Project Report submitted to

Kerala State Biodiversity Board
Pallimukku, Pettah,
Thiruvananthapuram-695024

Title of the KSBB Project

Abundance and Feeding habits of the *Chaoborus* larvae - A case study in Sasthamkotta Lake system, Kerala

Order No: 228/A1/2012/KSBB

Date : 20-08-2013

Total Estimated Cost : 3,00,150/-

Amount received : 1,53,973/-

Date of the Implementation of the Project : 30/10/2013

By

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March 2015

Budget

Sl. No.	Item	Amount Rs.
1	Project fellow Rs.8000/PM	96,000
2	Travel and field work	50,000
3	Labour charge, boat hire charge etc	50,000
4	Consumables	40,000
5	Report preparation	25,000
	Total	**2,61,000**
6	Institutional overhead 15%	39,150
	Total	**3,00,150**

CONTENTS

Introduction

Wetlands being one among the most biologically productive ecosystems in the world occupy the interface between land and water. Kerala blessed with the year- round greenery harbors 217 wetlands, which accounts for one fifth of the land area. Vembanad-kol, Ashtamudi and Samsthamkotta, are the three designated Ramsar sites of Kerala. These sensitive bodies are getting more and more polluted due to anthropogenic intervention. Recently most of the wetlands are facing the challenges of increasing population pressure, cultural eutrophication, improper use of watersheds and substantial changes in land-use/cover development projects. Reliable, adequate and updated information about these "kidneys of landscape" is meager. Despite many environmental laws, there is no significant development towards sustaining these ecosystems due to the lack of awareness of the values of these ecosystems among the policymakers and implementation agencies. Development of better monitoring methods is needed to increase the knowledge of the physical and biological characteristics of each wetland resources, and to gain, from this knowledge, a better understanding of wetland dynamics and their controlling processes.

Freshwater lakes are one of the dynamic ecosystems. The biodiversity of freshwater lakes has received much attention. Freshwater lakes provide an extensive range of valuable products for the sustenance of a large number of people. Ecologically they maintain a wide variety of life forms. The freshwater lakes are the habitat of several endemic species. From an ecological point of view, the diversity of species present in the

freshwater lakes is an indication of the importance of the aquatic biodiversity issue as a whole. The physico-chemical factors are important in study of any aquatic environment apart from understanding the state of water and its impact on the aquatic biota. Observation on the immediate changes on the physico-chemical parameter may also have practical implication in pollution studies.

The benthic animals inhabiting the bottom of lakes constitute an extremely diverse assemblage, both taxonomically and ecologically. Benthic invertebrates provide essential ecosystem services by accelerating detrital decomposition. The species richness and functional importance of fresh water benthic invertebrates generally go unnoticed. In recent times, Sasthamkotta lake is attributed to the presence of *Chaoborus*. Larvae of *Chaoborus* can be found near the surface of aquatic ecosystems, but also at considerable depths on the muddy bottom of lakes. Ample information on this larva from Kerala is deficient and the present surveillance is noteworthy in a biogeographically perspective on ecological systems. As Chaoboridae are not evenly distributed over time and space, we needed to better acquire dependable information on their occurrence, abundance and biology. The present study is focused on the ecology, occurrence, abundance and feeding biology of Chaoborus larvae on Sasthamkotta lake.

Objectives

- To study on the abundance of *Chaoborus* larvae found in the lake bed
- To study the feeding ecology of the Chaoborus larvae
- To study the role of Chaoborus in the purification of water in the Sasthamkotta lake
- Secondary information regarding the lake bed

Review of Literature

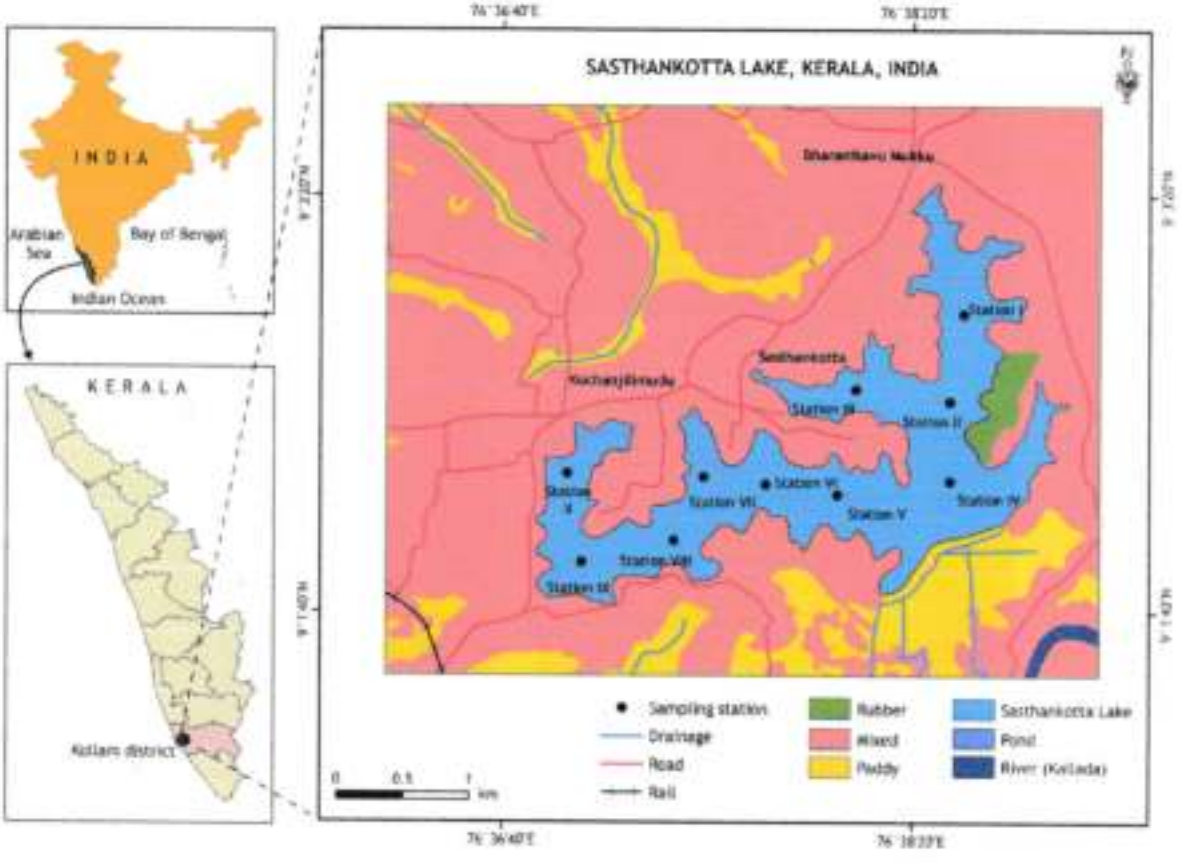
Sasthamkotta Lake

- Water sediment interaction and productivity in Sasthamkotta lake studied by Prakasam and Joseph (1991).
- Prakasam and Poul Martin (1991) studied the migratory teal *Anas querquedula* at Sasthamkotta lake
- Sreejith (1998) studied the hydrogeochemistry of the Sasthamkotta lake in Kerala with special reference to sediment-water interaction
- Bhuvanendran *et al.* (2004) studied the ecology and pollution of Sasthamkotta- fresh water lake.
- Resource potential of Sasthamkotta lake with special reference to fish fauna and their sustainability studied by Girijakumari (2007).
- George *et al.* (2008) studied the water quality studies of Sasthamkotta lake of Kerala

STUDY AREA

Kerala is endowed with diverse types of wetlands. Sasthamkotta Lake (Map. 1), the largest fresh water lake in Kerala, one among the nineteen wetlands identified for conservation and management. The rain fed lake is surrounded by vertical hillocks except the south-eastern region where an earthern bund has been constructed separating the lake from the nearby paddy fields. The main source of water for the lake is from the underground sprouts. The inverted F shaped lake covers an area of approximately 375 hectares and forms the major source of drinking water in Kollam district. An emphasizing factor of this lake is that it does not shrink in the summers. The lake provides suitable conditions for the growth of fresh water fishes throughout the year. Sasthamkotta Lake has been a designated wetland of international importance under the Ramsar Convention since November 2002. The lake is located in Kollam district between latitude 9°00'-9°05' N and longitude 76°35'-76°40' E. At present a water supply scheme was drawn up by the Kerala Water Authority with an estimated demand of 46.35 million litres of water per day to benefit population of 3.7 lakhs by 2001. In this status, there had been several correspondents about the ecological threats faced by lake.

Map. 1. Map of the Sasthamkotta lake showing sampling stations



Photographs of Sasthamkotta lake

METHODOLOGY

The water samples for the study were collected monthly from ten sampling stations during the period from December 2013 to October 2014. Stations were selected randomly. Analysis on the physicochemical parameters was done as per the standard methods (APHA, 1992, Trivedy and Goel, 1986). The sediment samples from lake bed were collected using Ekman dredge. The abundance of the larvae was estimated on the basis of number of larvae obtained within m^2 from each sampling station. Quantitative estimation of the benthic organisms was done based on the methods of Michael (1976). A detailed benthic biodiversity done as per the observations of standard references and also from published literature. Feeding of Chaoborus analyzed as per the method of Swift and Fedorenko (1973). Feeding ecology of the larvae was examined by crop evaluation. Larvae for crop evaluation were collected and fixed with 5% formalin. The material contained in the crops of larvae was analyzed. Individuals were selected in the samples and put on a slide, where the fixative was replaced by drops of water. The head of each individual was then pulled with a needle, resulting in the extraction of part of the gut from the exoskeleton. The gut was then cut just in front of the crop, and its content squeezed with a gentle pressure of the needle. The material in each drop was then analyzed with a microscope.

RESULT AND DISCUSSION

Physico-chemical parameters

Monthly variations of physicochemical parameters are depicted in Table 1 to 11.

The atmospheric temperature varied from 25°C to 30°C during the study period. The surface water temperature ranged from 25°C to 29.5°C throughout the study period and these variations were in accordance with the atmospheric temperature. The bottom water temperature was measured between 25°C and 28 °C during the study period and similar to the findings of surface water temperature.

Transparency ranged from 75cm to 252cm and showed fluctuation between months. The depth of study area varied from 1.75m to 10.75m and maximum depth achieved in October due to rainfall. Values for pH remained close to neutral throughout the investigated period but highest value of 7.48 was observed in the month of December at Station III. The pH range of all stations is within the permissible limits for regular uses and which was considered to be conductive for aquatic life (Schroeder, 1980).

Dissolved oxygen varied between 6 mg/1 and 10.4 mg/1 throughout the study period. These observations were similar to George and Koshy (2008) in the waters of Sasthamkotta Lake. In the present investigation CO_2 concentration varied from 5.2 mg/l to 19.8 mg/l and observed a variation in CO_2 concentration from all the stations. The fluctuation in CO_2 concentration may be due to the decaying of organic

matter. Total alkalinity ranged from 20 mg/l to 70 mg/l. These findings did not show any remarkable variation throughout the study period. The chloride concentration ranged from 16.4 mg/l to 28.95 mg/l. The lowest value of salinity 0.059ppt was observed in station IV during the month of December and highest value of salinity 0.0912ppt was in Station IX during the month of February. In the present study chloride concentration and salinity did not show many fluctuations during the investigation period. The total hardness ranged between 18mg/l and 38 mg/l. The calcium hardness varied between 4.008mg/l and 12.15mg/l during the month of September and December. The magnesium hardness varied from 0.25 mg/l to 4.38 mg/l during June and March. These findings did not show much difference between stations during the study period.

The total solid values ranged from 0.02 mg/l to 0.21 mg/l. The total suspended solid showed a maximum value of 0.18 mg/l and minimum value of 0.01 mg/l. The total dissolved solid varied from 0.01 mg/l to 0.11 mg/l. These observations confirmed there are modest variations in total solid, total suspended solid and total dissolved solid between stations.

The nitrite concentration ranged from 0.0016 ppm to 0.0619 ppm. The nitrate concentration varied from 0.0126 ppm to 0.8895 ppm in the month of April and February respectively. The phosphate concentration measured from 0.0112 ppm to 0.0885 ppm. The silicate concentration varied between 1.4375 ppm and 9.9875 ppm during the month of January and February respectively. The level of nitrite, nitrate, phosphate and silicate was not at dangerous limit.

Table 1. Physico-chemical parameters of Sasthamkotta lake during December 2013

PARAMETERS	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp. (a) Atmos.(°C)	26		26		26.5		28		29		28		30		30		30		30	
(b) Surface water (°C)	26.5		27		27.3		27		27		28		28.7		28.5		28.8		28.5	
(c) Bottom water (°C)		26		25.5		26		26.5		26		27.5		27.8		27		27.5		27.5
Transparency (cm)	88		107.5		118.5		90		90		124.5		100		95		93.5		91.5	
Depth (m)	6.35		6.25		2.5		8.5		5.75		4.5		2.35		2		6		5.35	
pH	7.1	7.2	6.9	6.9	7.4	7.2	6.8	6.8	7.2	7.2	7.2	7.2	6.9	6.8	6.9	6.9	7.3	7.2	7.3	7.2
DO (mg/l)	8.1	6.2	7.3	6.1	8	7.1	6	6.1	7.2	7	8.9	9	7.8	7.2	6.9	8	7.1	10	10.2	8
Free Carbondioxide (mg/l)	11.2	8.9	12.3	11.4	11.1	12.5	8.8	8.9	10.3	8.5	8.8	11.5	7.7	13.1	8.1	7.1	10.5	19.3	9.1	5.5
Total Alkalinity (mg/l)	20	25	25	35	25	20	25	25	30	25	20	30	20	20	25	25	20	25	20	20
Chloride (mg/l)	17.85	25.3	28.35	28.32	25.31	26.85	22.38	26.8	23.88	22.31	23.88	23.85	23.88	25.31	23.89	23.85	27.01	26.79	25.3	22.95
Salinity (ppt)	0.0723	0.0745	0.066	0.0751	0.0723	0.075	0.059	0.068	0.072	0.06	0.071	0.071	0.081	0.081	0.075	0.072	0.075	0.075	0.72	0.072
Total hardness (mg/l)	24	32	24	36	20	26	36	20	26	26	28	26	28	26	30	28	26	36	28	30
Ca Hardness (mg/l)	8.012	8.821	6.212	12.15	5.321	8.817	8.012	7.115	9.688	7.113	6.214	9.817	9.119	6.914	6.914	8.011	7.317	9.519	10.42	8.214
Mg Hardness (mg/l)	0.974	2.433	2.071	1.381	1.638	0.972	3.902	0.545	0.44	2.01	3.046	0.362	1.276	2.131	2.986	1.951	1.88	2.984	0.483	2.315
Total solid (mg/l)	0.03	0.04	0.03	0.04	0.05	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.02	0.03	0.02	0.05	0.02	0.09	0.05	0.06
TSS(mg/l)	0.01	0.03	0.02	0.03	0.03	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.01	0.02	0.01	0.03	0.01	0.06	0.03	0.05
TDS(mg/l)	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.03	0.02	0.02
Nitrite (ppm)	0.0058	0.0061	0.003	0.0085	0.0027	0.006	0.002	0.008	0.007	0.009	0.009	0.008	0.007	0.009	0.006	0.0069	0.006	0.009	0.009	0.008
Nitrate (ppm)	0.3214	0.2761	0.433	0.2742	0.1289	0.325	0.026	0.348	0.059	0.069	0.689	0.072	0.562	0.348	0.058	0.0421	0.039	0.048	0.391	0.299
Phosphate (ppm)	0.0421	0.0398	0.032	0.0543	0.0428	0.027	0.049	0.023	0.036	0.062	0.041	0.035	0.046	0.037	0.072	0.0633	0.074	0.068	0.045	0.037
Silicate (ppm)	5.9872	7.0112	5.226	7.0124	6.5432	2.784	4.565	5.464	5.852	8.351	7.234	6.237	8.479	7.998	5.982	8.921	4.789	5.984	7.568	8.992

SW- Surface Water BW- Bottom Water

Table 2. Physico-chemical parameters of Sasthamkotta lake during January 2014

	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
PARAMETERS	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Tempe (a) Atmos. (°C)	26		26		26.5		28		29		28		30		30		30		30	
(b) Surface water (°C)	27		27		27		27		27		28		29		28.5		29		28	
(c) Bottom water (°C)		26		25		27		27		27		27.5		27.8		28		28		27
Transparency (cm)	87.5		107.5		116.25		80		85		122.5		95		95		92.5		92.5	
Depth (m)	5.35		5.5		2		8		5.75		4.125		2.5		1.75		5.5		4.38	
pH	6.8	6.9	7	7.2	6.7	6.7	6.9	7.1	7.2	7.3	7.1	7.1	6.9	6.9	7	7.2	6.8	6.9	6.9	6.9
DO (mg/l)	8	6	7	6	8	7	6	6	7	7	9	9	8	7	7	8	7	10	10	8
Free CO2 (mg/l)	11	8.8	12.1	11.4	11	12.3	8.8	8.8	10.1	8.1	8.8	11.8	7.7	12.9	7.9	6.8	10.3	19.1	9.2	5.2
Total Alkalinity (mg/l)	25	30	20	35	25	20	20	20	30	25	25	35	20	20	20	25	20	30	25	25
Chloride (mg/l)	17.89	25.34	28.32	28.32	25.34	26.83	22.36	26.83	23.85	22.36	23.85	23.85	23.85	25.34	23.85	23.85	26.83	26.83	25.34	23.85
Salinity (ppt)	0.0615	0.0745	0.08	0.0798	0.0745	0.077	0.069	0.077	0.072	0.069	0.072	0.072	0.072	0.075	0.072	0.072	0.077	0.077	0.075	0.072
Total hardness (mg/l)	22	30	22	34	18	24	34	22	26	24	26	24	28	24	30	26	24	34	30	26
Ca Hardness (mg/l)	8.016	8.817	6.412	12.02	5.611	8.817	8.016	7.214	9.619	7.214	7.214	8.817	9.619	7.214	7.214	8.016	7.214	9.619	10.42	7.214
Mg Hardness (mg/l)	0.484	1.948	1.459	0.972	0.973	0.484	3.412	0.972	0.483	1.46	1.948	0.484	0.971	1.46	2.924	1.46	1.46	2.435	0.971	1.948
Total solid (mg/l)	0.02	0.04	0.03	0.02	0.05	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.02	0.03	0.02	0.02	0.02	0.09	0.05	0.03
TSS (mg/l)	0.01	0.03	0.02	0.01	0.03	0.02	0.01	0.02	0.03	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.01
TDS (mg/l)	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.02	0.01	0.03	0.01	0.02	0.01	0.01	0.01	0.06	0.02	0.02
Nitrite (ppm)	0.0064	0.0068	0.002	0.0077	0.0016	0.007	0.013	0.006	0.002	0.009	0.01	0.009	0.002	0.011	0.002	0.0097	0.006	0.008	0.002	0.006
Nitrate (ppm)	0.6619	0.1039	0.219	0.2284	0.117	0.389	0.231	0.33	0.02	0.07	0.508	0.235	0.434	0.047	0.026	0.2303	0.122	0.286	0.268	0.274
Phosphate (ppm)	0.0315	0.0517	0.022	0.0464	0.0254	0.039	0.026	0.022	0.026	0.031	0.027	0.025	0.021	0.029	0.026	0.0508	0.034	0.035	0.033	0.022
Silicate (ppm)	6.5625	7.375	6.688	6.4375	7.3125	4.438	3	6.938	2.5	7.625	5.75	6.938	6.438	7.375	4.563	7.0625	1.438	1.813	6.938	7.438

