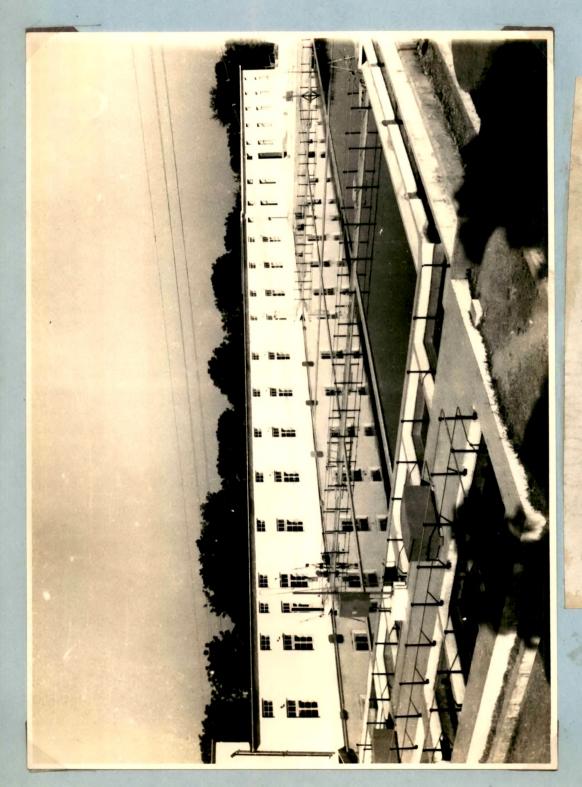
S E C T I O N "B"

5. BIOLOGY OF THE NIMETA WATER WORKS

PREFACE

"A water treatment plant may be compared with a Refinery in which the raw material is crude and impure water obtained from rivers or lakes and the end product is pure water which must conform to all rigid standards for drinking water. Like all refineries the aim of a Purification Works is to manufacture at low cost pure and safe water fit for human comsumption from highly polluted water. This can be done only by efficient maintenance and intelligent operation of the plant and is solely dependent on the personnel managing and running the Works."

(S.Y. Gore 1961).



I. INTRODUCTION

A water works system consists of (a) the source of raw water supply, (b) the conduit or open channel taking the raw water from the source to the treatment works, (c) pre-treatment units, (d) filters, (e) chlorinators for disinfection, (f) underground filtered water storage tanks or reservoirs and (g) service reservoirs, water towers and distributory system. All the above seven stages in a water works system can be considered from a purely engineering, physico-chemical or biological aspect.

All natural surface waters contain a diversity of micro-organisms in suspension. "These low forms of life can give rise to various difficulties in the water works. They may cause trouble at the filtration stage by blocking the beds too quickly or, by penetrating the beds, bods, spoil the clarity of the filtrate. They may render the water unpalatable, form unsightly scums or block pipes and strainers. In any event the biological examination will be of great value in ascertaining the cause of the difficulty, in assessing its extent and in controlling any remedial measures which may have to be taken "
(Manual of British Water Supply Practice 1954, p. 718).

So biological management of a Water Works is as important as the engineering or physico-chemical management and one of the essential characteristics of a good biological management is a systematic collection, identification and enumeration of the micro-organisms found at different stages of the purification system. It is only in this way that one can know how far the treatment processes are successful in removing the offending organisms. It may also disclose the weak points in the system of purification in order to evolve an intelligent method of operation of the plant and to effectively operate it. The results of a regular and systematic biological examination of the Nimeta Water Works at Baroda made during 1963 and 1964 are discussed in this paper; and for the first time the Water Works Superintendent at Baroda will have an idea of the intensity and types of growth in the filtered water supplied to the town.

II. Methods and collection of biological samples and numerical estimation of micro-organisms.

Plankton samples were collected from the raw water inlet, clarified water before reaching the filters and from the filtrates of each of the six individual rapid

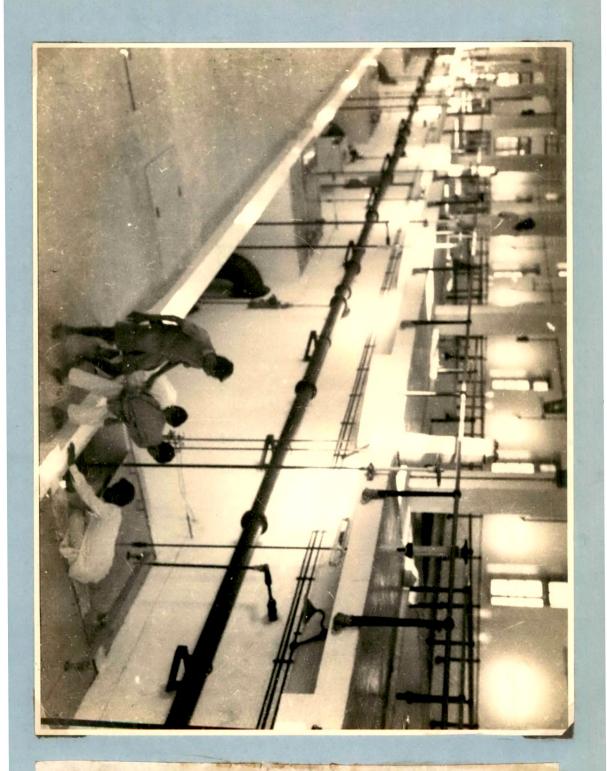


Fig. 20. Collection of biological samples with the plankton net from the filtered water well in Rapid Sand Filter No. 2.

sand filters in operation within the Water Works as detailed below:

(a) Raw Water Plankton: This was collected from the raw water passing over the rectangular weir by holding the plankton net firmly across the weir for five minutes.

The quantity of water passing through the net was calculated as follows:

Length of the rectangular weir = 84"

The height of water passing over the weir = 10"

The rate of flow of raw water = 3,95,800 gallons per hour.

The diameter of the mouth of the net = 6"

. The approximate quantity of water passing through the net in 5 minutes =

$$= \frac{3,95,800}{84 \times 10} \times \frac{22}{7} \times \frac{3 \times 3 \times 5}{60}$$

= 1111 gallons.

- (b) Clarified Water Plankton: This was collected by filtering 50 litres of clarified water through the net each time.
- (c) <u>Filtred Water Plankton</u>: This was collected **2900** from the filtred water cell or inspection box as the water was passing over the weir in each filter by means of the same plankton net which was held across the weir for

5 or 10 minutes on each occasion. The quantity of water passing through the net was calculated thus:-

Length of the rectangular weir = 18"

Height of water passing over the weir = 7"

The rate of flow of filter water over the weir = 700 gph.

The diameter of the net = 6^{11}

... The approximate quantity of filtered water passing through the net in 5 minutes

=
$$\frac{56,000 \times 22}{18 \times 7} \times \frac{3 \times 3 \times 5}{7}$$

= 1048 gallons

- (d) Sessile Organisms: The organisms attached to the side walls of the raw water channels, sedimentation basins and filters were carefully examined on each occasion and the organisms found were separately collected and preserved for later identification.
- (d) Counting of Organisms: Numerical estimation of the organisms found in each situation was made by the "drop-sedimentation" method as detailed in the American "Standard Methods," and in Part I Section A of the thesis.

III. The Biology of Nimeta Water Works at Baroda.

The Nimeta Water Works system consists of (i) the Ajwa reservoir which is the source of raw water supply; (ii) the two covered-in conduits (30" and 36" diameter)

carrying raw water from the bottom of the reservoir to the Water Works at Nimeta; and (iii) the water works system consisting of the raw water flume, two Paterson flocculators, open channels carrying the alum-treated and flocculated water, three series of rectangular sedimentation basins each series containing three tanks, six Paterson rapid sand filters, filtered water conduit, the underground filtered water reservoir, high level filtered water storage tank and the distributory system. The biology of the Ajwa reservoir has already been dealt with in Part I- section A; and in this paper the biological conditions in the two covered-in conduit pipes carrying the Ajwa reservoir water for a distance of nearly five miles and in different situations of the Nimeta Water Works system alone will be described.

(a) Raw Water Conduits: Towards the latter part of the year i.e. in October 1964 there was a leak in one of the conduits carrying raw water about a mile from the reservoir towards the Nimeta Water Works. That part of the leaky pipe had to be replaced by a new one. The Department had to cut open the pipe. An opportunity to study the inside conditions of the pipe was thus afforded. A careful study of the deposits revealed that there was an incrustation of about 9" consisting essentially of iron hydrous

oxide and slimy organic matter. On the outer surface of the incrustation there were profuse whitish growths of <u>Megascalaris</u> of Porifera, Infusors, Crustaceans, Nematodes and Oligochaete worms.

(b) Raw Water inlet at the Nimeta Water Works:
The raw water from the Ajwa reservoir is conveyed through the two gravity conduits (30" and 36") to the purification plant at Nimeta where it discharges into a stilling chamber suitably baffled to quieten the delivery and to ensure accurate measurement of water and addition of chemicals for clarification. At the entrance to the stilling chamber a regulating penstock is fitted. A scale is attached on the wall of the stilling chamber to record the depth of water flowing over the seven feet rectangular weir.

Just before the raw water overflows the weir, the plankton net was held across a portion of the area of the weir for five minutes every time. As the length of the weir, the area or cross section of the water overflowing the weir, the rate of flow of raw water and the diameter of the net are known, the quantity of water passing through the net was calculated on every occasion as shown at the beginning.

After five minutes, the catch retained by the net was carefully washed and transferred to specimen tubes to make a volume of 15 ml and later preserved after a microscopic examination in the field laboratory by the addition of enough formalin to make a 4% solution. The sediments were later measured after centrifuging and again made up to a much smaller volume for counting depending upon the density of the organisms in the sediments.

The plankton flora and fauna identified from catches made during the two year period from the raw water are listed below:

A. PHYTOPLANKTON

CHLOROPHYTA

- 1. Cosmarium depressum Nag.
- 2. Cosmarium contractum Kirchn.
- 3. Odegonium Sp.
- 4. Pediastrum simplex. Meyen.

EUGLENOPHYTA

5. Trachelomonas volvocina (Ehrenb.)

CHRYSOPHYTA

6. Botryococcus Bragnii

BACILLARIOPHYCEAE

- 7. Achnanthes exilis (Kutz).
- 8. Achmanthes minutissima (Kutz).

BACILLARIOPHYCEAE (Contd.)

