

## ANNEXURE – VI

**UNIVERSITY GRANTS COMMISSION**  
**BAHADUR SHAH ZAFAR MARG**  
**NEW DELHI – 110 002**

**FINAL REPORT OF THE WORK DONE ON THE MINOR RESEARCH PROJECT**

1. Project Report No: **FINAL**
2. UGC Reference No:  
**Ref: MRP(S)-0589/13-14/KLCA 008/ UGC - SWRO Dated 28<sup>th</sup> March, 2014.**  
**Ref: MRP(S)-0589/13-14/KLCA 008/ UGC - SWRO Dated 28<sup>th</sup> March, 2016.**
3. Period of Report: **16-04-2014 to 15-04-2016**
4. Title of Research Project:  
*Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala*
5. (a) Name of the Principal Investigator: **Dr. TESSY PAUL. P.**  
(b) Dept. **BOTANY**  
(c) College where work has progressed:  
**CHRIST COLLEGE (AUTONOMOUS)**  
**IRINJALAKUDA,**  
**THRISSUR DISTRICT, KERALA**
6. Effective date of stating of the project: **16-04-2014**
7. Grant approved and expenditure incurred during the period of the report:
  - a. Total amount approved: **Rs. 1,70,000/-**
  - b. Total expenditure: **Rs. 1,69,990/-**
  - c. Report of the work done:
    1. Brief objective of the project:
      - Biodiversity analysis of phytoplankton from the selected perennial ponds in Thrissur district, Kerala.
      - Biodiversity analysis of macrophytes from the selected perennial ponds in Thrissur district, Kerala.

- Preparation of the photographs of the wetland macrophytes and the phytoplankton.
  - Analysis of physico-chemical parameters.
  - Systematic assessment of phytoplankton and the macrophytes collected up to the species level.
  - To identify the pollution indicating and tolerant algal species that can be used as bioindicator organisms.
2. **Work done so far and results achieved and publications, if any, resulting from the work** (Give details of the papers and names of the journals in which it has been published or accepted for publication)
- The algal flora of the thirty two selected ponds of Thrissur district, Kerala, comprised 114 genera and 602 taxa belonging to eight classes namely Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Bacillariophyceae, Euglenophyceae, Dinophyceae and Cyanophyceae.
  - The present investigation reported 151 taxa as new additions to the algal flora of Kerala.
  - 228 taxa are new additions to the algal flora of Thrissur district, Kerala.
  - 41 macrophytes were identified which comes under 35 genera belonging to 24 families including Pteridophytes.
  - This project report fills the gap of biodiversity of lower groups and will be useful for assessing the algal biodiversity of Thrissur district and Kerala state.

**Publications from the project:**

**(1) Articles in International Journal - 1**

Tessy Paul P. and Anu P.K. (2016). *Algal diversity of Guruvayur temple pond, Thrissur district, Kerala.*

*International Journal of Advanced Life Sciences (IJALS)*, 2016, 9(3): 302-306. (ISSN: 2277-758X).

<http://www.unitedlifejournals.com/ijals/view-pdf.php?id=746>

**(2) Seminar Proceeding (National) - 1**

Jisha C.R. and Tessy Paul, P. 2014. *Blue green algae of Koodalmanikyam and Kodungallur temple ponds, Thrissur District, Kerala.*

Proceedings of UGC sponsored **National Seminar cum Workshop** on 'Plant Systematics and Herbarium techniques' held on 24<sup>th</sup> and 25<sup>th</sup> September 2014 organized by Dept. of Botany, KKTU College, Pullut, Kodungallur. pp. 66-71.

### (3) Seminar Abstracts - 1

Tessy Paul, P. 2015. *Temple pond algae of Thrissur District, Kerala: A review*. Abstracts of the 25<sup>th</sup> Swadeshi Science Congress Organized by Swadeshi Science Movement, Kerala and Sree Sankaracharya University of Sanscrit, Kalady held on 16-18<sup>th</sup> December 2015. pp. 176-177.

