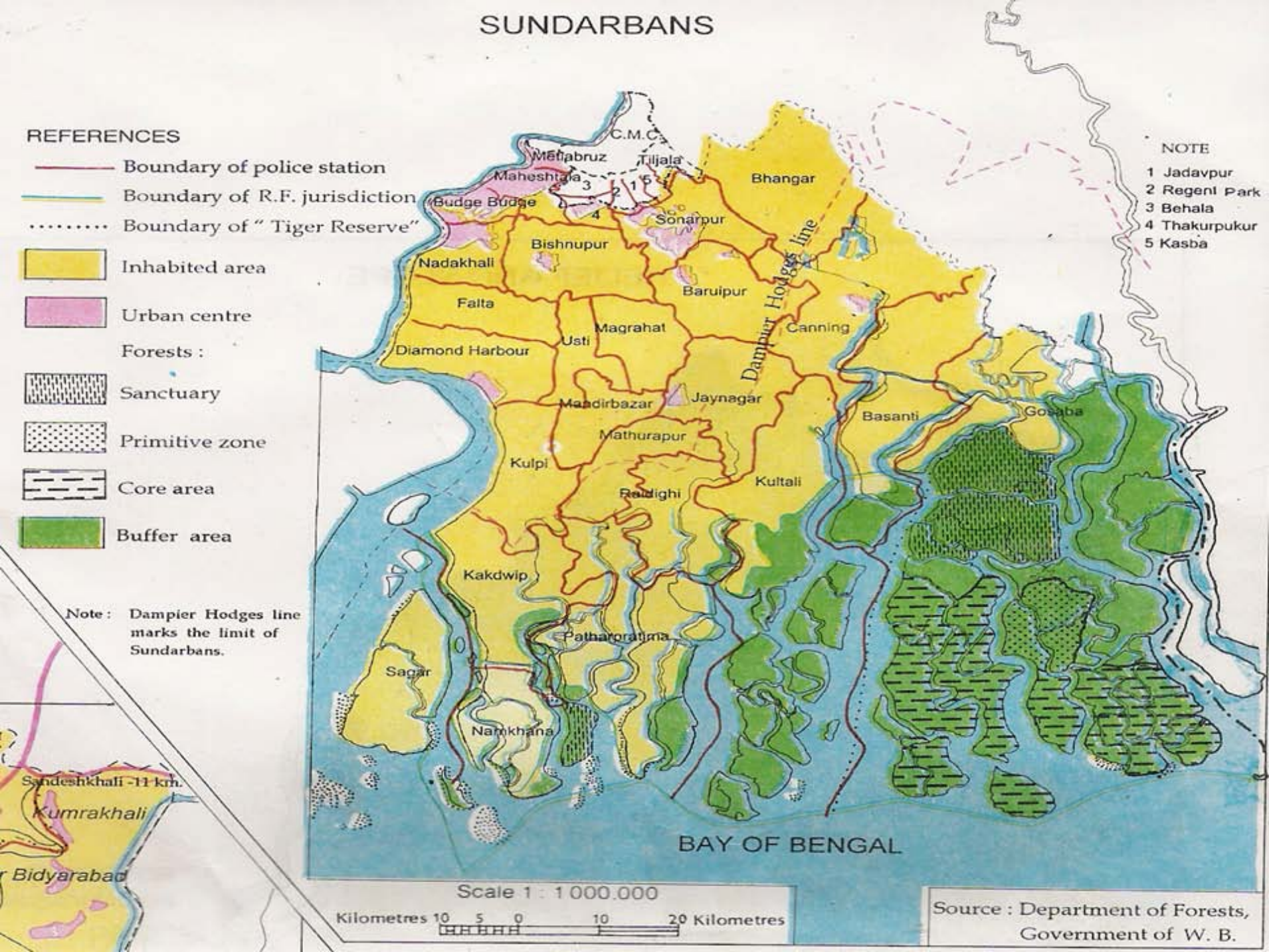
COMMUNITY STRUCTURE AND TRACE ELEMENTS IN ZOOPLANKTON IN SUNDARBAN MANGROVE WETLAND, NORTHEAST PART OF BAY OF BENGAL, INDIA