- 9. Amphora beneta (Kutz) Hust.
- 10. Cocconeis placentula (Ehr.) var. lineata.
- 11. Cymbella affinis (Kutz).
- 12. Cymbella microcephala (Grun).
- 13. Cymbella tumida (Breb.) V.H.
- 14. Diploneis (Cf. D. Smithii) Breb.
- 15. Epithemia sorex (Kutz).
- 16. Epithemia argus (Kutz).
- 17. Fragillaria crotenensis Kitt.
- 18. Gomphonema gracile var. auritum (A.Br.) V.H.
- 19. Gomphonema gracile var. dichotomum (W.Sm.) V.H.
- 20. Gomphonema subclavatum Grun.
- 21. Mastigloia smithii v. amphicephala Grun.
- 22. Melosira granulata var. angustissima O. Mull.
- 23. Navicula cryptocephala Kutz.
- 24. Nitzschia (cf. N. acicularia W.Sm.)
- 25. Nitzschia Kutzingiana 0. Hilse
- 26. Pleurosigma delicatulum W. Sm.
- 27. Rhopaloidia gibba (Ehr.) 0.Mull
- 28. Surirella tenera var nervoša A.S.
- 29. Synedra ulna (Nitz) Ehr.
- 30. Synedra acus (Kutz)
- 31. Synedra acus var. radians (Hust).

CYANOPHYTA

- 32. Anabaena sp.
- 33. Anacystis cyana (Kutz) Dr. & Daily.

143

CYANOPHYTA (Contd.)

- 34. Cylindrospermum sp.
- 35. Micro-coleus chthonoplastes(Mert) Zanard.

B. ZOO-PLANKTON

PROTOZOA

- 1. Arcella
- 2. Difflugia hydrostatica
- 3. Centropyxis
- 4. Lecquerevsia
- 5. Vorticella -

ROTIFERA

- 6. Anuracopsis coclata
- 7. Anuracopsis fissa
- 8. Ascomorpha saltans indica
- 9. Brachionus angularis
- 10. Brachinous caudatus
- 11. Brachinous diversicornis
- 12. Brachinous falcatus
- 13. Brachinous forficula
- 14. Cephalo-della gibba
- 15. Cephalo-della megalo-cephala
- 16. Collotheca
- 17. Colurella oxycauda
- 18. Dicranophorus epicharis
- 19. Euchlanis dilatata
- 20. Filinia terminalis

144

ROTIFERA (Contd.)

- 21. Keratella valga tropica.
- 22. Lecane arcuata
- 23. Lecane arcula
- 24. Lecane bulla
- 25. Lecane clostero-cerca
- 26. Lecane galeata
- 27. Lecane hamata
- 28. Lecane harringi
- 29. Lecane hornimanni
- 30. Lecane luna
- 31. Lecane lunaris
- 32. Lecane papuana
- 33. Lecane quadridentata
- 34. Lecana thienemanni
- 35. Lecane unquitata
- 36. Lecane ungulata
- 37. Mytilina ventralis
- 38. Notommata
- 39. Pidalia
- 40. Polyarthara
- 41. Pompholyx complanata
- 42. Ptygura furcata
- 43. Ptygura sp.
- 44. Testudinella patina
- 45. Tetramastix opoliensis
- 46. Trichocera mycersi

ROTIFERA (Contd.)

- 47. Trichocera ruttneri
- 48. Trichocera similis
- 49. Bdelloidea

COPEPODA

- 50. Allodiaptomus Raoi Kiefer.
- 51. Allodiaptomus cinctus (Gurney).
- 52. Mesocyclops leuckart deccanensis (Lindberg).

-

- 53. Mesocyclops
- 54. Nauplius larvae
- 55. Diaptomus
- 56. Helio-diaptomus cinctus Gur.
- 57. Harpatctictade

CLADOCERA

- 58. Alona Baird
- 59. Alona affinis
- 60. Alona Cf. Archeri
- 61. Alona chydorus
- 62. Alona macrothrix
- 63. Alona verrucosa
- 64. Alona cambouei
- 65. Alona intermedia
- 66. Alonella karua
- 67. Bosminopsis cf. Pernodi
- 68. Cerodaphnia riguadi Rich.
- 69. Chydorus Barroisi
- 70. Daphnia lumhdtzi

CLADOCERA (Contd.)

- 71. Diaphanosoma paucispinosum Brehm.
- 72. Dunhe vedia
- 73. Macrothrix Baird
- 74. Moina dubia Rich.
- 75. Sida sp.

PORI FERA

76. Megascalaris (of a fresh water sponge).

Percentage composition of the different plankton groups:

TABLE NO. 1 (a) PHYTOPLANKTON

Mame	of the algal g	roup No. of species	%of the total
1.	Chlorophyta	4	11.1
2.	Euglenophyta	1	2.9
3.	Chrysophyta	26	72.2
4.	Cyanophyta	Total $\frac{5}{36}$	$\frac{14.1}{100.3}$
	(b)	ZOO-PLANKTON	
1.	Protozoa	5	6.7
2.	Rotifera	44	58.7
3.	Copepoda	7	9.3
4.	Cladocera	18	24.0
5.	Porifera	Total $\frac{1}{75}$	1.3

THE DOMINANT & CONSTANT FORMS:

The Most dominant algal organisms were <u>Pediastrum</u>
<u>simplex Meyen, Trachelomonas volvocina, Botryococcus</u>

<u>Braunii; Achnanthes exilis (Kutz); and Surirella tenera</u>

var <u>nervosa</u> A.S.

Among the zoo-plankton organisms the dominant ones were Anuracopsis coclata; Brachionus diversicornis; Brachionus forficula; Keratella valga tropica; and Bdelloidea of the Rotifer group; Mesocyclops leukart deccanensis (Lindberg); and Nauplius larvae; of the Copepoda group; Daphnia Lumholtzi of the Cladocera group and Megascalaris of a fresh water sponge.

(c) Raw Water Channels Carrying Alum Treated and
Flocculated Water to the Segimentation basins

Spirogyra Sp. in long trailing filaments were seen attached to the two side walls of the channels carrying the alum treated raw water. This was found almost throughout the year. These were periodically scrapped off by manual labour.

Microcoleus chthonopleastes (Mert) Zanard and Microcoleus subtorulosus (Breb) Gom., sporeless indet., were the
two other organisms which were seen in "Carpet-like", thick,
growths attached to the walls and bottom of the channels.



Fig. 21. Photo-micrographs of organisms from the raw and sedimented water.



These carpet-like, thick, slimy growths were found to peal off from the sides on some occasions, and to be carried off to the sedimentation basins, where they began to have another lease of life.

(d) <u>Sedimentation basins</u>: Raw Water with or without treatment with alum is flocculated by means of two Alexandria type of Paterson flocculators and sedimented in 3 rows of rectangular tanks of the old conventional " over and under flow" type with three compartments in each. Each of them has a conical hopper bottom with ridges and furrows in which holes are provided for scouring the accumulated sludge periodically hydrostatic pressure. The retention time is stated to be 3-4 hours.

The biological conditions in the sedimentation basins are described below under two heads: (a) Sessile organisms; and (b) planktonic organisms.

(a) Sessile Organisms

TABLE No. 2

Date	Organisms
24.4.1963	 Mollusean fauna; Succinea putris. Spirogyra sp. upto a depth of 10 feet seen in long trailing filaments.
24.5.1963	Globular slimy balls seen sticking to the sides of the basins. They consisted of Rivularia globiceps.

20-6-1963	Spirogyra Sp. seen slowly developing
19-7-1963	Molluscan fauna: Succinea putris and Limnaea palustris (Mull)
30-8-1963	Spirogyra Sp., Oscillatoria limnetica
25-9-1963	Spirogyra Sp., Oscillatoria limnetica
24-10-1963	Oedogonium Sp. Spirogyra Sp., Megascalaris of a fresh water sponge.
29-11-1963	Very young molluscan fauna and a few bigger ones also seen sticking to the sides in hundreds.
19-12-1963	Gastropods in different stages of growth seen attached to the walls of all the compartments in hundreds.
23-1-1964	Slight slimy growth of Spirogyra sp.
24-3-1964	Gastropods seen again attached to the side walls.
28-4-1964	Gastropods in thousands seen.
11-6-1964	A few gastropods seen.
24-7-1964	Spirogyra and a few gastropods.
28-8-1964	Shrimps in abundance seen. Long trailing filaments of Spirogyra sp.
24-9-1964	Gastropods, Spirogyra and Oscillatoria Sp.
24-10-1964	Gastropods, Spirogyra and Oscillatoris Sp.
26-11-1964	Spirogyra Sp., Naias plant visible in one of the compartments.
17-12-1964	- do do -

(b) Planktonic organisms:

The organisms found in a litre of the clear sedimented water are shown in Table No. II (Appendix). Fifty litres of

water were strained through the net and the catch obtained was examined. The table shows that the number of organisms found is comparatively less than that in raw water i.e. about 18% of the number of species for raw water are seen in the sedimented water.

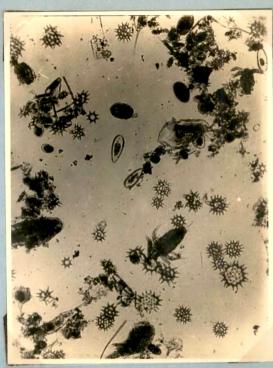
(e) FILTERED WATER

The effluents from each of the six Paterson rapid sand filters were examined for their planktonic content systematically as detailed at the beginning of this paper. The results of the qualitative and quantitative microscopic examination are shown in Table No. III (a to f) from which the following conclusions are made.

(i) The number of genera in each group recorded in the filtrates from the six rapid sand filters is shown below:

Nome of the	T	BLE	NO.	3				
Name of the group.						ded in		
					•	Sand Fi	lter N	٥.
	water	1	2	3 /	4	5 '	6	
A. Phytoplankton								
Chlorophyta	4	1	1	1	1	. 1	1	
Euglenophyta	1	-	1	1	-	-	**	
Chrysophyta	26	1	2	1	1	1	1	
Cyanophyta	5		-	•	-	-		
Total	36	2	4	3	2	. 2	_. 2	





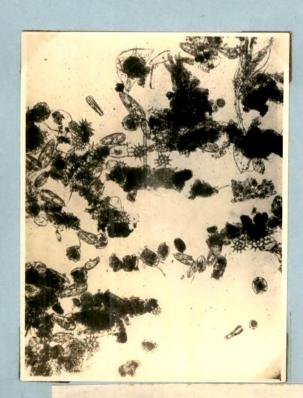




Fig. 22. Photo-micrographs of phyto and zooplankton organisms collected from the filtrates from the Rapid Sand Filters.

TABLE NO.III (Contd.)

Name of the					reco			
group	Raw water		trate 2	Trom	кар10 4	Sand 5	Filter 6	NO.
B. Zoo-plankton:		•			`			
Protozoa	5	1	1	1	1	1	1	
Rotifera	44	31	29	28	18	24	20	
Copepoda	7	3	3	3	3	3	3	,
Cladocera	18	4	3	3	3	4	4	
Oligochaeta	1	1	-	1	1	1	1	
Nematoda	4	4	2	4	3	4	4	
Porifera (megascaleres)	1	1	1	. 1	1	i	1	,
Total	80	45	39	41	.30	38	34	

From a study of the above table, it will be seen that while comparatively few plant organisms passed through the filters, a largest percentage (56.2) of animal organism passed through Filter No. 1 and the least (37.5) passed through the Filter No. 4.

