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Invertebrate Fauna in Flyash Discharge Pond

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Abstract

Fly ash is a by-product. It was produced during the coal combustion process at high temperature in thermal power plants. This fly ash is disposed-off outside of the power-plant in fly ash dyke in form of slurry. Fly ash discharge pond is made for the discharged water storage and settlement of the slurry to allow it to drain in natural water body. Present research work deal with the presence of invertebrates' community in fly ash discharge pond. To study the invertebrate community, fly ash discharge pond was divided into 5 zones and samples were collected with the help of nets and sieves of different mesh sizes. Physico-chemical parameters of pond were also tested. During the study period of two years, presence of Protozoan, Rotifers and Arthropods were reported in fly ash discharge pond.

Keywords: Fly ash, fly ash discharge pond, invertebrates, protozoa, rotifers.

Introduction

Fauna, on basis of their habituating medium, are classified as aquatic, terrestrial and avian which are again divided in vertebrate and invertebrates. Among all these life forms water is the foremost where life starts as a single cell known as Koaservate, and protozoans are supposed to be the first to appear, Aquatic medium always have a rich and versatile life form. Though many water bodies have been studied earlier like the ground water[1] and also for estuary in India[2], but no work has been done for fly ash water till now.

As we know fly ash is a byproduct produced during coal combustion at high temperature and its properties depends on the feed coal and combustion condition[3] and no life form is reported yet in this hot slurry[4]. Thorat and Charde, in 2013, studied the physico-chemical parameters of Kanhan river after receiving fly ash disposed water, but it was only a physico-chemical study and no biological form were discussed[5].

Excess water from the slurry is collected in a manmade pond; The fly ash discharge water pond, which gets water from ash dyke as main source all over the year. Chemically this water is very different from normal fresh water ponds. But in our study we have reported that this type of water is also supporting life, some submerged, long weeds also grow in this pond. Local people and labours use this water for their daily chores; this water gets affected not only through atmospheric factors as wind and monsoon etc. but also by anthropogenic activities. All these factors become reason for invasion of life forms. This invaded fauna may be invertebrates or vertebrates. As we know from previous studies, some protozoan and grasshopper were already reported in wet slurry[4,6].

So it was possible to find these organisms in this pond also. Though some work on fly ash habituating animals has been done[7] but no data was available for invertebrate fauna in this type of water till now, thus this study was undertaken. Present work was done during January 2010 to December 2011 at Dhanras village in Korba district. Korba is the largest fly ash producer in Chhattisgarh state[8]

Material and Methods

The physiochemical parameters and fauna identification, both were done in monthly manner. To test physiochemical properties of fly ash discharge water samples were collected and preserved in sterile plastic bottles. Temperature ,pH tested on the spot and BOD, COD, DO, Hardness, Sulphate, Phosphate and Chloride tested in lab by standard method followed by APHA[9] and Work book on limnology by Adoni et al[10].

To study invertebrate fauna in fly ash discharge water pond, samples were collected from five stations as following: Station A: inlet point, Station B: pond bank at right from inlet, Station C: pond bank at left side from inlet, Station D: outlet of pond, Station E: middle portion of pond.

Sampling was done at most probable biological point of each station, with the help of planktonic net and sieves of different mesh size. Lugol solution and formalin solution were used for sample preservation during study. Some samples without preservative were also taken to lab for culture.

Observation for (invertebrates) sample was done with the magnifying glasses and compound research microscope at 45 X 10 and 45X 15 magnification and photographs were also taken with the help of camera attachment system. All collected invertebrate fauna were identified by Endmson[11] and with help of subject experts.

Results and Discussion

Physiochemical parameters help to assess the water quality which affects directly the inhibitating fauna[12]. Every organism has their own niche that's why they are marked as bio-indicator in limnology[13]. Any kind of contamination in water body creates changes the physiochemical aspects and relative composition of inhibitating organisms[14]. Walia et al, studied some physiochemical parameters of fly ash pond and river Yamuna. They reported slightly high temperature, where river was received effluents from thermal power plant[15]. In the ground water study the pH was above 7.8 in Motiram Adda and 8.41 in Gahira Gaon[16], while in our study mean value of pH was recorded 7.72 during 2010 and 8.12 during 2011 in fly ash discharge pond.

The present study showed the physic-chemical parameters of fly ash discharge water pond. The Temperature was stable between 27 ^{O}C to 30 ^{O}C but it reached to 39 ^{O}C to 40 ^{O}C at the time of receiving hot discharge from dyke . pH was at the range of 7.72 to 8.12 but increased to 11-12 at a time of receiving discharge from dyke. Hardness was 74.72 in 2010 and increased in 2011 to 103.23; BOD and COD both increased in 2011 but DO decreased in 2011; Ion concentration of sulphate, phosphate and chloride increased in 2011, table 1. In Morocco Mounjid with his co-workers studied the physicochemical and microbiological quality of river water at Oued Bouskoura but no invertebrate and rotifers reported by him[17].