BY

SANTOSH KUMAR SARKAR

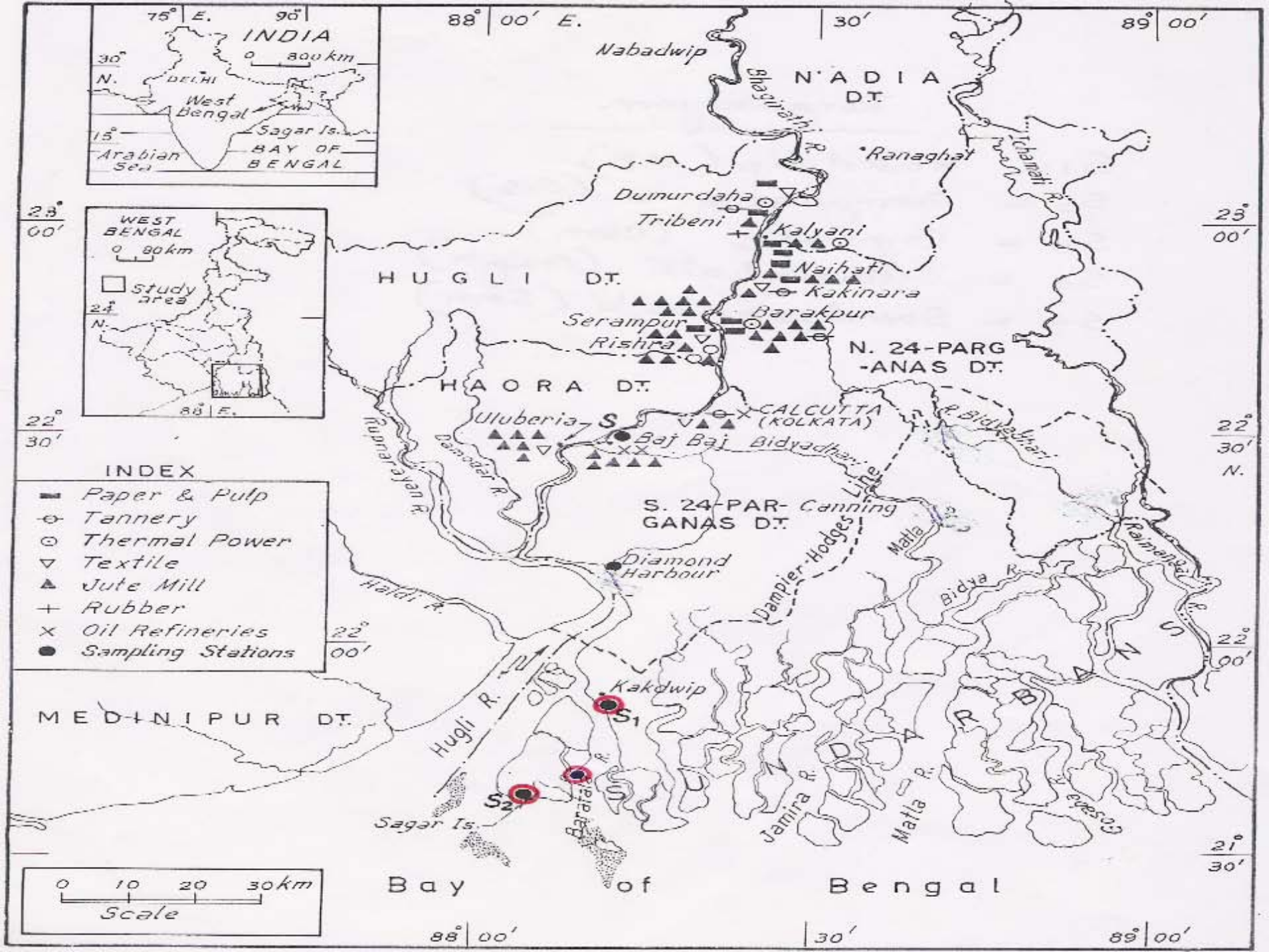
BHASKAR DEB BHATTACHARYA

SUNDARBANS


REFERENCES
Boundary of police station
Boundary of R.F. jurisdiction
Boundary of " Tiger Reserve"
Inhabited area
Urban centre
Forests :
Sanctuary
Primitive zone
Core area
Buffer area
Note : Dampier Hodges line marks the limit of Sundarbans.
NOTE
1 Jadavpur
2 Regent Park
3 Behala
4 Thakurpukur
5 Kasba
C.M.C.
Metiabruz
Tiljala
Maheshtala
Budge Budge
Bhangar
Sonarpur
Bishnupur
Nadakhali
Baruipur
Falta
Magrahat
Usti
Canning
Diamond Harbour
Dampier Hodges line
Mandirbazar
Jaynagar
Basanti
Gosaba
Mathurapur
Kulpi
Kultali
Raidighi
Kakdwip
Patharpratima
Sagar
Namkhana
Sandeshkhali -II km.
Kumrakhali
Bidyarabad
BAY OF BENGAL
Scale 1 : 1 000 000
Kilometres 10 5 0 10 20 Kilometres
Source : Department of Forests, Government of W. B.