(ii) The names of the species passing through the rapid sand filters are shown below:

A. Phytoplankton

- a) Chlorophyta Pediastrum simplex. Meyen
- b) Euglenophyta Trachelomonas volvocina(Enrenb).
- c) Bacillariophyceae Surirella tenera var nervosa.
 A.S. Nitzschia (cf. N. acicularis W. Sm).

B. Zoo-plankton

- d) Protozoa Centropyxis
- Anuracopsis coclata e) Rotifera Anuracopsis fissa Ascomorpha saltans indica Brachionus angularis Brachinous caudatus Brachionus diversicornis Brachionus falcatus Brachionus forficula Cephaledella gibba Cephalodella megalocephala Collotheca Colurella oxycauda Dicranophorus epicharis Euchlanis dilatata Filinia terminalis Keratella valga tropica Lecane arcuata Lecane arcula Lecane bulla Lecane closterocera Lecane galeata Lecane harringi Lecane luna Lecane lunaris Lecane papuana Lecane quadridentata Lecane unquitata Lecane unqulata Mytilina ventralis Notommata Sp. Pidalia Sp. Polyarthra Sp. Pompholyx complanata Ptygura furcata Tetramastix opoliensis Trichocera mycersi Trichocera ruttneri

Rotifers are reported to be "often present in small numbers although their growth seldom, if ever reaches troublesome proportions" in the water works of England Manual of British Water Supply Practice 1954, p.723.

Bdelloidea

Trichocera similis

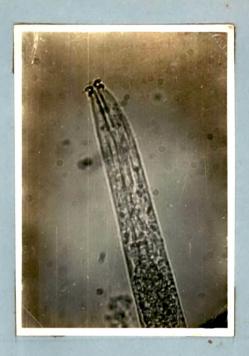




Fig. 23. Photo-micrographs of oligochetes and Nematodes in the filtrates from the Rapid Sand filters.





But it is not so in Baroda.

f) Copepoda Mesocyclops leuckart deccanensis(Lindberg)
Nauplius larvae

Diaptomus .

g) Cladocera Bosminopsis cf. Pernodi. Cerodaphnia riguadi Rich.

Daphnia Lumholtzi.

Diaphanosoma paucispinosum. Breb. Moina dubia Rich.

Moiña dubia Rich. Macrothrix Baird.

"Like the Rotifera the Entomostraca rarely cause difficulty in Water Works but the brown winter eggs of Cladocera often collected, forming thick scums in the corners of reservoirs and filter beds" (Manual of British Water Supply Practice 1954, p. 723).

i) Nematoda Aposcelaimus sp. Cylindrocorpus Sp. Ironus Sp. Myoliamus sp.

j) Porifera Megascaleres. (Fresh water sponge)

(iii) Constant Forms:

Of these, the forms occurring constantly in almost all the collections during the two year period were:

(a) Chlorophyta - Pediastrum simplex. Meyen:

(b) Bacillariophyceae - Surirella tenera var nervosa A.S.

(c) Protozoa - Centropyxis

(d) Rotifera - Keratella valga tropica

(e) Copepoda - Mesocyclops leuckart deccanensis (Lindberg). Nauplius larvae

(f) Cladocera - Daphnia lumholtzi - Megascaleres.

(iv) DISCUSSION OF RESULTS

(a) Occurrence of Zoo-plankton organisms in the Filtrates.

From the foregoing it is evident that a fairly large number of planktonic organisms, especially zeo-plankton forms are passing through the six rapid sand filters. Of the 110 genera recorded for raw water, 47 genera in all are passing through; and of these 7 genera are almost always found indicating that they are really troublesome. In the Water Works in England 68 genera are stated to have caused trouble, though only in the case of 28 can the difficulties be classed as acute.

The organisms reported as having caused difficulties in British Water Works are classified under five heads:

(a) those blocking filters, (b) penetrating filters,

(c) causing taste or odour, (d) growing in pipes, filter drains etc. and (e) causing unsightly scums. Of these five categories of the organisms, we are concerned only with one group viz. those organisms, which are reported to penetrate through the filters. They are listed below:

TABLE NO. IV

Group

Genus

Phytoplankton

Diatoms Isokontae Synedra, Nitzschia & Stephanochi scus Green unicells ("Pleurococcus") &

Chlamydomonas

Chrysophyceae Synura and Mallomonas Euglenineae Euglena

Zoo-plankton

Rotifera

- Diglena, Colurella, Anurea, Polyarthra & Tirathra

Crustacea

- Cyclops, Diaptomus, Canthocampus, Niphargus, and Daphnia

But, Cyclops, Daphnids, Nematodes, Oligochetes and Megascaleres of Porifera (Freshwater sponge) have been noted in the filtrates from the rapid sand filters of Baroda. George and Kausik (1964) have reported about the presence of Nematodes alone in the two water supplies (Rapid Filtration Plants) at Delhi drawing water from the river Yamuna. The worms were stated to be unaffected by the excessive does of more than 1.1 ppm of residual free chlorine. They have been identified as Triplidae Andrassy (Syn. Trilobus) of the family Triplidae in different stages of growth. But the nemas found in Baroda belong to different families altogether. Four genera have been recorded and they are: Aposcelaimus sylindrocorpus sp., Ironus sp., and Myoliamus Sp. Of these Cylindrocorpus Sp. and Myoliamus Sp. were most numerous. They were not affected by the terminal dose of residual chlorine, of 0.2 ppm. According to Dr. Calaway (personal communication) who helped us in the identification believes that they are present either in the form of eggs or adults in the underdrains of the six rapid sand filters at Baroda. Chang et al (1959) and Chang et al (1960) have also reported about the passage of nematodes through rapid sand filters in the Water Works of some cities in the United State of N. America.

Cyclops have been recorded by Crabill (1966) in the Water Supply at Indianopolis. The eggs of these organisms were not killed by the dose of chlorine applied at the plant and very large numbers of these organisms were able to pass through the filter sand and hatch out and develop in the mains. He has suggested the addition of cupric-chlor-amine as being very effective against Nais. Worms, Water fleas, rotifers and nematodes. Hart (1957) found Cyclops, Daphnia, Nais and Nematodes in the Water Supply of Faringdon, England. He was able to destroy Naias worms using a free chlorine residual of 0.5 ppm in thirty minutes, while Nematodes, Cyclops and Daphnia required much heavier concentrations to kill them. English (1958). tried to kill Daphnia with pyrethrins and found that it required a dose of 1.0 ppm within 24 hours and 0.1 ppm within 48 hours.

(b) Significance of the occurrence of Nematodes:

cobb (1918) was perhaps the first to draw the attention of Water Works Engineers to the presence of nematodes in slow sand filters. Later Chang and his coworkers [1959,1960 (a) 1960 (b) have reported about their occurrence in the final distributed waters of some cities in the States, and urged the necessity for an understanding of their possible role in disease transmission.

Kelly (1955) and Chang (1960) have demonstrated the ineffectiveness of chlorine in controlling them. The latter also showed that nematodes which preyed upon pathogenic bacteria and viruses gave complete protection although 90% of them were immobilised. Recently Engelbrecht and Austin (1965) and Calaway (1963) have discussed the factors influencing their occurrence in Water Supplies and the various genera recorded in Water Supplies. Calaway (1963) \$p.100) states: " The occurrence of nematodes in the treated waters of various cities has been of recent primary concern. Most of these worms which we are considering here are normally the inhabitants of the soil. Their presence in water then indicates that contamination is occurring. This is not a definitely polluting contamination, but it does indicate the incipient danger of contamination of possible sanitary significance. The presence of nematodes may be likened to a high bacterial plate count or even to the presence of Aerobacter aerogenes, both of which may arise from soil contamination, but both the worms and the bacteria raise some question concerning the quality of the water examined. The presence of nematodes in water supplies presents problems the actual severity of which cannot be fully evaluated because of the present state of our knowledge. Not only can the presence of these worms be likened to high bacterial counts, but since many of them feed on bacteria or prey upon other organisms that are bacterial

feeders, they are associated with conditions that produce high bacterial plate counts. They are found in many surface waters in varying abundance and their presence in well waters is known to occur when conditions in the aquifer allow the entrance of surface waters. Such conditions may make the supply subject to sanitary pollution. Cobb stated in 1918 paper already cited that nematodes were common in the tap water of some cities."

"The two reports of Chang et al (9) and Chang et al (10) then should be no real news to those interested in Water purification and quality. These reports only give further specific instances of the occurrence of these animals whose presence in many tap waters has been known for almost half century. Therefore, the American Water Works Association, in a recent article (11), has taken what appears to be a fairly logical stand which may be summarised as follows:"

waters has been known for a number of years and there are no known cases in which the relation of their presence to disease has been traced, their occurrence in a water, while not desired, need not be a cause for excessive alarm. So the major problem they pose at present is an aesthetic one and research is going on in the States for a better understanding of the subject with a view to develop adequate methods of their control (Engelbrecht &

Austin 1965). Peterson (1965) has studied the removal of free living nematodes by rapid sand filters and concluded that (a) the present worm removal was independent of concentration at the flow rate, concentrations and length of filter periods studied; and that the concentration of worms in the lower layers of sand increased with the increased worm removal by the filter.

(c) Causes for the penetration of Zoo-plankton organisms.

Again, in the Manual of the British Water Supply Practice (1954, p.744) it is stated: "It has been recognised, however, that under some circumstances the rapid sand filter is an imperfect method of removing plankton unless used in conjunction with chemical treatment. Indeed the removal of micro-organisms may be anything from . 100 per cent downwards, according to conditions. The case with which plankton penetrates a sand bed will depend on several factors, the principal ones being the types of growth, the velocity of filtration and the grading of the sand. Apparently there are very few data as to the relative importance of these factors, though they likely to be effective. For instance flagellate organisms like Euglena, Synura and Chlamydomonas penetrate with great facility, probably because of their motility, and there can also be little doubt that the higher the rate of flow, the more easily the growth will wash through. Obviously,

too, sand grading is important and here it has to be borne in mind that the sand in rapid filters may become encrusted with Chalk when a water of high temporary hardness is being filtered?

"If a plankton growth is tending to penetrate a bed it may only be washed through quite gradually, the zone of penetration slowly spreading downwards. It may be some hours before this zone reaches the under drains and the clarity of the filtrate becomes visibly impaired. In these circumstances the bed is in effect acting as a large "trap", and frequent washing, even though the bed is not blocking, will sometimes help to maintain a filtrate of low algal content".