SW- Surface Water BW- Bottom Water

Table 3. Physico-chemical parameters of Sasthamkotta lake during February 2014

PARAMETERS	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp (a) Atmos (°C)	25.8		26.5		26.5		28		29		28		30		30		30		30	
(b) Surface water (°C)	27		27		27.5		26.8		27		28		29		29		29.5		28	
(c) Bottom water (°C)		26		25		26		26		27		27		27		28		28		27.3
Transparency (cm)	87		105.5		110		100		85		125		105		95		95		98	
Depth (m)	6		5.5		2.25		8.5		5.5		4.5		2.5		2		6.25		5.25	
pH	7.2	7.2	6.7	6.8	6.8	6.8	7.2	7.3	6.9	6.9	6.9	7.1	6.9	6.9	6.9	6.9	7.3	7.3	7.3	7.2
DO (mg/l)	8.3	6.1	7.2	6.5	8.2	7.1	6.2	6	7.1	7	9.2	9	8.4	7.1	7.2	7.8	6.9	9.9	10.1	8
Free CO2 (mg/l)	11	8.4	11.9	11.1	10.8	12.1	8.5	8.8	9.9	7.8	8.4	11.9	7.9	12.5	7.5	6.9	9.9	17.5	8.7	5.9
Total Alkalinity (mg/l)	25	30	25	30	25	20	25	25	35	25	20	35	25	20	20	25	25	30	25	25
Chloride (mg/l)	17.89	25.34	28.32	28.32	25.34	26.83	22.36	26.83	23.85	22.36	23.85	23.85	23.85	25.34	23.85	23.85	26.83	26.83	25.34	23.85
Salinity (ppy)	0.0693	0.0824	0.075	0.072	0.0845	0.075	0.075	0.069	0.072	0.081	0.069	0.069	0.089	0.075	0.082	0.062	0.091	0.082	0.069	0.079
Total hardness (mg/l)	28	30	26	38	26	28	36	26	30	28	30	28	32	28	32	30	26	38	30	28
Ca Hardness (mg/l)	7.013	8.123	6.234	11.918	5.637	8.197	7.345	7.231	8.654	7.651	7.044	8.516	8.643	7.112	7.241	7.899	7.149	9.543	10.99	7.142
Mg Hardness (mg/l)	2.56	2.37	2.55	2.013	2.91	1.84	4.31	1.94	2.05	2.17	3.03	1.65	2.54	2.5	3.39	2.51	1.98	3.45	0.63	2.48
Total solid (mg/l)	0.04	0.05	0.03	0.02	0.05	0.07	0.06	0.04	0.04	0.03	0.05	0.04	0.03	0.06	0.03	0.02	0.02	0.08	0.05	0.03
TSS (mg/l)	0.03	0.03	0.02	0.01	0.03	0.05	0.04	0.02	0.03	0.02	0.03	0.03	0.02	0.03	0.02	0.01	0.01	0.06	0.04	0.02
TDS (mg/l)	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.02	0.01	0.01
Nitrite (ppm)	0.0059	0.0062	0.002	0.0085	0.0027	0.01	0.023	0.008	0.002	0.004	0.015	0.002	0.062	0.052	0.042	0.0192	0.007	0.006	0.005	0.004
Nitrate (ppm)	0.0726	0.3039	0.219	0.4321	0.2482	0.567	0.451	0.89	0.075	0.092	0.801	0.435	0.732	0.066	0.034	0.2729	0.325	0.553	0.452	0.573
Phosphate (ppm)	0.0624	0.0727	0.022	0.0567	0.0482	0.06	0.045	0.042	0.033	0.046	0.047	0.054	0.042	0.045	0.03	0.0598	0.044	0.038	0.038	0.041
Silicate (ppm)	8.9241	8.375	6.688	7.8632	9.4321	9.745	6.985	8.837	7.927	8.826	6.891	9.828	7.888	8.981	6.293	9.0125	5.437	7.84	9.988	8.478

SW- Surface Water BW- Bottom Water

Table 4. Physico-chemical parameters of Sasthamkotta lake during March 2014

	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
PARAMETERS	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp (a) Atmos (°C)	26		26		27		28.4		28.5		29		30		30		30		30	
(b) Surface water (°C)	27		26		26		27		27		28		29		29		28.5		28.5	
(c) Bottom water (°C)		25.5		25		25.8		26.5		27		27.5		28		28		27.5		27
Transparency (cm)	89.5		105.5		120		90		85		150		90		95		90		95.5	
Depth (m)	5.75		5.75		2.5		7.5		6		4.5		2.75		2		5.75		4.5	
pH	6.9	6.9	6.9	7.1	7.1	7.2	6.8	6.8	7.3	7.3	6.9	6.9	6.7	6.8	6.9	6.9	6.9	6.9	7.2	7.2
DO (mg/l)	7.8	6.4	7.2	6.1	8.1	7.3	6.3	6.2	7.3	6.8	8.7	8.8	8.3	7.4	7.2	8.2	7.3	10.4	10.2	8.6
Free CO2 (mg/l)	11.8	8.9	12.1	11.4	11.1	12.9	8.4	8.1	10.3	7.9	8.5	11.5	7.5	12.4	7.3	6.4	9.3	18.7	8.9	5.5
Total Alkalinity (mg/l)	25	25	25	35	25	20	25	25	35	30	30	35	25	20	20	25	20	25	25	25
Chloride (mg/l)	17.02	25.12	28.95	27.93	24.69	25.67	23.39	25.93	24.86	22.56	24.78	24.31	23.53	24.89	24.78	22.97	26.97	26.89	26.97	24.98
Salinity (ppt)	0.0712	0.0825	0.068	0.0698	0.0841	0.077	0.075	0.068	0.072	0.089	0.072	0.072	0.085	0.075	0.07	0.0748	0.072	0.083	0.084	0.08
Total hardness (mg/l)	26	32	28	38	26	26	38	24	26	24	26	28	28	28	32	28	26	38	32	28
Ca Hardness (mg/l)	7.918	8.192	6.413	12.09	4.98	7.875	8.012	7.214	8.543	7.125	6.945	9.012	8.917	6.879	6.316	7.899	7.098	9.013	10.59	7.652
Mg Hardness (mg/l)	1.52	2.82	2.93	1.91	3.31	1.55	4.38	1.46	1.14	1.52	2.11	1.34	1.4	2.64	3.96	2.02	2.02	3.77	1.35	2.16
Total solid (mg/l)	0.02	0.04	0.07	0.03	0.05	0.03	0.07	0.04	0.06	0.08	0.04	0.04	0.05	0.03	0.06	0.03	0.02	0.09	0.05	0.08
TSS (mg/l)	0.01	0.03	0.05	0.02	0.03	0.02	0.04	0.03	0.05	0.06	0.03	0.03	0.03	0.02	0.05	0.02	0.01	0.03	0.03	0.06
TDS (mg/l)	0.01	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.06	0.02	0.02
Nitrite (ppm)	0.0071	0.0083	0.006	0.0084	0.0019	0.01	0.033	0.008	0.01	0.008	0.012	0.029	0.006	0.023	0.008	0.0091	0.007	0.005	0.005	0.007
Nitrate (ppm)	0.8629	0.2639	0.439	0.6214	0.4172	0.572	0.439	0.729	0.068	0.07	0.537	0.435	0.674	0.042	0.057	0.4303	0.522	0.686	0.668	0.774
Phosphate (ppm)	0.0525	0.0717	0.031	0.0661	0.0254	0.049	0.066	0.052	0.046	0.039	0.077	0.045	0.062	0.059	0.046	0.0598	0.064	0.03	0.043	0.052
Silicate (ppm)	8.5926	9.375	8.752	6.4875	9.3225	7.078	6.899	8.938	6.998	8.629	8.759	9.918	8.418	6.375	9.523	7.1425	5.438	6.813	6.988	7.49

SW- Surface Water BW- Bottom Water

Table 5. Physico-chemical parameters of Sasthamkotta lake during April 2014

	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
PARAMETERS	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp (a) Atmos (°C)	26		26		26		28		29		28		30		30		30		30	
(b) Surface water (°C)	27		26		27		27		27		27		29		28		29		28	
(c) Bottom water (°C)		26		25		26		26.5		27		27.5		27		27.7		28		27
Transparency (cm)	88.5		110		120		100		85		130		100		95		88.5		95.75	
Depth (m)	5.75		6.25		2.35		8.25		5.75		4.75		2.75		2		5.75		5	
pH	7.3	7.3	7.1	7.1	6.9	6.9	7.1	7.2	7.1	7.1	7	7.1	7.1	7.2	7.2	7.2	6.9	7	7.1	7.1
DO (mg/l)	8.1	6.4	7.9	6	8.2	7.2	6.2	6.1	7	7.2	9.1	9	8.3	6.9	7.1	8.2	7	10.3	10	8.9
Free CO2 (mg/l)	11.7	8.7	12.5	10.4	11.2	13.1	8.2	8.6	10.3	8.3	8.2	11.4	7.4	12.7	7.5	7.1	10.5	19.1	9.5	5.2
Total Alkalinity (mg/l)	25	25	30	35	30	25	20	25	30	25	25	30	20	20	25	25	20	30	30	25
Chloride (mg/l)	17.07	26.34	27.03	27.78	26.34	27.2	23.61	25.89	24.86	23.43	24.83	24.76	25.61	24.95	23.81	23.85	25.81	26.05	24.34	24.31
Salinity (ppt)	0.0692	0.0841	0.08	0.0811	0.0745	0.069	0.081	0.069	0.08	0.079	0.072	0.061	0.075	0.075	0.072	0.0719	0.062	0.077	0.064	0.072
Total hardness (mg/l)	28	28	20	34	20	26	34	24	26	24	26	28	30	26	32	26	28	38	30	28
Ca Hardness (mg/l)	8.145	6.789	4.126	11.01	5.312	8.234	8.114	7.119	9.512	7.213	7.673	7.621	9.614	6.912	7.111	7.919	7.214	9.109	11.01	7.146
Mg Hardness (mg/l)	1.86	2.69	2.36	1.58	1.64	1.33	3.35	1.52	0.54	1.46	1.67	2.18	1.46	2.14	3.47	1.52	2.44	3.72	0.61	2.47
Total solid (mg/l)	0.03	0.04	0.06	0.03	0.05	0.07	0.07	0.04	0.08	0.05	0.04	0.04	0.02	0.05	0.02	0.04	0.08	0.07	0.05	0.03
TSS (mg/l)	0.01	0.03	0.04	0.01	0.02	0.05	0.04	0.02	0.05	0.03	0.03	0.02	0.01	0.02	0.01	0.03	0.05	0.04	0.03	0.01
TDS (mg/l)	0.02	0.01	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.01	0.02	0.01	0.03	0.01	0.01	0.03	0.03	0.02	0.02
Nitrite (ppm)	0.0044	0.0068	0.003	0.0019	0.0024	0.006	0.033	0.009	0.002	0.019	0.014	0.019	0.009	0.02	0.006	0.0197	0.003	0.003	0.004	0.016
Nitrate (ppm)	0.7611	0.5039	0.419	0.1204	0.1704	0.387	0.831	0.13	0.013	0.071	0.071	0.424	0.784	0.067	0.016	0.2103	0.132	0.222	0.468	0.474
Phosphate (ppm)	0.0612	0.0717	0.052	0.0412	0.0554	0.089	0.066	0.042	0.046	0.052	0.025	0.065	0.023	0.019	0.071	0.0201	0.014	0.052	0.083	0.052
Silicate (ppm)	8.5925	9.375	7.689	6.4971	9.3105	7.408	8.991	6.931	7.5	8.925	8.752	7.988	6.598	8.375	6.563	7.0221	7.408	8.813	9.903	8.438

SW- Surface Water BW- Bottom Water

Table 6. Physico-chemical parameters of Sasthamkotta lake during May 2014

	STATIONS																			
	STATION I		STATION II		STATION III		STATION IV		STATION V		STATION VI		STATION VII		STATION VIII		STATION IX		STATION X	
PARAMETERS	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp (a) Atmos (°C)	26		26		26.5		28		29		28		30		30		30		30	
(b) Surface water (°C)	27		26		26		27		27		28		29		28		29		28	
(c) Bottom water (°C)		26		25		26		26.8		27		27		27		27		28		27.5
Transparency (cm)	88		125		130		80		95		145		80		120		110		94.5	
Depth (m)	6.25		5.5		2.5		8.5		5.75		4.35		2.5		1.75		6.24		5.35	
pH	6.8	6.9	6.9	6.9	7.1	7.1	7.2	7.2	6.8	6.8	6.9	6.9	7.1	7.1	7.1	7.2	6.9	6.9	7	7.1
DO (mg/l)	8.2	6.1	7	6.1	8.3	7.1	6.5	6	7.3	7.1	9	8.7	8.1	7.2	7.2	8	7.4	10	10.1	8.1
Free CO2 (mg/l)	11.3	8.6	12.2	11.3	11	12.5	9.1	9.2	10.6	8.5	8.1	11.4	7.9	12.3	8.1	6.5	10.7	19.6	9.2	5.9
Total Alkalinity (mg/l)	25	25	20	25	30	25	25	25	30	30	25	30	20	20	25	25	20	25	25	25
Chloride (mg/l)	16.98	26.34	27.91	28.67	26.13	27.89	23.05	27.01	24.03	23.01	24.12	24.07	24.85	26.03	24.85	24.31	27.02	26.43	24.89	24.06
Salinity (ppt)	0.0615	0.0645	0.09	0.0808	0.0648	0.077	0.081	0.078	0.069	0.069	0.071	0.082	0.07	0.08	0.062	0.0645	0.087	0.077	0.062	0.072
Total hardness (mg/l)	22	30	26	34	22	28	34	22	26	26	28	24	28	26	32	26	24	34	28	24
Ca Hardness (mg/l)	7.099	9.012	6.412	11.01	5.932	9.112	7.012	7.218	10.01	7.116	7.146	8.975	8.891	7.214	8.321	7.899	6.932	9.11	7.921	6.912
Mg Hardness (mg/l)	1.04	1.83	2.44	1.58	1.75	1.28	4.02	0.97	0.244	2.01	2.47	0.38	1.42	1.94	2.74	1.53	1.63	2.74	2.01	1.65
Total solid (mg/l)	0.05	0.04	0.05	0.03	0.05	0.06	0.06	0.04	0.06	0.06	0.04	0.06	0.04	0.06	0.04	0.02	0.07	0.08	0.06	0.03
TSS (mg/l)	0.03	0.03	0.02	0.02	0.03	0.04	0.05	0.02	0.03	0.04	0.03	0.03	0.02	0.05	0.03	0.01	0.05	0.03	0.03	0.01
TDS (mg/l)	0.02	0.01	0.03	0.01	0.02	0.02	0.01	0.02	0.03	0.02	0.01	0.03	0.02	0.01	0.01	0.01	0.02	0.05	0.03	0.02
Nitrite (ppm)	0.0072	0.0088	0.003	0.0177	0.0026	0.009	0.018	0.016	0.005	0.01	0.021	0.019	0.012	0.041	0.051	0.0192	0.008	0.01	0.012	0.014
Nitrate (ppm)	0.6821	0.1044	0.32	0.2214	0.2207	0.386	0.481	0.521	0.07	0.081	0.598	0.194	0.437	0.076	0.029	0.3903	0.202	0.586	0.468	0.572
Phosphate (ppm)	0.0425	0.0171	0.042	0.0364	0.0154	0.031	0.034	0.052	0.066	0.062	0.077	0.065	0.03	0.082	0.05	0.0708	0.064	0.075	0.063	0.062
Silicate (ppm)	8.4625	7.0175	8.608	9.4375	7.4405	6.138	9	9.938	7.932	8.125	7.85	6.998	8.428	8.325	6.562	7.0612	7.408	8.823	7.908	7.228

SW- Surface Water BW- Bottom Water

Table 7. Physico-chemical parameters of Sasthamkotta lake during June 2014

	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
PARAMETERS	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp (a) Atmos (°C)	26		26		26		27		28		28		29		29		29.3		29	
(b) Surface water (°C)	27		26.7		27		26		27		28		28		28.5		29		28	
(c) Bottom water (°C)		25		25		25		25.4		26		26.5		27.5		28		28		27
Transparency (cm)	75		100		112		80		90		110		92		95		88		95	
Depth (m)	6.75		7		4		10		7		5.75		3.5		3		7		5.5	
pH	7.2	7.2	7.3	7.3	7.2	7.2	7.1	7.2	7.1	7.1	7.2	7.2	7.2	7.1	7.2	7.2	7.1	7.1	7.2	7.2
DO (mg/l)	8	6.2	7.3	6	8.3	7.8	6.3	6.1	7	7.8	9.1	8.9	8	7.2	6.8	8.1	7.2	10	9.5	8
Free CO2 (mg/l)	10.8	8.8	12.3	11.4	10.9	12.9	9.2	8.2	10.1	8.3	8.6	11.1	7.3	13.1	7.9	7.1	10.5	19.8	9.2	5.9
Total Alkalinity (mg/l)	30	30	20	35	20	20	20	20	30	30	25	35	25	25	25	25	20	25	25	25
Chloride (mg/l)	17.89	26.12	27.32	28.32	25.34	27.13	21.36	26.34	23.85	21.9	24.01	24.01	22.86	24.32	23.85	24.11	27.12	25.89	26.12	24.13
Salinity (ppt)	0.0615	0.0615	0.071	0.0781	0.0693	0.077	0.075	0.082	0.082	0.082	0.072	0.072	0.062	0.071	0.071	0.0708	0.067	0.071	0.075	0.077
Total hardness (mg/l)	24	32	26	34	24	24	34	24	26	28	28	28	32	28	32	28	26	32	34	28
Ca Hardness (mg/l)	8.112	8.989	6.543	11.99	5.613	8.254	7.981	7.012	10.01	6.331	7.014	8.912	9.619	7.021	7.214	8.112	7.214	8.621	10.42	7.214
Mg Hardness (mg/l)	0.915	2.33	2.35	0.99	2.44	0.83	3.43	1.58	0.25	2.97	2.55	1.4	1.95	2.55	3.41	1.89	1.95	2.55	1.95	2.44
Total solid (mg/l)	0.05	0.04	0.04	0.04	0.05	0.04	0.07	0.04	0.07	0.05	0.05	0.08	0.08	0.03	0.06	0.04	0.04	0.09	0.07	0.09
TSS (mg/l)	0.03	0.03	0.02	0.02	0.03	0.02	0.06	0.02	0.03	0.03	0.03	0.05	0.06	0.01	0.03	0.03	0.02	0.03	0.04	0.07
TDS (mg/l)	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.04	0.02	0.02	0.03	0.02	0.02	0.03	0.01	0.02	0.06	0.03	0.02
Nitrite (ppm)	0.0074	0.0088	0.008	0.0087	0.0036	0.008	0.018	0.018	0.003	0.008	0.02	0.011	0.012	0.009	0.008	0.0119	0.016	0.015	0.004	0.008
Nitrate (ppm)	0.7119	0.2939	0.529	0.4428	0.1192	0.383	0.431	0.729	0.03	0.04	0.618	0.536	0.635	0.041	0.067	0.3303	0.222	0.341	0.568	0.774
Phosphate (ppm)	0.0419	0.0591	0.042	0.0561	0.0454	0.039	0.041	0.052	0.056	0.061	0.019	0.035	0.057	0.069	0.076	0.0808	0.055	0.076	0.073	0.083
Silicate (ppm)	7.5635	8.3751	6.888	7.4775	6.4225	8.407	9.321	9.108	6.322	7.123	7.75	8.908	9.408	9.308	8.56	8.0115	7.438	8.814	6.919	7.49

