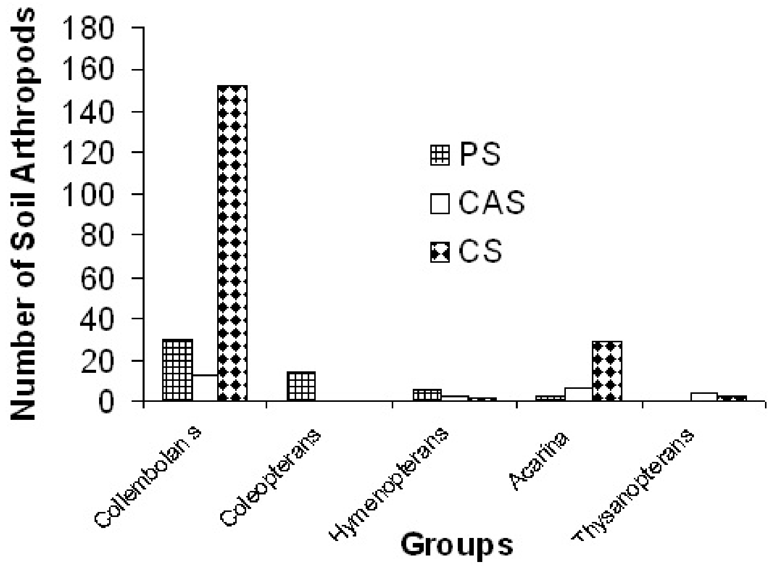

Fig. 1: Number of Soil Micro Arthopods in Different Station.
PS: Petroleum Treated Station
CAS: Carbide Treated Station
CS: Control Station

An increase in THC in petroleum waste station leads to increase in soil microarthropod. This was probably due to addition of hydrocarbon to the soil through the activities of soil microarthropod e.g. excretion, death and decomposition by microbes this result in slight increase in THC values.

The negative correlation between THC and the microarthropod groups in the carbide area invariably meant that THC value decreased as the number of microarthropod increased as was observed from June to July.

In general, the total Hydrocarbon content correlated positively with microarthropod in petroleum treated station and negatively with carbide treated station and control. Collembolans and coleopterans increased with increase THC while in control and carbide treated stations, a decrease in THC leads to an increase in soil microarthropod in the month of July (Table 2).

There was absence of microarthropod in some of the soil samples collected in the area polluted with petroleum waste and carbide waste in the month of May, this even extended to the month of July in some soil samples collected in the area polluted with carbide waste. The absence of microarthropod in the area polluted with petroleum waste is due to depletion of oxygen because of increase in demand of oxygen by hydrocarbon degrading microbes for metabolic activities, and this cause them to migrate even below the 10cm depth, in order to avoid harsh condition. In general, soil animals may move downward or to lower soil layers when conditions at the surface are harsh[8, 9]. Furthermore, the percolation of some of the petroleum waste and the diffusion of carbide into the soil is intolerable to the organism.

The most abundant microarthropod present in the area polluted with petroleum waste is the collembolan followed by coleopteran. Their number increased from the month of May to June. This is probably because they rely upon moist habitat.

In the carbide station, collembolans were more in abundant. Thysanoptera were also present but it is absent in petroleum station. The most abundant microarthropod was the collembolans, this is probably because they rely more on moisture habitat for terrestrial existence and are particularly adapted to these conditions[14].

For microarthropod abundance, a total of 268 microarthropods were collected with May having the relatively lowest abundance and July recording the highest as shown in Table3 and Figure 1.

The petroleum station recorded higher microarthropod abundance than the carbide station. In the petroleum station, almost all the soil microarthropods were represented except the thysanoptera. The control station recorded the highest abundance of collembolans and Acarina. Collembolans were the most abundant in all stations followed by the Acarina with the least being thysanoptera (Table 3).

Conclusion: From this study, petroleum and carbide in the environment affect the soil microarthropod that inhabits the soil. These organisms move downwards when they are disturbed by petroleum product and carbide in order to avoid these unfavorable conditions. As a result of these, there is a decrease in the number of soil microarthropod, which invariably would affect the soil structure and nutrient availability for plants among other related factors.

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