Let us now examine the several factors mentioned above which are likely to cause the trouble at Baroda. The bed of sand is the "heart " of a rapid sand filter and it may be considered first:

Filter Sand: Filter sand from one of six rapid sand filters i.e. Filter No. 5 was collected on 19.7.1963 and its characteristics were determined as detailed below:

Size grading: Samples of sand from different depths were taken from six different places after draining away the water; and representative samples were analysed for particle size. The results are shown below:

TABLE NO. V

Sand taken from depths	Effective Size (mm)	Uniformity Coefficient
0" = 6"	0.53	1.47
6" - 12 "	0.56	1.51
12" - 15"	0.56	1.51
15" - 18"	0.57	1.66
18" - 24"	0.60	2.37(Coarse sand mixed?
Average	0.564	1.70
-		

In the six Paterson rapid sand filters at Baroda, filter sand which passed through a 16-mesh and retained on a 30-mesh sieve has originally been used. Ordinarily such a sand will correspond to an effective size of 0.54 mm and uniformity coefficient of 1.33 (Jain & Dhaneshwar 1960). But the effective size of sand in actual use is slightly higher than the normal size.

In England it is usual to specify the grade of sand to be used as that which passes a 16-mesh and is retained on a 30-mesh sieve, the meshes used being in accordance with B.S. 410:/1943. The meshes have a nominal width of 1.003 mm and 0.5 mm respectively. According to British Practice the terms "effective size and uniformity coefficient "developed by Hazen in America have no particular meaning.

True Density of the Sand

TABLE No. 6

Sand taken from depths	True density		
0" - 6"	2.2		
6 ⁿ - 12 ⁿ	2.3		
12" - 15"	2.2		
15" - 18"	2.5		
18" - 24"	2.5		
Average	2.34		
**************************************	Hadragh Printer (Control of Automotive Control of Automotive Contr		

The silica sand has a density of 2.6 but the average density of sand used in the filters is 2.34 only and it shows that it is lighter so that washing may not be effective.

TABLE NO. 7

Sand taken from depths	Moisture	Organic matter	Insoluble	Calcium
0" - 6"	0.416	1.50	98.0	0.062
6" - 12"	0.580	1.58	97.5	0.092
12" - 15"	0.600	1.60	97.9	0.053
15" - 18"	0.545	1.03	96.2	0.049
18" - 24"	0.520	2.10	96.2	0.076
Average	0.532	1.56	96.8	0.064
222222222	100 mm 100 mm 100 mm	***************************************		******

The bottom layers of the sand seem to contain more organic matter indicating that fouling of the under-layers had taken place in the filter. The quantity of Calcium also is very low, and the hardness of raw water is also not very high.

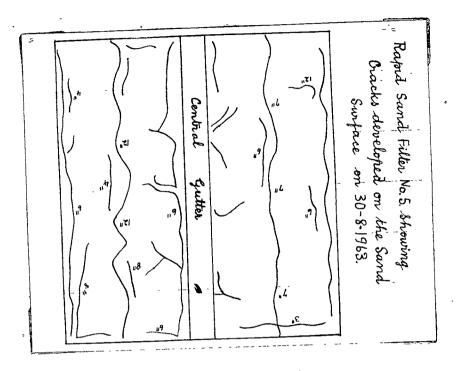
The depth of sand provided in the filter usually is considerably greater than the maximum penetration which is likely to occur with a normal type of water. This extra depth provides an ample safety factor and is normally capable of dealing with the finest suspended particle likely to occur (Manual of British Water Supply Practice 1954, p. 420). In the Paterson rapid sand filters at Baroda the depth of fine sand is 24 inches so that normally it should be capable of dealing even with the smallest sized micro-organisms. But that is not so.

Velocity of filtration: The rate of filtration is ordinarily 80 gallens per square foot per hour for a major portion of the year and is 100 gallens for the summer season. This velocity of filtration is also normal and therefore, cannot be held responsible for the penetration animal plankton organisms through the filters.

Type of Growths: Most of the organisms passing through the filters are rotifers, copepods, crustaceans, nematodes and oligochaetes, which are comparatively larger in size.

There is one special feature of the Water Works practice at Baroda which calls for comment. The Water Works authorities at Baroda do not add alum for nearly seven months in the year (January, February, Marfh, April October. November and December) on the plea that the turbidity of the raw water then is about 10 or less than 10 ppm. It is a point for consideration whether it is a correct practice to do so. It has already been pointed out in the Manual of British Water Supply practice (p.744) that " under some circumstances the rapid sand filter is an imperfect method of removing plankton unless used in conjunction with " Chemical Treatment". Indeed the removal of micro-organisms may be anything from 100 per cent downwards according to conditions". So, it would appear that the non-addition of alum for seven months in the year may be a contributory factor for the passage of the large sized rotifers, cyclops, daphnids, nematods and oligochaetes.

A careful examination of the surface of the sand filters was done several times with a view to find out whether any cracks had developed on the sand surface. The surface, after draining away the water revealed a number of cracks including side-wall shrinkage on all the occasions. A typical picture of the sand surface in filter No. 5 taken on 30th August 1963 is shown



The cracks were several inches deep. Also, the fact that the bottom layers of sand contained more organic matter would seem to confirm the observation that the zoo-plankton organisms were most probably passing through the side wall shrinkage and cracks formed on the filter sand surface.

(d) Control of Filtrate turbidity:

Its importance has not yet been realised in India, as the following will show: Although the U.S.P.H.S., the W.H.O. and the Govt. of India have specified 5 units of turbidity as permissible for public water supplies, it is not known why the water works authorities at Baroda were filtering at all their raw water from the Ajwa reservoir for seven months in the year when the turbidity was less than 10 ppm and also when no alum was being added during that period. Even after filtration the turbidity of the filtrates was never below 1.0 ppm though

authority on water treatment may be appropriate in this connection. "An operator of a filter plant would be horrified if his plant turned out a treated water no better than this standard permits. In fact, if he has a turbidity of over 1.00 ppm he is probably worried. Most specifications, even for pretreatment units a-head of filtration, require an effluent turbidity of not over 10 ppm and 5 ppm is not at all uncommon in actual practice. The effluent of a pre-treatment unit thus theoritically complies with the foregoing standard but obviously no operator would think of turning it directly into the mains ...".

Again, Walton (1956) from an interesting study of about 80 water treatment plants in the States for finding out the relationship existing between incidence of infectious hepatitis and the quality of the treated waters established bacterial quality. He found low hepatitis morbidity rates in cities supplying filtered waters of excellent bacterial quality and very low turbidity of less than 0.1 ppm.

Again, Hudson (1969) has furnished data showing the relationship between filtered water with extremely low turbidity and virus diseases as shown below:

City	Average turbidity of filtered water(units)	Residual' Chlorine' (ppm)	Per 100,00 Jaundice cases	00 population Polio cases
1	1.0	0.8	130.0	No data
2	0.66	No data	13.3	10.2
3.	0.20	1.0	8.6	7.9
4	0.08	0.65	4.7	3.7

It will be evident from a study of the above the correlation between the incidence of virus diseases and the amount of clarification expressed in terms of filtrate turbidity. The clear the filtrate the less the incidence of viral diseases. So, the importance of controlling the final turbidity of filtered water will be evident. A much greater refinement of filter performance is needed particularly in regard to turbidity at Nimeta Water Works at Baroda. The turbidity of filtered water should not average more than 0.1 ppm and in which case no organisms is likely to pass through. Naturally, fine control of turbidity requires highly accurate and precise testing instruments and cannot be achieved by the use of turbidimeters now in use in the water works at Baroda.

(e) Remedial measures: So, the following remedial measures are suggested for preventing the penetration of zoo-planktonts through the rapid sand filters into the

filtrates. The first step that is recommended is the break-point chlorination of the raw water, the breakpoint doses varying between 1.8 and 2.9 ppm. This will kill all the organisms and also precipitate them in the sedimentation basins. Next, the correct dosage of alum should be added irrespective of the raw water turbidity throughout the year. Thirdly, once a fortnight one or two beds at a time after back-washing should be completely drained, raked and the sand exposed to atmosphere for drying. In this way, the organic and inorganic coatings on filter sand will dry up. Then the filters should be back-washed immediately so that the fine dry dust of organic and inorganic matter may be removed. Fourthly, every month one filter may be super-chlorinated for a period of atleast one hour and then back-washed. By all these measures it should be possible to free the filtrates from any organic growth of animal or vegetable origin.

V. SUMMARY

- The biological conditions in the different situations of the Nimeta Water Works system were examined for a period of two years.
- Largest per centage of 56.2% of the genera was found to pass through the rapid sand filter No. 1 and the smallest per centage of 37.5% of the genera was found to pass through the rapid sand filter No.4. In the remaining four filters the percentages of genera penetrating through them were found to vary between these two limits.
- 3. The causes for the break-through of the zooplankton organisms have been investigated and
 practical remedial measures have been suggested.



IV. REFERENCES

- Calaway, W.T.
 J. Water. Poll. Contr. Feder. 35, 1006-1016 (1963).
- 2. Calaway, W.T.

 Personal Communications dated 3.5.1965 and 9.6.1965.
- 3. Chang, S.L., J.H. Austin, H.W. Poston, and R.L. Woodward: J. Am. W.W. As. 51, 671 (1959).
- 4. Chang, S.L., R.L. Woodward & P.W.Kabler: J. Am. W.W. As. 52, 613 (1960).
- 5. Chang, S.L.
 Am. J. Trop. Med. & Hyg. 9, 136(1960).
- 6. Cobb, N.A. Contributions to Science of Nematology, 7,189 (1918).
- 7. Crabill, M.P.
 J. Am. W.W. As. 48, 269-274 (1956).
- 8. Engelbrecht, R.S. & J.H. Austin.
 Water & Sewage Works, 1965, Feb. issue.
- 9. English, E. The Soc. f. Water Treat & Exam. 7,127-143 (1958).
- 10. George, M.G. & N.K. Kaushik. Environmental Health, 6, 229-233 (1964).
- 11. Gore, S.Y. CPHERI. Bulletin. 3, 61-64 (1961).
- Report to U. S. National Research Council, (1959).
 - 14. Jain, S.C. & R.S.Dhaneshwar: CPHERI. Bulletin, 2, 28-45 (1960).
- 15. Kelly, S.N.
 J. Am. W.W. As. 47, 330 (1958).

- 16. Manual of British Water Supply Practice.

 Compiled by the Institution of Water Engineers.

 2nd Ed., 963 pages (1954).
- 17. Peterson, R.L.

 Civil Engineering Studies, Sanitory Engineering
 Series No. 26, University of Illinois (1965).
- 18. Rankine, R.S. Report No. 166, Public Works.
- 19. Standard Methods.