SW- Surface Water BW- Bottom Water

Table 8. Physico-chemical parameters of Sasthamkotta lake during July 2014

PARAMETERS	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp. (a) Atmos.(°C)	25.5		25		26		25		25.5		26		26		26.5		26.5		26.5	
(b) Surface water (°C)	26		26		26.5		26		26		26		26		26		26		26	
(c) Bottom water (°C)		25		26		26		25		26		25		25		25.5		26		25.5
Transparency (cm)	205.5		214		208.5		198.5		210.5		200.5		189.5		205.5		202.5		200.5	
Depth (m)	6.75		4.25		5.75		3.25		4.38		3.25		4.75		3.75		4.75		5.85	
pH	6.8	6.9	6.9	7	7	7.1	7.1	7.1	6.9	7	7	6.9	6.9	7	7.1	7.1	6.9	7	7.1	7.1
DO (mg/l)	8.6	9	10	8	8.5	8.9	8	8	8.6	8.6	9	9.2	8.8	8.8	7.2	7.4	9	9	8	8
Free Carbondioxide (mg/l)	9.62	10.46	12.12	13.12	10.88	13.82	12.42	15.22	12.48	14.42	10.78	12.88	12.48	13.88	11.48	12.78	13.61	14.88	10.42	12.12
Total Alkalinity (mg/l)	30	35	35	35	30	30	25	25	35	30	35	40	30	30	30	40	25	30	30	35
Chloride (mg/l)	25.34	21.901	22.86	24.76	25.61	27.78	22.36	24.34	24.95	19.38	22.38	25.31	23.89	17.85	28.32	25.34	23.85	25.34	25.34	27.78
Salinity (ppt)	0.0693	0.0824	0.062	0.061	0.0745	0.081	0.069	0.064	0.075	0.064	0.059	0.081	0.075	0.072	0.075	0.0824	0.089	0.075	0.069	0.081
Total hardness (mg/l)	26	28	26	24	20	18	20	32	26	28	26	28	22	24	20	26	28	26	26	28
Ca Hardness (mg/l)	6.234	8.197	7.231	7.214	6.412	5.611	4.809	8.643	7.149	6.413	8.234	6.879	5.932	7.125	4.126	8.643	6.789	7.919	8.234	6.413
Mg Hardness (mg/l)	2.55	1.84	1.94	1.461	0.973	0.973	1.95	2.54	1.98	2.93	1.33	2.64	1.75	1.52	2.36	1.33	2.69	1.52	1.33	2.18
Total solid (mg/l)	0.04	0.04	0.03	0.07	0.04	0.08	0.05	0.04	0.04	0.02	0.08	0.07	0.05	0.03	0.05	0.06	0.06	0.05	0.06	0.08
TSS(mg/l)	0.01	0.02	0.01	0.04	0.02	0.05	0.03	0.03	0.02	0.01	0.05	0.04	0.02	0.02	0.03	0.04	0.05	0.03	0.05	0.05
TDS(mg/l)	0.03	0.02	0.02	0.03	0.02	0.03	0.02	0.01	0.02	0.01	0.03	0.03	0.03	0.01	0.02	0.02	0.01	0.02	0.02	0.03
Nitrite (ppm)	0.0061	0.0063	0.005	0.0064	0.0039	0.007	0.052	0.007	0.008	0.009	0.032	0.049	0.007	0.024	0.007	0.0081	0.008	0.005	0.006	0.008
Nitrate (ppm)	0.6229	0.3629	0.539	0.7224	0.5177	0.422	0.519	0.839	0.768	0.31	0.517	0.315	0.204	0.012	0.025	0.4102	0.321	0.236	0.363	0.474
Phosphate (ppm)	0.0312	0.0717	0.011	0.0611	0.0354	0.029	0.062	0.022	0.056	0.039	0.067	0.055	0.061	0.042	0.046	0.0529	0.044	0.023	0.041	0.052
Silicate (ppm)	8.5006	9.015	7.212	5.4875	8.3025	6.073	6.129	7.928	5.998	9.603	7.176	9.923	8.018	7.312	9.501	7.1024	5.175	6.813	6.902	8.43

SW- Surface Water BW- Bottom Water

Table 9. Physico-chemical parameters of Sasthamkotta lake during August 2014

PARAMETERS	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp. (a) Atmos.(°C)	26		26		25		27		27		27		27		28		28		28	
(b) Surface water (°C)	26		26		26		26		26		27		26		27		27		27	
(c) Bottom water (°C)		25		25.5		25		26	25			26		25.5		26		26.5		26.5
Transparency (cm)	130		140.5		160.5		200		190		184.5		170.5		195		193.5		202.5	
Depth (m)	6.25		5.25		3.5		5.5		4.75		4.75		3.35		3.75		5.75		4.35	
pH	7.1	7.1	7	7	6.9	6.9	7	7	7	7	7.2	7.2	6.8	6.8	6.9	6.9	7.3	7.2	7	7
DO (mg/l)	8	7	7.6	7.6	8	8	7	7	8	8	9	9	8.8	8.2	7.8	8	7.6	7.8	9.6	9
Free Carbondioxide (mg/l)	10.2	9	12.3	10.4	11.1	12.5	9	8.9	10.8	9.5	10.8	11.5	10.7	13.1	11.8	10.1	9.5	11.5	10.5	8.5
Total Alkalinity (mg/l)	20	20	25	30	25	25	20	20	30	25	25	30	20	20	30	25	20	30	25	20
Chloride (mg/l)	27.03	23.43	24.83	23.85	25.81	23.43	27.89	23.05	26.03	24.85	24.06	25.89	24.86	27.93	24.69	22.97	26.97	26.79	26.32	22.95
Salinity (ppt)	0.0798	0.0793	0.072	0.0719	0.0623	0.079	0.077	0.081	0.08	0.062	0.072	0.069	0.08	0.07	0.084	0.0748	0.072	0.075	0.72	0.072
Total hardness (mg/l)	24	38	26	28	32	38	32	20	28	26	26	28	30	32	30	18	24	24	34	30
Ca Hardness (mg/l)	8.012	12.09	4.98	6.879	6.316	9.013	10.59	7.115	9.628	7.231	7.149	7.112	8.654	7.241	7.899	5.611	8.817	7.214	9.619	8.214
Mg Hardness (mg/l)	0.974	1.91	3.31	1.381	1.638	0.972	3.902	0.545	0.442	1.94	1.98	2.5	2.05	3.39	2.51	0.973	0.484	1.46	2.435	2.315
Total solid (mg/l)	0.03	0.04	0.04	0.02	0.03	0.02	0.03	0.04	0.04	0.02	0.02	0.02	0.09	0.05	0.03	0.05	0.04	0.03	0.06	0.03
TSS(mg/l)	0.02	0.03	0.02	0.01	0.02	0.01	0.02	0.02	0.03	0.01	0.01	0.01	0.03	0.03	0.01	0.03	0.03	0.02	0.03	0.02
TDS(mg/l)	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.06	0.02	0.02	0.02	0.01	0.01	0.03	0.01
Nitrite (ppm)	0.0038	0.0031	0.002	0.0042	0.0278	0.004	0.002	0.008	0.007	0.009	0.009	0.008	0.007	0.009	0.006	0.0069	0.006	0.009	0.009	0.008
Nitrate (ppm)	0.2124	0.2151	0.331	0.2222	0.2389	0.405	0.021	0.208	0.031	0.041	0.79	0.032	0.502	0.104	0.051	0.0211	0.011	0.018	0.31	0.19
Phosphate (ppm)	0.0301	0.0411	0.012	0.0123	0.0212	0.031	0.032	0.017	0.011	0.016	0.023	0.042	0.032	0.032	0.03	0.0433	0.022	0.062	0.035	0.026
Silicate (ppm)	2.1802	3.0102	2.201	6.0204	3.5012	2.281	4.513	3.411	5.82	4.35	5.23	6.231	4.419	5.91	3.91	4.0131	4.789	5.901	6.062	8.901

SW- Surface Water BW- Bottom Water

Table 10. Physico-chemical parameters of Sasthamkotta lake during September 2014

	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
PARAMETERS	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp. (a) Atmos.(°C)	25.5		25		26		27		27		26		27.4		27		27.8		28	
(b) Surface water (°C)	28		29		28		27		28		27		28		27.8		28.5		28.5	
(c) Bottom water (°C)		28		27		27		27		28		27		27.5		26		27		27
Transparency (cm)	197.5		185		207.5		188.5		188.5		200.5		189.5		205.5		202		199.5	
Depth (m)	4.37		5.25		6.75		2.25		2.38		3.25		4.75		2.75		5.75		4.85	
pH	6	6.5	6.9	6.6	7	7.1	7.2	7.2	6.9	7	7	7.2	6.9	7	7.2	7.1	6.8	7	7.1	7
DO (mg/l)	8	9	11	9	7	8	8	8	8	8	9	10	7.8	8.2	8.4	8.4	9	9	7.2	7.2
Free Carbondioxide (mg/l)	9.62	10.46	12.98	13.48	9.88	13.82	12.42	16.22	13.48	14.42	11.78	12.28	13.72	14.88	12.48	13.88	13.61	14.72	10.98	12.42
Total Alkalinity (mg/l)	35	35	30	30	25	20	25	20	25	30	35	40	30	35	30	30	25	30	35	35
Chloride (mg/l)	20.87	22.36	19.38	19.38	20.87	17.89	22.36	16.4	20.87	19.38	25.3	23.88	25.3	23.85	25.34	25.34	28.32	26.34	27.03	27.78
Salinity (ppt)	0.0664	0.0691	0.064	0.0639	0.0664	0.061	0.069	0.059	0.066	0.064	0.075	0.071	0.72	0.089	0.075	0.0824	0.075	0.084	0.08	0.081
Total hardness (mg/l)	20	20	22	24	20	18	18	24	20	24	26	28	22	28	26	28	24	26	26	28
Ca Hardness (mg/l)	4.809	6.412	6.412	7.214	4.809	5.611	4.008	8.817	6.412	5.611	8.234	7.621	5.932	7.921	7.116	8.891	8.112	6.543	8.234	7.621
Mg Hardness (mg/l)	1.95	0.973	1.461	1.461	1.95	0.973	1.95	0.484	0.973	2.437	1.33	2.18	1.75	2.01	2.01	1.42	0.915	2.35	1.33	2.18
Total solid (mg/l)	0.04	0.04	0.03	0.03	0.05	0.05	0.05	0.21	0.05	0.13	0.08	0.07	0.03	0.05	0.04	0.03	0.09	0.05	0.06	0.04
TSS(mg/l)	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.18	0.03	0.09	0.05	0.04	0.02	0.03	0.03	0.02	0.06	0.03	0.05	0.03
TDS(mg/l)	0.03	0.02	0.02	0.02	0.04	0.03	0.03	0.03	0.02	0.04	0.03	0.03	0.01	0.02	0.01	0.01	0.03	0.02	0.02	0.01
Nitrite (ppm)	0.0051	0.0067	0.005	0.0075	0.0047	0.006	0.003	0.006	0.008	0.008	0.01	0.007	0.009	0.01	0.007	0.0079	0.009	0.009	0.009	0.009
Nitrate (ppm)	0.3111	0.2661	0.433	0.2882	0.1389	0.426	0.036	0.399	0.059	0.07	0.789	0.078	0.582	0.448	0.068	0.0521	0.048	0.058	0.492	0.299
Phosphate (ppm)	0.0432	0.0348	0.043	0.0543	0.0411	0.037	0.042	0.033	0.044	0.052	0.04	0.033	0.03	0.037	0.073	0.0633	0.074	0.061	0.055	0.027
Silicate (ppm)	6.9272	7.2012	6.006	7.8124	7.5432	3.704	5.665	6.064	7.812	9.035	7.234	6.017	7.029	6.908	6.989	9.921	5.789	6.974	7.048	8.012

SW- Surface Water BW- Bottom Water

Table 11. Physico-chemical parameters of Sasthamkotta lake during October 2014

PARAMETERS	STATIONS																			
	I		II		III		IV		V		VI		VII		VIII		IX		X	
	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW	SW	BW
Temp. (a) Atmos.(°C)	24.5		24		24		25		25		25.5		25.5		26		25.5		26	
(b) Surface water (°C)	27		25		27		27		27		26		27		27		26		27	
(c) Bottom water (°C)		26		25		26		26.5		27		26		26		26		26		26
Transparency (cm)	251.5		205		214.5		252		243.5		235.5		250.5		214.8		242.5		220.5	
Depth (m)	5.5		2.75		5.75		9.75		10.75		8.75		10.5		9.5		8.75		9.5	
pH	6.9	6.9	7	7	7	7.1	6.9	7	6.8	7	7.1	7.1	6.9	7	7	7	6.9	6.9	7	7
DO (mg/l)	7	7.8	7.6	7.6	6.6	8.6	7	7.4	7.6	8.4	8	8	8.2	8.6	7.9	8	8.6	8.6	7.4	7.4
Free Carbondioxide (mg/l)	8.58	9.02	12.32	13.86	12.1	6.6	12.54	20.68	14.74	19.36	9.28	11.26	12.22	10.24	12.22	15.22	8.28	12.48	14.32	16.22
Total Alkalinity (mg/l)	65	45	70	55	50	30	60	55	60	60	45	55	55	40	45	45	55	60	65	65
Chloride (mg/l)	22.36	19.38	17.89	19.38	20.87	19.38	19.38	17.89	19.38	20.87	21.36	17.89	25.3	21.36	19.38	25.34	22.36	27.01	24.12	26.03
Salinity (ppt)	0.0691	0.0639	0.061	0.0639	0.0664	0.064	0.064	0.061	0.064	0.066	0.075	0.061	0.72	0.075	0.064	0.0745	0.069	0.078	0.071	0.08
Total hardness (mg/l)	26	24	26	24	28	24	24	28	28	30	26	26	28	32	28	28	26	28	22	26
Ca Hardness (mg/l)	9.619	5.611	7.214	8.016	8.817	8.817	8.817	6.412	10.42	8.817	7.116	7.214	7.014	8.989	8.912	8.112	6.543	9.112	7.099	9.512
Mg Hardness (mg/l)	0.484	2.437	1.948	0.972	1.46	0.484	0.484	2.925	0.483	1.948	2.01	1.94	2.55	2.33	1.4	1.89	2.35	1.28	1.04	0.54
Total solid (mg/l)	0.05	0.05	0.04	0.04	0.05	0.04	0.19	0.14	0.06	0.05	0.04	0.04	0.02	0.05	0.04	0.07	0.03	0.05	0.04	0.05
TSS(mg/l)	0.02	0.01	0.02	0.01	0.01	0.02	0.08	0.05	0.02	0.02	0.03	0.02	0.01	0.02	0.03	0.05	0.02	0.03	0.01	0.01
TDS(mg/l)	0.03	0.04	0.02	0.03	0.04	0.02	0.11	0.09	0.04	0.03	0.01	0.02	0.01	0.03	0.01	0.02	0.01	0.02	0.03	0.04
Nitrite (ppm)	0.0061	0.0073	0.005	0.0064	0.0029	0.01	0.042	0.007	0.008	0.009	0.022	0.039	0.007	0.024	0.007	0.0081	0.008	0.009	0.004	0.008
Nitrate (ppm)	0.8629	0.5239	0.339	0.6144	0.5272	0.607	0.729	0.813	0.078	0.08	0.337	0.445	0.574	0.082	0.067	0.5503	0.522	0.596	0.628	0.704
Phosphate (ppm)	0.0625	0.0717	0.042	0.0561	0.0454	0.054	0.072	0.059	0.066	0.04	0.076	0.055	0.067	0.052	0.066	0.0792	0.061	0.05	0.053	0.063
Silicate (ppm)	7.4926	9.307	6.702	7.4175	9.0025	8.078	6.899	9.038	7.118	7.602	8.016	9.911	8.048	7.038	9.053	7.1025	5.204	5.213	6.988	8.41

SW- Surface Water BW- Bottom Water

Benthic Fauna

Qualitative and quantitative analysis of benthic fauna is depicted in the Tables 12 to 23.

Benthic fauna in Sasthamkotta Lake comprised of orders Trichoptera, Diptera and class Oligocheate

Trichoptera is diverse in number of Ten families

1. Phryganopsychidae
2. Limnocentropodidae
3. Limnephilidae
4. Goeridae
5. Leptoceridae
6. Polycentropodidae
7. Unenoidae
8. Apantaniidae
9. Sericostomatidae
10. Lepidostomatidae

Diptera or true flies were represented by four families

1. Chaoboridae
2. Pelecorhynchidae
3. Thaumalidae
4. Chironomidae.

Chironomidae comprised of 4 genera

1. Cryptotendipes
2. Metriocnemus
3. Denopelopia
4. Polypedilum tritum

Oligocheate consist of 4 genera

1. Stylaria sp.
2. Pristina,
3. Nais
4. Chaetogaster

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3. Nais
4. Chaetogaster

The benthic fauna of Sasthamkotta Lake categorized under two orders Trichoptera and Diptera and one class Oligocheate were collected from all the sampling sites in the present study. Quantitative analysis of benthic fauna and its Percentage composition is represented the Figures 1 and 2.

Among the benthic fauna collected, the order Trichoptera (87.35%) was the major group contributed by all the stations. It was diverse in number of ten families viz., Phryganopsychidae, Limnephilidae, Leptoceridae, Unenoidae, Apantaniidae, Limnocentropodidae, Goeridae, Lepidostomatidae, Polycentropodidae and Sericostomatidae. Of these, Phryganopsychidae was the common family among Trichoptera in all the stations. Trichoptera was distributed in all lake reaches. This may have been due to flow regime and allochthonous food availability (Dinakarana and Anbalagan, 2010).

Among Trichoptera, Phryganopsychidae (71.46%) was the predominant form and next dominant form was Limnephilidae (5.32%). Further Apantaniidae(2.94%), Goeridae(2.05%), Limnocentropodidae(1.42%), Leptoceridae (1.41%), Lepidostomatidae (1.26%), Unenoidae (0.55%), Polycentropodidae (0.5%) and Sericostomatidae (0.44%).