Table-1
Physiochemical parameter of fly ash discharge water pond (2010 and 2011)

S. No.	Physiochemical Parameters	Year 2010	Year 2011
		Mean value	Mean value
1	Temparature ^{0}C	27.00	29.83
2	Ph	7.72	8.12
3	Hardness (mg/l)	74.72	103.23
4	BOD (mg/l)	2.77	3.4
5	COD (mg/l)	19.27	20.00
6	DO (mg/l)	7.44	6.26
7	Sulphate (mg/l)	3.28	5.99
8	Phosphate (mg/l)	0.34	0.82
9	Chloride (mg/l)	16.49	19.58

In present study total 36 species of invertebrates belonging from only 3 phyla were found in fly ash discharge water during study period of 2 years. This study reveals the presence of only 3 phyla of invertebrates as I – protozoa; II – Rotifera; III – Arthropoda, table 2. We found pseudopodia, flagellates, ciliates protozoan's. Whereas in some earlier studies, Arthropoda as Dipterans' and cyclopedia's were also reported with Cladocera and Copepod in waters receiving industrial effluent[14].

Table-2
Invertebrates Phyla in Fly ash Discharge Water Pond (January 2010 to December 2011)

S.No.	Invertebrate Phylum According to Classification	Invertebrate Species FADP
1	Protozoa	22 species
2	Porifera	nil
3	Cnidaria	nil
4	Ctenophora	nil
5	Mesozoa	nil
6	Platyhelminthes	nil
7	Nemertini	nil
	Rotifera	7 species
8	Aschelminthes	nil
9	Acanthocephala	nil
10	Entoprocta	nil
11	Annelida	nil
12	Echiurida	nil
13	Sipunculida	nil
14	Arthropoda	7species
15	Mollusca	nil
16	Priapuloidea	nil
17	Bryozoa	nil
18	Phoronida	nil
19	Brachiopoda	nil
20	Pogonophora	nil
21	Echinodermata	nil

Sharma et al. in 2013 reported Annelids, Arthropods', and Mollusks' in normal pond water[18] but there is no Annelids and molluscan found in fly ash discharge water pond during our study period.

Spencer D.F. with his coworkers' in1983, studied the water quality of lake in relation to zooplanktonic community structure after the fly ash treatment. They were found alteration in inhibitating Cladocerance community structure after the fly ash treatment[19]. In the present study phylum protozoa, showed highest number of species with 22 is species and Rotifera and Arthropoda both had only 7 species of invertebrates. All organism of above stated phylum had reported 19 genus of protozoa, 5 genus of Rotifera and 5genus of Arthropoda phyla.

As reported in fly ash discharge pond ,protozoa is the major and dominant phylum followed by rotifer and Arthropoda,while in Tighra reservoir the Rotifera were dominant on protozoa[20]. In fly ash discharge pond, the Protozoan's, Paramecium and Spirostomum genus had 2 species and other genus reported only 1 species (table 3); Phylum Rotifera had three species of keretella and other genus had only one species of Philodina, Epiphanus, Eosphora and Proalonopisis, table 3. Phylum Arthropoda 3 species of Monia genus and Daphnia, Macrothrix, Nauplis larvae, Cyclopes reported only one species present in fly ash discharge water pond.