 For the Examination of Water, Sewage and Industrial
 Wastes Published by A.P. HA., 11th Ed., 1960.
- 20. Walton, G. J. J. Am. W.W. As. 48, 1281 (1956).

	(Gryanisms for letre)	misn	ns Je	۲ د و	<u>(</u>												ı
Vear				1963	9	1						19.	1964				1
	24-9 24.5 21.6	21.6	19.7		25.9	30.8 25.9 2410 29.11 2012	11.67	2 210	24.1 25	253 28	4	24.7	26.8	25.9		2410 27 #	10.01
A Phytoplankton									,								
Chlorophyta																	1
Cosmanum deforessum Nag	1	1,	 6	9	1	,	1 .	1	:		١.	1 .	- 1	-	1	1	t
", contractum Kinchm	ŧ	ı	=	a	2	٠	*	4	, 10	Ŋ.		n :	2	2	1		ı
Gedogonum st Gedrastum sampler Neym	50 60	1 2	3 5	ð 5	1 %	49	20	20 4	40 70	+ 0	, Y	× 4	80	2 40	2. %	18	1 8
<u>Eusfenophyta</u> Grachelemenas volvocuna (Ehaenb)	40 56	2	120	180	90	Ue Se		4.	48 27	32.	001	162	45	4	K	90	, , , , , , , , , , , , , , , , , , ,
(c) Chrysothafu.	20:36	44	4	es es	90	100	==		LE. 021	. 6		30,30	. 30		79: 06:	2	35
Bacillanuchtugeeae 7. Achmanthes exitis (Kuts) 8. Invahora torneta(Kuts) Hust 10. Coconers fracentala (Ehrs) Hust 11. Coconers fracentala (Ehrs) Hust 12. Immedia affirms (Kūts) 13. Immedia (Breb) V H 14. Depithemia sorsa (Kuts) 15. Tragitlavia Crotinnus, Kuts 16. Mashina apraent tras aundum (HBF) V H 18. Gomphonum aprucit ras aundum (HBF) V H 20. Aicholomum (H. Sm) V H 21. Mashina apramulata vun annyustisshmu o Mutt 22. Austenda crup focesphala flutis	5 + 14 + 3 4 1 5 + 1 + 0 4 L 4 + 4 + 6 + 1 10 = 1 1 1 L L 2 = 2 + 4	1	<u>u</u> 111144190 100 100 100 100 100 100 100 100 100	4 14 100 1 100 444 4 4 4 4 4 4 4 4 4 4 4	₩	w 1440 12444444444	# = 449 N 4 14 m c 4 m 4	ב א שאר א שון שא שון א שאר א שו	3 1+0 1+0 × 10+++0 = 0	== 111014041511054	īrī 1994 i 19 waday 4 w p	12 1 a r + + 12 + + m a + a a r	15000 14 18 WW 4 1 14 MW	22cos11110 +m 1+on3	n = am a h of f 1 1 m as = 1	20 TILL4114 11 1 - 4 +	521141=114111001

	year	_			<u>.</u>	1963								1964	*				
	Sate	24.4.2	245 2	6: 9.12	-	30.8 25.	25.9 2410 49.11	D 29.1	1 2812		25.3	14.1 25.3 28.4	11.6	24.7 28	28.8	8 259	24 10 27.11		18-12
7.	Nilyschu (cf. N aacularis W Sm)	~	3	3	+	6	4	4	+	2	9	ત	9	4-	m	+	H	2	4
3.5.	Kullyngrama O Hile	•	₩.	 	+	7	1	1		1	٠ ٠	~	9	s)	+	ત	+	^	4
3.6	rgma	ત		+	•	٠. دخ	4		œ.	•	4		*	4	m	•	*	ન	4
អ	Rhotzalodia gibba (Ehv) O Mull	6	9	+	٠	4	u,	7	ત્યે	4	4	4	h	•	ų	•	•		'n
\$3	Surrella tenera vor norvosa As	2	20	9	8	10 40	25.0	01 . 1	0	+0	30	2	35	20	9	8+	t		m
57	Synedra Wina (Mtg) Ehr	+	eş	허	ĸ	w 4	4	1	1	*	7	ب	9	4	M	4	•	1	ţ
30	", " acus (Kulby)	9	ন	3	4	3	4	1	{ -	-	t.	ł	I	+	•	m	1	1	ì
76	"	જ	7	ત	N		1	1	ī	_! 	f	ı	1.	~	~	ત્ર	1	i	1
उ	Cyanojinya						-								-				
ď	Anabaena sp	ŧ		1	ì			u) -	ı	1	ţ -	ſ	1	I	+	1	-	N	1
Ę	Anacystis eyana (Kuts) Or & Duily	٩	 +	4	+			-	-	20		1	ţ	f	1	1	;	٨	٠
34	Cylindrosper mum sp >	ŧ	ı	ĺ	ŀ	8	·	,	1			1	+	٠,	+	1	1	1	1
5	Mucrocoleus chthornofilusts (Mun) Zamand	સ	4	4	و	i	1.		٠.	-		∾	C)	ŀ	1	4	+	1	ı
	B ZOO-PLANKTON		•									-			,,,,				
3	Prologon					-			-			-					,		
	strella	4	ŧ	ı	ì				•		ŧ	1	i	1	1	ł	4	•	+
~	Biffluyia hydrostatica	1	+	N	ŀ	4	ı	α,		<u>+</u>	9	2	~	4	1	Ŋ	ŧ	~	4
6	Contrapyais	12	~	1	ŧ	-	+	,	. 15	7	2 10	1	27	·	1	‡	7	4	ſ
_	Lecquereusia	ŀ	1	ł	1	1		1	۱		1		1	+	1	Į,	!	Ī	1
is.	Vor tretta	1	1	ı	ı	1	*	~	,	 -	1	+	* .	+	-	1	1		1
•	Rollpus										-								
9	Anwaeopsis collata	8	26	80	99	1 801	128 4	45 3	39 27		106,144	1 248	3 500	¥ 0	•	\$05. 208	200	ē	2
1	" fisha	+	٠	+	60	ત	~		7	3	~··	6	b	÷	M.	~	4	^	m
80	Ascomortha saltans indicu	~	4	2	6	m	o,	رہ		~	.c	4	m	0	+	T.	6	۴	4
نن	Brachionus angularus	m	2	6	4	6	-€V	٠. باد		70	س	'n	^	+	•	6	+	•4	4
<u>0</u>	", Candalus	~	•	4	ત્ર	7	4	٠.	`	<u>.</u>	٠ 2	1	1		ન	5	m	+	6
#	. diversi cornis	2	401 010	12.0	3.0	•	1001	1 60	100	120 12	13,	7 . 2	126 138 108 127		711 721	2,00	8	8	8

	-
bryomisms in Raw Water,	
Sable No.I (conts): Benodicily of Theyboplankton and 1900-plankton 6	Nimeta Water Works . at Baroda.

E Coll	Date	_	7.14		_	_	-	L	<u></u>				ŀ		-		١
THE COL		24-4 245		19.7 34	30 8 35.5	\$ 24.10		29 11 20.12	7.7	193 2		116 24	247 48.8	132	01-12	11-12	54.5
S F S F E	Brachionus falcatus.				2 2	4		1	-	-		4	-	'	1.	١ ا	١ ا
4 5 4 E	", forticula	19 40	77	79			9	25	2	e.	30 : 6	4	9 70	. <u></u>	36	33	40
i r coll	CephalodMa gibba.		l		ţ [1	=	1	,	- 1		. <u>.</u>	1		i	1
es col	n megalocephala	-		1	= .	. , ,	4	1					٠,	.=	4	1	ſ
r Cole	Collethera ".	1	. :		. [. ,	!		ŧ	2	77		7	· · · ·	. !	1	ţ	Ì
	colurella oxycanda		ł	-:			4-	<u></u>	1	1	 		<u></u>	٦ ت		!	1
: 2	nametehorus cpichwis				•	•	90	ש	1	 1	ં લો	<u>_</u>		10	6	N	9
E S	Euchlanis dulatati	1	+		9	~	3.	4	m	S	-S	4	~	٠.	-	~	4
75 02	Februa terminalis		9	4	6	4-	. 1	. f	+	4	ю 	w	4		4	ڡ	4
21 Ker	Keratella valga Fropica	230 150	384	305 2	210 2	0 17	12.6	0 0	9	170		۰	9	70 S	4=	128	7.26
i Z	Lecane arouata	3		14	=	1 ~	l	+	6	۳	더		<u>~</u> .	4		۲.	=
57	" aruta	4	ત	=	<u>r</u>	.	7	4	2	ŭ	렆		<u></u>	10			. 27
7	" bulla			f	1	ر م	4	4.	3	1	ı	{	~	4	•	~	4
4.55	" clostinocenia	4		ત્ર	٠. 4	×.	*	4	1	i			۔ د	7 . 13		****	==
25	" -ysleata	-	1	1		.'		•	4	-	ſ	1	ستند م	7			!
æ	" hamata.	7	•	I	ť	1	- 1	1	1	1	1	- -	۰	4	+	~	1
7	", havingi	1	1	Į	į	1	{	*	4	1	ı	1	ب ق	4		1	1
2	normann	4	*	-	5	6 3	ŧ	**	4-	1	~	~	~	4 3	٠		١,
30	", luna	લ	'n,	ત્ર	7	4	•4	1	f		1	4	<u>۔</u>	4	4	اب	
- 6	" Lunams	!	ł	f	1	9 ~	4	ŧ	ŧ	1	4	5	=	4	 	1	
32	", patenana			۲-	2	2 3	4	ŧ	1	{	ه-	٠,	4				
33	", quadrudontaka	10 7	۳,	~	4.	+	'n	ŧ	!	4	어	4	<u></u>	iù ex	EA	.	+
	", thienemann	~	*	3	و	4 3	ar	9	.		<u>د</u> ه	ತ	5			2	3
SE	" unquitata		m	+_	=	ت ت	3	-	9	+	60	9	4	 #3	٠ د	+	r
	" unqulata	4	+	~	-	*	ب ر	•	*	٥	•	4	٠٤٨	<u>.</u>	٠ مر	*	0
37 May	Mykelima ventralis	2	m	+	5	ۍ 80	~	· m	«	7	_ ન	m	4	'n	e4 	*	•
	Notommata .	9	7)	=	<u></u>	٠.	 	0	=	و	م. پ	~	٠			5	ò
39 Be	Pedaha.	7		f	1	 	4	4		7	4	ي .	4	i,	- 9	=	•
40 Poh	yarthra	, m	. 1	તો ~	 რ	+	 ب	+	<u>~</u>	40	90	· ·	~	•	 	2	•
# 9°		4	÷	ر. م	+	4	3	ري	2	2	٦	=	~	-		*	9
42 8	Physical furcula	,	!	1	9	~ +	ส	5		5	1	4	~	•	<u> </u>	<u>.</u>	