Diptera (6.04%) or true flies were represented by families Chaoboridae, Thaumaleidae, Pelecorhynchidae and Chironomidae. *Chaoborus* was recorded as the most abundant group in Chaoboridae from all the stations. *Cryptotendipes*, *Metriocnemus*, *Polypedilum* and *Denopelopia* were reported in Chironomidae. Maximum number of *Chaoborus* was observed during the month of February in the lake bottom(Fig.3) Stahl (1966) indicated that young *Chaoborus* larvae tended to be benthic during the daytime but at night, vertically migrate. This may account for the

reduced numbers during the summer months. The presence of pollution-tolerant species of Chironomidae family indicates the eutrophic condition of the lake bottom and is the most useful indicators of oxygen level (Brudins, 1949).

Oligochaeta (6.60%) comprised of Haplotaxidae was represented by the family Naididae was one of the major group recognized in all the stations. Oligocheata consisted of *Stylaria* sp., Pristina, Nais and Chaetogaster. *Stylaria* was common throughout the study. *Stylaria* sp. was dominant during March. *Stylaria* being a principal biotic component contributes to diet of bottom feeding omnivores. Brinkhurst and Cook (1974) also reported that the organically enriched bottom supports quantitative increase of Oligocheates. The Oligochaetes are considered as the bio indicators of organic pollution (Indumathi and Ramanibai, 2009).

Table 12. Benthic organisms (No/m^2) of Sasthamkotta lake during December 2013

	STATIONS									
BENTHIC FAUNA	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	630	900	1170	600	900	870	570	600	690	810
Limnephilidae	60	210	150	240	0	150	0	270	90	0
Leptoceridae	120	60	120	90	30	150	60	0	30	60
Unenoidae	0	30	0	60	0	0	0	0	0	30
Apantaniidae	60	150	90	0	0	0	0	60	0	0
Limnocentropodidae	90	0	30	0	0	0	0	0	0	30
Goeridae	0	30	0	60	0	0	0	90	0	0
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	300	210	330	210	300	450	240	450	210	150
Thaumaleidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	60	30	90	30	0	30	0	0	0	0
Metriocnemus	60	0	90	0	0	0	60	150	0	0
Denopelopia	90	0	60	0	0	30	0	0	30	0
Polypedilum tritum	0	0	30	0	60	0	0	30	0	0
Stylaria sp.	300	330	630	210	360	0	0	240	90	300
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 13. Benthic organisms (No/m^2) of Sasthamkotta lake during January 2014

	STATIONS									
BENTHIC FAUNA	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	750	930	1200	720	900	720	870	930	900	990
Limnephilidae	60	300	270	450	0	210	0	240	90	0
Leptoceridae	90	120	150	210	90	150	60	0	30	90
Unenoidae	0	60	0	30	60	0	30	0	0	30
Apantaniidae	90	240	270	0	120	90	0	210	0	0
Limnocentropodidae	90	0	90	0	0	60	0	0	30	60
Goeridae	0	60	0	30	0	0	120	0	0	30
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	240	210	300	210	300	240	90	60	120	150
Thaumaleidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	90	30	90	60	0	30	0	60	0	0
Metriocnemus	30	60	120	0	0	0	90	60	0	0
Denopelopia	60	0	90	0	0	30	0	0	30	0
Polypedilum tritum	0	0	30	0	60	0	0	30	0	0
Stylaria sp.	450	600	750	300	390	0	0	570	210	330
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 14. Benthic organisms(No/m^2) of Sasthamkotta lake during February 2014

	STATIONS									
BENTHIC FAUNA	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	870	1110	1350	930	1170	1020	840	990	900	750
Limnephilidae	90	390	420	510	0	240	0	300	120	0
Leptoceridae	60	150	240	120	90	210	30	0	60	120
Unenoidae	0	90	0	60	30	0	60	0	0	60
Apantaniidae	150	330	570	0	60	0	30	120	0	0
Limnocentropodidae	150	0	60	0	0	30	0	0	30	90
Goeridae	0	60	0	90	0	0	30	150	0	30
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	300	150	450	240	260	300	210	570	240	270
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	90	60	120	60	0	60	0	90	0	0
Metriocnemus	120	30	240	0	0	0	150	210	0	0
Denopelopia	120	0	180	0	0	90	0	0	60	0
Polypedilum tritum	0	0	60	0	90	0	0	60	0	0
Stylaria sp.	540	870	930	450	600	0	0	750	270	450
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 15. Benthic organisms(No/m^2) of Sasthamkotta lake during March 2014

BENTHIC FAUNA	STATIONS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	930	1440	1650	1590	1350	1050	1410	1140	1170	1110
Limnephilidae	90	420	240	150	0	90	60	0	0	270
Leptoceridae	150	240	270	0	0	210	0	120	0	150
Unenoidae	30	0	0	60	30	0	0	120	0	0
Apantaniidae	150	210	270	0	0	60	0	0	150	210
Limnocentropodidae	90	0	0	60	90	0	30	0	0	0
Goeridae	0	60	0	90	0	0	30	0	0	30
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	450	120	300	90	510	90	240	330	150	120
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	0	0	150	0	210	0	0	90	0	0
Metriocnemus	0	0	60	0	0	90	0	30	0	0
Denopelopia	30	0	210	0	0	90	0	0	60	0
Polypedilum tritum	0	0	60	0	30	0	0	90	0	0
Stylaria sp.	660	570	1260	900	540	750	90	1410	150	60
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 16. Benthic organisms(No/m^2) of Sasthamkotta lake during April 2014

BENTHIC FAUNA	STATIONS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	1050	1380	1170	1500	1440	930	41	930	900	840
Limnephilidae	150	450	300	540	270	0	210	90	0	330
Leptoceridae	0	150	210	0	0	150	0	270	0	240
Unenoidae	0	30	0	120	90	0	0	180	0	90
Apantaniidae	90	270	330	0	0	120	0	0	240	60
Limnocentropodidae	60	0	0	30	0	0	90	0	0	0
Goeridae	0	150	0	210	0	0	60	0	0	30
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	600	30	570	150	330	300	180	300	240	120
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	0	0	210	0	150	0	0	330	0	0
Metriocnemus	0	0	150	0	0	60	0	30	0	0
Denopelopia	60	0	240	0	0	120	0	0	30	0
Polypedilum tritum	0	0	90	0	30	0	0	120	0	0
Styiaria sp.	600	510	1500	450	310	300	570	0	270	0
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 17. Benthic organisms(No/m^2) of Sasthamkotta lake during May 2014

BENTHIC FAUNA	STATIONS									
	I	IIIIII II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	750	990	1230	1050	1110	900	750	930	870	720
Limnephilidae	120	300	330	450	0	300	0	240	210	0
Leptoceridae	90	210	120	210	150	150	30	0	30	90
Unenoidae	0	30	0	90	30	0	90	0	0	90
Apantaniidae	180	210	450	0	90	0	30	60	0	0
Limnocentropodidae	150	0	90	0	0	60	0	0	60	30
Goeridae	0	60	0	90	0	0	30	90	0	60
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	210	240	300	270	210	150	210	330	150	90
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	120	150	90	30	0	0	0	150	60	30
Metriocnemus	60	30	150	0	0	0	90	120	0	0
Denopelopia	60	0	90	0	0	30	0	0	30	0
Polypedilum tritum	0	0	30	0	60	0	0	30	0	0
Stylaria sp.	450	600	750	540	690	120	150	510	150	300
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 18 Benthic organisms(No/m^2) of Sasthamkotta lake during June 2014

BENTHIC FAUNA	STATIONS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	750	900	1110	1050	720	840	930	630	570	690
Limnephilidae	60	150	270	300	30	210	30	270	90	30
Leptoceridae	90	180	210	120	30	150	0	0	30	60
Unenoidae	0	30	0	60	0	150	0	0	0	30
Apantaniidae	90	0	30	0	0	0	0	120	0	60
Limnocentropodidae	60	0	30	0	0	60	0	0	60	30
Goeridae	0	30	0	60	0	0	0	90	0	0
Lepidostomatidae	0	0	0	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	0	0	0	0	0	0
Chaoborus	330	210	240	300	210	330	150	90	330	270
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	60	30	90	30	0	60	0	30	0	0
Metriocnemus	30	0	60	0	0	0	90	60	0	0
Denopelopia	90	0	60	0	0	90	0	0	60	0
Polypedilum tritum	0	0	30	0	60	0	0	30	0	0
Stylaria sp.	300	630	870	420	380	90	60	600	30	120
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	0	0	0	0	0	0

Table 19. Benthic organisms(No/m^2) of Sasthamkotta lake during July 2014

	STATIONS									
BENTHIC FAUNA	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	9922	1102	19282	12292	5492	3439	1322	722	1024	1428
Limnephilidae	0	122	0	0	0	0	0	48	0	0
Leptoceridae	0	0	0	144	0	0	0	0	0	0
Unenoidae	0	0	0	0	0	0	0	0	0	0
Apantaniidae	0	243	122	0	0	0	388	0	0	0
Limnocentropodidae	0	0	0	0	0	0	0	0	0	0
Goeridae	122	0	0	0	242	0	0	0	0	0
Lepidostomatidae	0	0	0	0	0	96	0	0	0	0
Polycentropodidae	0	0	48	0	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	48	0	0	0	96	0
Chaoborus	110	98	84	52	0	0	0	90	0	0
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	0	0	0	0	0	48	0	0	0	0
Metriocnemus	48	0	82	0	52	0	110	78	0	0
Denopelopia	0	0	0	48	0	0	0	96	0	0
Polypedilum tritum	0	0	48	0	0	0	48	0	0	0
Stylaria sp.	0	0	78	0	0	0	48	98	0	0
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	48	0	0	0	0	0	0

Table 20. Benthic organisms(No/m^2) of Sasthamkotta lake during August 2014

BENTHIC FAUNA	STATIONS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	17222	923	3222	722	1128	14242	20221	19626	13524	17322
Limnephilidae	457	0	724	0	0	372	0	0	0	0
Leptoceridae	0	96	0	0	0	0	0	0	0	0
Unenoidae	0	0	0	0	0	0	0	0	48	0
Apantaniidae	0	0	128	0	382	0	0	528	0	0
Limnocentropodidae	0	0	0	0	0	0	0	0	0	96
Goeridae	0	96	0	0	0	0	174	0	0	0
Lepidostomatidae	0	0	368	0	0	0	0	0	0	0
Polycentropodidae	0	0	0	96	0	0	0	0	0	0
Sericostomatidae	0	0	0	0	48	0	0	0	0	0
Chaoborus	110	48	108	0	0	0	0	48	0	48
Thaumilidae	0	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	0	0	48	0	0	119	0	0	158	0
Metriocnemus	0	0	0	48	0	0	0	0	0	0
Denopelopia	0	0	0	58	0	0	0	48	0	0
Polypedilum tritum	0	0	0		0	0	0	0	0	0
Stylaria sp.	0	0	0	96	0	0	158	0	0	0
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	48	0	0	0	0	0

Table 21. Benthic organisms (No/m^2) of Sasthamkotta lake during September 2014

BENTHIC FAUNA	STATIONS									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	8124	19232	10267	2782	17282	67328	1188	3896	982	1178
Limnephilidae	361	199	358	0	0	96	0	48	0	0
Leptoceridae	0	0	0	48	0	0	96	0	0	0
Unenoidae	0	0	0	0	48	0	0	0	0	0
Apantaniidae	0	144	96	0	0	0	0	0	48	0
Limnocentropodidae	144	0	0	0	0	48	0	0	0	96
Goeridae	0	0	114	0	0	0	144	0	0	0
Lepidostomatidae	0	96	0	0	252	0	0	0	0	0
Polycentropodidae	0	0	0	0	0	0	144	0	0	0
Sericostomatidae	0	0	0	48	0	0	0	0	0	0
Chaoborus	210	0	118	0	0	48	0	192	0	0
Thaumilidae	0	0	0	0	48	0	0	0	0	0
Pelecorhynchidae	0	0	0	0	0	0	0	0	0	0
Cryptotendipes	0	0	48	0	0	0	62	0	0	0
Metriocnemus	0	0	48	0	0	0	0	172	0	0
Denopelopia	0	0	0	0	48	0	0	0		0
Polypedilum tritum	0	0	0	0	0	0	0	0	52	0
Stylaria sp.	0	108	0	112	0	0	192	0	0	0
Pristina	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	0	0	0	0	0
Chaetogaster	0	0	0	0	96	0	0	0	48	0

Table 22. Benthic organisms (No/m^2) of Sasthamkotta lake during October 2014

	STATIONS									
BENTHIC FAUNA	I	II	III	IV	V	VI	VII	VIII	IX	X
Phryganopsychidae	2640	4368	25872	48	528	892	118	1124	10222	9928
Limnephilidae	816	240	4560	48	384	138	0	0	0	292
Leptoceridae	0	0	0	0	0	0	0	0	0	0
Unenoidae	0	0	0	0	0	0	0	48	144	0
Apantaniidae	384	480	2832	48	48	0	0	0	0	0
Limnocentropodidae	0	0	1920	0	0	0	0	0	0	0
Goeridae	0	528	3264	0	48	0	322	0	0	0
Lepidostomatidae	144	48	1296	0	144	0	172	0	0	182
Polycentropodidae	0	0	0	48	48	0	0	0	0	0
Sericostomatidae	0	0	0	192	0	0	0	48	0	0
Chaoborus	0	0	48	0	0	0	0	58	0	0
Thaumilidae	48	0	0	0	0	0	0	0	0	0
Pelecorhynchidae	0	48	0	0	0	0	0	0	0	0
Cryptotendipes	0	0	0	0	0	0	48	0	0	0
Metriocnemus	144	0	0	0	0	164	0	0	158	132
Denopelopia	0	0	112	0	0		0	0	0	0
Polypedilum tritum	0	0		0	0	48	0	0	0	0
Stylaria sp.	0	0	1296	768	0	1012	0	608	0	872
Pristina	0	0	0	192	0	0	0	0	0	0
Nais	0	0	0	96	0	0	0	0	0	0
Chaetogaster	0	0	0	196	0	0	0	0	0	0

Fig.1 Quantitative analysis (annual variation) of benthic fauna in Sasthamkotta lake during Dec 2013- Octo 2014

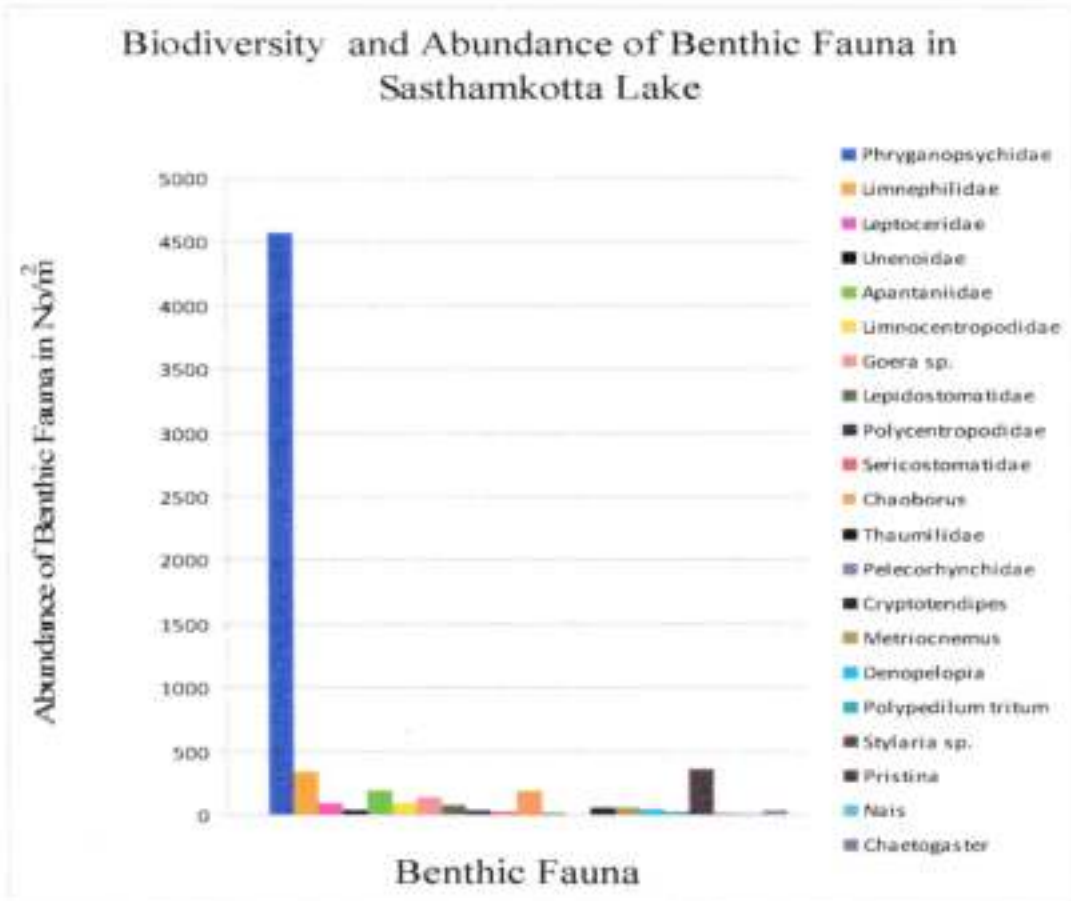
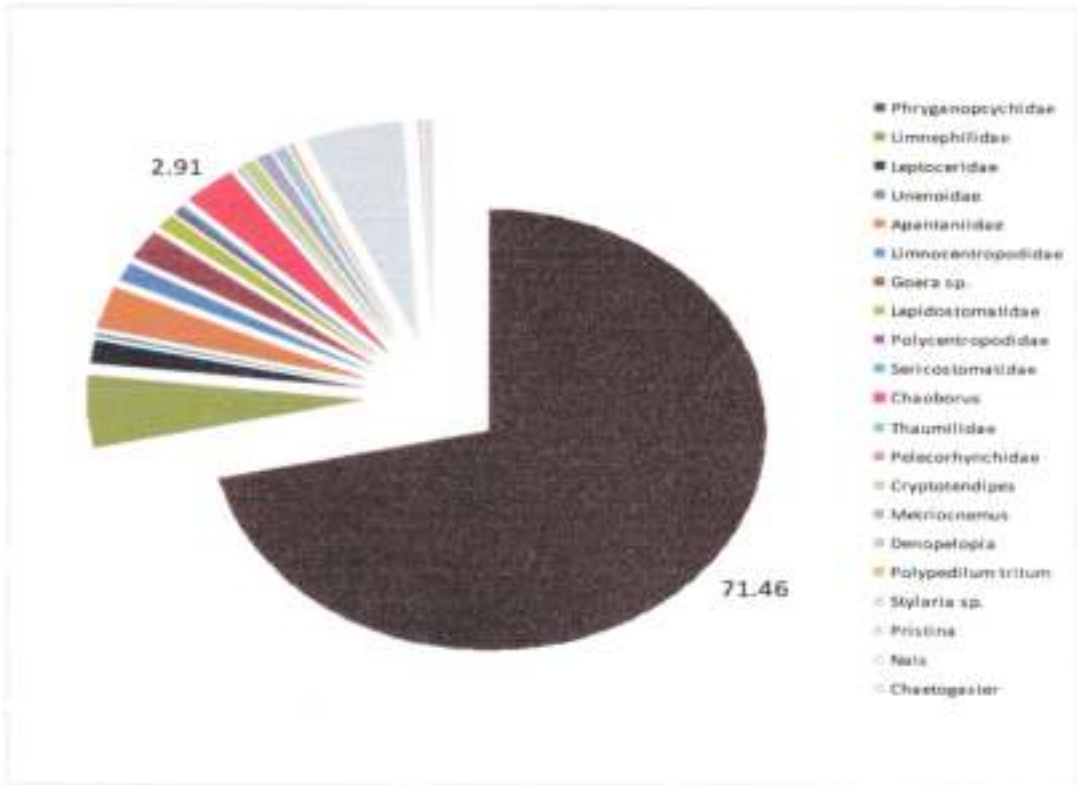


Fig.2 Percentage composition of Benthic fauna in Sasthamkotta lake during 2013-14



Abundance of Chaoborus among benthic composition is 2.91%.