Table-3
Invertebrate found in Fly ash discharge water pond

			Stations									
			Year 2010					**Year 2011**				
S.No.	**Invertebrate Phylum**	**Invertebrate found in fly ash discharge pond**	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
I	**Protozoans**											
1		Amoeba species	+	+	+	+	+	+	+	+	+	+
2		Mastigamoeba Reptans	+	--	+	--	--	+	--	+	--	--
3		Mastigella simplex	+	--	+	--	--	+	--	+	--	--
4		Bodopsis godboldi	--	+	+	--	--	--	+	+	--	--
5		Bodo caudatus	--	+	+	+	--	--	+	+	+	--
6		Arcella vulgaris	--	+	+	--	--	--	+	+	--	--
7		Clathrulina elegans	+	+	+	+	--	--	+	+	--	--
8		Urotricha species	--	+	+	+	--	--	+	+	+	--
9		Askenasia volvox	--		+	--	--	--	--	+	--	--
10		Didinum nasutum	--	+	+	--	--	--	+	+	--	--
11		Dogiella minuta	--	+	+	--	--	--	+	+	--	--
12		Chilodonella species	--	+	+	+	+	--	+	+	+	+
13		Paramecium caudatum	--	--	+	--	--	--	+	+	+	+
14		Paramecium Multimicronucleatum	+	+	+	+	--	+	+	--	--	--
15		Frontoria leucas	--	--	+	--	+	--	+	+	+	+
16		Spirostomum minus	--	--	+	--	--	--	+	+	+	--
17		Spriostomum teres	--	---	+	--	--	--	+	+	+	--
18		Condylostoma species	--	+	+	--	--	--	+	+	+	--
19		Stenor roseli	--	--	+	--	--	--	+	+	--	--
20		Stylonchia mytilus	--	+	+	--	--	--	+	+	+	+
21		Euplotes patella	--	---	+	--	--	--	+	+	+	+
22		Vorticella campanula	--	--	+	--	--	--	+	+	--	--
II	**Rotifers**											
1		Keratella species	--	+	+	--	--	--	--	+	--	--
2		Keratella cochlearis	--	--	--	--	--	--	--	--	--	--
3		Keratella earlinae	--	--	+	--	--	--	--	+	--	--
4		Philodina rocelli	+	+	+	--	--	+	+	+	--	--
5		Epiphanes macrourus	--	+	+	+	--	--	--	+	--	--
6		Eosphora species	--	+	+	+	--	--	--	--	--	--
7		Proalinopsis caudatus	--	--	+	--	--	--	--	--	--	--
III	**Athropods**											
1		Monia species	--	--	+	--	--	--	--	+	--	--
2		Monia brachiata	--	--	+	--	--	--	--	--	--	--
3		Monia dubia	--	--	+	--	--	--	--	--	--	--
4		Dephnia species	--	--	+	--	--	--	--	--	--	--
5		Macrothrix spinosa	--	--	--	--	--	--	+	+	--	--
6		Nauplius larvae	--	+	+	--	--	--	--	+	--	--
7		cyclopes species	--	--	--	--	--	--	--	+	--	--

(+ Stands for Presence of organism, -- stands for Absence of organism)

In some earlier studies done in Egypt at stressed coastal spots and assessed the protozoan diversity in relation to fish fry and pollution load and reported the significant effect of salinity and pollution on the protozoan communities[21].

In some studies Rotifer diversity assess in relation to recreational use of artificial water body in Poland at Pond located in Natural Landscape Complex "Szopienice-Borki" and significant change community composition of rotifers were reported in pond water which is frequently used in recreational activities[22].

Vaishali S. in studied the rotifer occurrence in relation to water quality during the bioremediation process at lake Kacharali, Maharstra.They reported 13 species of rotifers and find Brachionus *spp*. and *Keretella spp*.in abundance[23]; but Branchionus species was not observed during the study period and only 3 species of keretella were reported in fly ash discharge pond**.**

In same agreement and Summarwar studied the water reservoir and found the *Brachionus and Keratella* genuses of rotifer phylum were reported in abundant[24].

In fly ash discharge water philodina roseli was found during whole study duration in fly ash discharge pond, it was not reported by other workers in fresh water pond [23, 25] in fresh water bodies as lakes, river etc. but they found Branchionus and *Keratella*.

In our study rotifers were found in higher number as compared with Cladocera and Copepods, same result showed in the study of pond water in Bihar[25] but in fly ash discharge water pond Brachionus species were not observed whears it was reported in abundance in Mahendra Nath pond water in Bihar[25].

In some studies of pond water, invertebrates belonging from the rotifer phylum were reported in numeric superiority on the Cladocera and Copepods[24, 26]. Amsha and Suresh has reported more than 35 rotifers in Kullurchandai reservoir among them Brachionus caudatus and Brachionus calyciflorus were reported in highest number[27] while both were not found in our study in fly ash discharge pond.

While in our study members belonging from phylum protozoa were showed numeric superiority over the Rotifera, Cladocera and Copepoda. Presence of Ostracoda was also reported[26], but it was not found in fly ash discharge water pond during the study period.

In study of lake water, 32 texa of invertebrates were found in positive relation to vegetation at Iran, all reported invertebrates were macro invertebrates[29], which were not found in fly ash discharge pond. During our study period only 3 microscopic phyla were observed in fly ash discharge pond, figure 1.

In present invertebrates Protozoan species were dominant in number with 61%, which was followed by rotifers and Arthropods with 19% in species composition, figure 2. As in similar agreement protozoan were reported as an adaptive organism in river water which had been affected by industrial waste water[30].