		***************************************			A THE RESIDENCE AND A STREET AND A STREET ASSESSMENT AS						-							
year		+	-	1963	~			Ī					1961	_				
Bate	***	244 245 21.6		17 30	ed.	19 7 30.8 299 24.10 29.11	74.1	20.02	4	15.3	28-4	9 2	4.7 28	55 25	41 6	12 23 .1	18:12	
Besorption							•					The state of the s					_	
Physica str.	20	=	4	5	ا	1	1	,			=	1 2	و ا	19		-		
Gestudinella patina	1						=	10	ı		. લે	9	-	· ·			li	
Getramastra opoliensss	30	_	206	۵		2	. (1	(9	40	7,09		· '			1 1	
Grichocota mycersi	,	,		~~ !	!	4	ſ	Ţ	1	~	"	*	4	∩ئ ا ن		· .	1 1	
" muthren	!		1	~	4	=	m	t	1	1	બ		, LeJ	. 4	-	f	1	
" semules	1	ı			!	1	4	7	١	ı	ı	د ا	4	4		٠,	ŧ	
Bdellordea	9	30 5	50 2	20 60	Q 0	90	4	w.	4	œ	0	7 7	0	0 00	08 0	25	30	`
-	1	ί.	1	1		1	ſ	1	!	t	.11	1	4	1	!	_ <u> </u>	. ŧ	_
(e) Appenda	1			1			ſ	ı	1	ı	ſ			,	1		,	
3	ſ	ı		30	1	2	=	77	í	ŧ	ŧ		, m	42	۲,	-	1	
" Cernetius (Gurnoy)	-		9	2 60	-	1	ł	1	1	I	ı	4	187				_ !	
52. Mesocyclops leuckant deceamensis (Kundberg)	140	20 5	50 4	40 100	10 20	9	9	3.0	40	160	340		0	90 5	50 : 50	15	9	
Naufolius larvae.	120	30	8 09	80 13	130 150	07.1	100	•	80	70	20	8	0			18.0	2	~ ~~~
	3	-	1 51	ت ا		0	42	31	1	t	f	4	, 9	27 3	33 38	5		
Hellodiaplomus cemetus your	1	ì	[~		4	ſ	1	1	4	4	m	4-	,	+	Č	90	
Norgrafitietade	4	6	4	3	1	4-	3	I	1	ŧ	ŗ	, t-				!-	- 1	
00 - 1 - 00	<u> </u>	ţ	1	i	f	ſ	í	1	1	ı	7	1	;	,	1	 		,
מסנביים	1		ī	Į.		1	1	ſ	t	1	I	1				1	-	-
Mona Baird	<u> </u>	<u>.</u>	4	1 9	<u></u>	2	5	1	1	4	15	2	 -9		7 11	4	20.7	€
or Affinis	4-	=	3	÷ ∞	n	4	9	4	1	i	1	4-	<u>ر</u> م	` ∞		[. (1
n of Archer	1	1	,	1	1	1	1	ન	=	ı	ſ	4	,) 		5	
" . thydorus	1	4	E	0 - 1	4	1	1	1	1	t	ſ	. 7	95	4	نه ا	 	1	
" macrothrux	1		t	ı	જ	W	i	ı	1	ı	ŧ	4	+				ſ	_
n verrucosa	1	1	4	i In	in.	į	Ŋ	4		1	1		~	ſ	•	ا 	1	
" cambone	1	ı	· W	4	!	1	1	ł)	1	+	3	١		
" intermedia		8				4	100	4		Í	ľ	- E			-	- 4		-
ella Karua	^	, Pc		r 1	,	- 1	. 0		; ~	1 0	ŧ		1 4	ر. راد	 ! ••		- 1	
munopsis of Pernode	. 1	,		. ~	, - , 4	49	. 43	•	١	?	ı 4	2	-				' :	
Conodazhma Frquade Rech	! i				4	~	. 1	1	1	1	-		ſ	· · ·		ا الما	-	
Chudonis Barrossi	·			,	• •	. 1		1	[ŧ	ſ	-	<u></u>				!	

C. Colores Train T	owner not commy. I would of me into-land 200-standlow organisms from Raw Water, Mater water at Baroda.	persons in Raw Water,
yes	1963	1964
Sale	24-245 416 197 30.8 259 24-10 1911 2012 24-1 25-3 28+ 25 247 28 1 159 24 10 211 1612	1 25-3 26-4 10 24-7 28 8 259 24 10 27-11 1613
69. Bajshmia Kumholtzi.	50 20 16 80 90 40 60 80 65 40	1 40 130 100 100 9 30 50 26
10 Bighanosoma paucispinosum Brehm.	m 3 2 1 1 4 2 10 4 3 21 4 10 1 1 1 1 1 20 1	2 4 10
71 Bunke vedia.		4 4
13. Maenothrie Baind.	1 3 6 1	6.7.3.3.2
73. Morna dubia Rich	4 4 4 4 3 2 4 5 4 3	3 4 4 1
74. Sida sp	1 1 1 2 3 17 1 2 3	4 600 4 2
15 Megascalaris of Britera	120 356 210 210 228 246 590 140 560 400 16 350 110 240 128 360 140 127	721 041 050 120 040 040 140 140 140 140

TOUR				1963	_				Ì			- 1					
A STORY	24 + 24 5	21.6	147	1	30.8 25.9	34.10	11-62	29.11 20.12 24.1	14.1 25	3 23	4	11-6 24	24.7 258	8 25	bc 6	10 27-11	18:12
A Phytostankien								- 4 -	lorganisms for	\$ \$	r titie	ئۇ كىر					
Chlorophyla.	7	7.4	ã	9	5	3 0	<u>ۍ</u>	ч	•		4			_	51 4		ý +
Strongyna Ap	4 4 4 4	ie ie	4 9	e -	- ~	eo 1	4	* ~	<u>-</u> مد	4 1	ni oo	* m		n 4 n _	ı m) 4	, w
Englonophyta Trachelomonas volvoeuna (Ehrenb)	4 ⊦ 3	5	91	=	w	4	tų.	4	ન	m	4	.	2		%s 	ત	m
Chrysophytu Botryocorus Brunnu	ъ 2	4	ĸ	w	~	ત	6	4	m	od.	٠. م	w	4	ત	· · ·	ન	W
Bucklorusphyreae Notrs chia kubymgiana Suvirella lenera var norvosa A S Synedra ulna (Note,) Ehr	ન <u>.</u> ત	, n 1 1	9 ! I	14-	1 - 1	1 _ 1	11	4 1 4	તા ન	m	. d -	{	n 1 l m		- 4 - 4 !	_ [A]	ų
Cyanofrhyta Anacyskir cyana (kuliz) Or be Baviy Gsullatona Lonnis	ં _ તે	4	1 m	1 ન	1 4	1+	- 4	w	~ m		~	8 M	1 el] W	ek	, w	ા નો
B. 200-plunkton 9-otopoa. Contropyin 24 flugia Rotifusa Brachonus candalus Keratalla valga hopica Frikoveta hutinen Copyrodu. Meso cy elops leuckart deccanensis Capyrodu. Meso cy elops leuckart deccanensis Capyrodu. Meso cy elops leuckart (Lindlerg). Cladovetu. Baphmua Lumholtivi Gonifera. Megascaleres of push water Brigan	1140144-0	14444 m	1 100 4 104-+	1144114-4	44441114	114 - 41 - 10	114414-1-	44341-416	1 100 44 14 40	- 4 g p 4 14 - 0	111914	114 2 2 14 4 5		4 - 4 - 1 m	T = 3 4 4 T = 4		4-3-9 - 1

Numbly Works at Bure du Grquations appressed in monthers you who had by Works at Bure du Grquations of the second

Wan				963	8			H				1964	4			
sake	244 345 316 19.7	5. 216	19.7	30.8	308 259 2410 2911 2012 24-1 25 3 284 11-6 79-7 28-8 259 24 1021 11:15	+10 7	9.11.20	42 24	1 25	3 284	<u>=</u>	74.7	8.8	2 65	12016	1 15 19
A 8thyloplankton (a) Chlorophyla. 8edasbum. Simpler Meyen	** ***	85	01	\$0 *0	, ,	9	ı Ö		20	ล์	23 100	310	2	3.	. 94	9
(b) <u>Buglenophyta</u> Frachtemonas volvocunu (I hremt,	Î	1	1	1	50 50	1	1	:	ł	1	ţ	ı	1		بر د	1
(c) Bacillangthyeese Nitz shia (ty N -scieularis W. Sm) Euwrella tenanu var nervosu A s	l I	1.2	10	: 1	2 I		1.8	177	1 %	1 %	1 2	1 #	30 %	1 %	16 40	1 1
(a) Gratezon Centropy 225	!		50	•	1	9	£ 08	29 05	4.	7.0	36	1	1	9	** **	1
th Rottera	24 45 86	مد ب 5	à	ı	·	72	12 13	140 200 180 196	38.0	967	<u>~</u>	79	*	1 0 4	120 20	9
	1	i	1	į	1	;	\$	75.	¥9 .5			,	t			,
orphu	1				٠		18.8	1	:			1	ŧ	:		,
Bruchwins ungulun	1	46	ŧ	I	i	13	458		. 26	1	20	i	20	9	;	
	4	7.	t	45	90	20	4	45 182	2 +0		0		20	1		i
	1 36	9 140	•	90		22	,		•		٠				,	;
" fulcates	901		•	1.15	24							9+				+
", fortreala	;	160						63 142	2 184	÷.	30		<u>.</u>	71	38. 20	9 - c
Corrothera	1	1	į	<u>a</u>	i	1		1	1	ŧ	1	ŧ	i	de	ı	1
Accrandphones epichanis	1	. 35	,	1	:	,		- - 1	1	1	Į	i	į	ı	1	1
Filmsa terminalis	1	99	1	ŧ	:	•	,	1	1	i	1	2	9	ı	1	1
্ব	100 140	0170	99	4	90	110 5	55 80	190	941 0	9.8	130	80	30	3.9 .	232 PO	Ğ
Kreame uncula	1	45	;	i	;	į	1		,	1		ı	į	, 1	1	•
	,		,	1	65	4	400 3	350	35	45	į	ſ	1	, 0,	ı	1
", closteneera,				. [, ,	. [90	!	,	1	į	;	į	,
		. 1	,		1				1	30	1	t	1		1	ŧ