BENTHIC FAUNA	Annual Aveg.	Percentage	
Phryganopsychidae	2730	71.46	
Limnephilidae	232	5.32	
Leptoceridae	86	1.41	
Unenoidae	25	0.55	
Apantaniidae	147	2.94	
Limnocentropodidae	46	1.42	
Goeridae	67	2.05	
Lepidostomatidae	64	1.26	
Polycentropodidae	14	0.5	87.35% Trichoptera
Sericostomatidae	15	0.44	
Chaoborus	181	2.91	
Thaumilidae	1	0.19	
Pelecorhynchidae	0.5	0.06	
Cryptotendipes	44	0.81	
Metriocnemus	39	0.92	
Denopelopia	33	0.74	6. 04 %Diptera
Polypedilum tritum	15	0.41	
Stylaria sp.	332	5.69	
Pristina	2	0.25	
Nais	1	0.13	6.60 %Oligochaeta
Chaetogaster	12	0.53	

Descriptions of Benthic Fauna collected from Sasthamkotta lake

Chaoborus Larvae (Plate I)

Order : Diptera

Family : Chaoboridae

Genus : ***Chaoborus***

Commonly called 'Phantom Midges'. ***Chaoborus*** larvae mainly occur in standing water in lakes, ponds and marshes. Rarely they found in the calm water of streams. Size small to medium (6-12mm).

Head sclerotized, rounded and clearly separate from thorax; mandibles moving against each other on a horizontal plane; thoracic segments fused and swollen, wider than abdomen; prolegs absent; antennae terminating in long setae; terminal segment with ventral brush of setae.

Chaoborus larvae resemble mosquito larvae. The most common form of chaoborids are found in the water columns of lakes and ponds and are known for their vertical migrations. They migrate in order to follow their prey and to obtain air. These larvae have two air sacs that provide buoyancy and an air source as they move through the water column.

Order : Trichoptera

Trichoptera or Caddis flies

The Trichoptera or Caddis flies, one of the largest groups of aquatic insects, are closely related to the Lepidoptera. Caddis flies are aquatic in the immature stages. Adults of almost all species are active winged insects. Caddis flies occur in most types of freshwater habitats: springstreams and seepage areas, rivers, lakes, marshes and temporary pools. Caddisfly larvae are perhaps best known for the remarkable nets, retreats and portable cases they construct.

Free-Living Forms- Rhyacophilidae and Hydrobiosidae families

Saddle-Case Makers- Glossosomatidae family

Purse-Case Makers- Hydroptilidae family

Net-Spinners or Retreat-Makers- Annulipalpia-Curvipalpia families

Tube Case Makers – Integripalpia families

During present study Trichoptera composed of Tube Case Makers – Integripalpia families. **Phryganopsychidae, Sericostomatidae, Leptoceridae, Limnephilidae, Apatanidae, Lepidostomatidae, Uenoidea, Limnocentropodidae** and **Goeridae** are included in this Integripalpia family. **Polycentropodidae** incorporated in Annulipalpia family.

Family : Phryganopsychidae (Plate II, III, IV, V, VI and VII)

Identifying features

Case flimsy, of randomly placed plant debris

Antennae at anterior edge of head capsule

Lotic –depositional

Sprawlers

Shredders—detritivores

Pro sternal horn present; abdomen with lateral fringe; median dorsal hump segment small; abdominal gills single, short

Family : Sericostomatidae (Plate VIII)

Identifying features

Antennae near mandibles

Anal proleg dorsal sclerite small

Anal prolegs each with more than 30 setae

Tube-case, funeral mineral, curved, tapered

Lotic-erosional, lotic depositional

Sprawlers, Burrowers

Shedders- Detritivores ,Collectors-Gatherers

Family : Leptoceridae (Plate IX)

Identifying features

Antennae length >6X diameter and/or mesonotum with dark bars

Tube case, wide variety of shapes, materials

All types of habitats

Climbers, Sprawlers, Clingers

Shedders-Herbivores, Collectors-Gatherers, Predators, Engulfers

Family : Limnephilidae (Plate X)

Identifying features

Antennae midway between eyes and edge of head capsule

Mesonotum with one sclerite

Metanotum with small sclerite

Tube case, many shapes and materials

All types of habitats

Climber, Sprawlers, Clingers

Shedders, Collectors, Gathers, Scrappers, Detritivores

Family : Apataniidae (Plate XI)

Identifying features

Mandibles usually without teeth

one sclerites absent or with more than 25 setae between them

Tube-case, mineral, tapered, curved

Lotic-erosional, lotic depositional

Clingers, Sprawlers

Scrappers, Shedders-Herbivores, Collectors, Gathers

Family : Lepidostomatidae (Plate XII)

Identifying features

Antennae next to eyes

Mesonotum sclerotized

Mesonotum with small sclerites

Abdomen segment one with lateral humps only

Tube case, often square

Lotic-erosional, lotic depositional

Climber, Sprawlers, Clingers

Shedders- Detritivores

Family : Uenoidea

Identifying features

Larvae slender; pronotum longer than wide; mesonotum emarginated antero dorsally.; Larval cases smooth and very slender, of fine silk or short and thick, constructed of coarse rock fragments.

Family : Limnocentropodidae

Identifying features

Meso and metanotum similarly shaped; meso and meta thorax and abdominal segment 1 with sternites bearing many setae; abdominal 1 lacking dorsal humpbut with a transverse sclerite.

Family : Goeridae

Identifying features

Dorsal side of head brown or reddish brown; case with small stones laterally; mesonotum with 2 pairs of sclerites, metanotum with 3 pairs of small sclerites; case with two pairs of larger pebbles on side

Family : Polycentropodidae

Identifying features

Tarsi all narrower than their tibiae and more nearly cylindrical larvae in unbranched silken tube on substrate surfaces. Widespread in most types of aquatic habitats.

Diptera or True flies

Salient features

Diptera or True flies are one of the most diverse insect orders. Lentic habitat of Diptera larvae are equally diverse including lakes, springs, temporary pools and tree holes.

Chironomidae

The family Chironomidae is ecologically important group of aquatic insect often occurring in high densities and diversities. Chironomidae larvae are known to feed on a great variety of organic substrates. The overall diversity of the family is also reflected in the rich Chironomid faunas of many aquatic ecosystems.

Family : Chironomidae

Sub family : Chironominae

Genus : Cryptotendipes (Plate XIII)

Salient features

Cryptotendipes larvae are found in lentic and lotic situations. They are usually benthic and appear to tolerate organically enriched habitats. Cryptotendipes larvae are no identifiable at the species level

Family : Chironomidae

Sub family : Tanypodinae

Genus : Denopelopia (Plate XIV)

Salient features

Occur in wide variety of habitat ; springs, banks, flood plain, streams, rivers, lake etc. Denopelopia larvae are distinguished by the large lauterborn organs; fused to the apex of antennal segment two; giving a tuning fork appearance;

Lack of well developed dorsomental tooth plates. The immature stage occur in shallow water. It is tolerant of extended period of low dissolved oxygen.

Family : Chironomidae

Sub family : Chironominae

Genus : Polipedilum (Plate XV)

Salient features

The larvae are found in wide range of habitats under a variety of environmental conditions, ranging from pristine to heavily degraded. Base of sternite 8 and tergite 8 of male triangularly produced. Pulvilli bilobate or branched.

Family : Chironomidae

Sub family : Orthocladiinae

Genus : Metriocnemus (Plate XVI)

Salient features

Antennae with 3 to 7 segments, may be strongly reduced or may be longer than head capsule. Procerci well developed, at least twice as long as wide; supra anal setae shorter than anal tubules.

Larvae are known from a variety of aquatic habitats including water held by the pitcher plant Sarracenia, marine intertidal pools , sewage treatment beds, moss, tree holes, in damp soil, madicolous habitats (water flowing in a thin film) and in seeps, springs, strems , rivers and lakes

Family : Thaumaleidae

Respiratory system amphipneustic; prothoracic and anal prolegs unpaired.

Family : Pelecorhynchidae

Abdominal segments without prolegs or tubercles; segmentation bead like

Phylum – Annelida

Class- Clitellata

Sub class - Oligochaetae

Oligochaetae (Aquatic earth worm). The truly aquatic earworms are common in mud mud and debris of stagnant pools and ponds, streams and lakes. The aquatic oligochaetes burrow in mud. The form and arrangement of the chaeta is often the only external identification character available.

Stylaria (Plate XVII)

Active worms with the prostomium drawn out to form a long, tentacle like proboscis ; eyespots present. *S.lacustris*, up tpo 15mm long, is probably the sole species and is common in many habitats amongst filamentous algae and other plant life, or in the detritus; it swims with a stiff, wriggling action.

Nais (Plate XVIII)

Dorsal chaeta bundles absent from first to three or more segments, hair chaetae present; eyespots present or absent; never with proboscis or caudal gills. Many species of this large genus are common in a variety of habitats ; up to 20 mm long.

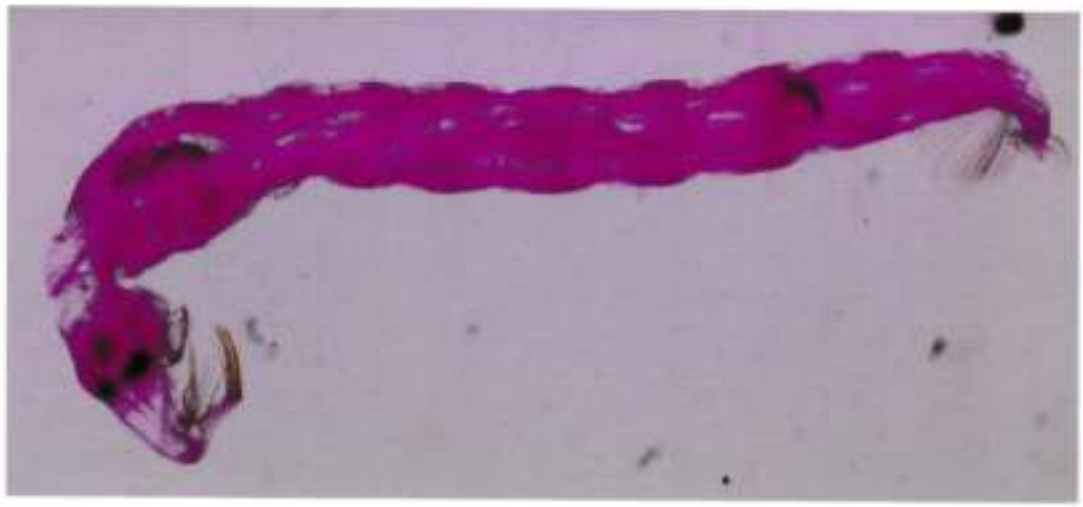
Pristina (Plate XIX)

Dorsal chaeta bundles present on all segments with long hair chaeta; prostomium produced as a slender proboscis in some species, eye spot absent; up to 15mm long

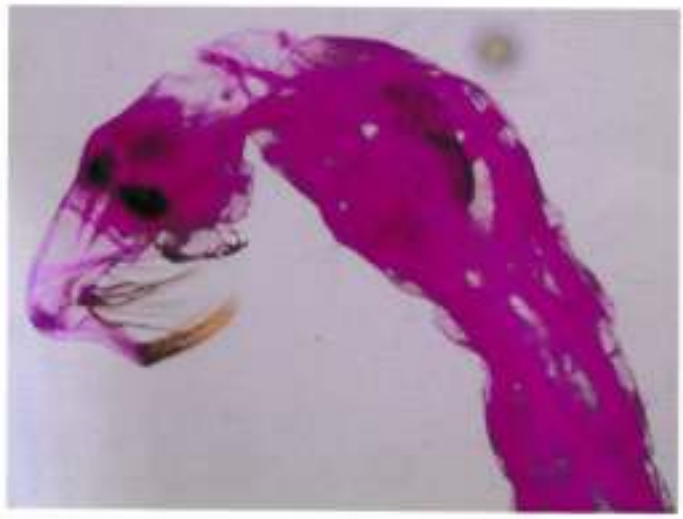
Chaetogaster (Plate XX)

Anterior part of the body very contractile, with a fan like bunch of chaeta on each side near the mouth; locomotion by 'looping' with the anterior part of the body and wriggling, stretching, etc. They are found in variety of habitats.

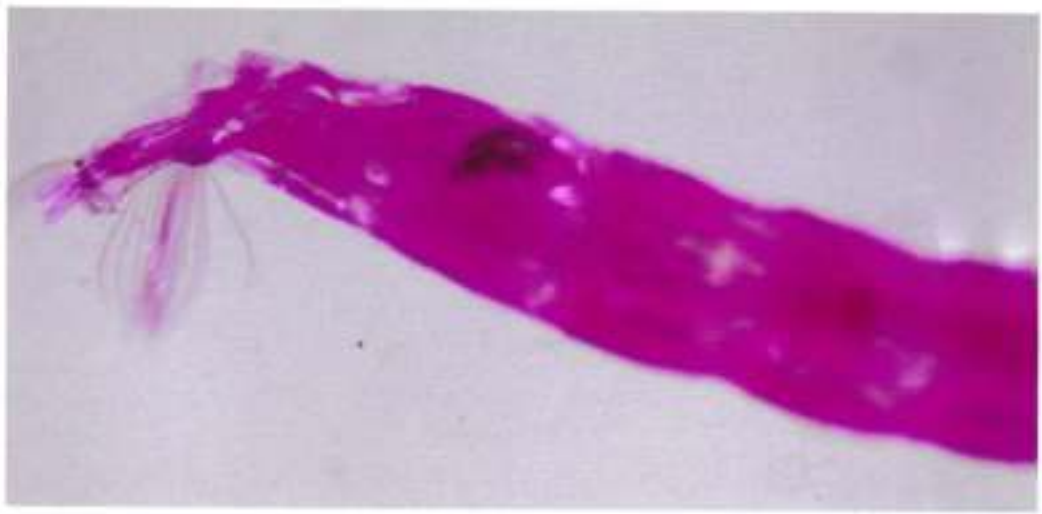
***Chaoborus* larva** **PLATE I**



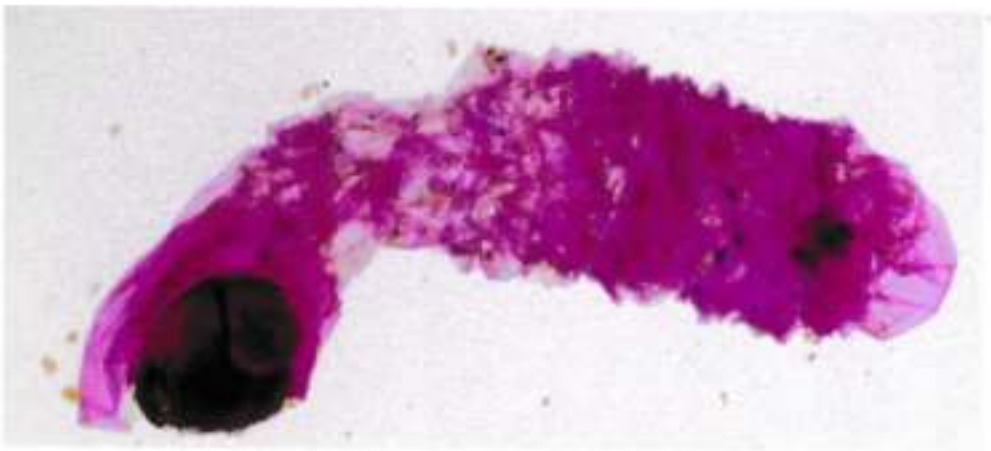
***Chaoborus* larva – Head region**

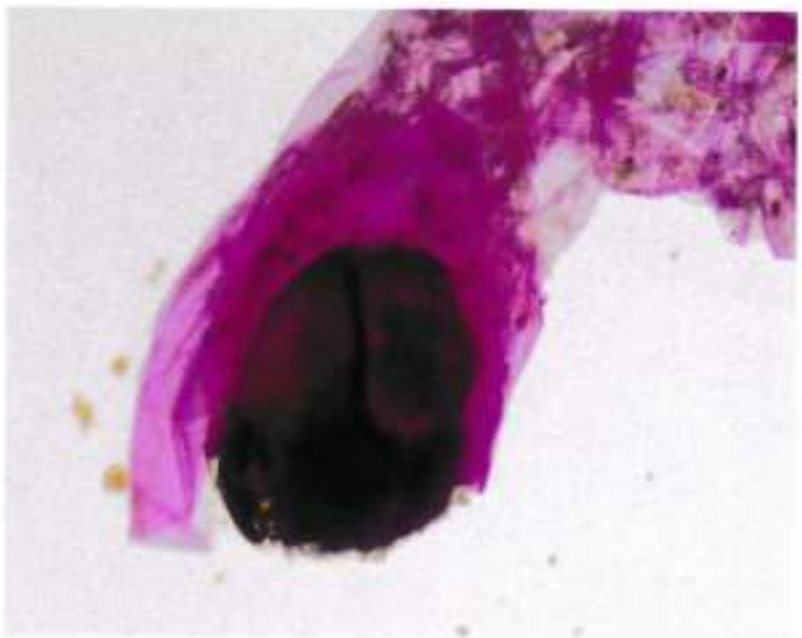


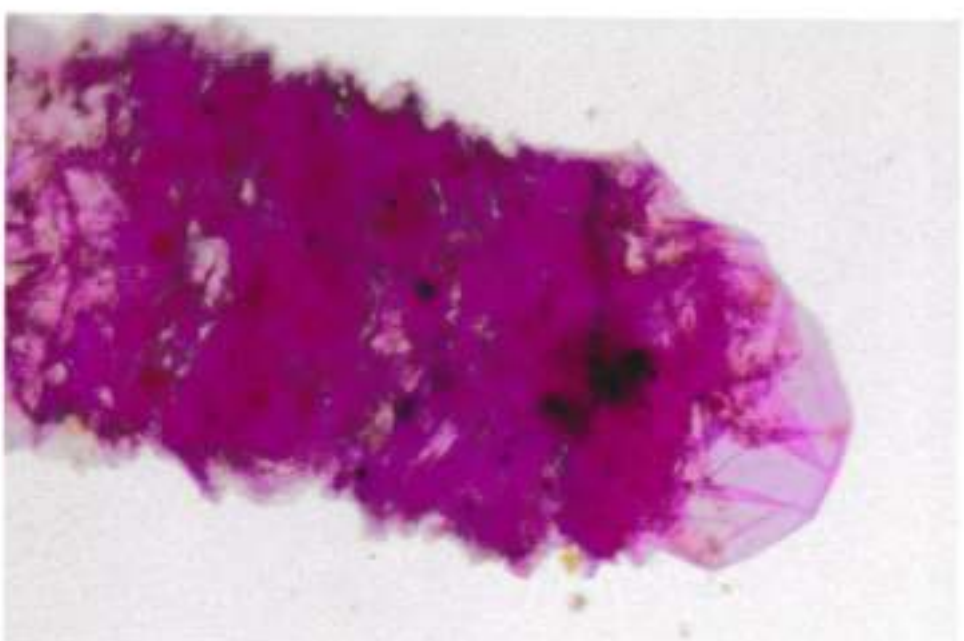
***Chaoborus* larva – Abdomen region**



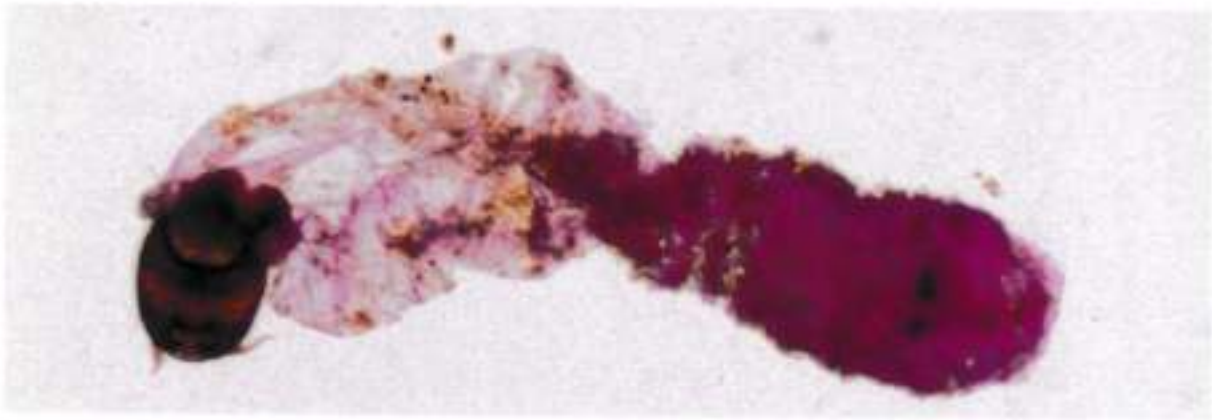
Phryganopsychidae **(Specimen 1)** **PLATE II**

