Study of Diversity of compost fauna from different Biocompost samples.

Gujarathi Gayatri and **Pejaver Madhuri** *

Education Officer, WWF-India, Pune divisional office. ggujarathi@wwfindia.net

**Principal, Head Dept. of Zoology B.N. Bandodkar College of Science, Thane.* formpejaver@yahoo.com

Abstract:

Bio-composting is one of the most beneficial and eco-friendly activity in current age to cope up with the increasing pollution in all the strata. It is the purposeful biodegradation of organic matter by micro-organisms with the help of macro- organisms under controlled aerobic conditions. Compost houses a large population of helpful macro organisms, along with the microbes. Although micro-organisms act as primary consumers and initiate the process of composting, it's also the secondary and tertiary consumers including worms, insects, snails and their associates that transform this semi converted organic matter into stable and cured compost. They help keeping the compost pile cleaner and enhance the process of composting. However, the data available on these macro-organisms is fragmentary and it is necessary to have a detailed investigation of the same. Hence, the present work was undertaken to study the diversity and role of invertebrate fauna in 6 different biocompost samples. The samples included compost prepared from household kitchen waste, garden waste, mixture of these two etc. Since the feedstalk in composts was different, it was thought to study the diversity in them. Hence these biocompost samples were compared. Total **22 organisms** were found in the comparative study. Among the 4 major phyla i.e. Nematoda, Annelida, Arthropoda and Mollusca; Phylum Arthropoda was dominant with 19 organisms. This unfolds the diversity of organisms that have created their niche in the compost as well as their contribution in the making and development of compost. **The present work thus concludes that the compost shelters organisms other than microbes which are equally helpful for the formation of compost. Hence, further study regarding these macro-contributors needs to be done.**

Keywords: biocompost, diversity, compost fauna.

Introduction:

Diversity although observed in every field, is more evident in nature than anywhere else. The term biodiversity encompasses different ecosystems, organisms in them and their relative

abundance. This biodiversity, like in all other ecosystems is also found in compost which is nothing but a detritus ecosystem. Composting has been defined scientifically as **"the process of natural degradation of botanical and putrescible waste by the action of bacteria, fungi and other organisms in the presence of an adequate air supply" (Hester and Harrison 2002)** and the product obtained is the bio-compost. Composting also acts as a supporting element to climate changes. The chemical fertilizers give out harmful **nitrous oxide hence** use of compost restricts addition of greenhouse gases in the atmosphere. Similarly when the bio-degradable waste gets composted, it diminishes the emission of hazardous methane given out by huge piles of wastes dumped on the ground.

The compost houses its own **micro** flora-fauna and **macro** flora-fauna which include predators, scavengers and decomposers. The micro flora mainly includes bacteria; fungi and macro flora constitutes of bracket fungi, mushrooms etc. While Micro fauna include nematodes, protozoa, Macro fauna comprise diverse organisms of various shapes and sizes right from tiny mites to large beetles and bulky worms. In order to understand the decomposition process within an ecosystem, it is essential to asses the populations of these groups (Singh & Singh 1978). However, except for few references like Hazra *et al* (1999) from India and Odegard & Tommeras (2000) from Europe, not much work seems to be done to explore macro fauna of the compost.

Material and methods:

A) Sample selection- For the present study, compost samples from six different sites was collected seasonally as winter (Oct-Jan), summer (Feb-May) and monsoon (June-Sept). Samples were collected twice in every season for 14 months (Oct 06-Dec 07). The samples contained different types of feedstock (raw materials) and method of preparation for each of them was different. It included household compost, purely garden waste compost etc.

B) Methods of collection of samples- While collecting, compost was handpicked in random amount from three different levels in the compost and the process was repeated twice so that organic matter from all the strata was collected. When necessary, gardening shovel was also used. Though samples were collected randomly, 100 gm of wet compost was weighed and used every time for study of fauna.

C) Methods for extraction of the fauna- At present there are not any standard methods provided to find out macro organisms in the compost. A lot of techniques are available on extraction of soil arthropod fauna but they can not be directly used as compost contains higher organic matter. Hence standard methods were studied and modified as per the need to extract and enlist the macro-organisms in the compost.

The faunal diversity observed among the compost samples was recorded using various extraction methods. The mechanical methods including hand sorting and flotation methods were used along with direct microscopic observations for separation of insect fauna. Among flotation methods, Ladell's modified method and Salt and Hollick's method were used for the separation of insects.