During the study in year 2010, protozoan's were observed in all studied station but reported at station C, which was full with vegetation. Minimum species of protozoa were observed at station E, which is the middle portion of pond and there is very less or none vegetation reported over the year. Rotifers were observed maximum species at station C and minimum species at station A; while there was no rotifers observed in station E. Arthropoda observed only at station B and they are not present at stations A, C, D and E., figure 3.

During the study in year 2011, protozoans were again observed in all studied station but reported highest no of species at station C, which was full with vegetation. Minimum no of species of protozoa observed at station A, figure 4, which was also less in comparison to year 2010.

Rotifers were observed in maximum species number at station C, followed in decreasing order by station D, A, B and C. station A. Arthropods observed only at station B and C. and reported maximum no. of species at station C., figure 4.

During the year 2010, maximum numbers of invertebrate species were reported in station C and minimum in station E, figure 5.

After the study of two year in total 36 species of invertebrates are reported in fly ash discharge water pond, and station C was most diversified station during the study period. Protozoans were developed as most adaptive phylum in fly ash discharge water pond.

During the year 2011, maximum numbers of invertebrate species were reported in station C and minimum in station A, figure 6.

Conclusion

Present study is reported maximum number of invertebrates at Station C which situated far from the pond inlet in fly ash discharge pond. Minimum number of invertebrate species reported in Station A, which is very near to inlet of pond as compared other stations. Station A received maximum fluctuation according to receiving discharge from ash dyke.