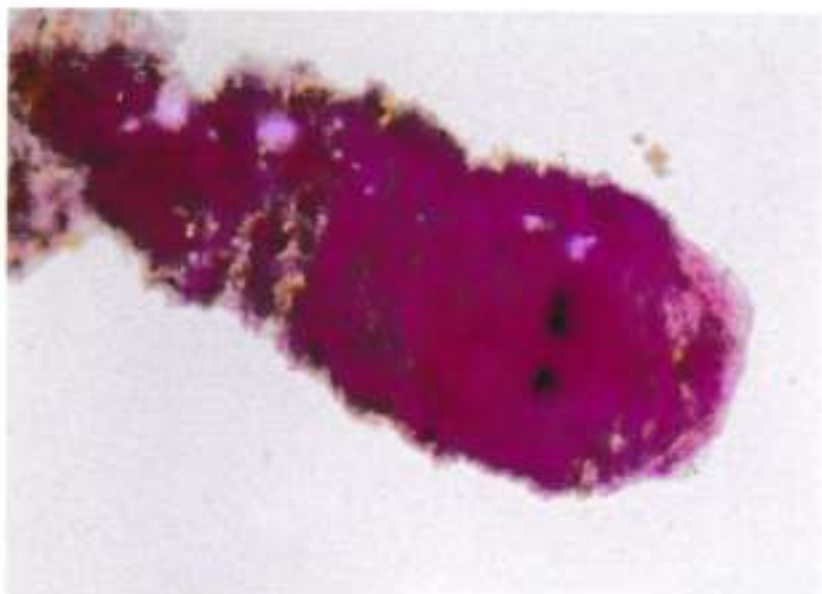




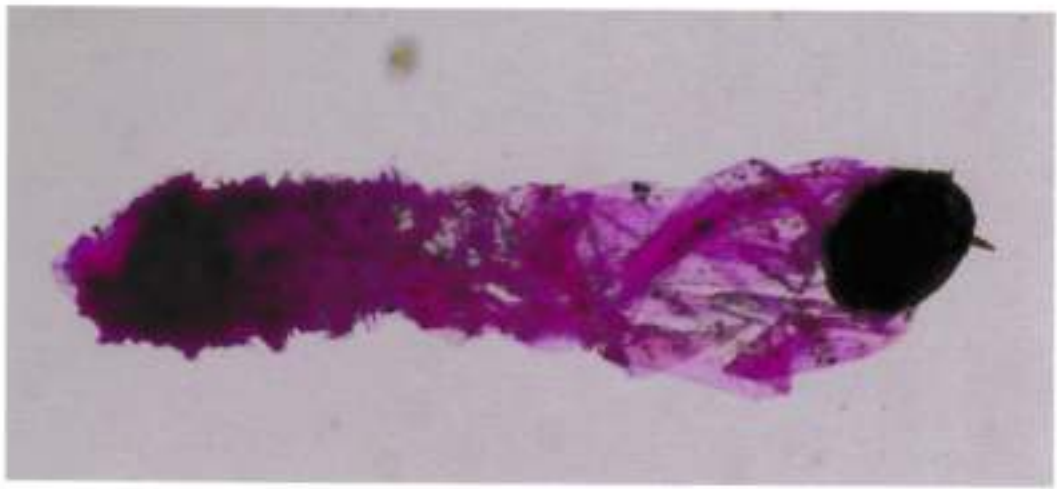


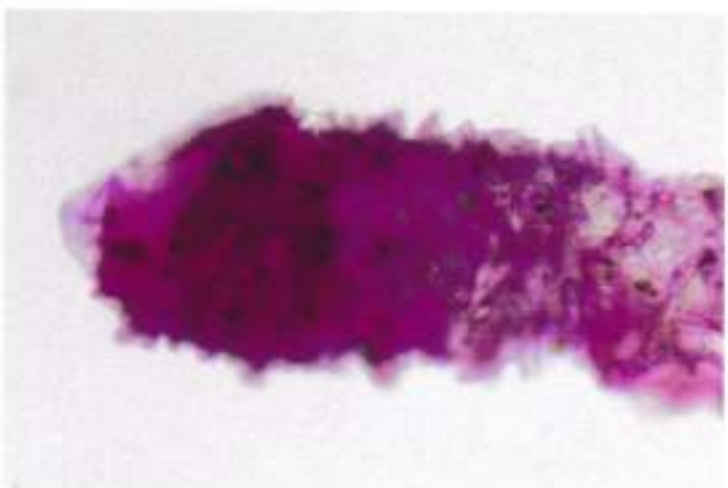
Phryganopsychidae **(Specimen 2)** **PLATE III**



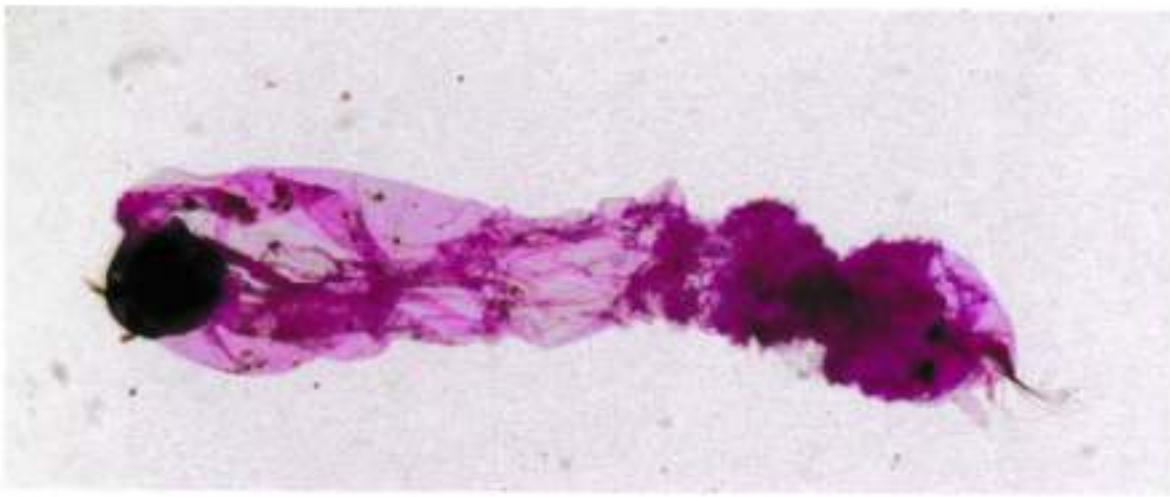


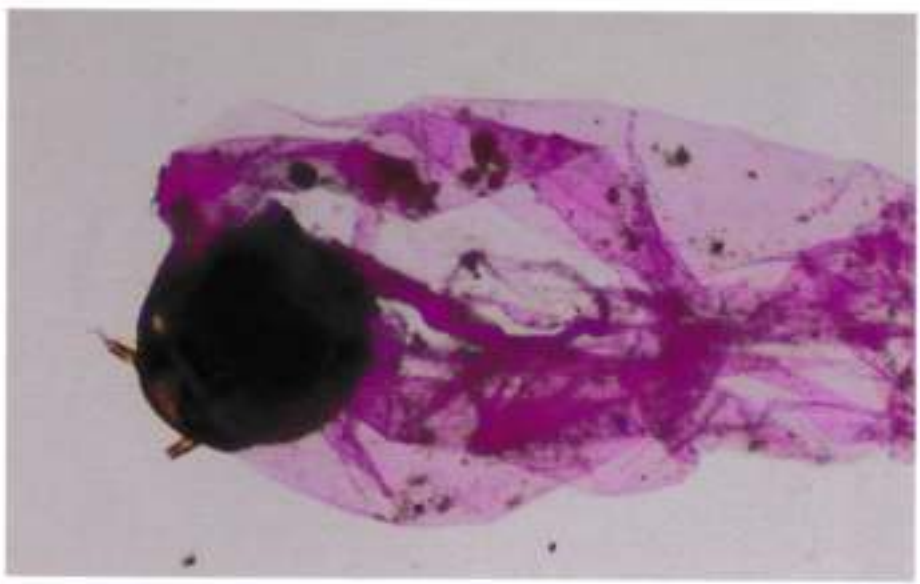
Phryganopsychidae (Specimen 3) **PLATE IV**

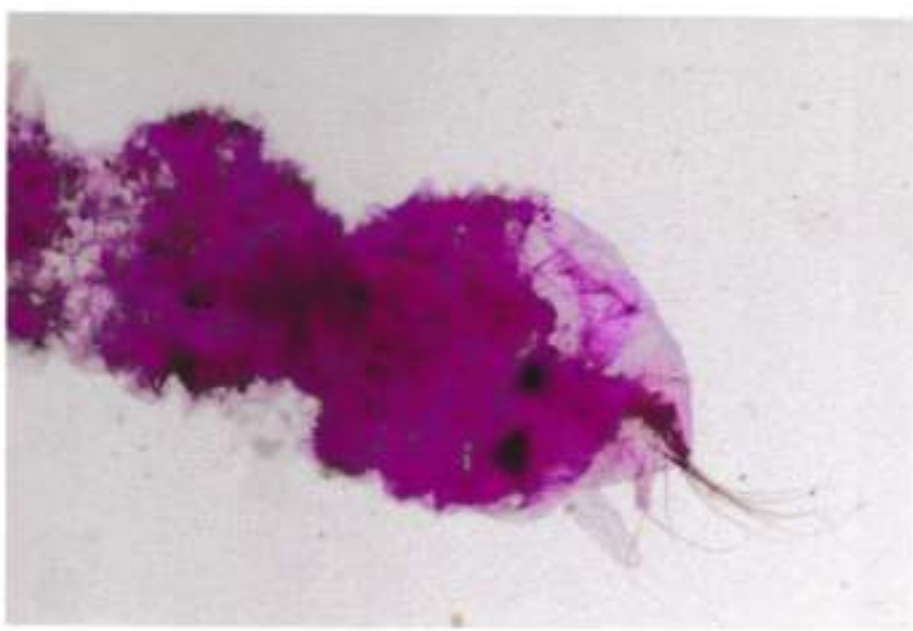




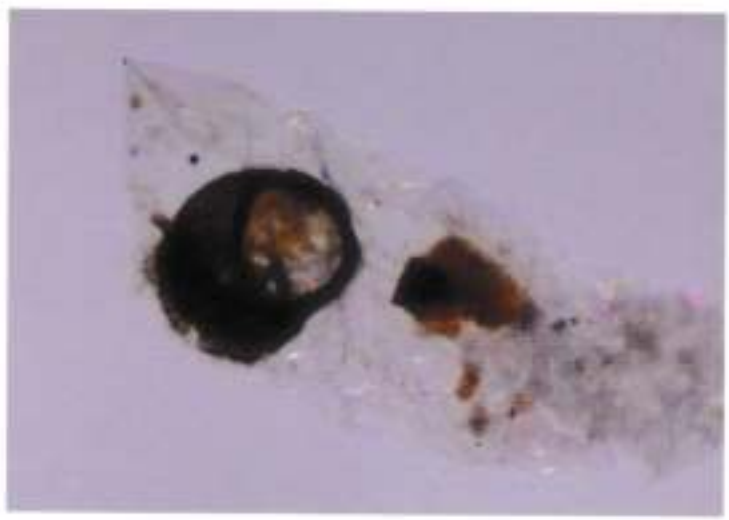
Phryganopsychidae **(Specimen 4)** **PLATE V**



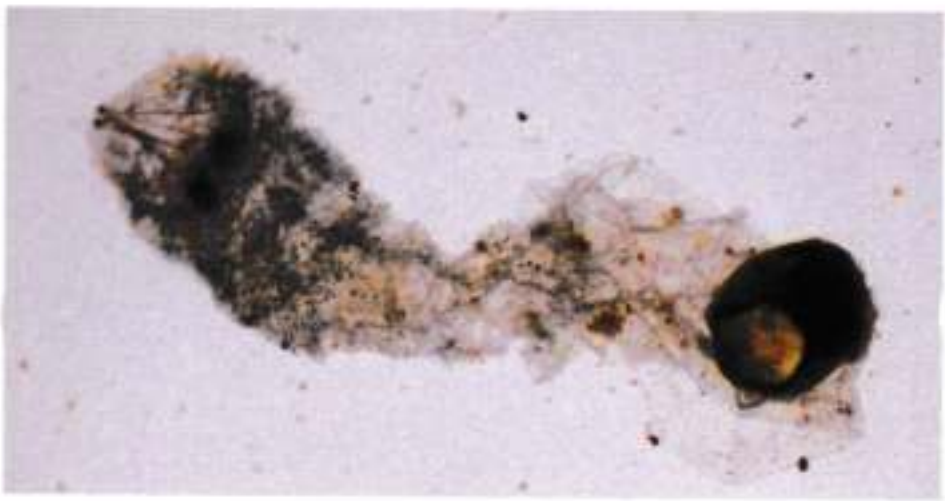


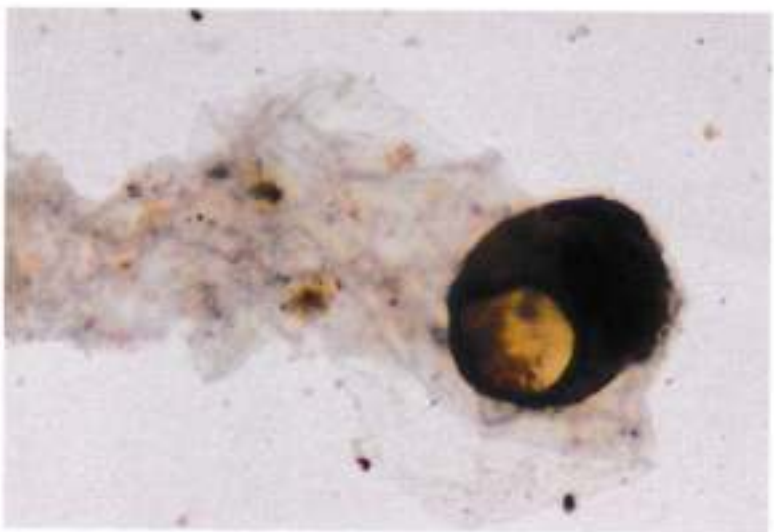


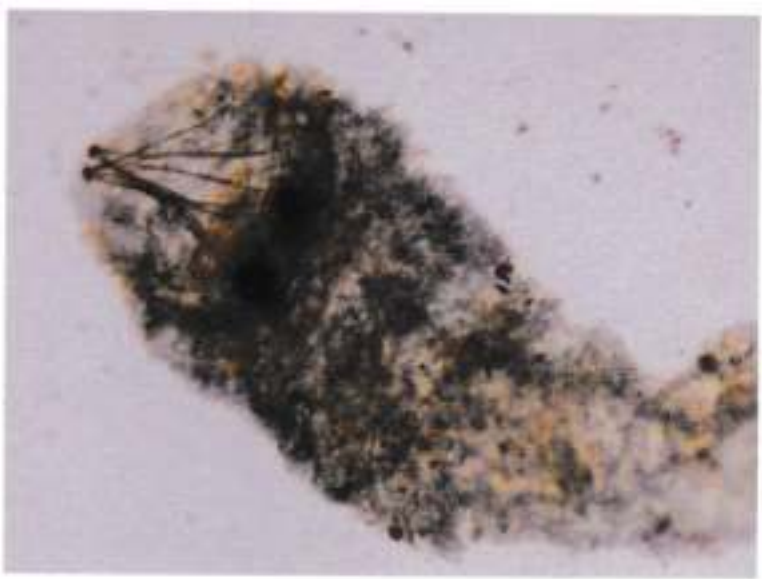
Phryganopsychidae (Specimen 5) **PLATE VI**