D) Methods of preservation and identification of insects- The organism were collected using pointed and blunt forceps and were preserved in the mixture of 70% alcohol and Glycerol [70:30]. The preserved organisms were further identified and classified using identification keys. The references and keys used for the study included- A general textbook of Entomology by A.D. Imms (Ninth edition 1957), Fauna of British India, Ceylon and Burma by Arrow G. (1910) and Guide to invertebrate animals by Webb *et al* (1978). Along with these major reference books some Internet references were also used for the identification purpose.

Result and discussion:

For classification, binomial nomenclature method was followed. Out of total 22 macro organisms, Phylum Arthropoda was dominant and was represented by nineteen organisms. Among this phylum, class insecta dominated with 12 insects. Out of 12 insects, all were identified till family level and only 2 were identified till species level. The organisms are identified and described as follows- According to catalogue of life http://data.gbif.org/species/browse/provider/2/taxon/11314359/

1. Nematode worm

Phylum: Nematoda

Class: Secernentea

Scavenge on decaying vegetation.

Some feed on bacteria, fungi,

2. Earthworm

Phylum: Annelida

Class: Clitellata

Sub-class: Oligoschaeta

Order: Haplotaxida

protozoa & other nematodes.
Present in compost in large amount.
Found in compost made from garden
Waste as it contains some soil.

(Image 1)

Sub-Order: Lumbricina
Feed on dead decaying plants
Keeps on tunneling thus aerating
the compost. Excretory casts rich in
minerals thus improves compost quality.
They were inoculated in 2 of 6 samples.

(Image 2)

Phylum	Sub phylum	Class	Sub class/Division	Order	Sub order	Family	Organism
Nematoda		Secernentea					
Annelida		Clitellata	Oligochareta	Haplotaxida	Lumbricina	Annelida	Earthworm
Arthropoda	Chelicerata	Arachnida	Pseudoscorpiones	Pseudoscorpionida			Pseudoscorpion
			Acari	Acarina			Mite
				Araneae			Spider
	Myriapoda	Chilopoda		Geophilomorpha			Centipede
		Diplopoda		Polydesmida			Millipede
	Hexapoda	Insecta	Exopterygota	Dermaptera	Forficulina	Anisolabididae	Earwig
				Blattaria	Blattaria	Blattellidae	Cockroach
			Endopterygota	Hymenoptera	Apocrita	Apidae	Honey-bee
						Formicidae	Ant
				Coleoptera	Polyphaga	Tenebrionidae	Lesser meaworm
							Lesser mealworm sp.
						Nitidulidae	Sap beetle
						Staphylinidae	Rove beetle
				Diptera	Brachycera	Stratiomyidae	Soldier fly
					Cyclorrhapha	Drosophilidae	Fruit flt
						Calliphoridae	Green bottle

							fly
					Nematocera	Mycetophilidae	
		Entognatha		Collembolan			Springtail
	Crustacea	Malacostraca		Isopoda			Woodlouse
Mollusca		Gastropoda					Garden snail

3. Pseudoscorpions

Phylum: Arthropoda
Sub-phylum: Chelicerata
Class: Arachnida
Sub-class: Pseudoscorpiones
Order: Pseudoscorpionida
Found in the upper and middle part of the compost. Prey on small mites, nematodes, larvae. Seize victim with claws, inject poison and paralyze the prey. Found in all samples.

(Image 4)

4. Mite

Phylum: Arthropoda
Sub-phylum: Chelicerata
Class: Arachnida
Sub-class: Acari
Order:Acarina
Second most abundant in compost. Scavenge on rotten wood, organic debris, Predatory mites eat nematodes, fungi, eggs, insect larvae, dead beetles etc. Grow enormously when conditions are moist. It was found in all 6 compost samples.

(Image 5)

5. Spider

Phylum: Arthropoda
Sub-phylum: Chelicerata
Class: Arachnida
Order: Araneae
Spiders are attracted by ready sources of food such as invertebrates in compost. Most spiders in compost are harmless And work as scavengers. Found in compost Sample stored in cement pits.
http://dpw.lacounty.gov/epd/sg/tech_sheets/bc_qa.pdf

(Image 7)

6. Centipede

Phylum: Arthropoda
Sub-phylum: Myriapoda
Class: Chilopoda
Order: Geophilomorpha
Fast moving predator present in top few inches. Paralyzes small worms, insect larvae, arthropods by their claws which contain poison. Controls insect growth in compost. Found in compost containing garden waste.