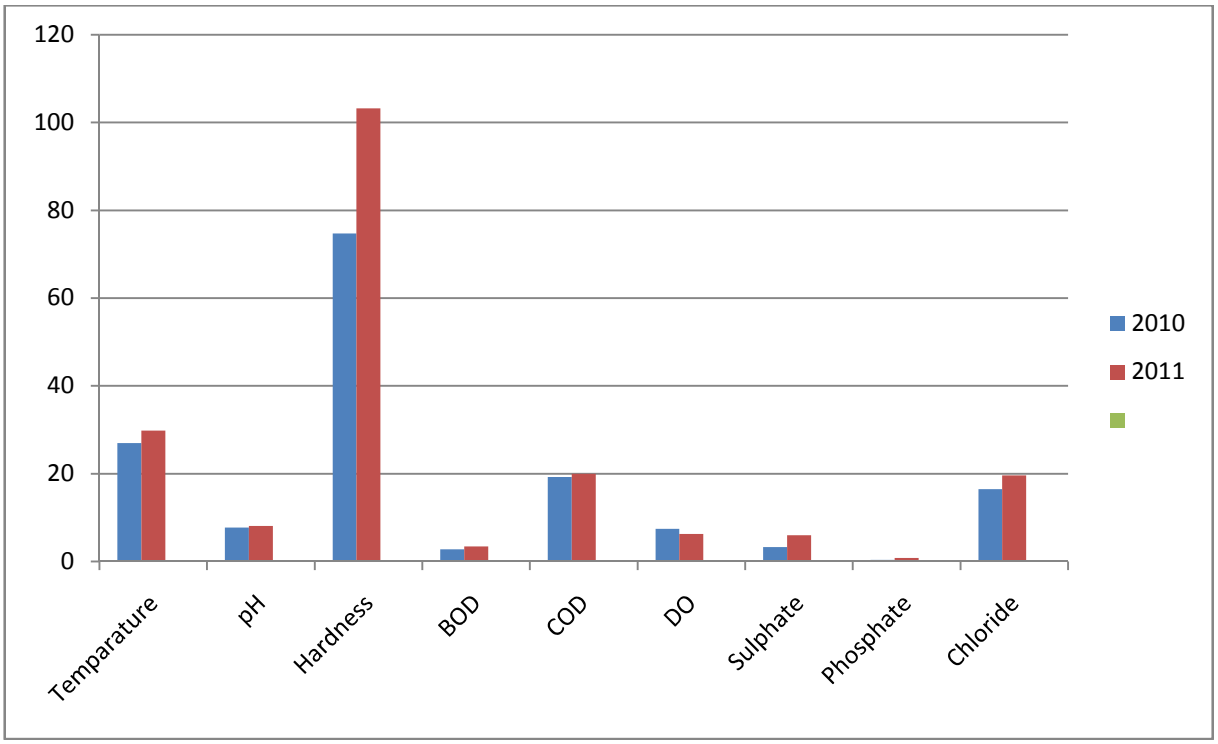


Figure-1
Yearly Comparative Overview of Physio-chemical parameters of FADP

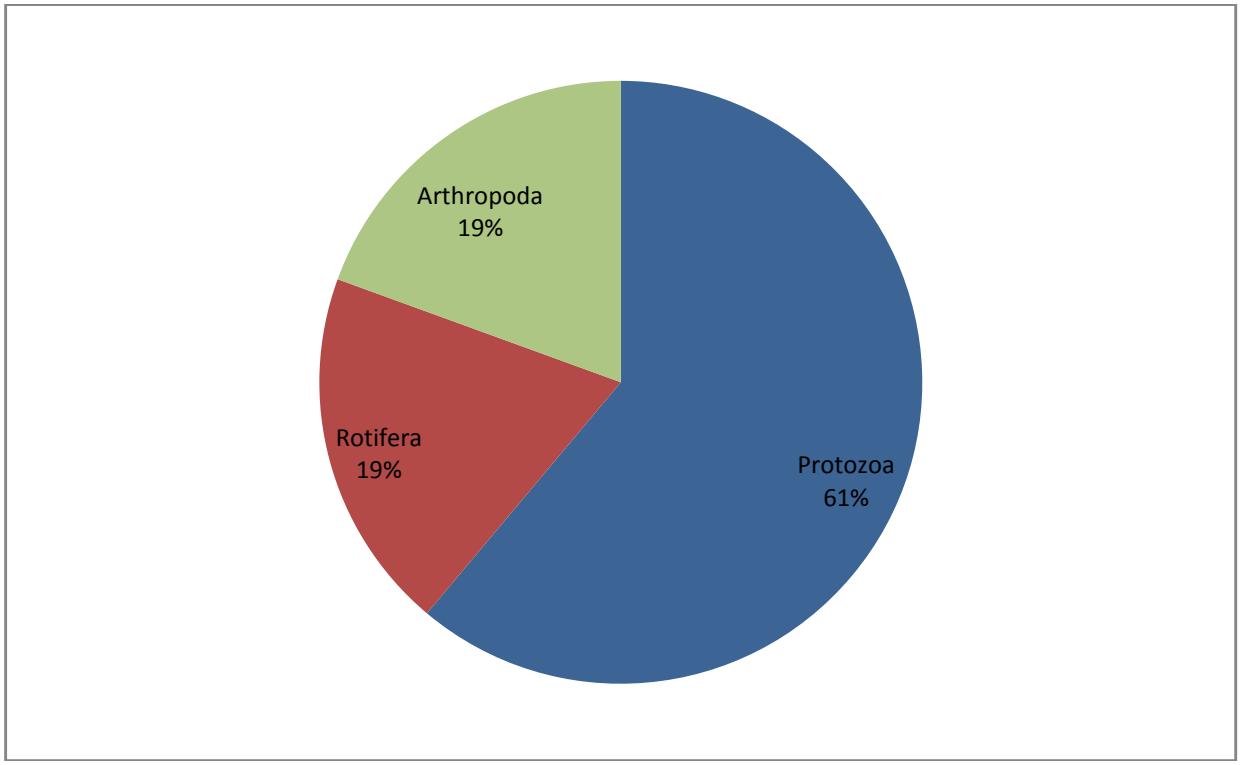
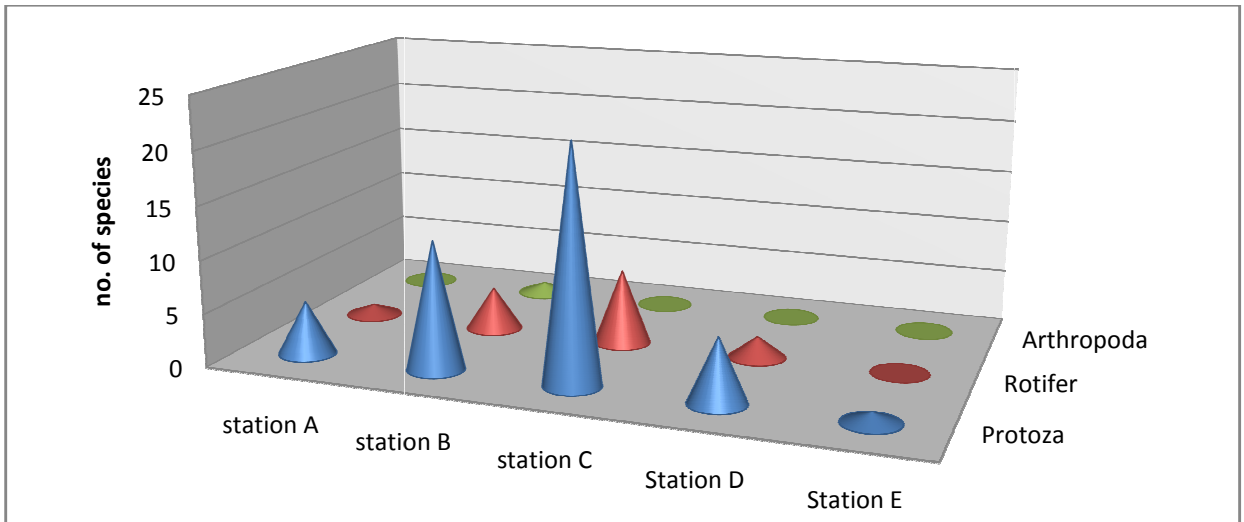
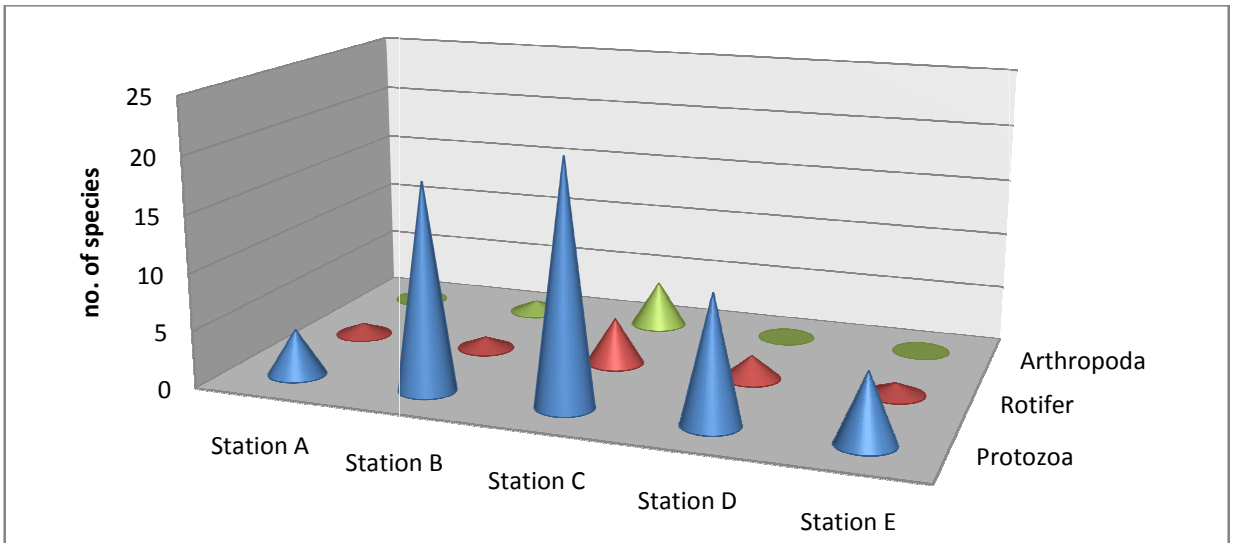