### (4) M.Sc. Environmental Science Dissertation - 1

**Ms. Anu P.K. (2014).** *Studies on the hydrographic parameters and algal biodiversity of Sree Krishna Temple pond, Guruvayoor, Thrissur District, Kerala*, submitted to University of Calicut, Kerala State.

### (5) Invited talks by Dr. Tessy Paul P. - 6

- i) 'Phycological biodiversity in the Freshwater Ecosystems of Kerala' in the seminar on 'Taxonomy, Diversity and Ecology of lesser known Algae and Fungi' on 13<sup>th</sup> October 2015 organized by Dept. of Botany, Govt. College, Chittur, sponsored by Directorate of Collegiate Education, Govt. of Kerala.
  - ii) 'Taxonomy of Freshwater Algae' in the seminar on 'Taxonomy, Diversity and Ecology of lesser known Algae and Fungi' on 13<sup>th</sup> October 2015 organized by Dept. of Botany, Govt. College, Chittur, sponsored by Directorate of Collegiate Education, Govt. of Kerala.
  - iii) 'Algal diversity in the Freshwater Ecosystems of Kerala' in the three day UGC sponsored **National seminar** on 'Biodiversity of Microbes and Climate Change Mitigation' on 5<sup>th</sup> February 2016 organized by Dept. of Botany, Catholicate College, Pathanamthitta, co-sponsored by Kerala State Council for Science, Technology & Environment and Kerala State Higher Education Council.
  - iv) 'Biodiversity and Taxonomy of Freshwater Algae' in the **Species the Passion II - National seminar** on 17<sup>th</sup> June 2016 organized by Dept. of Botany, St. Thomas College, Thrissur, co-sponsored by KSCSTE, Thiruvananthapuram.
  - v) 'Taxonomy of Freshwater Algae of Kerala' in the **Two day Seminar on Cryptogams of Western Ghats: A Botanical Perspective** - 16<sup>th</sup> February 2017 organized by Mar Thoma College, Thiruvalla and Mahatma Gandhi University, Kottayam.
  - vi) 'Biodiversity of Temple pond algae in Thrissur District'. **National seminar - Species the Passion III** - on 17<sup>th</sup> June 2017 organized by Dept. of Botany, St. Thomas College, Thrissur, sponsored by KSCSTE, Thiruvananthapuram.
- iii. Has the progress been according to original plan of work and towards achieving the objective? If not, state reasons: **Yes**



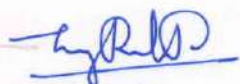
- iv. Please enclose a summary of the findings of the study. One bound copy of the final report of work done may also be sent to the concerned Regional Office of the UGC.

**Final bound copy of the project submitted with this final report.**

- v. Any other information:

*136 pages.*

NIL



**SIGNATURE OF THE  
PRINCIPAL INVESTIGATOR**

**Dr. TESSY PAUL P.**  
Associate Professor &  
Head of the Department of Botany  
Christ College (Autonomous)  
Irinjalakuda-680 125



**PRINCIPAL**

**Associate Professor  
In-Charge of Principal**  
Christ College (Autonomous) Irinjalakuda

## ANNEXURE – VII

**UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI – 110 002**

**PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF  
SENDING THE FINAL REPORT OF THE WORK DONE ON THE PROJECT**

1. TITLE OF THE PROJECT:  
*Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala*
2. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR: **Dr. TESSY PAUL. P.**  
DEPARTMENT OF BOTANY  
CHRIST COLLEGE (AUTONOMOUS)  
IRINJALAKUDA,  
THRISSUR DISTRICT, KERALA
3. NAME AND ADDRESS OF THE INSTITUTION: **CHRIST COLLEGE (AUTONOMOUS)**  
**IRINJALAKUDA,**  
**THRISSUR DISTRICT, KERALA**
4. UGC APPROVAL LETTER NO: AND DATE:  
**Ref: MRP(S)-0589/13-14/KLCA 008/ UGC - SWRO Dated 28<sup>th</sup> March, 2014.**  
**Ref: MRP(S)-0589/13-14/KLCA 008/ UGC - SWRO Dated 28<sup>th</sup> March, 2016.**
5. DATE OF IMPLEMENTATION: **16-04-2014**
6. TENURE OF THE PROJECT: **2 YEARS**
7. TOTAL GRANT ALLOCATED: **Rs. 1,70,000/-**
8. TOTAL GRANT RECEIVED: **Rs. 1,64,000/-**
9. FINAL EXPENDITURE: **Rs. 1,69,990/-**