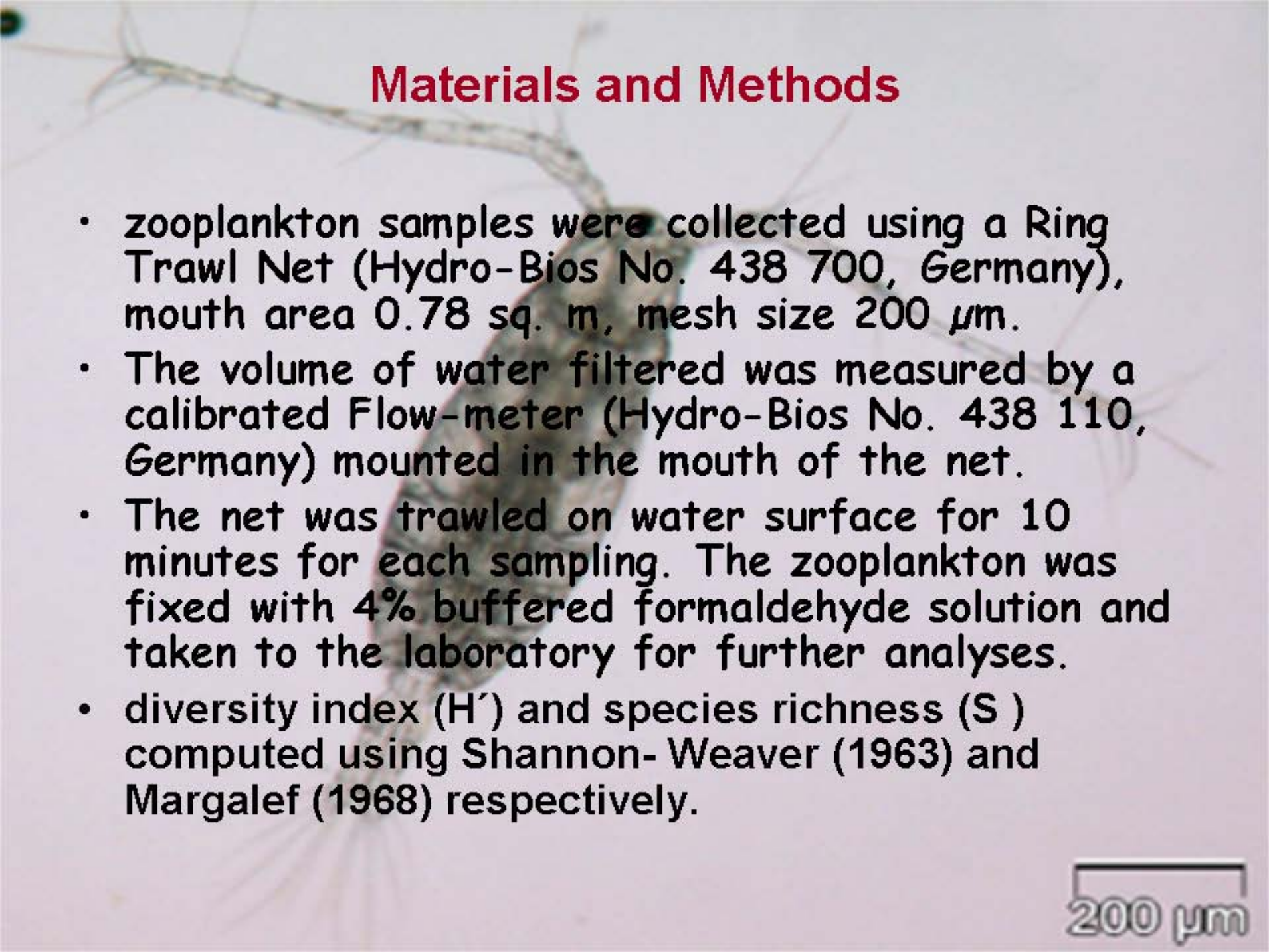
ABOUT SUNDARBANS

- Indian Sundarban is situated in the estuarine phase of the River Ganges, northeast coast of Bay of Bengal.
- Comprises 9600 km2 area, out of which 4264 km2 of intertidal area covered with mangrove.
- Unique bioclimate zone in the land ocean boundary – evolved during Holocene period.
- Climate is humid (up to 96%), tropical and the seasons are pronounced with 4-month duration. Premonsoon (March to June), monsoon (July to October) and postmonsoon (November to February).


INDIA
75° E.
95°
30° N.
DELHI
West Bengal
Sagar Is.
BAY OF BENGAL
Arabian Sea
0 800 km
WEST BENGAL
0 80km
Study area
24° N.
88° E.
88° 00′ E.
30′
89° 00′
Nabadwip
Bhagirathi R.
N. 24-PARGANAS DT.
Ranaghat
Jalangi R.
Dumurdaha
Tribeni
Kalyani
HUGLI DT.
Naihati
Kakinara
Barakpur
Serampur
Rishra
HAORA DT.
CALCUTTA (KOLKATA)
Uluberia
Baj Baj
Bidyadhari
Rupnarayan R.
Damodar R.
S. 24-PARGANAS DT.
Canning Line
Diamond Harbour
Dampier-Hodges Line
Matla
Raimangal
Bidya R.
Haldi R.
Kakdwip
Hugli R.
MEDINIPUR DT.
Jamira R.
Matla R.
Gosaba
Sagar Is.
Bay of Bengal
23° 00′
22° 30′ N.
22° 00′
21° 30′
INDEX
Paper & Pulp
Tannery
Thermal Power
Textile
Jute Mill
Rubber
Oil Refineries
Sampling Stations
0 10 20 30km
Scale

Materials and Methods

- zooplankton samples were collected using a Ring Trawl Net (Hydro-Bios No. 438 700, Germany), mouth area 0.78 sq. m, mesh size 200 µm.
- The volume of water filtered was measured by a calibrated Flow-meter (Hydro-Bios No. 438 110, Germany) mounted in the mouth of the net.
- The net was trawled on water surface for 10 minutes for each sampling. The zooplankton was fixed with 4% buffered formaldehyde solution and taken to the laboratory for further analyses.
- diversity index (H´) and species richness (S) computed using Shannon- Weaver (1963) and Margalef (1968) respectively.



HYDROLOGY

- Hydrology of the estuarine environment presents a cyclic pattern, Characterized by large amount of precipitation and tidal interplay.
- A marked difference in the hydrological parameters in different seasons was noticed for all the 3 stations.
- Water temperature higher in premonsoon months (March-June) and lower during postmonsoon months (November-February).
- Ranged from 21oC (January) to 31oC (June) – normal for a tropical estuary.
- Salinity gradient increased to a maximum level during late premonsoon months paralleling with higher temperature and decreased during monsoon months.
- pH and dissolved oxygen values did not show any major fluctuation.
- Sechhi disc reading showed that Gangasagar experienced high turbidity throughout the year.

COPEPODS IN STUDY AREA

- Copepods, dominating group of the plankton community throughout the year constituting 73 – 97% of total zooplankton.

- Bimodal type of copepod distribution closely followed that of biomass – relatively higher values in June/July, a gradual trend of rise in January/February. A sharp fall in copepod population associated with lower diversity of copepod species recorded in late monsoon months.