Figure-2
Invertebrate Phylum-wise Composition in %



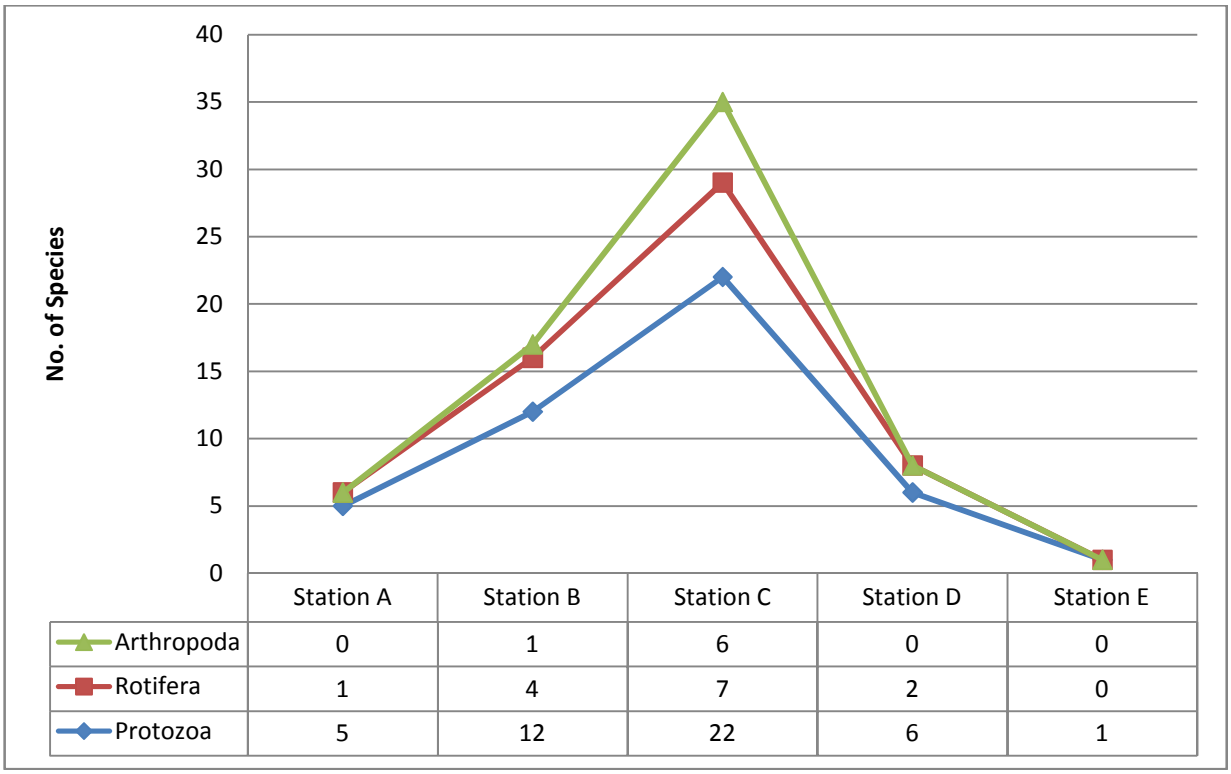
	station A	station B	station C	Station D	Station E
Protoza	5	12	22	6	1
Rotifer	1	4	7	2	0
Arthropoda	0	1	0	0	0