## 10. TITLE OF THE PROJECT:

*Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala*

## 11. OBJECTIVES OF THE PROJECT:

- Biodiversity analysis of phytoplankton from the selected perennial ponds in Thrissur district, Kerala.
- Biodiversity analysis of macrophytes from the selected perennial ponds in Thrissur district, Kerala.
- Preparation of the photographs of the wetland macrophytes and the phytoplankton.
- Analysis of physico-chemical parameters.
- Systematic assessment of phytoplankton and the macrophytes collected up to the species level.
- To identify the pollution indicating and tolerant algal species that can be used as bioindicator organisms.

## 12. WHETHER OBJECTIVES WERE ACHIEVED: YES

Details:

- The algal flora of the thirty two selected ponds of Thrissur district, Kerala, comprised 114 genera and 602 taxa belonging to eight classes.
- 41 macrophytes were identified which comes under 35 genera belonging to 24 families including Pteridophytes.
- Photographs of the wetland macrophytes and the phytoplankton - Prepared.
- Physico-chemical parameters – Analysis done.
- Systematic assessment of phytoplankton and the macrophytes collected up to the species level done.
- Out of the one hundred and fourteen genera found in the study area, forty-four were pollution tolerant.
- During the present investigation thirty nine algal species tolerant to organic pollution were identified from the selected ponds and are indicators of pollution in the ponds of Thrissur and the deteriorated nature of the water.

### 13. **ACHIEVEMENTS FROM THE PROJECT:**

- The algal flora of the thirty two selected ponds of Thrissur district, Kerala, comprised 114 genera and 602 taxa belonging to eight classes namely Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Bacillariophyceae, Euglenophyceae, Dinophyceae and Cyanophyceae.
- The present investigation reported 151 taxa as new additions to the algal flora of Kerala.
- 228 taxa are new additions to the algal flora of Thrissur district, Kerala.
- 41 macrophytes were identified which comes under 35 genera belonging to 24 families including Pteridophytes.
- This project report fills the gap of biodiversity of lower groups and will be useful for assessing the algal biodiversity of Thrissur district and Kerala state.

### 14. **SUMMARY OF THE FINDINGS:**

The present work on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala is a comprehensive and systematic analysis of the aquatic flora. The analysis of aquatic biodiversity was conducted in thirty two ponds of Thrissur district, Kerala, for a period of two years from April 2014 to March 2016.

The water samples from sixteen ponds were collected and the parameters such as Temperature, pH, dissolved oxygen (DO) turbidity, conductivity, total hardness, calcium hardness, magnesium hardness, total dissolved solids (TDS), chloride and salinity were analyzed in the laboratory as per the standard methods. The diversity and the community structure of these freshwater resources were different because of the different hydrological conditions of the selected ponds studied.

The identification of the algal taxa up to the species level was carried out with the help of keys and descriptions given by standard publications and the



photomicrographs were taken. The algal flora of the thirty two selected ponds of Thrissur district, Kerala, comprised 114 genera and 602 taxa belonging to eight classes namely Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Bacillariophyceae, Euglenophyceae, Dinophyceae and Cyanophyceae.

The taxonomic analysis revealed that the phytoplankton of the study area belonged to six divisions namely Chlorophyta, Chrysophyta, Bacillariophyta, Euglenophyta, Pyrrophyta and Cyanophyta. Out of the 602 taxa, 151 taxa are new reports to Kerala and 228 taxa are new additions to the algal flora of Thrissur district, Kerala.