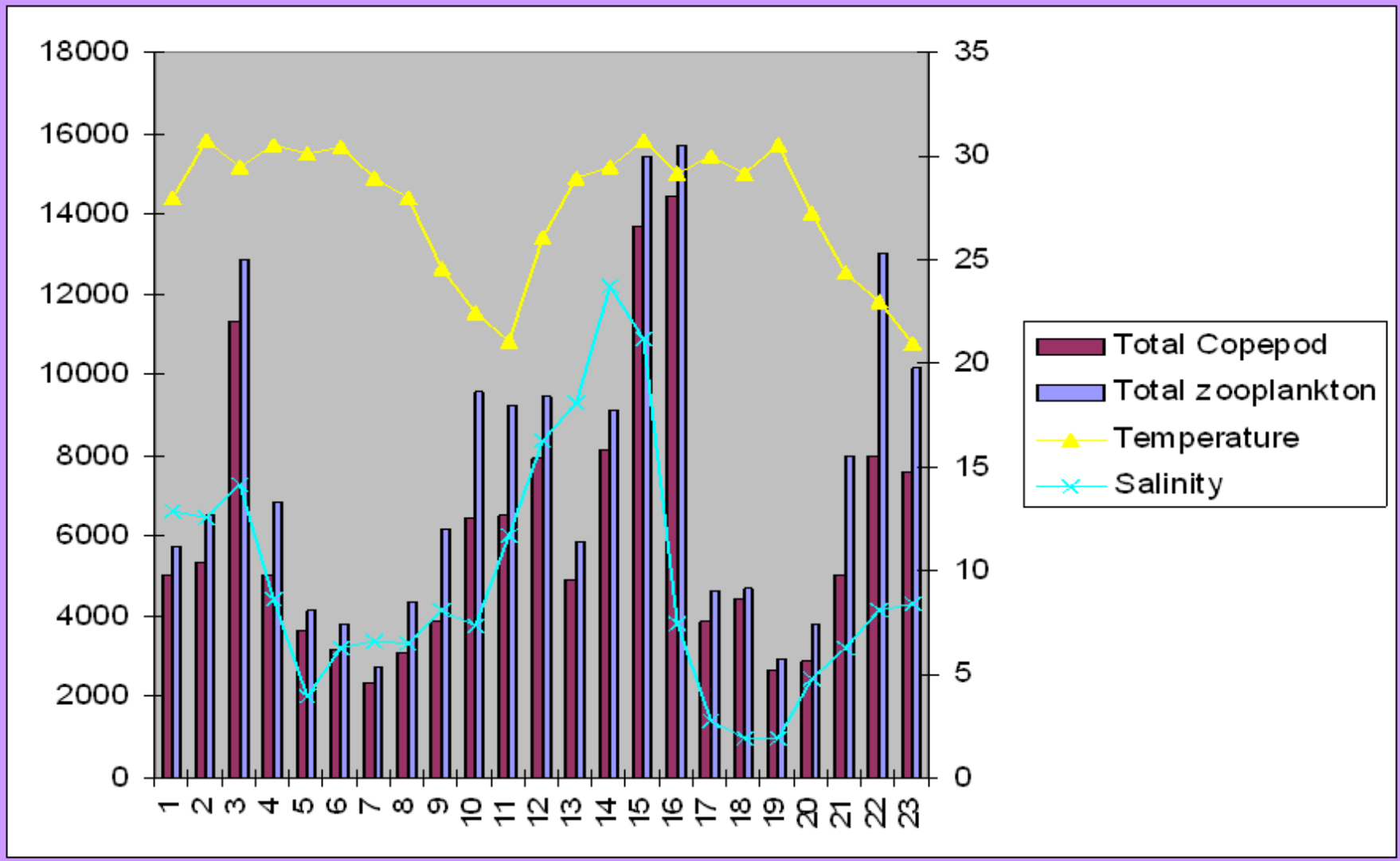
- Out of 32 genera and 54 species, calanoids were represented by 17 genera and 37 species, cyclopoids by 7 genera and 9 species, harpacticoids by 8 monogeneric species.

- During monsoon months, a good assemblage of oligohaline species, *Acartiella keralensis, Pseudodiaptomus binghami, Halicyclops tenuispina, Mesocyclops and Cyclops* were recorded at station 1 for the greater inflow of fresh water from Hugli River.