	year				1963	m		1	Γ				-	1961	_		İ	
	Bate	24429	295 216	6 197	1 1	30-8 25-9		X4-10 29 11 2012	2012	24.1	25.3	7.87	11.6 2	247 24	18.87	259 24	14101711	18 12.
ដ	Lecane lunary	1		į į	ı	I	1	1	40	1	35	ŧ	,	,	Ì	1	1	I
ŧ	7	1	s opo	8.5	I	1	ŧ	1	40	i	38	1	i			•	I	1
25	", quadradentata	1	1		1	i	1	36	,	ı	i	i	ì	!	4	++	1	1
3.6	" thienenum	1	1	1	29	ţ	1	1	ı	;	í	;			i	1	1	i
74	" unquitata	1		1	1	1	I	176	891	2	45			1	,	,	ı	i
32	nrnat	1	,		1	30	12.6	40	156	10	60	20	6 001	3 00	50 46	9	,	Ξ
25	Pedalia sp	1	,	;	1	;		1		40		4.5		•	,			
30	Gohzarthra sp		7.7	1	8.0			•	;	. :	;	40		*		i	I	ſ
3	Gompholy - womplanata	1	90	. 6	176	ī	į	162	ı	400	90	;	;	,	1	ì	٠	1
2	4	4	1	4.4	4	37	1	ſ	,		43	1		i		1	3	1
æ			30		ı	- 1	1	1	ı		ı	-	0	38	92			1
*			32			! !	!	99		1	۱	1			3	ا ر		1
. K	,	1			;	1	ı ;		1 6		180				· ·		. 2	
							!					•	١.					
*	(c) Copepada. Mesotycleps luukart decemensus (Lindberg)	56 61	9:	6 2 5 9	9 340	₹	<u>6</u>	0	ō	9	4	1	6 6	. 4	. 4	2	4	50
. 26	. 3	92 104		140 206	6 210	52	99	19	50	100	ı	40 130		70 11	- 001	7	20	7.7
38	Diafrtomus	20			i	9	80	1	Į.	0)		01		0,	- 36	ا	1	*
<u>~</u>	(d) Cladocena. Bosminopsis et Jernode	1,	و.	-	1	t	;	ı	;	1	õ	1		±2 60	5 5	=	97	4
4	. 2	140 12	126 91		3.6	89	5.6	38	4	2.6	4			100 3	30 ~	3.9	0	1
7	Fumple vedica	1	I	ļ			<u>.</u>	=	1	ı	ı	1	0	,	5	-	ı	9.
7	Moina dubia Ruch	<u>e</u>		هه	ł	~	òq	91	4	ı	i	Ós	1	4-	1		6	Ž,
	(e) Nematoda																	
	Aposrelaimus sp	i	1	1	ſ	l	4	f	ì	1	ŧ	20	1	i		1	160	٥,
Į	Orfundro-contras sp	1		1	1	ı	9	1	ı	ŧ	1	36		•	1	1	20	7
45	Fromus Sp		1	1	ſ	1	1	ı	1	ſ	į	90		·	1	- 1	10	1
4	Myolamus sp.						,1	1	1	1	_	4			1	1	S	1
	(4) Fortona (Fresh waler shonge)																-	
F	Megascaleres.						•					,						

23. Notommula sp. 24. Notommula sp. 24. Gestalua sp. 25. Somphoryz complanala 26. Sebramasliz opolumsus 27. Grehoveta mycersi 28. Albhidea Tulknesi.	244 345 216		_	1963	•		_				1964			
Notommaka n Pedadua sp Pomphokya Iekamaska Grichovera ,,		21.6 19	-06 1-1	14.7 30.8 25.9	24.10	2911 2	24-10 29 11 2012 24 1 253 284 11 6 24-1 286 259 2410 2711 1812	1 25.	284	= 6	7 6.7	66 25	147 6	2711
Pedala sp Pomphoby. Setramastr Grichoteta P. Allinides	3	1	1	1	100	1	82 110	991 (120	001	7.0	50 66	1	١
Generation of the Section of the Sec	1	26	7 25		ſ		<u> </u>	1	38	1	ı	l l	•	1
Getramastiz Grehoevta ",	1	180	120	l	t	-	86 400	58 0	4	ì	į	1	i	J
Grichoteta ", RdeMaidea	1	1	25	1	12	1		١,	1	8	•	,	1	1
", R. dollaidea		,	1	=	í		- <u>I</u>	ſ	ı	ı	i	1	ł	ŧ
	1	ده	1	į	1	101	140 160	9 95	<u>د</u>	i	i	!	į	86
•	1	1	90 -	I	ı	1	- 54	1	ı	t	ı	1 64	1	ļ
(c) Copepada:	-			•										
30 Mesocyclops buckunt decements (Lundbong)	84 65	76 1:	126 220	3.6	. 1.2	8	89 56	33	1	į	32	38 _	2	98
s Nauplius larvae.	28 32	150 11	165 90	977 (75	9	58	40	4	180	0,9	99 06	20	3
32 Biaptomus	6	6	16 -	19	į	ı	- 24		ı	1	22	±	*	1
2002														
34 Bosminopsis of Fornod	\$	w	4	ત	+	1	9	i	ï	m	ı	+	4	Ф,
ξ	18 26	14 13	138 132	35.	3.6	12. 5	26 50	90	7 8	40	9	46 24	ŀ	2.2
36 Moina dubra Ruch	7 72	1	41 38	i 	ı	30	12 41	1	f	Į	1	1	20	8
(e) Glagochaeta: 37 Enchybueus styr	1	4	4	t ·	1	- 1	1	1	1	1		1	1	ŧ
4) Nomatrala					1		 		5				94	
(m) am and (c)	1	ī	•	f		' !	-;	1		į	[(·)	1
34 Entendro Cottons Tr	1	i	200	1	4	1	1	1	i o	ı	1	1	4	ŧ
40 Fromus sp.	1	1		i	•	1	1	1	ţ	{	ſ	1	0/ .	1
11 Myoleamus sp	! !	1	2	. 1	œ		1	1	•	ſ	í	1	70	1
(g) <u>Geryena (Fresh weder spenge)</u> 12 Megus calenes	8£ 9]	0	ı I	ſ	ı	مه ا	\$0 \$0	4	S	1	6 0	, 92	1	3.6
	···													
	•													
	-													

(c) Congrada. 22. Mareoyology, buskent decements (Lindberg) 23. Mareoyology, buskent decements (Lindberg) 24. Mareoyology, buskent decements (Lindberg) 25. Mareoyology, buskent decements (Lindberg) 26. Mareoyology, buskent decements (Lindberg) 27. Mareoyology, buskent decements (Lindberg) 28. Mareoyology, buskent decements (Lindberg) 29. Mareoyology, buskent decements (Lindberg) 20. Cologochocology 20. Cologochocology 21. Mareology 22. Mareology 23. Mareology 24. Mareology 25. Mareology 26. Cologochocology 27. Mareology 28. Mareology 29. Mareology 29. Mareology 20. Cologochocology 20. Cologochocology 20. Cologochocology 21. Mareology 22. Mareology 23. Mareology 24. Mareology 25. Mareology 26. Cologochocology 27. Mareology 28. Cologochocology 29. Mareology 29. Mareology 20. Cologochocology 20. Cologochocology 20. Cologochocology 21. Mareology 22. Mareology 23. Mareology 24. Mareology 25. Mareology 26. Cologochocology 27. Mareology 28. Cologochocology 29. Mareology 29. Mareology 20. Cologochocology 20. Cologochocology 20. Cologochocology 21. Mareology 22. Mareology 23. Mareology 24. Mareology 25. Cologochocology 26. Cologochocology 27. Mareology 28. Cologochocology 29. Mareology 29. Mareology 29. Mareology 29. Mareology 29. Mareology 29. Mareology 29. Cologochocology 20. Cologochoco		Mar					1963	~							-	1991				
Leackant deceanensis (Lindlang) 180 190 221 110 166 130 96 28 80 60 70 66 42 250 52 104 180 190 221 110 166 130 96 28 80 60 70 66 42 250 52 104 32 46 40 18 26 48 9 12 12 10 14 6 180 190 221 110 166 130 96 28 80 60 70 66 42 250 52 104 32 46 40 18 26 48 9 12 24 29 14 6 10 176 196 199 95 32 36 18 26 46 18 26 35 42 46 10 176 196 199 95 32 36 18 26 46 18 26 35 42 46 10 176 196 199 95 32 36 18 26 46 18 26 35 42 46 10 176 196 196 196 196 196 196 12 46 11 18 24 14 16 16 17 16 17 12 18 26 41 16 17 16 17 14		& ale	284	2+5	21.6	19.7	308	8.52	14-10 3	4 4 6	41	3	5.3 26	=	4	2 28.	162	2 6	72.0	181
Chacks. The standard of the s	Ι.	(C) Coperada.	2	9	3	5	90	i.	90	**	<u></u> -	**			وَ م	da da	3.2	ij	90	
teera is of Farmordu is of F		Marchaele description of the second	8	. 6	7 7	2	991	9	9	00	و			و و	4	25	2.5	104	*	
the lift sq jr = - + 8 12 24 29 - 45 the lift she lift lift she lift sh	, 	Staptonus	32	4	4	*	76	8	on'				ر م	1	Ξ.	1	2	9	ŀ	
the life 29, 32 = + 8 12 24 24 24 46 the the the life 196 195 32 36 18 26 46 18 26 35 42 + 46 i. 2 18 26 41 4 - 8 - 6 7 - 8 10 12 i. 18 26 41 4 - - - 4 - 8 - - - - - - i. 18 2 2 2 2 2 2 2 2 2		(d) Cladocera.														•				
the twelfing 4forage): 10.2 in the 196 ing 45 32 36 is 26 46 is 26 35 42 46 12. is 26 41 4 - 8 - 6 7 - 8 10 12 12. is 26 41 4 - 8 - 6 7 - 8 10 12 13. is 26 42	بيز	Bosmingtosis of Pernodu	2	8	29	₹,	1	ı	1	4.	<u>-</u>	N	,	4	4	1	29	1	ą ę	
12 18 26 41 4 8 6 7 8 10 12 1		Dephna Lumholtze	102	176	961	601			96			14		9	4	ا بہ	1	+	30	
24 walts florage);		Moina duba Ruch	12	8	3.6	4		1			1	30	ı	•	7	90	2	7	4	
2h walts florage):	9e6	(e) <u>Glygo</u> chaeta. Enshytriaen spr		ı	ı	, 1	1	t			 i	, re	مة ا	ı	1	1	2	ı	1	mers)+u-
Aproscelarmus spr Cylindrocerpus spr Gylindrocerpus spr Gronus spr Mydliamus spr (y Pottferia (Fresh wulis sponge): 60 - 60 - 100 16 26 30 40 30		(4) Nematoda.	<u> </u>																	***
Sylindrocerpus sp. Froms. sp. Mydliomus. sp. (9 Pottlera (Fresh wulis sponge): 50 - 60 - 60 - 60 - 60 - 60 - 60 - 60 -	9	Aposcelarms sp	i	1	1	Į	1	ſ	91	œ,	0,	,	'	1	ı	i	1	1	30	700
Fresh walts stonge): \$60 - 60 - 100 76 26 30 40 30		Cylindrocarpus sp	ı	1	į	ŧ	ı	ţ	28	4	٠	'	1		ţ	Ī	1	1	8 7	·
Fresh walts stonge]: \$60 - 60 - 60 16 26 30 40 30		Fromus sp		ī	į	f	i	1	ŧ	٠	<u> </u>	i	,		1	1	1	1	ų	V
50 60 40 80 42 80 40 30 60 60	~	My oliamus -sp	,	1	ŧ	ŧ	i	ī	4	ı	œ	,		•		1	ı	1	ŧ	M*P
		(g) Portfera (Fresh wuts sponge):	3	• }	j	9	ı	ı		90	- 7	3	•	ě.	6	1	ţ		ŧ	~2