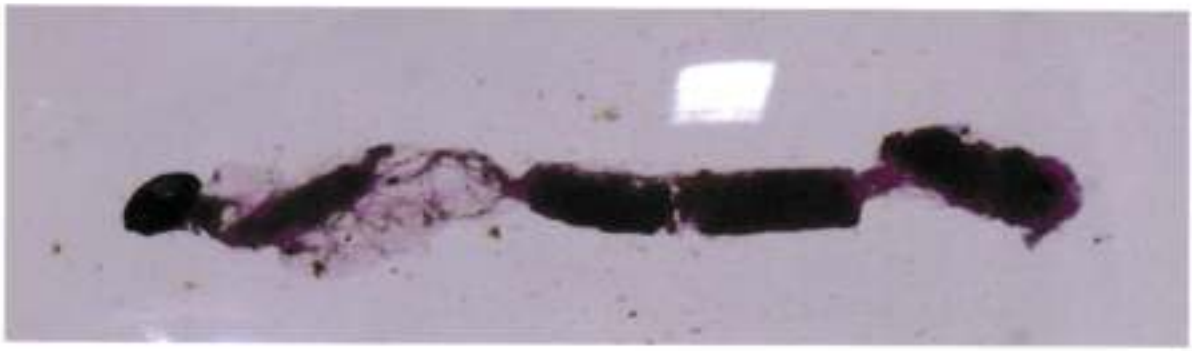


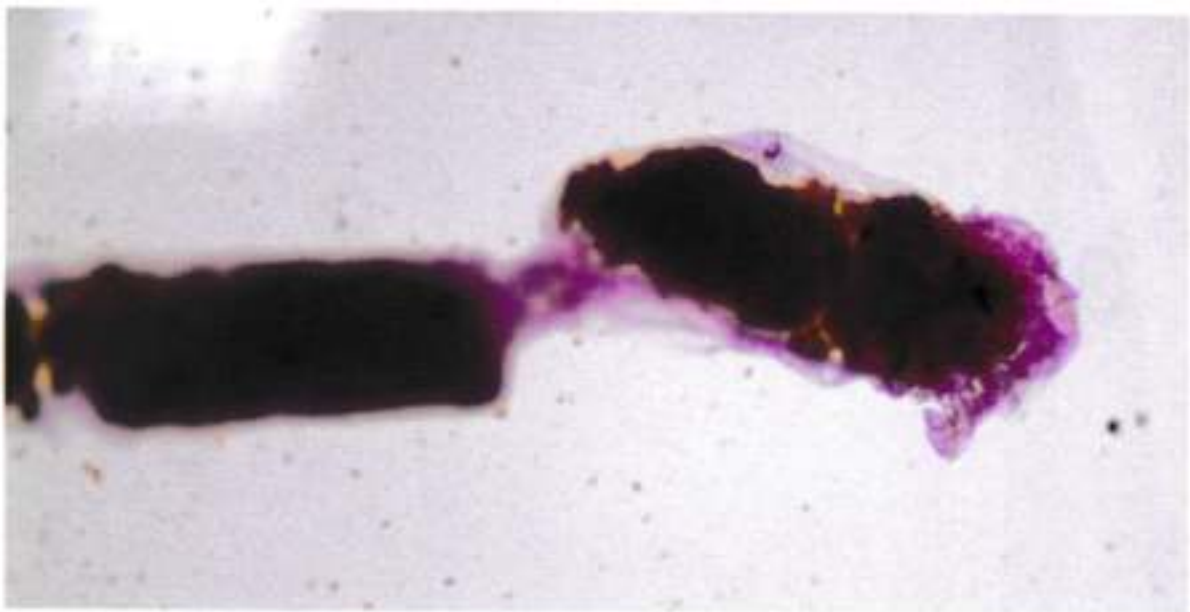
Phryganopsychidae (Specimen 6) **PLATE VII**