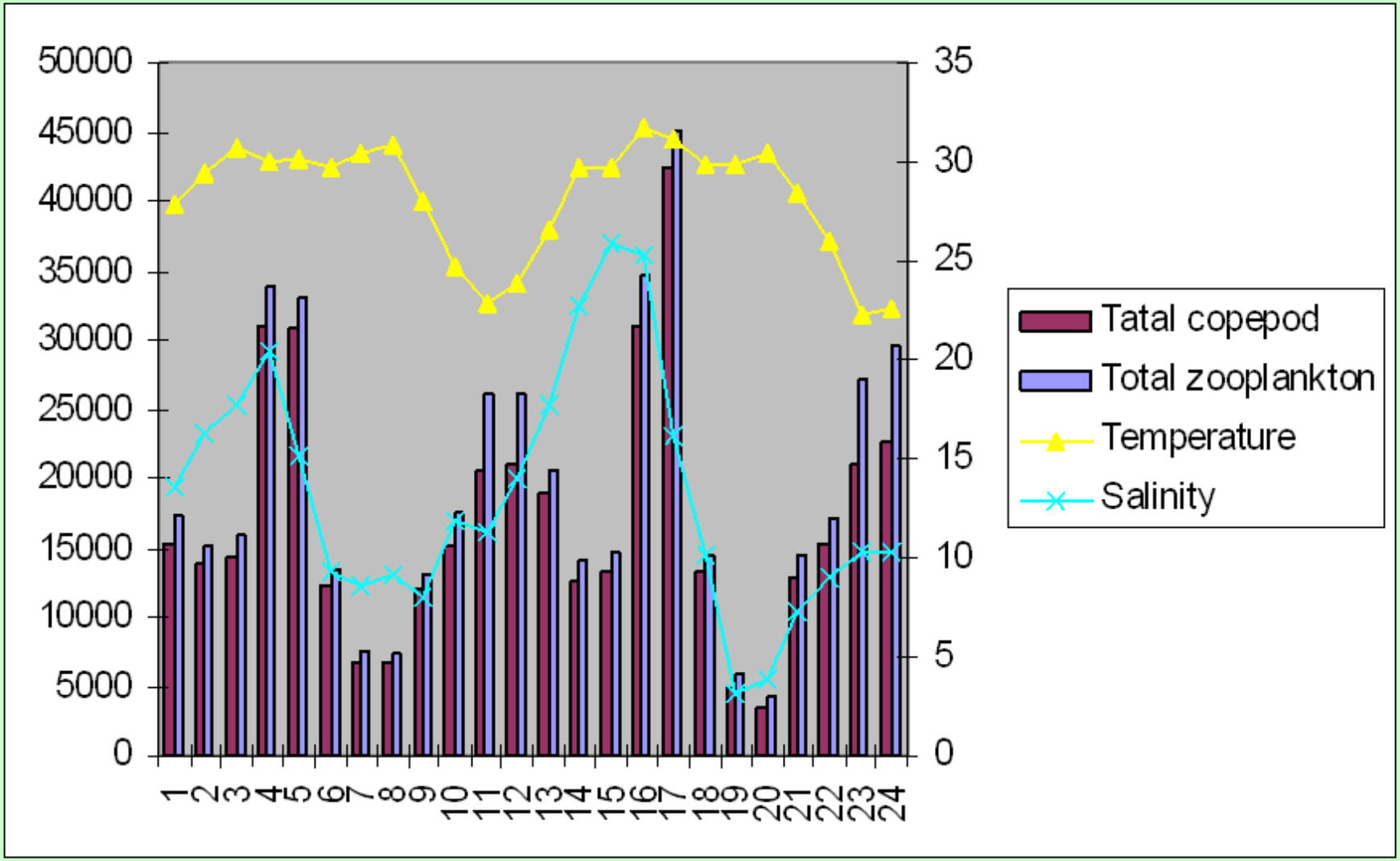
Diversity Index of Copepods

	Diversity Index	Species richness	Species evenness
Station 1	1.87	2.41	0.58
Station 2	2.06	3.19	0.49
Station 3	1.23	1.05	0.52

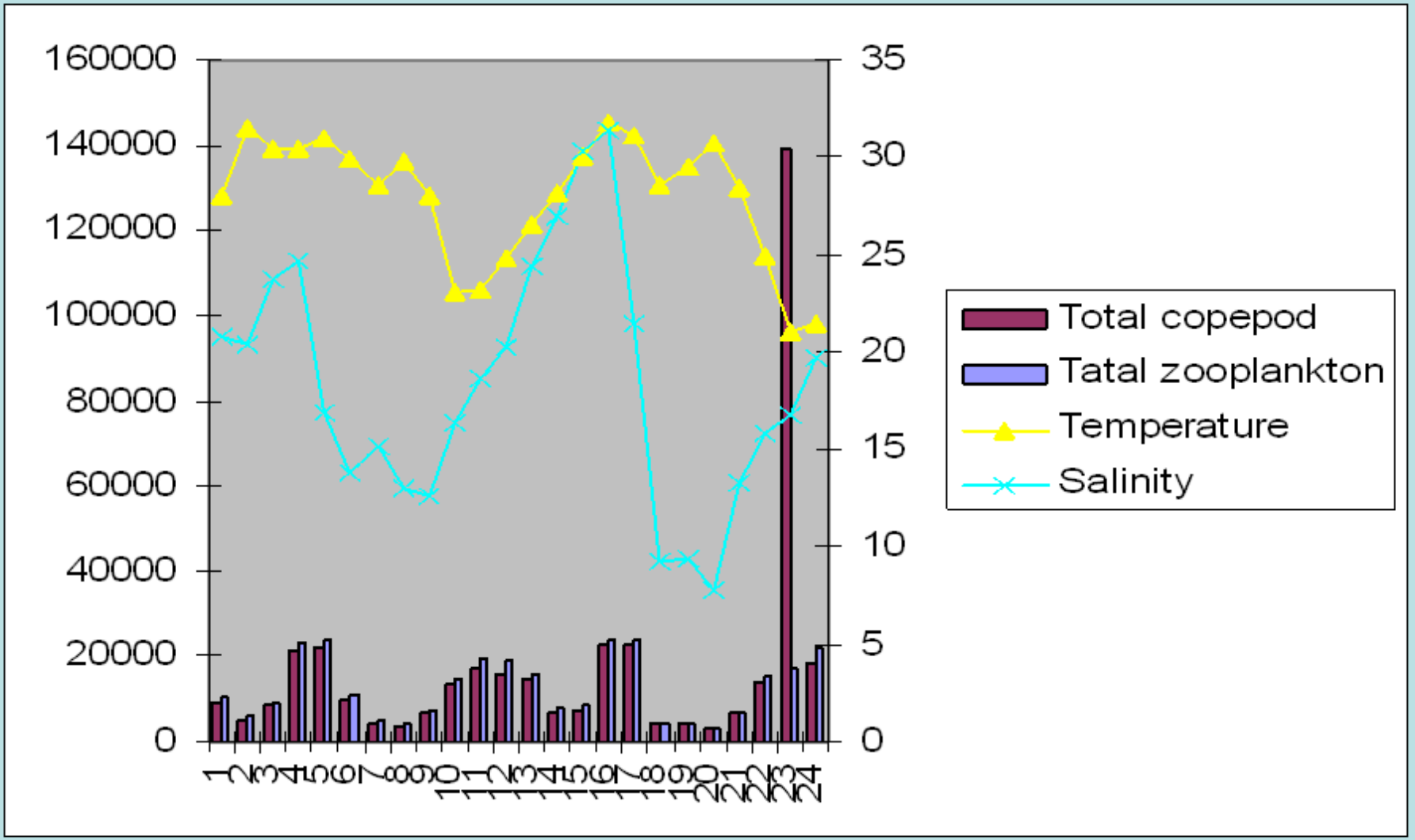
Station Kachuberia



Station Chemaguri



Station Sagar south



Showing relationship between zooplankton population and hydrological parameters at station 2.

