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Short Communication

Metal concentrations in five mangrove species of the Bhitarkanika, Orissa, east coast of India

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The study deals with metal concentrations in five mangrove species *Rhizophora mucronata, Avicennia officinalis, Bruguiera cylindrica, Ceriops decandra,* and *Xylocarpus granatum* with regard to the heavy metals like Fe, Cu, Mn, Zn and major elements like Na, K, Ca. The metallic concentrations were analysed in sediment samples collected from surrounding root zone of mangrove species and in the leaves of the same plant. *Avicennia officinalis* accumulated high concentrations of all the metals analysed, followed by *X. granatum*, *B. cylindrica*, *R. mucronata* and *C. decandra*. The samples collected during the monsoon period (26th August 1996) showed high metallic concentrations than the samples of post-monsoon (10th January 1997) and pre-monsoon (11th April 1996) period.

[**Key words**: Metals, Mangrove, Bhitarkanika]

Mangrove ecosystems play a key role in nutrient and metal cycling[1,2]. The level of trace metal which accumulate in mangroves differ seasonally and spatially varying with saline environment that may affect uptake and distribution of metals in the plants[3]. Trace metals like Mn, Cu, Mo, Zn from some mangroves of Ganapatipule and inorganic constituents viz Na, K, Mg, Fe, Mn and P have been studied from soil and water from Deogarh of Maharastra[4,5]. Seasonal variation in heavy metals (Cu, Co, Na, Mn, Pb) in foliage of some mangrove species has been reported for Goa mangroves[6]. The chemical composition of mangrove species has been studied from Ratnagiri, west coast of India[7]. All these studies are confined to west coast of India, only a limited work is available for the east coast mangroves[8]. The metal concentration is known to be accumulated in different species, in different order, with respect to the seasons and surrounding environment. Hence, the present study has been made to survey metals composition of mangroves in relation to their surrounding sediment. The study had been carried out during 1996-97 period, only sediment and leave samples were collected for five mangrove species. The water samples were not collected during the study. Because, there was no water inundation along the root zone areas of the mangrove species like *Bruguiera cylindrica* and *Xylocarpus granatum*; these grow in swampy and muddy beds. Other three species grow in aquatic environment and with respect to tidal conditions in the study area.

The study area is the Bhitarkanika mangrove (lat. 20° 4′ N; long. 86° 45′ E) ecosystem of Orissa state, east coast of India, which is situated in the deltaic

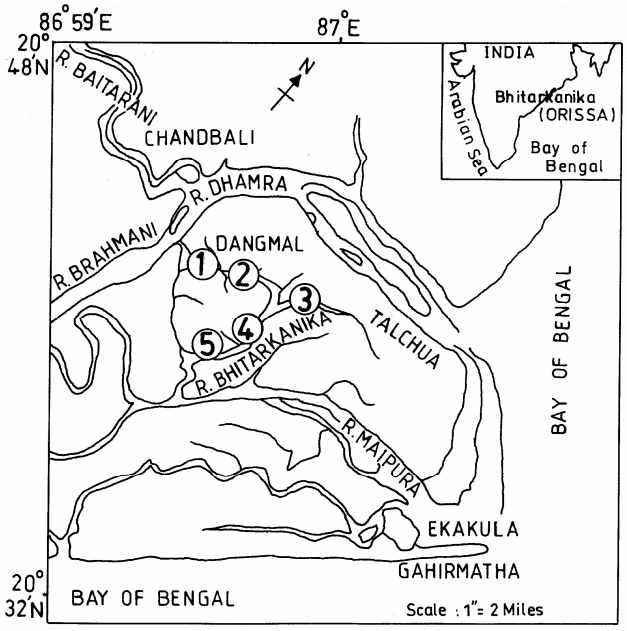

Fig. 1—Bhitarkanika mangrove swamp showing sampling sites (1-5)

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region of Brahmani and Baitarani rivers of Orissa. Five mangrove sites were sampled (Fig. 1) for sediment and leaves of five species in three different periods: 11th April 1996 (pre-monsoon), 26th August 1996 (monsoon) and 10th January 1997 (post-monsoon). The sediment samples surrounding the root system of five different mangrove species were collected using vertical corer, transferred to clean polyethylene bags and shade-dried to a constant weight. Sediments were ground and sieved (mesh size of 0.5 mm) before digestion[9]. Matured leaves (2nd and 3rd from the top of the branch) of the species *Rhizophora mucronata, Brugiera cylindrica, Ceriops decandra* (Dicotyledons, Polypetalae, Calyciflorae, Rhizophoraceae), *Avicennia officinalis* (Dicotyledons, Gamopetalae, Bicarpellatae, Avicenniaceae) and *Xylocarpus granatum* (Dicotyledons, Polypetalae, Disciflorae, Meliaceae), were collected. The leaves were washed thoroughly, shade-dried and powdered. For digestion process 20 ml of the concentrated HNO_3 and perchloric acid were added to 5 g of dried samples in the beaker and the mixture was left for 24 h and mixture was digested on the hot plate. Then 10 ml of 10% nitric acid was added and the constituents were transferred to 20 ml polytop vials and allowed to stand for 2 hours for the residue to settle down[10]. The supernatant liquid was filtered through a 0.45 µm Millipore membrane filter. This diluted solution was calibrated with standards. The sample solutions were then aspirated to the AAS (Perkin-Elmer, model 373) for the estimation of Fe, Cu, Mn, Zn and other major ions (Na, K, Ca) were analysed in a digital flame photometer (Varian, model CL22D).