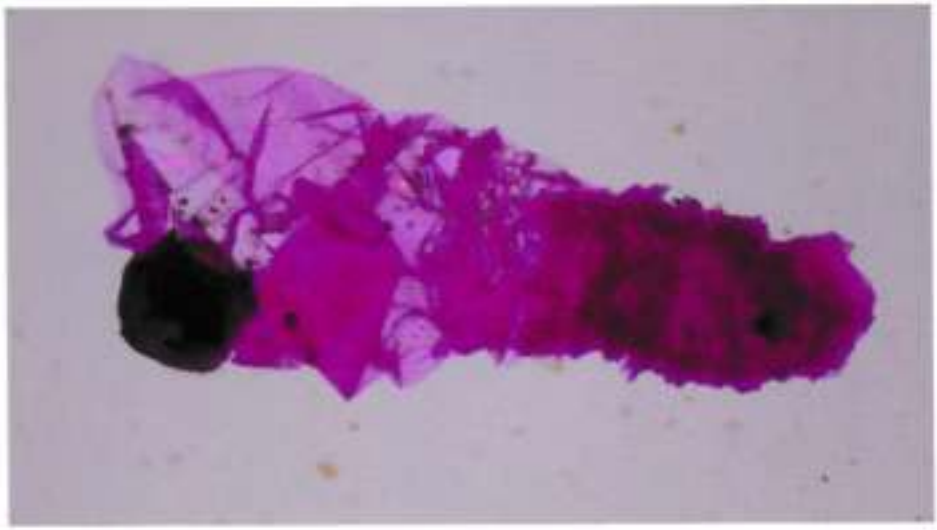


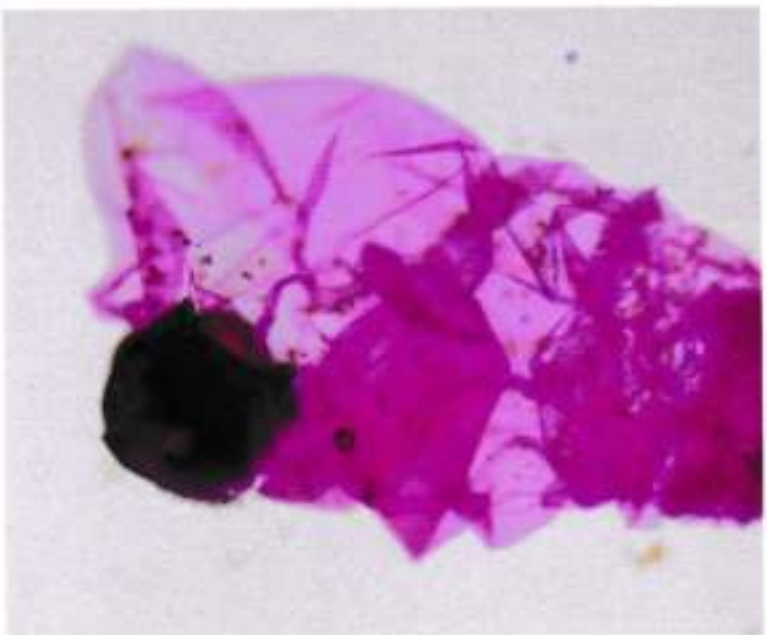


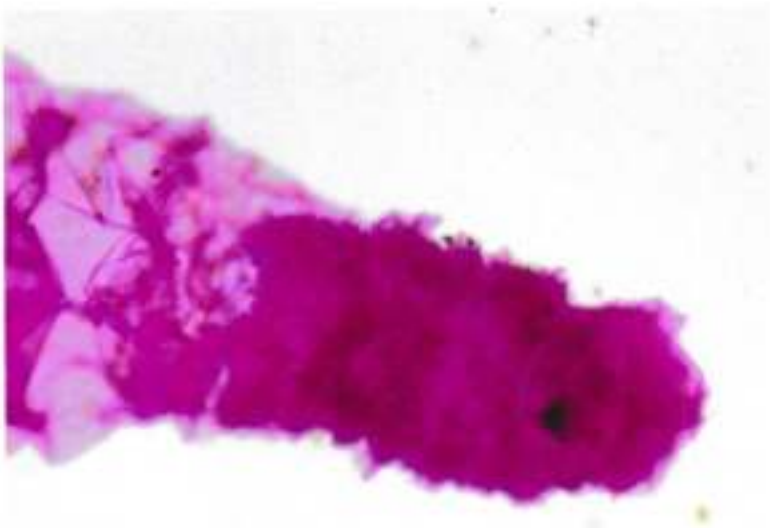


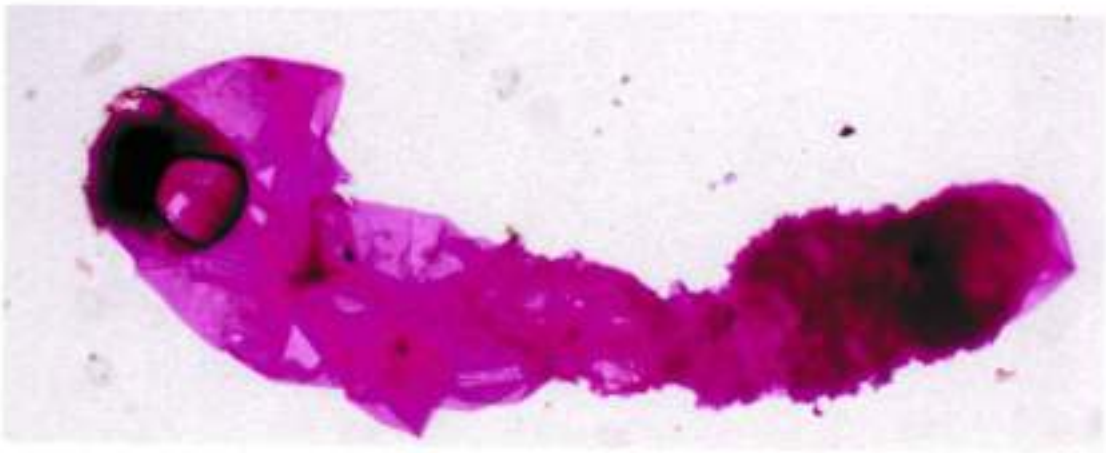


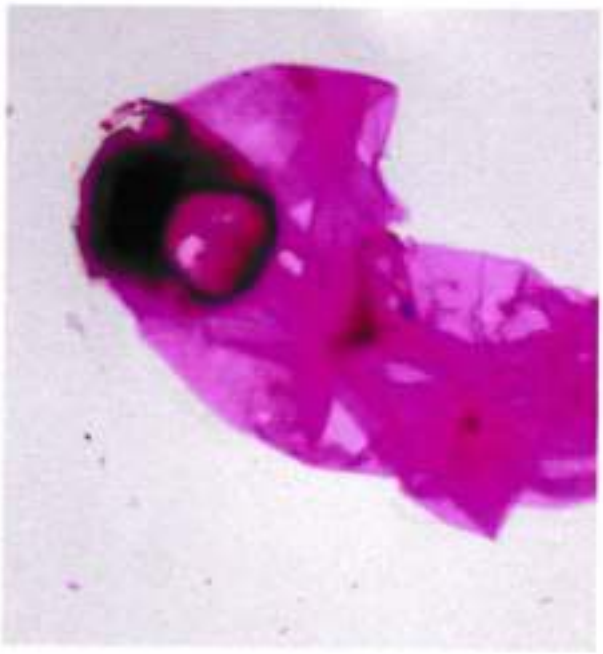


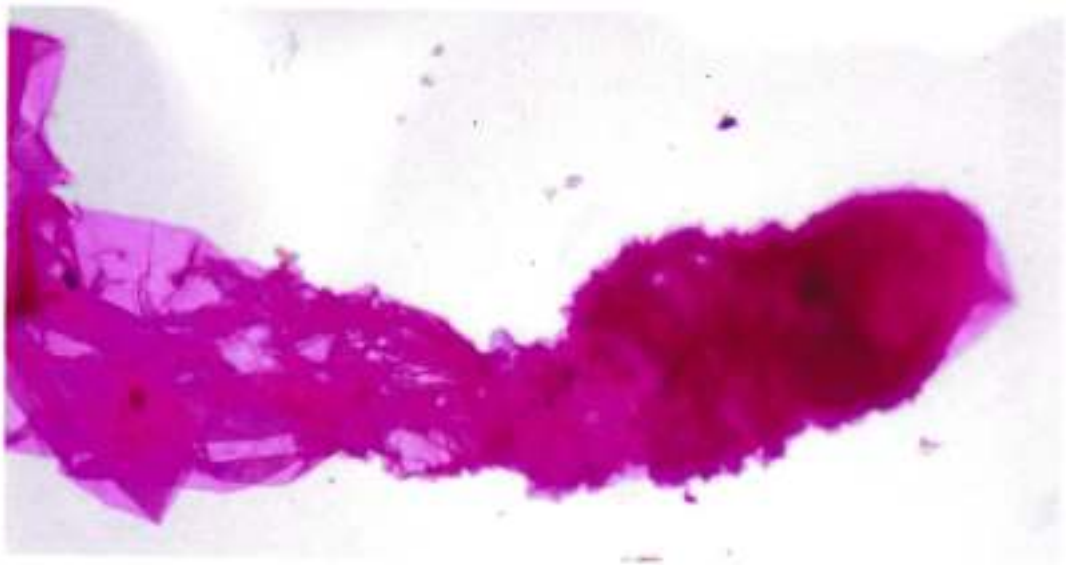


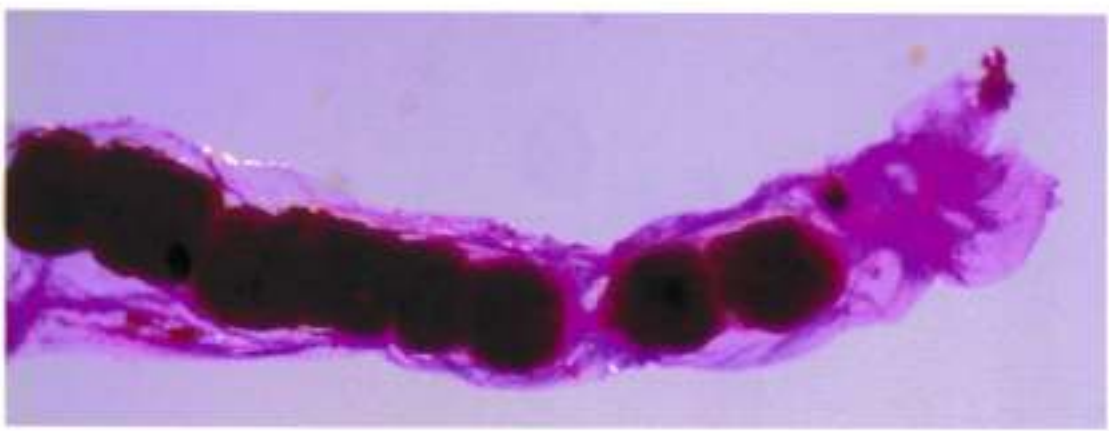


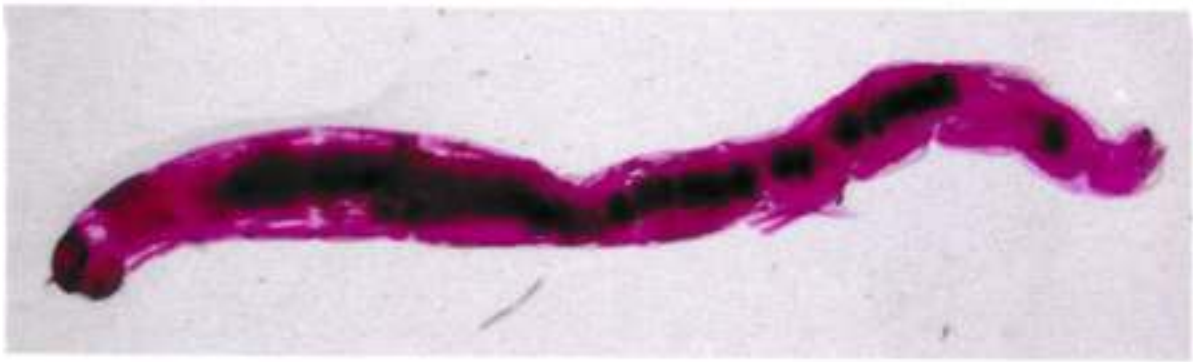


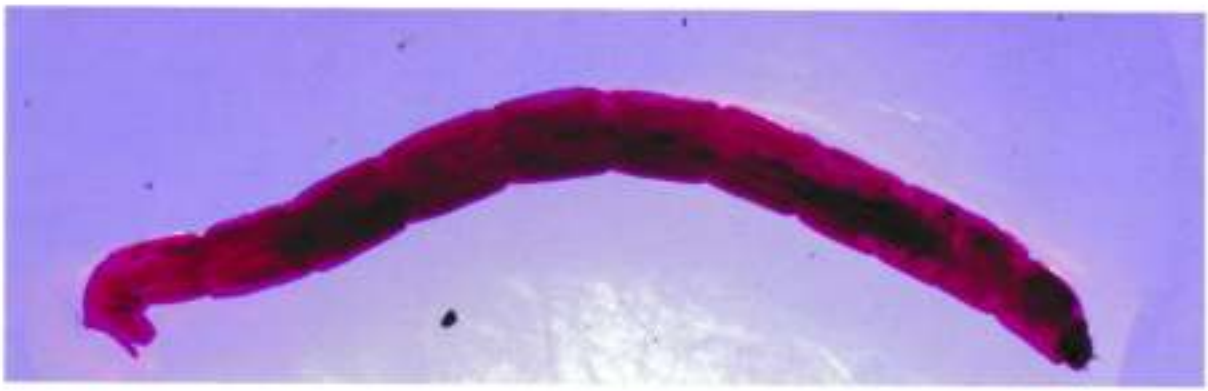












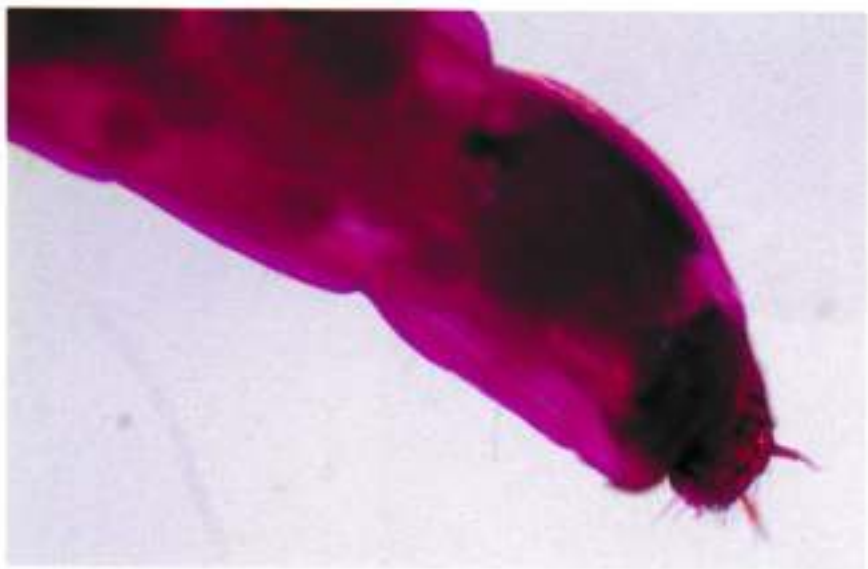
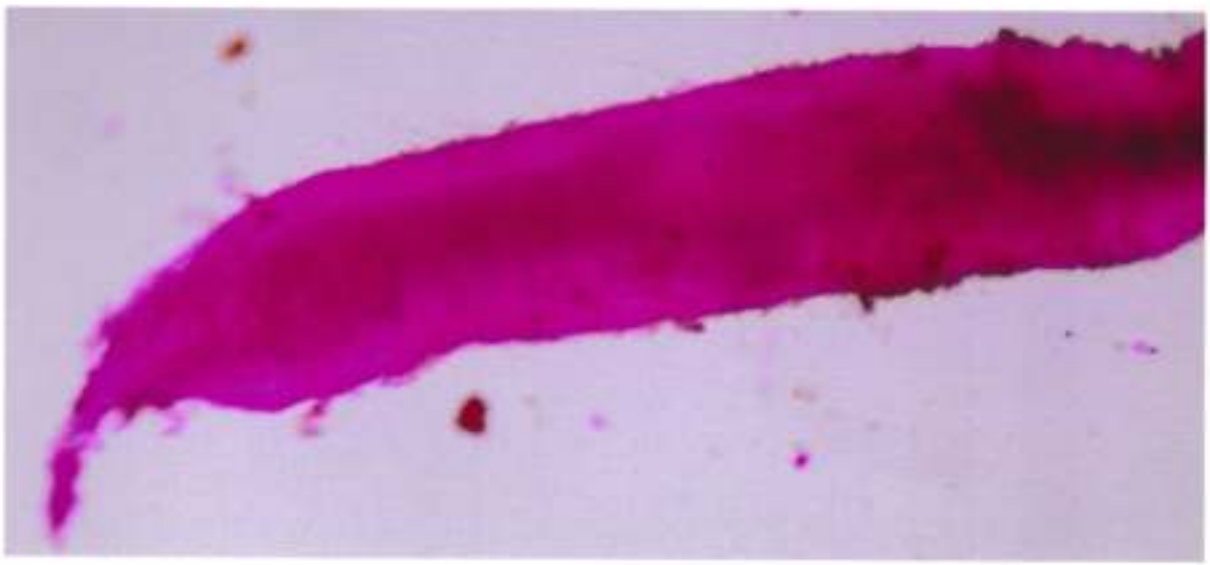
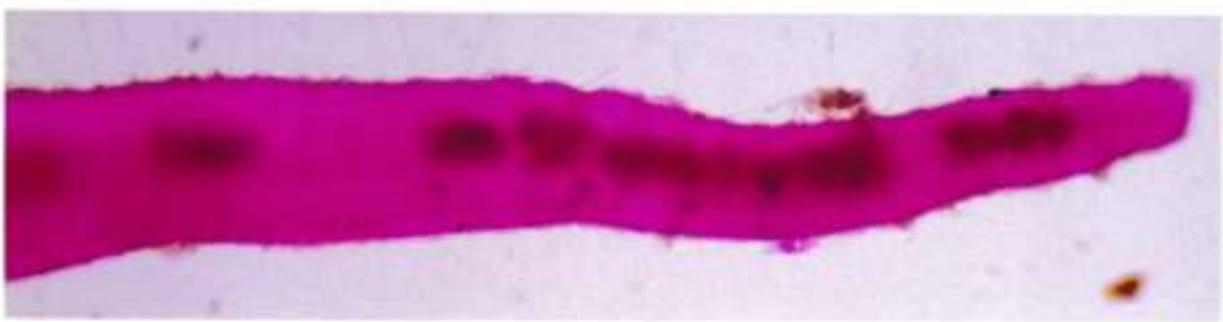
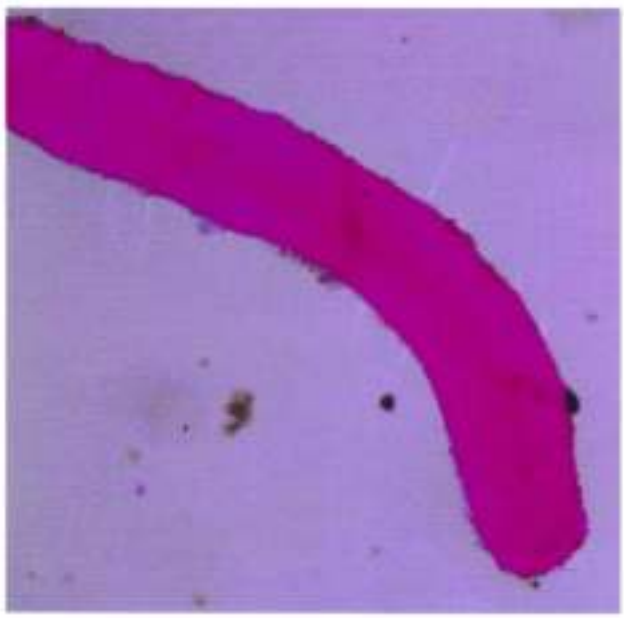


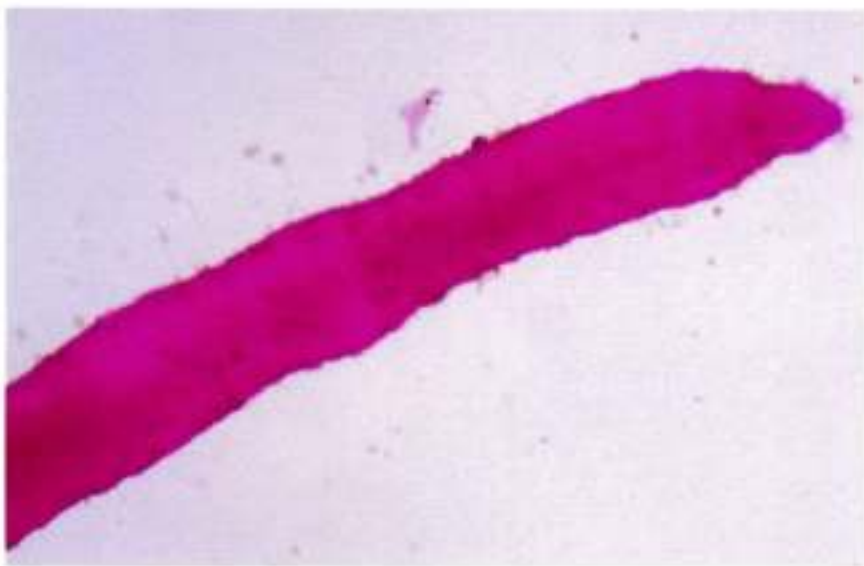
PLATE XVII

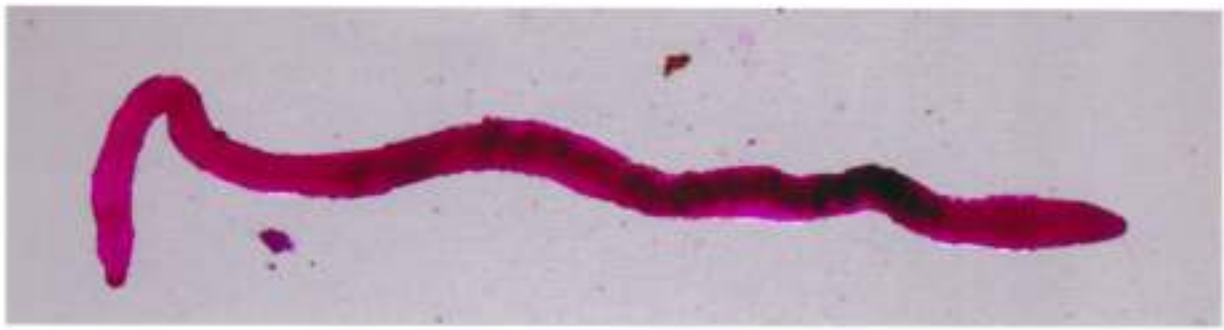
Stylaria

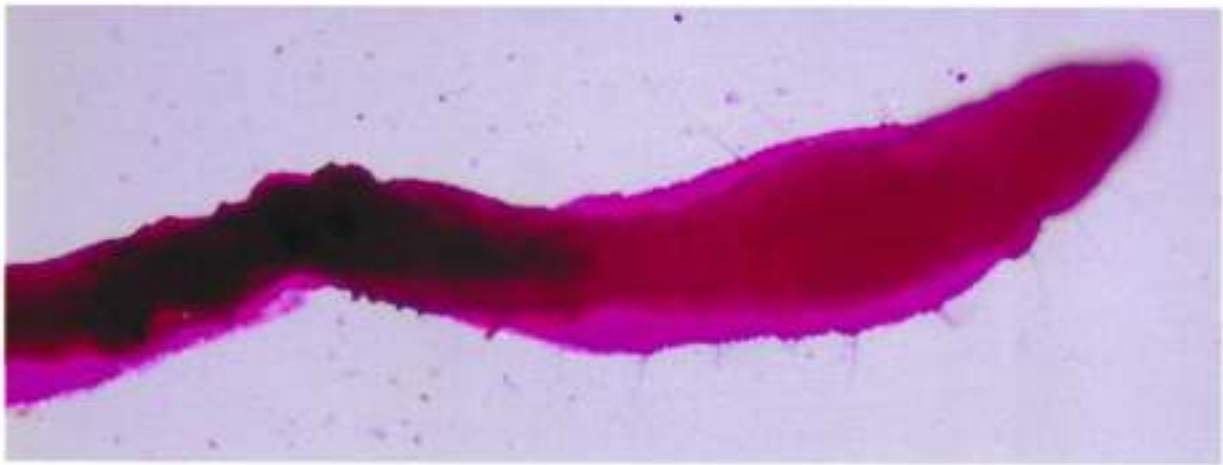


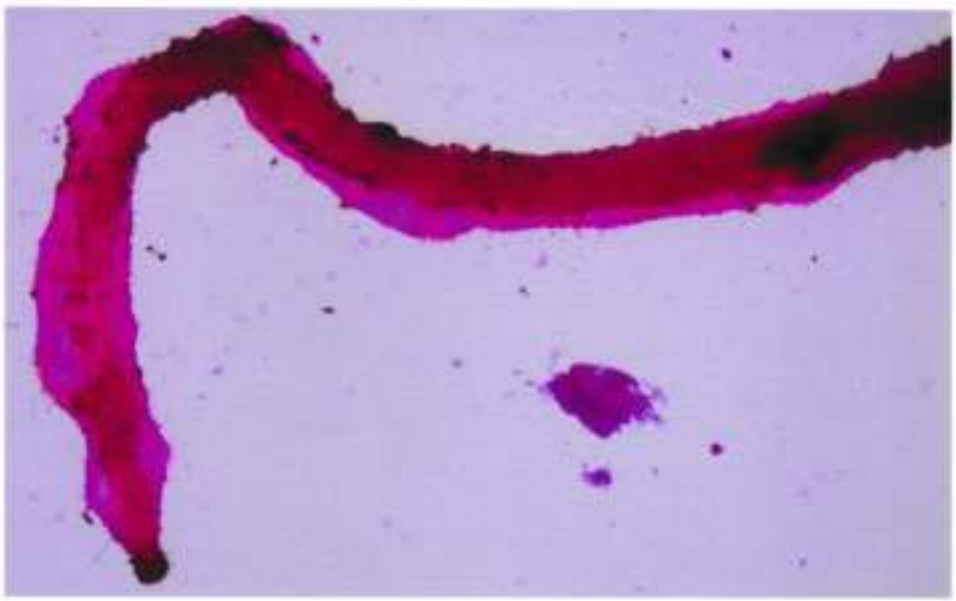












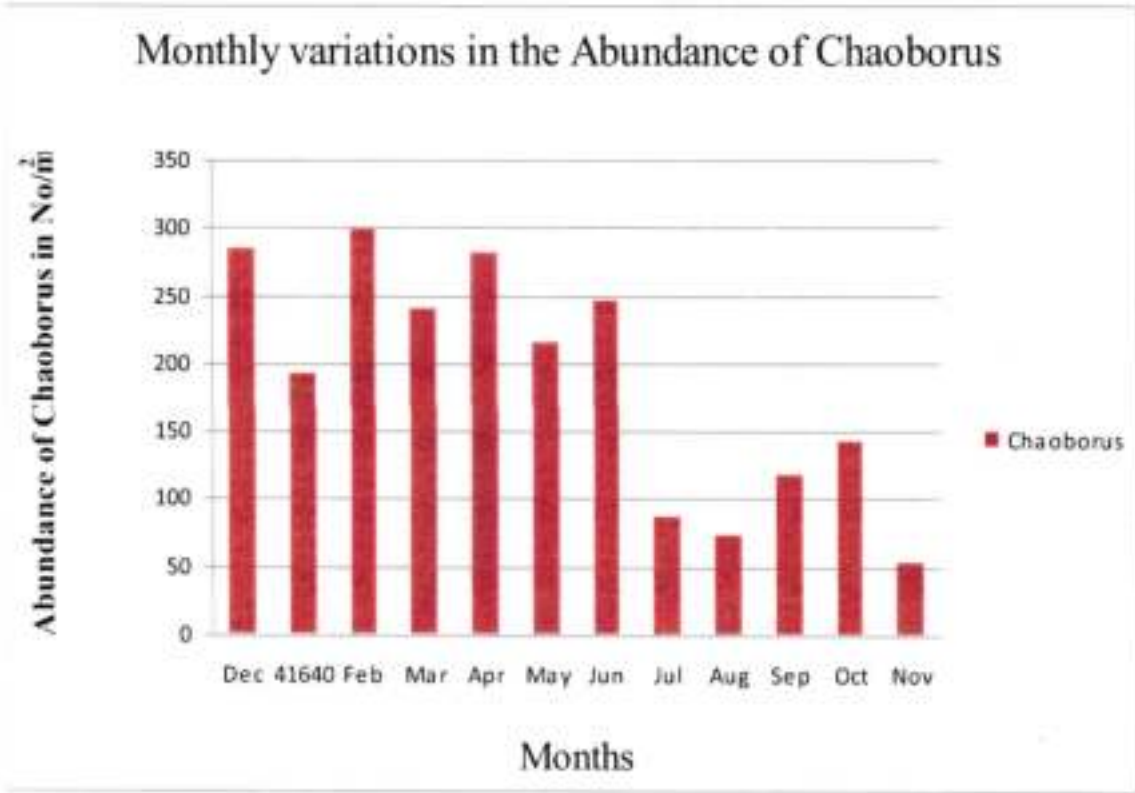
Chaoborus Population

The maximum number of (299 No./m^2) *Chaoborus* in the benthic population was found during February and minimum (11 No./m^2) observed in October (Fig. 3). The station wise estimation of *Chaoborus* population varied from a minimum of 30 No./m^2 to maximum of 600 No./m^2 during the investigation period. *Chaoborus* is the fourth dominant group among benthic population. The fourth instar larvae are collected for the study. These findings on the monthly abundance of Chaoborus larvae showed much variation throughout the study period. The normal abundance of Chaoborus was found to be less. Maximum Chaoborus population was observed during the months of Dry season. The percentage of Chaoborus in benthic population was 2.91%.

Role of Chaoborus in the purification of water

The less population of Chaoborus marks that it is insufficient for the purification of water. The interlinked action of benthic organisms may account for the purification of water.

Fig. 3. Monthly variation in the abundance of Chaoborus larvae during 2013-14



Gut content analysis of Chaoborus

The preliminary investigation on the gut content analysis of *Chaoborus* larvae revealed that diet composition includes Cladocera, *Daphnia*, *Keratella*, *Nauplius* and *Diaptomus* sp. The findings revealed that the abundant diet in *Chaoborus* is Cladocera.

Secondary information regarding to lake bed

Chaoborus asiaticus was observed by Pillai(1981) in Sathamkotta lake during 1981. The present investigation also confirmed the findings of Pillai(1981).

CONCLUSION

The fresh water lake wetland is one of the dynamic ecosystem. Ecologically they maintain a wide diversity of life forms. Present study reveals the **population of Chaoborus larvae was low.**

The saga related to the **purification of water in Sasthamkotta lake may be due to the combined function of benthic fauna**.

Study of benthic organisms with respect to its **DNA analysis reveals transparency of the taxonomy and interconnected relation between organisms.**

Therefore there is a close scrutiny and careful assessment of aquatic system is very essential.

FURTHER NECESSARY STUDIES

A detailed study on benthic organism by DNA sequence is needed. The study is essential to portray the taxonomy and interconnected action of benthic organisms in the purification of lake water.

REFERENCE

Anonymous, 1983. Water supply scheme to Kollam, *World Bank Assistance Project Report, PHED (KWA)*, Govt. of Kerala.

APHA, 1992. Standard method for the examination of water and water wastes 19th ed. American Public Health Associations, Washington.

Bhuvanendran, C and Harikuttan Unnithan, C., 2004. Ecology and pollution of Sasthamkotta-fresh water lake- A review. *Indian Environment Congress.* Tvm, 229-232.

Brinkhurst, R. O. and Cook, D. G. 1974. Aquatic Earth worms (Annelida: Oligochaeta). In: *Pollution Ecology of Freshwater Invertebrates*, Hart, C. W., and Samuel, L. H.F.(eds.).Academic

Brundin, L. 1949. Chironomiden und andere Bodentiere der südschwedischen Urgebirgseen. Ein Beitrag zur Kenntnis der bodenfaunistischen Charakterzüge schwedischer oligotropher Seen. Institute of freshwater research, Drottningholm, 30: 1-915.

Dinakaran S and Anbalagan S. 2010. Spatio-temporal dynamics of caddisflies in streams of southern Western Ghats. *Journal of Insect Science* 10:46.

George Ajith Varghese and Mathew Koshy, 2008. Water quality studies of Sasthamkotta lake of Kerala. *Poll.Res.* 27(3):419-424.

George,A.V and Koshy.M., 2008. Water quality studies of Sasthamkotta Lake of Kerala. *Poll. Res.* 27(3): 419-424

Girijakumari, S., 2007. Resource potential of Sasthamkotta lake with special reference to fish fauna and their sustainability. Ph.D Thesis, Mahatma Gandhi University, Kottayam, India.

Indumathi S. and Ramanibai. R.2009. Diversity of benthic organisms from Krishnagiri Reservoir, Tamil Nadu, India. *Current Biotica*, 3(2), 63170.

Maleug, K.W.,1966. An Ecological Study of *Chaoborus* sp. Ph.D. Thesis, Univ. Wisconsin, Madison, WI, U.S.A

Michael, P., 1976. Ecological methods for field and laboratory investigations. Tata Mc Graw Hill Publishing Company Limited, New Delhi,India. 404

Moore, M.V., 1986. Method for Culturing the Phatom Midge, *Chaoborus* (Diptera: Chaoboridae), in the Laboratory. Aquaculture, 56: 307-316.

Prakasam, V.R. and Joseph, M.C., 1991. Sasthamkotta lake: Water sediment interaction and productivity. *Proc. 11th Kerala Sci. Cong.* 28 Feb-03 March 1991. Kozhikode. Kerala,21-22

Prakasam, V.R. and Poul Martin, 1991. Notes on the migratory teal Anas querquedula at Sasthamkotta, Kollam. *J. Ecobiol.*3(2):169-171.

Press, New York, 143-156.

Radhika C., Mini I. and Ganga Devi T., 2004. Studies on abiotic parameters of a tropical fresh water lake Vellayani Lake- Trivandrum, Kerala. *Poll.Res.* 23(1): 49-69

Schroeder G.L. 1980. Fish farming in marine loaded ponds, ICLARM-SEARCA conference in integrated agriculture and aquaculture farming systems, ICLARM proceedings, 4, 73-86.

Sreejith, S., 1998. Hydrogeochemistry of the Sasthamkotta lake, Kollam District, Kerala with special reference to sediment-water interaction. *Proc. Kerala Sci. Cong.* 02-04 Jan, Kozhikode, 4-7.

Stahl, J.B.1966. The ecology of Chaoborus in Myers Lake, Indiana. *Limnol. Oceanogr.*11: 177-183.

Swift,M.C and Fedorenko A.Y. 1973. A rapid method for analysis of the crop content of Chaoborus larvae. Limnol. Oceanogr. 18, 785-797

Trivedy, R.K, and Goel, P.K. 1986. *Chemical and Biological Methods of Water Pollution Studies*. Env. Publ. Karad.