Zooplankton	Correlation values (r)				
	Water temperature	salinity	Dissolved Oxygen	pH	Transparency
Paracalanus spp.	-0.0851	0.4904	- 0.3441	0.6012	0.4273
Acrocalanua spp.	-0.0065	0.4637	- 0.36	0.6643	0.4953
Acartia sp.,	-0.8495	- 0.3150	0.1069	0.0947	0.3460
Acartiella sewelli	0.2526	- 0.7200	0.7246	- 0.7672	- 0.4028
Labidocera euchaeta	0.0074	0.4752	0.4329	0.6018	0.5204
Eucalanus subcrassus	0.1092	0.7647	- 0.6283	0.4790	- 0.0124
P.Annandalei	-0.3334	-0.2257	0.1316	0.0648	0.0064
Oithona sp.,	-0.2160	0.4802	- 0.4034	0.6549	0.5954
Saphirella indica	0.2309	0.8892	- 0.5628	0.541	0.1437

Cntd……

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Zooplankton	Correlation values (r)				
	Water temperature	salinity	Dissolved Oxygen	pH	Transparency
Microsetella rosea	0.4039	0.6671	- 0.3625	0.4509	0.1616
Lucifer hanseni	0.4328	- 0.3206	0.5062	- 0.4639	- 0.3657
Hydromedusae	0.4464	0.7833	- 0.5076	0.5404	0.0474
Amphipoda	-0.0152	0.7098	- 0.4523	0.5096	0.3472
Mysid	-0.0772	-0.2033	- 0.1749	-0.1384	- 0.0213
Polychaete Larvae	0.1878	0.3892	- 0.0903	0.3806	0.3333
Nauplius	-0.8195	0.0736	- 0.1683	0.4462	0.5696
Zoea	-0.7614	0.1462	- 0.2150	0.4973	0.5184
Megalopa	-0.6470	0.0092	- 0.0142	0.3318	0.2881

Blue = Significant at 5% level

Red = Significant at 1% level

Correlation matrix for copepods belonging to 10 major families at Sagar South.

	A	B	C	D	E	F	G	H	I
A	-	-	-	-	-	-	-	-	-
B	-0.53	-	-	-	-	-	-	-	-
C	0.86	-0.58	-	-	-	-	-	-	-
D	0.90	-0.47	0.18	-	-	-	-	-	-
E	-0.55	0.84	-0.61	-0.43	-	-	-	-	-
F	0.51	-0.52	0.50	0.54	-0.49	-	-	-	-
G	0.87	-0.39	0.90	0.83	-0.49	0.51	-	-	-
H	-0.17	-0.17	0.01	-0.20	-0.03	-0.36	-0.24	-	-
I	0.83	-0.49	0.61	0.78	-0.38	0.48	0.64	-0.30	-
J	0.65	-0.44	0.82	0.62	-0.57	0.66	0.74	-0.02	0.42

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Red = Significant at 5 % level

Blue = significant at 1 % level

A = Paracalanidae, B = Acartiidae, C = Pontellidae
D = Eucalanidae, E = Pseudodiaptomidae,
F = Cenropagidae, G = Oithonidae, H = Clausidiidae,
I = Ectinosomidae, J = Laophontidae.

ZOOPLANKTONS

Category I

Paracalanus sp., *Acrocalanus* sp., *Acartia* sp., *A. spinicauda, Labidocera euchaeta, Pontella andersoni, Eucalanus subcrassus, E. elongatus, Pseudodiaptomus annandalei, P. hickmani, Oithona* sp., "*Saphirella*" of *indica, Microsetella rosea, Laophonte* sp.

Category II

Pseudodiaptomus aurivilli, Euchaeta marina, E. wolfendeni, Euchaeta sp., *Centropages dorsispinatus, Acartiella sewelli, Corycaeus danae, Euterpina acutifrons, Cladorostrata brevipoda, Harpactcus* sp., *Clytemnestra scutellata, Macrosetella gracilis.*

ZOOPLANKTONS

Category III

Acartiella keralensis, Labidocera sp., L. minuta, Pontellopsis herdmani, Eucalanus sp., pseudodiaptomus tollingeri, P. masoni, P. binghami, P. daughlishi, Pseudodiaptomus spp., Neodiaptomus strigilipes, Euchaeta tenuis, E. concinna, Centropages furcatus, Temora turbinata, T. discaudata, Tortanus gracilis, T. forcipatus, Candacia bradyi, Canthocalanus pauper, Undinula darwini, Corycaeus catus, C. agilis, Oncaea venusta, Halicyclops tenuispina, Cyclops sp., Tachidius discipes.

CHAETOGNATHS

- Estuarine epipelagic chaetognath, *Sagitta bedoti* dominant throughout the year – euryhaline, tolerating a wide range of salinity.