The distribution of heavy metals and major elements in sediment samples around the root system of different mangrove zones and their leaves for three seasons are shown in Table 1. The concentration of metals analysed, for the study are found to be higher for different species like *Avicennia officinalis* followed by the *Xylocarpus granatum*, *Bruguiera cylindrica*, *Rhizophora mucronata* and *Ceriops decandra.* The accumulation of metals in leaves is significantly lesser than sediment. The concentration of Ca is very less and some species show concentrations of undetectable ranges. In monsoon (26 Aug. 1996 sample) the chemical composition of sediment and leaves was

Table 1 — Metallic composition of sediment of Bhitarkanika mangrove ecosystem

[Values are average of 3 samples and those of standard error are < 10% of average]

Period	Fe (ppm)		Cu (ppm)		Zn (ppm)		Mn (ppm)		Na (mg/kg)		K (mg/kg)		Ca (mg/kg)	
	S	L	S	L	S	L	S	L	S	L	S	L	S	L
Rhizophora mucronata														
A	32	21	2.6	1.5	0.7	0.7	6.8	6.8	432	363	401	476	12	04
B	28	19	2.9	1.5	1.2	1.1	8.4	7.2	639	61	336	331	35	08
C	41	32	2.9	1.9	0.9	1.1	8.4	7.1	602	67	303	335	28	02
Avicennia officinalis														
A	39	36	6.2	2.1	1.2	0.7	10.3	6.2	830	103	796	618	24	21
B	42	33	6.1	3.7	1.6	1.5	10.3	6.7	1023	119	478	438	48	13
C	68	61	6.7	3.1	1.7	1.5	10.9	6.8	990	116	417	401	51	26
Xylocarpus granatum														
A	21	07	3.1	2.05	0.8	0.6	9.1	6.4	602	112	423	379	26	18
B	34	21	3.7	2.1	0.8	0.4	10.2	6.4	631	113	203	281	32	24
C	47	36	4.7	2.2	1.0	0.4	10.3	6.6	544	94	304	276	28	10
Ceriops decandra														
A	22	19	3.1	1.7	0.7	0.3	7.7	6.1	562	85.9	603	337	28	15
B	34	22	2.6	1.0	0.7	0.7	10.1	6.6	633	81	391	284	66	32
C	38	22	2.7	0.8	1.2	1.0	10.3	6.8	500	77	396	306	27	11
Bruguiera cylindrica														
A	30	19	2.6	2.1	0.8	0.8	7.9	5.7	441	91	521	406	63	31
B	36	17	2.9	1.7	0.9	0.8	10.3	6.1	495	91	378	307	84	72
C	45	41	2.9	2.0	1.1	2.0	10.7	6.1	306	102	645	439	67	37

*A = 11 April 1996 (pre-monsoon), B = 26 August 1996 (monsoon), C = 10 January 1997 (post-monsoon); S = Sediment, L = Leaf

found more due to riverine input and flood nutrients. *Avicennia officinalis* is found to be more efficient in accumulating the elements under the same environmental conditions as these plants are salt-excreting types. X*ylocarpus granatum* is observed to maintain high metal concentrations, as it is known to be a salt accumulating plant. In general, the plants belonging to Rhizophoraceae family exhibit relatively low concentration of metals due to the salt-exclusion mechanism that is operative in the species[2,3]. Internal salt control mechanisms have been reported to affect metallic content of mangrove plants and cause differences among species[3]. The order of abundance in concentration of heavy metals falls as Fe > Mn > Cu > Zn and that of major elements is K > Na > Ca. The samples collected during the monsoon period (26th August 1996) showed high metallic concentrations than the samples of post-monsoon (10th January 1997) and pre-monsoon (11th April 1996) period.

Concentration and accumulation of heavy metals in the sediments is closely related to the frequency and duration of tidal flood and river pollution is thus due primarily to heavy metals. The uptake of elements by the plants varies with each element. The differences in the seasonal flood and ebb tidal condition could also affect availability of heavy metals for plant uptake[11]. However extensive surveys on the metallic composition of mangrove species is needed for monitoring the transformation and accumulation property of these mangrove plants in regular interval, seasonally or may be on monthly basis for more information.

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