Figure-3
Invertebrates in year 2010



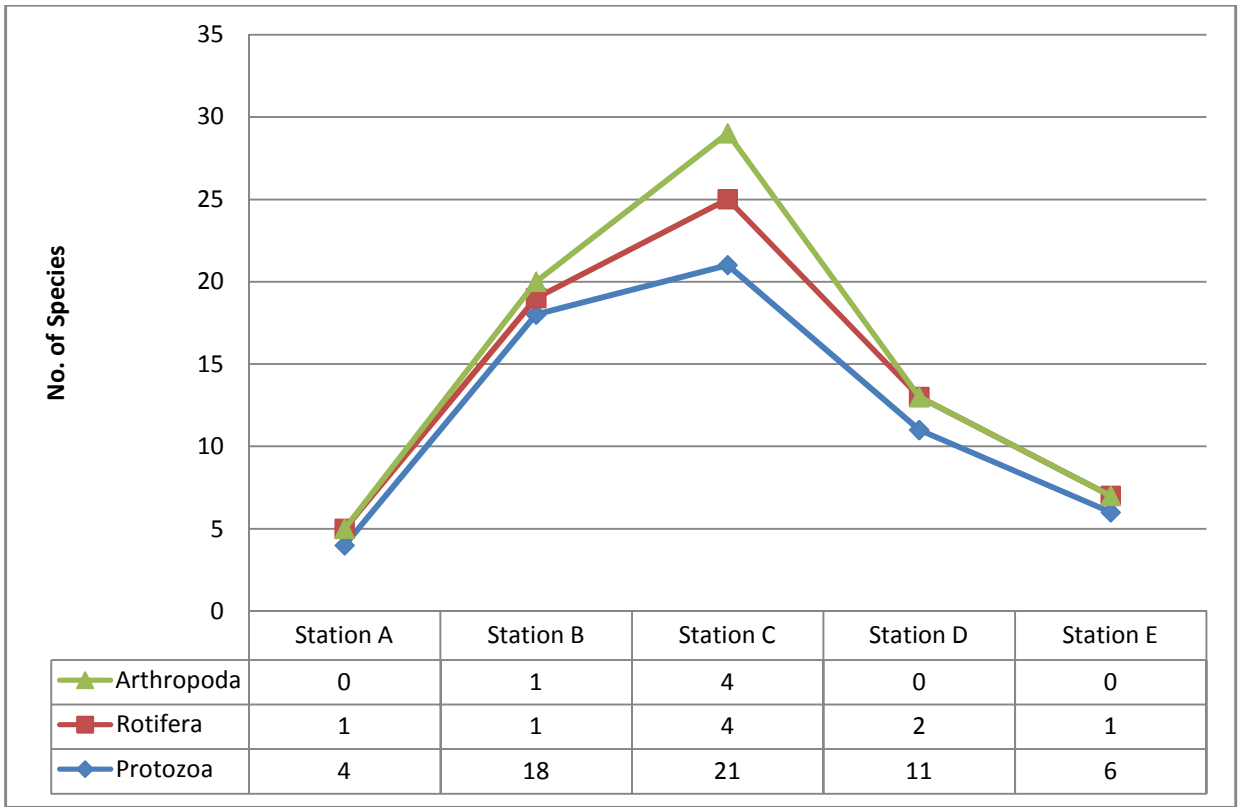
	Station A	Station B	Station C	Station D	Station E
Protozoa	4	18	21	11	6
Rotifer	1	1	4	2	1
Arthropoda	0	1	4	0	0