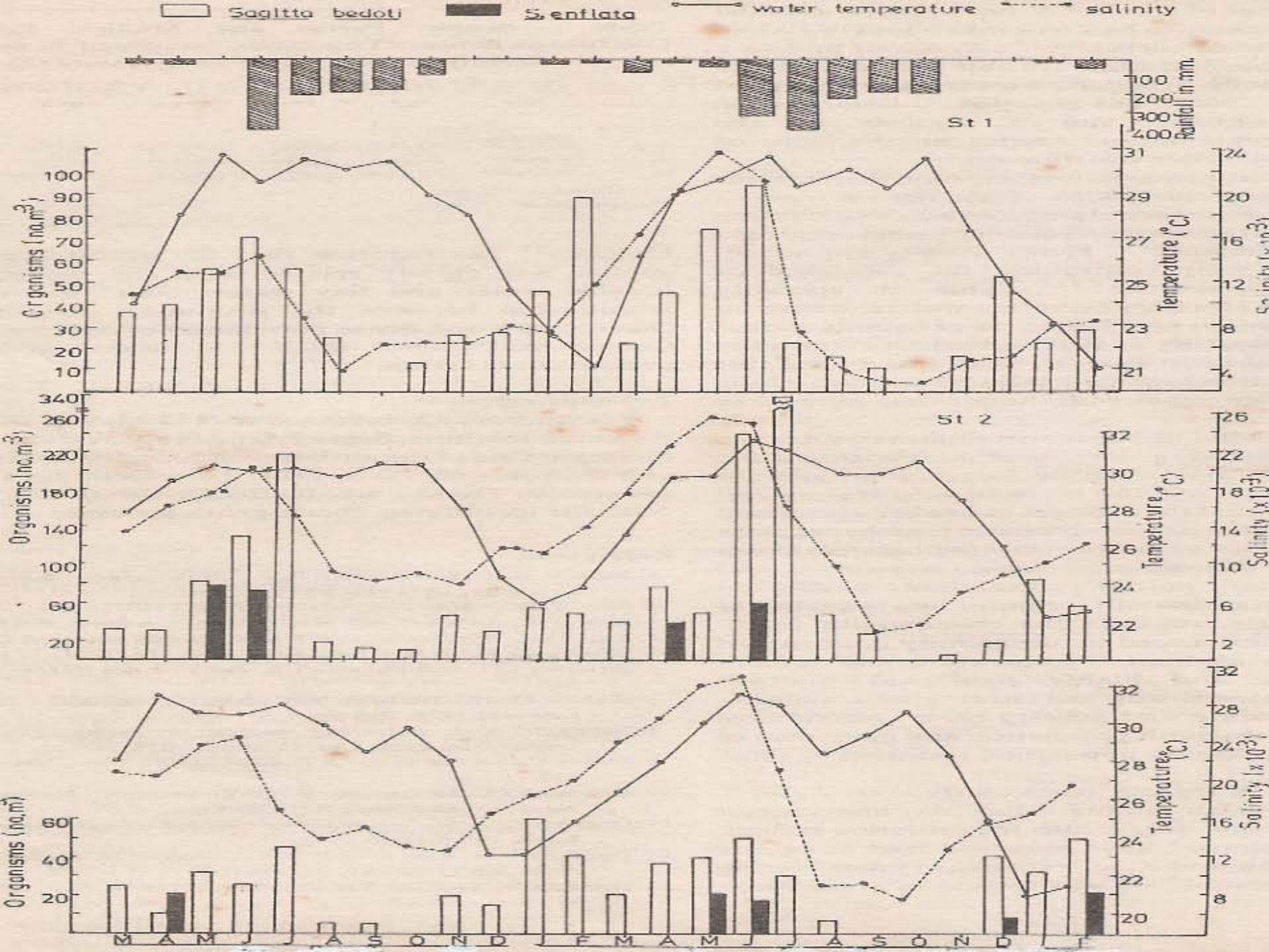
- Maturity stages of chaetognath was based on the development of ovaries (Zo, 1973) as follows:

  (a) Stage I: no visible ovaries.

  (b) Stage II: developing ova, some ova of different sizes but none yet matured.

  (c) Stage III: One or more mature ova of dimension larger than the quarter of body width.

- Frequency of mature *S. bedoti* was very small in number in comparison with the juveniles (Station 1). Scarcity of adults is attributed to their presence in deeper layers.


Sagitta bedoti
S. enflata
water temperature
salinity
Rainfall in mm.
St 1
St 2
Organisms (no./m³)
Organisms (no./m³)
Organisms (no./m³)
Temperature (°C)
Temperature (°C)
Temperature (°C)
Salinity (x10³)
Salinity (x10³)
Salinity (x10³)
M A M J J A S O N D J F M A M J J A S O N D J

Simple, Partial and multiple correlation coefficients between population density of *Sagitta bedoti* (M), salinity (y) and water temperature (Z) at stations 1, 2 and 3.

	r_{MY}	r_{MZ}	r_{YZ}	$r_{MY\text{-}Z}$	$r_{MZ\text{-}Y}$	$r_{M\text{-}YZ}$
Station 1	0.7325[b]	- 0.1231	0.0530	0.7458	- 0.2382	0.7501[b]
Station 2	0.4434[a]	0.2882	0.1959	0.4142[a]	0.2290	0.4887[a]
Station 3	0.6119[b]	- 0.3090	0.1091	0.3424	- 0.4778	0.5172[b]

Size ranges of different breeding stages of *S. bedoti*

	Size range (cm)	Mean ± SD
Station 1	0.55 - 1.05	0.776 ± 0.139
Station 2	1.30 – 1.90	1.557 ± 0.142
Station 3	1.75 – 1.90	1.825 ± 0.106

Digestion of zooplankton for trace elements

. 1 g dry zooplankton sample was treated with 2 ml HNO_3 (65%) and 1 ml H_2O_2 (30%) (proanalysis E. Merck) (Dalziel and Baker, 1983) in a 'Parr bomb' at 110°C for 2 hr.

- The mass was transferred into an Erlenmeyer flask and the volume reduced to about 1 ml by gently heating the flask. When dark fumes of NO_2 subsided, 2 ml of 30% H_2O_2 was added.
- The volume reduced to almost dryness.

For selenium

- For Se, an aliquot of 10 ml was taken into a separating flask followed by addition of 10 ml 2.5 vol. % tri-iso-octylamine solution. The flask was shaken for 2 min and after clear phase separation, the aqueous phase was drained out. Se stripped from the loaded organic phase by shaking with 2 ml of 0.1 M HCL solution. Depending on selenium content, 200-500 µl solution was transferred in to the reaction vessel of hydride generator along with 10 ml of 1.2 M HCL solution.