(Image 6)

7. Millipede

Phylum: Arthropoda
Sub-phylum: Myriapoda
Class: Diplopoda
Order: Polydesmida
Feeds mainly on decaying plant tissues, rotting wood, basically only plant matter. Important link in recycling organic matter as it transfers microbes in the compost, while running continuously through the compost. Found in compost containing garden waste

(Image 8)

8. Earwig

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Division: Exopterygota
Order: Dermaptera
Sub-order: Forficulina
Family: Anisolabididae
Eat variety of animal and plant matter. Acts as scavengers, eat smaller Flies, springtails (Burton and Burton 2002). Majority of the species omnivorous, But more species incline to animal food. Found in all the compost samples.

(Image 9)

9. Cockroach

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Exopterygota
Order: Blattaria
Sub-Order: Blattaria
Family: Blattellidae
Get attracted to damp conditions more often hence found sometimes in moist compost. Not of great use to compost but sometimes act as scavengers (Copeland 2003). The one found during study is known as German cockroach, though it originated in Asia.

(Image 9)

10. Honey bee

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Endopterygota
Order: Hymenoptera
Sub-order: Apocrita
Super-family: Apoidea
Family: Apidae
It was a surprise visitor to the compost. Probably was feeding on the juices of the decaying fruits and vegetables. Did not appear accidentally but was hovering and settling on compost heap.

(Image 10)

11. Ant

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Endopterygota
Order: Hymenoptera
Sub-order: Apocrita
Super-family: Vespoidea
Family: Formicidae
They feed upon varied materials like fungi, seeds, sweets, scraps, other insects and sometimes other ants (Martin *et.al.* 1992). Usually seen when the pile is cooler and drier. During study, large ants, about 6-7mm in length were found.

(Image11)

12. *Alphitobius diaperinus.*

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Endopterygota
Order: Coleoptera
Sub-order: Polyphaga
Super-family Cucujoidea
Family: Tenebrionidae
Sub- family: Tenebrioninae
Tribe: Alphitobiini
Genus: *Alphitobius*
Species: *diaperinus*
Common name 'lesser mealworm'. The most dominant beetle among all the insects in all samples. Both larva and adult helpful as cut down larger particles into smaller providing space for microbes to act.

(Image 12)

13 Alphitobius laevigatus

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Endopterygota
Order: Coleoptera
Sub-order: Polyphaga
Super-family: Cucujoidea
Family: Tenebrionidae
Sub- family: Tenebrioninae
Tribe: Alphitobiini

14. Nitidulid beetle

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Endopterygota
Order: Coleoptera
Sub-order: Polyphaga
Super-family: Cucujoidea
Family: Nitidulidae
Commonly known as sap beetles. Are Small (2–6 mm) ovoid. Feed upon plant

Genus: *Alphitobius*

Species: *laevigatus*

The feeding habits and habitat is similar with the sp *diaperinus*

(Image 13)

sap, over- ripe fruits. Help in cleaning compost pile.

(http://en.wikipedia.org/wiki/Nitidulidae)

(Image 14)

15. Rove beetle

Phylum: Arthropoda

Sub-phylum: Hexapoda

Class: Insecta

Sub-class: Pterygota

Division: Endopterygota

Order: Coleoptera

Sub-order: Polyphaga

Super-Family: Staphylinoidea

Family: Staphylinidae.

Prey on snails, insects and other small animals. Found in decaying matter including dung and Carcass as are predacious (Imms 1957). Are Swift cusrorials.

(Image 15)

16. **Soldier fly**

Phylum: Arthropoda

Sub-phylum: Hexapoda

Class: Insecta

Sub-class: Pterygota

Division: Endopterygota

Order: Diptera

Sub-order: Brachycera

Family: Stratiomyidae

These are rather large, more flattened, with white, yellow or green markings. mostly occur in damp situations. Larvae are saprophagous scavengers, voraciously eat the debris, while the adult fly feeds upon vegetable trash.