Figure-4
Invertebrates in year 2011



	Station A	Station B	Station C	Station D	Station E
Arthropoda	0	1	6	0	0
Rotifera	1	4	7	2	0
Protozoa	5	12	22	6	1

Figure-5
Station wise distribution of invertebrates



	Station A	Station B	Station C	Station D	Station E
Arthropoda	0	1	4	0	0
Rotifera	1	1	4	2	1
Protozoa	4	18	21	11	6

Figure-6
Station wise distribution of invertebrates in 2011

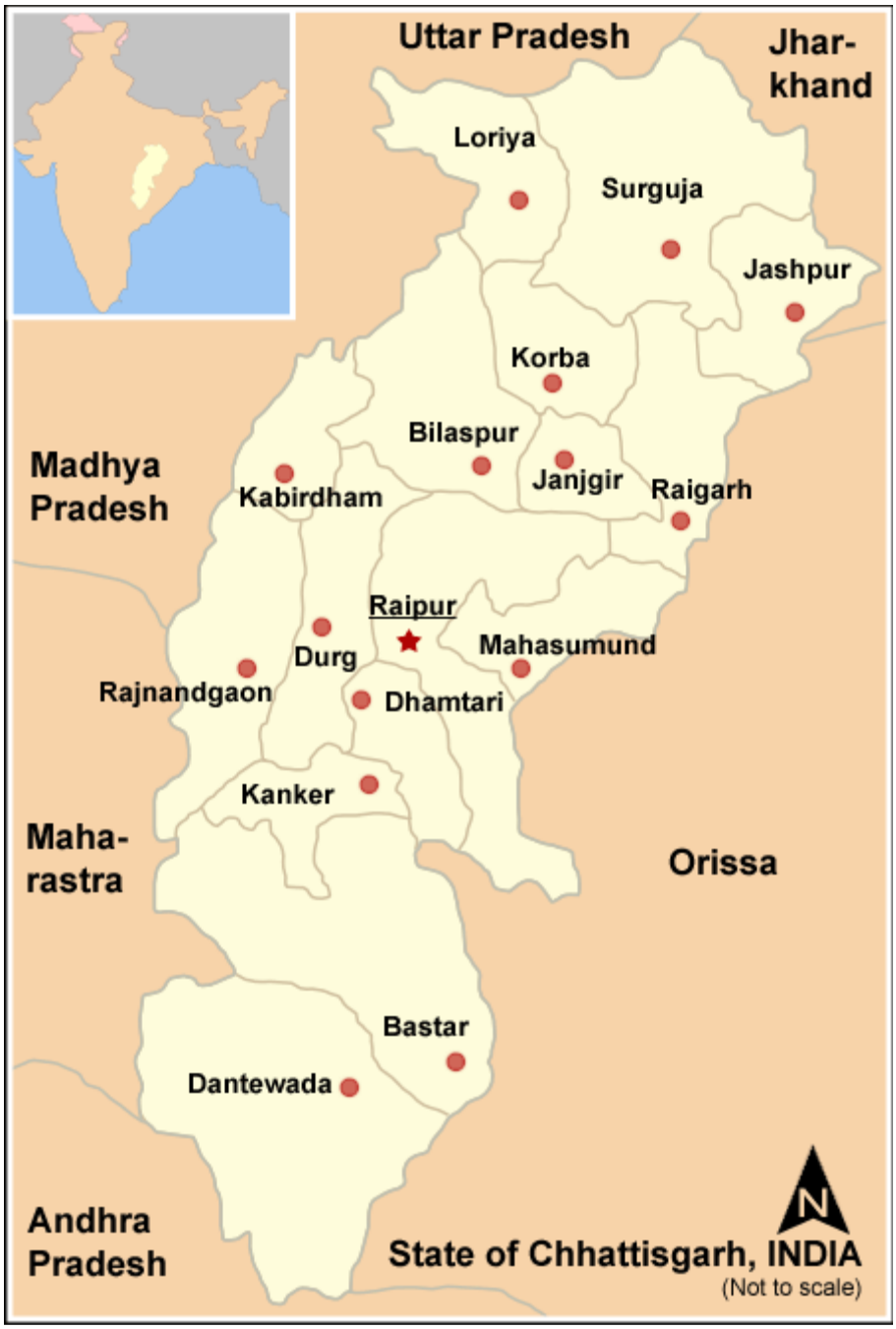


Figure-7
Location of Korba District in Chhattisgarh State

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