- Se content was measured by the hydride generation atomic absorption spectrometric (HG-AAS) technique . Blank digestion was also performed to determine the background correction of reagents.

- A Perkin-Elmer atomic absorption spectrometer, equipped with Perkin-Elmer hydride generating system (model MHS-10) and deuterium background corrector, was used to record the absorption signals.

- For quality control, certified reference material 'Oyster tissue (NBS SRM 1566)' was also considered.

TRACE METALS

- Zooplankton accumulate metals in two ways: by direct adsorption from water and by assimilation of metals from food and detrital particles ingested by the animals.

- High concentration of Zn in mixed zooplankton during premonsoon period might be due to presence of the dominant copepod group accumulating Zn by adsorption induced by several factors.

- Meroplanktons accumulated higher concentration of metals where Pb was also present – most susceptible to environmental conditions modified by human activities.

- Prevalent variation of metals in zooplankton may be due to combination of factor affecting the uptake rate of metals by individual groups.
- Elevated Se concentration in zooplankton results from grazing on phytoplankton and retention of Se.

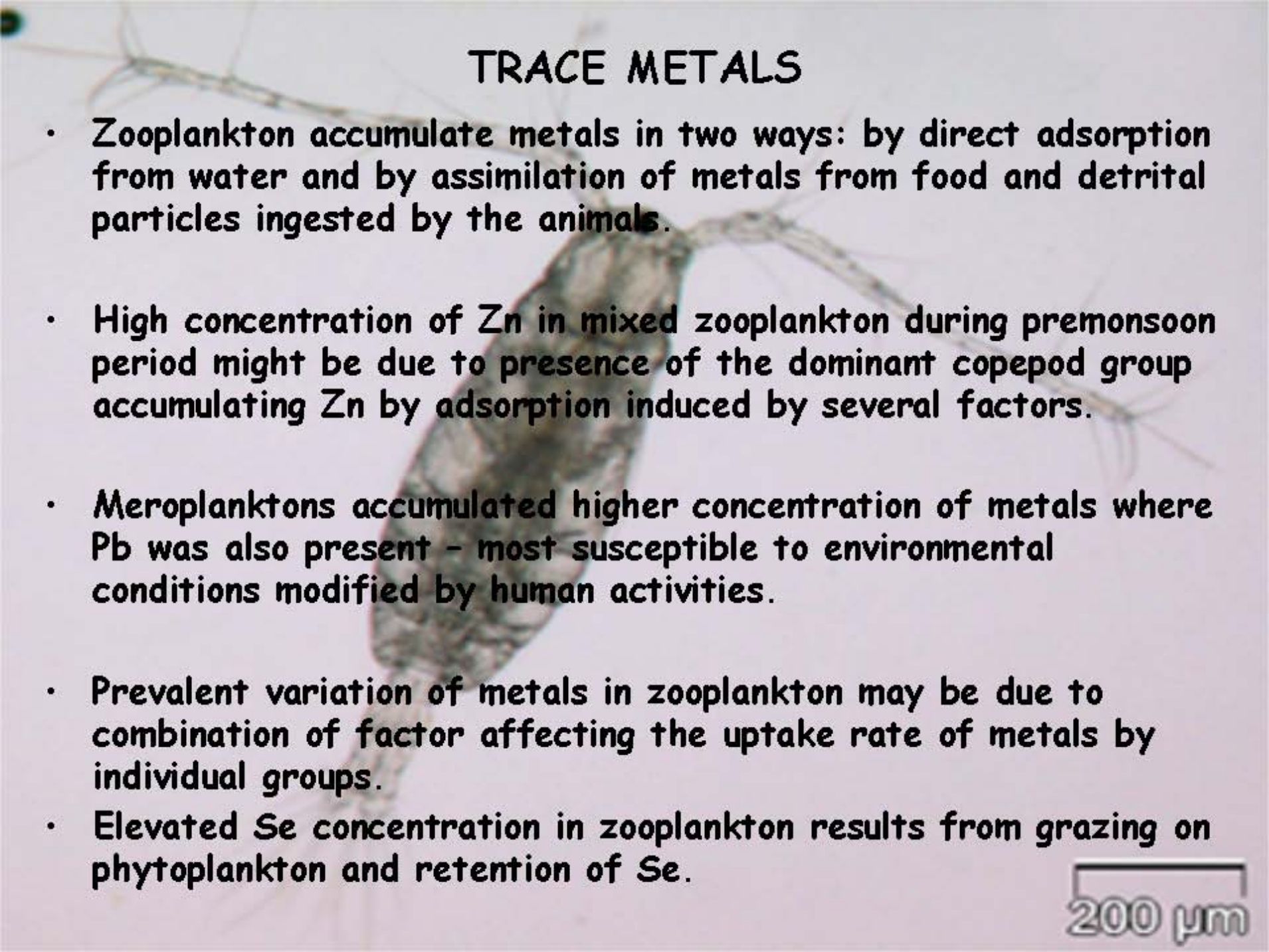


Table: Concentration of heavy metals (mg/kg) in some major groups of zooplankton from Hugli Estuary

Zooplankton groups	Fe	Zn	Cu	Mn	Ni	Se
POSTMONSOON						
Mixed zooplankton	950.0	30.0	25	70.0	3.0	3.85
Prawn larvae	1478.0	136.8	37.6	105.8	ND	4.84
Fish larvae	257.0	280.0	40	ND	8.0	3.05
Megalopa	925.5	120.5	25.0	65.5	ND	3.15
PREMONSOON						
Mixed zooplankton	209.0	510.0	90.0	ND	7.5	1.24
Prawn larvae	1143.8	162.0	50.1	95.9	ND	2.19
Fish larvae	417.58	106.07	22.28	128.28	ND	1.05
Megalopa	1058.0	101.19	70.47	75.62	ND	2.18

ND = Not detectable.