(Image 16)

17. Fruit fly

Phylum: Arthropoda

Sub-phylum: Hexapoda

Class: Insecta

Sub-class: Pterygota

Division: Endopterygota

Order: Diptera

Sub-order: Cyclorrhapha

Family: Drosophilidae

Flies are identified with prominent

18. Green bottle fly.

Phylum: Arthropoda

Sub-phylum: Hexapoda

Class: Insecta

Sub-class: Pterygota

Division: Endopterygota

Order: Diptera

Sub-order: Cyclorrhapha

Family: Calliphoridae

Unmistakable large bulky and

red eyes. Feeds on flowing decaying fruit or fleshy parts of vegetables, fermenting and decomposing matter. Wonders on freshly added feedstock.

(Image 17)

19. Fungus gnat

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Insecta
Sub-class: Pterygota
Division: Endopterygota
Order: Diptera
Sub-order: Nematocera
Family: Mycetophilidae
Tiniest of all the insects. Feeds mainly On fungal pores in compost and Decomposing fruits and vegetables Keeps hovering on compost.
(Image 19)

21. Woodlouse

Phylum: Arthropoda
Sub-phylum: Crustacea
Class: Malacostraca
Order: Isopoda
As the name indicates feeds on wood-hard to decompose. Other food includes fungi, dead plant materials. Break larger particles into smaller ones helping the decomposition

metallic green colored flies. Larvae flesh feeders hence occur in carrion During study the green bottle fly was confined to the compost containing raw and processed meat. Fly lay eggs in meat remnants and newborn feed on it.
(Image 18)

20. Springtail

Phylum: Arthropoda
Sub-phylum: Hexapoda
Class: Entognatha
Order: Collembola
Most common and abundant organism in the compost. continuously hops in compost. They are primarily detritivores and microbivores thus Help in controlling overgrowth of microbial population in compost. Found in all Compost samples.
(Image 20)

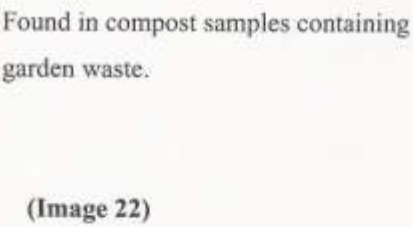
22. Snail

Phylum: Mollusca
Class: Gastropoda

These snails generally attack fresh garbage and plant debris in compost (Martin *et al* 1992). They act as natural vacuum cleaners. Speed up the process of composting as they eat voraciously.

process to speed up. Has 7 pairs of legs which help them run swiftly in compost. Common in all compost samples

(Image 21)



Found in compost samples containing garden waste.

(Image 22)

Conclusion:

In the urbanization era composting of the household garbage is essential as this will reduce the dumping problem, lessen health hazards and curb methane emission, which in turn supports the environment and fights the climate change.

The organisms found in compost should be used for the composting process which will also save biodiversity. But further study related to them need to be done. The present study thus leads to the following conclusions-

- The compost formation initiates with the microorganisms but gets completed with the help of macro-organisms.
- The compost contains other invertebrates than earthworms- majorly arthropods- which are equally helpful for the formation of compost.
- The study of diversity of compost macro fauna revealed presence of 22 organisms including 12 insects viz. earwig, cockroach, 2 mealworm sp, sap beetle, rove beetle, ants, honey bee, soldier fly, fruit fly, green bottle fly and fungus gnat in the compost which help in formation and curing of the compost.
- Some insects complete their entire life cycle in compost and thus help composting in their larval as well as adult stage.
- Some organisms are specific to certain type of feedstock like garden waste.non veg waste etc. In future they should be studied with reference to their food in compost and their role in formation.
- Thus it can be suggested that, household biocompost is a niche for insect diversity and it can be maintained without use of earthworms in the compost

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Photo plate

Image 1

Nematode worm

Image 2

Earthworm

Image 3

Pseudoscorpion

Image 4

Mite

Image 5

Spider

Image 6

Centipede

Image 7

Millipede

Image 8

Earwig

Image 9

Cockroach

Image 10

Honey-bee

Image 11

Ant

Image 12

Lesser mealworm

Image 13

Mealworm *sp*

Image 14

Sap beetle

Image 15

Rove beetle

Image 16

Soldier fly

Image 17

Fruit fly

Image 18

Green bottle fly

Image 19

Fungus gnat

Image 20

Springtail

Image 21

Woodluse

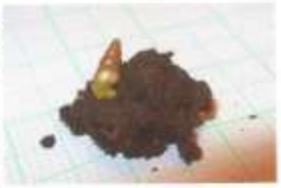

Image 22

Snail