MEAN	-			-	1963	٠.			_				1964	_			
Sate	24.4	24.4 24.5 24.6 19.7	1.6 19		30.8 25 9 2410 29:11 2013 24 1	9 Z41	1.6%	1 20-13	7+7	25.3	311 482		147 2	7 9 8	247 288 259 2410 2711 16:12.	2 01 -	11 18
1. Phyloplanklon. 12. Chlorophyla.: 1. Pediastrum. simpla Neyen	8	46 162	4	40 46	6 52	2	15	33	ŧ	3.2	20	0+ 0E7 0b1 0+ 095 09E 02	995	9	9	30 4	97
(4) Bacillanophyceae 2 Swittla lenora var nerrosa AS	2	49 150		36 67	20	4	7	ล	1	22	7.6	26 320 328 50	4 8		4	18 24	\$
100 Protegoa 1 Contropos	t	1	ન	7E 01	ا د	i	ŧ	ı	96	2	*	+	1	1	90	2	*
(to Rolligna: Anunacethis corlata			46			150	162	4			2					·	
Brachenus	1 2	, <u>.</u>	, ,		1 1	1			i e o	1 1	3%	(1	1 1	30			, ,
:		1	i		1	120			70	4 3	36	9.5	9	2	20		*
		ı	•	58 09	23	130	•	20	52	3.6	0	44	ŧ	00	,,,	4	
6 forteula	- 1	-	140	,	1	*	<u>2</u>	\$	1	70	30	1	1	į	í	1	30
Cephalodolla	80	-	67	,	1	1	ţ	1	9	ſ	ŧ	ı	9	ę	;		,
8. Collotheea.	1	1	200	1	1	1	82	i	1	ı	ŧ	ı	80	1	1		,
colunella	9	ı		1	1	1	ļ	ı	1	1	170	ı	ı	ŧ	1	,	1
10 Filmia Commalis	2				20 16	8	f	ı		ı	f	5		*	1	••	τ.
Kenalella valga Brotuca	9	9	140 3	30 65	2	2	3	90	2 =	99	40	9	9	9	લ	ń Ł	2 2
xecame aneura	1	1		1	1	1 :	l	I	1	į	P	ı	i	ı	ı	,	
13 3, vulla	(9		, ,			9 2	, (1	, ,	, ,	1 (, 1	1 1	1 1	1 2	, , , ,	, .
: :		٠ ،	4	'		-	. 1	1	ı	. 1	: 1	1		ı	Ì	·	1
hormanan	_			,		7	- 1	ı	١	ı	. 1		i	ı	ı	,	Ì,
The state of the s	1		· •	, <u>5</u>	150		1	59	20	! !	1	200	, t		† ;	= 	20
		. 1					ا !	<u>, 3</u>		ı	0	i	i	1	1		
	. t	1		•	}	W.	ì	150	1	I	35	1	I	i		,	
28 unqulata		ı	,	1	1	. 5	}	1	1	I	i	ſ	ı	1		1	
21 Mytelma ventralis.		. 1				. (1	20	1	Ī	j	1	i	1			,
22 Notamala As														,			•

	1963	1964
	284 245 21.6 14.7 30.8 25.9 24.10 2411 2012 24.1 25	253 284 116 247 265 259 24 1027 11 1612.
23 Fedana sp	1 1 1 1 1 1 1 1	20, 27, 11, 11, 11, 11, 11, 11, 11, 11, 11, 1
24 Tetramastra opolemsw		50 24
25 Frehoute mycenic	1 66 1 40	
26 m Tuddenini	60 - 32 62 50	
27 n simulus	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1
3		ď
28 Musocyclops leuckurd discomensis ("Landberg)	31 46 56 140 228 210 66 32 20	24 20 26 50 28 48 12, 20
larvae	180 201 284 210 276 222 90 28 76	66 70 46 100 52
30 Braptomus	- 12 -	+
(d) Cladotera		
31. Bosminofists of Fernan	1 1 4 4 1 1	
32 Sazhrua Lumhottzr	100 160 108 48 46 16 29 81	- 91 81 66 04 08 04
-	79 12	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
24 Macrothuz Barrd	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1
Moma duba Ruch	10 - 12 18 16	9 1 1 1 10 1
(e) Olyochaeta	-	
3h Enchytraeus spp	1 61 1 1 1 1 1 1	
(4) Nematoda		
Aposeelarmus		
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Fromus sp	1 28 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 9
40 Myolarmus sp	1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
9 24	1 18	
(4) Forton (Fresh water shonge)		;
	2 1 00 10 10 071 1 1 1 1	13 38 - 10

-	2000				-	1963								1964	4				
+		24-4 24-5 21-6 14-9 30-8 259 24-10 2911 2012 24-1 25-3 28-4 11-6 24-7 28-6 25-9 24-10 27-11 18-12	1.5 2	9	7 30	8 25	9 24	0 29 1	ş	ż	25-3	26.4	÷	24.9	1.52	583	9.4	7	순
1	26	93	34	30 3	36 12	70	35	ÙS.	4	46 10	20		420 130	130	30	26	9	30	2
	(6) Bacillaruphyceae: Surirella lenera vav nervosa 1.5	360 84	35 6	9	26 10	જો જ		31 10 106	106	1	09		280	160	286 160 40	79	1	1	ā
	B. Zooplankton											4							
	(a) Protosa. Centropysis	2	<u>~</u>	2 01	26 45	∕ √1	ţ	9-	0	29	9	srys	80	87	1	1 2	97	9.	9
	4) Rotlar					34	4	20	30		200	brin	. 1	í	í	I	1	ı	ţ
_	Anarotopsis weedle.	1 [' - ' 1	۱ ط	, , , ,	: 1 ! !				!!				1	1	4	Į	1	1
_	Caudatus	\$0	(,	,	1	. 36				30	-8ru	09	30	36	99	ŧ	ŧ	1
			+ 2	<u>۔</u> ا	- 951	. 36	081 9	0	۲-	lin.		14	0	70	24	1	92	<u>.</u>	2
	" + alcabus	22	-	30		1	1		90	1	70	u-A	ı	ſ	ı	•	1	1 9	1
	Cephalodella megalocephala.	1		- 1	9	1		1		<u>'</u>	1	1	ı	1 5	ſ	f	1	è	1
	Collothera.	i	•			. 4	. 5	1 4	1		1	14	100		1 2	, 1	t I	r 1	1
	bilania terminalis	1 4	1 2	1 6	1 00 200		64 120		100	20	1 5	nı			25	35	160		20
· =	desane luna					- 011				1	340		1	ı	ſ	150	ı	ţ	1
4		ન	ı	,	ì	ľ	1		1		01	יגים	i	ŧ	9	į	1	ł	ľ
		· 	1	!		7	30	260 350 410 500	0 20	1			1	ſ	f	I	ı	í	1
<u></u>	•	1	1	ſ	:	4	45 1	150 150			. 26		ţ	1	ī	ı	ı	9	ţ
5		1	ı	į	ſ	3	09	1		-	. 12	للقم	t	1	ţ	ı,	ı	ſ	ī
2	Notommata str	ł	1	1	1	ı	7	70	7.4	15	90		1	9	46	99	1	ı	1
=	Pedalia sp	1	1	91	1	1	1	1	!		1		t	1	1	I	ſ,	ı	I
=	Pompholys complanata	1	-1	08/	•		ı	7	700		1		ſ	ι	ı	1	\$	ı	1
£	Getramasta opotensis	ı	,	3	_	021	1	i	I	10	1		30	7	20	ſ	1	1	1
2	Inchoconea ruttneri		1	4.2	1	1	,	1	٠ ا	20 120	1		ŧ	ŧ	1	i	f	1	î
										_									

	year				=	1963		1					-	1964				
1	sate	244 245 21.6 14.7 30.8 25.9 2410 2411 2011 24.1 25.3 25.4 11.6 24.7 28 8 259 2410 2711 1612.	2 24	619.	.7 30	8 25:	7	241	2041	ž	15.3	*22	1.6 2	47.2	18 2	19 24	-10 17	1 181
4	(c) Operator . Assemblers (Euckart deceanersis (Kindlers)	200	74 8	9	= 4	80 101 420 68 48 26	8	9 2	38	1	9		4	60 40 30 59	0 5	2	1	۵۰
ដ	Nouthlus larrae	100 110 120 146 175 170 46 38 59	٥	2	11	5 170	4	ы 90	59	12	55		0	20 2	30 2	10 120 130 200 50	± ~	1
7	7.	4.	39 4	46	16	9 18	00	4	2.0	81	ı	po	1	00	9	~.	•	20
	(4) cladotera:											nod						
25	Bosminghals Ct. Fernadi.	4	,	,	oes ;	4	í	ŧ	2	-	1	\$	ı	,		*	Í	į
1	Fathmie Lumbolto	 	٠ د	11 9.4	116 92	. 4	5	31	I	9	80	14 3	,	0+	60 20	95 0	5 12	+
	2	1	90	٠.	4 =	ı	ł	1	9	+	ı	· ŧ	ı	1	+	4		-1
28	Mainother Band.	٠.	1		ž	1	2	ī	19	(1)	ı	nini	ī	ī	·	1		1
XI	(0) Chigothaeta: Enehydraens App.	1	1	,	-35	1	12	ı	f	I	* 2	mp bunte	t	f	ľ	. '	1	4
	W. Nematoda											urs .				,		
3	Aproxelarmus sp	1		1	. 260	0	00	ŧ	ł	1	I	70 7	ı	1	ı		1	•
	Cashandhocorpus sp	1	,	•	*	240	*	1	ŧ	ŧ	f	u,	f	ı	1		,	ผ
*	From the	1		1	125	l da	es)	ţ	l	t	f	61	1	1	,	,	!	Ξ
23	Angoliamus sp	,		,	+	15	Çeo	1	ī	į	1	D(T)	1	1	ı	,	t t	Ϊ.
	(9) Portera (Freshwater Stunge)											بللتم						