Chlorophyceae was the major group comprised 284 taxa (47.18%) belonging to 51 genera of which 175 taxa belonging to 16 genera were desmids (29.07%). Bacillariophyceae was represented by 112 taxa (18.6%) belonging to 21 genera, Cyanophyceae represented by 113 taxa (18.77%) belonging to 31 genera and Euglenophyceae represented by 85 taxa (14.12%) belonging to 5 genera. Dinophyceae (0.5% with 3 taxa belonging to 2 genera), Cryptophyceae (0.33% with 2 taxa belonging to 1 genus), Xanthophyceae (0.17% with 1 taxon belonging to 1 genus) and Chrysophyceae (0.33% with 2 taxa belonging to 2 genera) were also found in the study area.

Out of the 114 genera found in the study area, 44 were pollution tolerant. During the present investigation 39 algal species tolerant to organic pollution were identified from the selected ponds and are indicators of pollution in the ponds of Thrissur and the deteriorated nature of the water and were showing the signs of pollution.

During the period of study 41 macrophytes were identified which comes under 35 genera belonging to 24 families including Pteridophytes. 46.34% of total plant species that were recorded fall into the category of marshy land, followed by 19.51% submerged hydrophytes, 12.2% emergent hydrophytes, 12.2% free floating hydrophytes and 9.7% attached floating hydrophytes. Prominently represented plant family is Poaceae and other dominant families are Hydrocharitaceae, Onagraceae and Asteraceae.



This work will be useful for analyzing the biodiversity of the phytoplankton and the macrophytes in the ponds of Thrissur district, Kerala. The present investigation reported 151 taxa as new additions to the algal flora of Kerala.

15. **CONTRIBUTION TO THE SOCIETY:**

The biological diversity serves as an incentive for the future business of biotechnology. The information on the algae in the ponds of Thrissur district, Kerala, is helpful to design the inland fisheries. The totality of information on genes, species and ecosystems of biota, biodiversity in essence, is relevant in the current and future context. For achieving success in sustainable development, economy and ecology, the primary activity in research protocol is taxonomy, for authenticated product development and materials management.

16. **WHETHER ANY Ph. D ENROLLED / PRODUCED OUT OF THE PROJECT:**

No

**M.Sc. Environmental Science Dissertation - 1**

**Ms. Anu P.K. (2014).** *Studies on the hydrographic parameters and algal biodiversity of Sree Krishna Temple pond, Guruvayoor, Thrissur District, Kerala*, submitted to University of Calicut, Kerala State.

17. **NO: OF PUBLICATIONS OUT OF THE PROJECT:**

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*International Journal of Advanced Life Sciences (IJALS)*, 2016, 9(3): 302-306. (ISSN: 2277-758X).

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PRINCIPAL INVESTIGATOR

**Dr. TESSY PAUL P.**  
Associate Professor &  
Head of the Department of Botany  
Christ College (Autonomous)  
Irinjalakuda-680 125



PRINCIPAL

**Associate Professor**  
**In-Charge of Principal**  
Christ College (Autonomous) Irinjalakuda



**STUDIES ON THE ECOLOGY, BIODIVERSITY AND SYSTEMATIC  
ASSESSMENT OF FRESHWATER PHYTOPLANKTON AND  
MACROPHYTES IN THE PERENNIAL PONDS OF  
THRISSUR DISTRICT, KERALA**

*Principal Investigator:*

**Dr. TESSY PAUL P.**



**DEPARTMENT OF BOTANY  
CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA  
THRISSUR DISTRICT - 680 125, KERALA, INDIA**

**FINAL REPORT  
UGC MINOR PROJECT**

*Financial assistance provided by:*

**UNIVERSITY GRANTS COMMISSION  
NEW DELHI - 110 002**

**MRP(S) - 0589 / 13-14 / KLCA 008 / UGC - SWRO Dated 28th March, 2014**

**2016**

**STUDIES ON THE ECOLOGY, BIODIVERSITY AND  
SYSTEMATIC ASSESSMENT OF FRESHWATER  
PHYTOPLANKTON AND MACROPHYTES IN THE  
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**UGC MINOR RESEARCH PROJECT - FINAL REPORT**

*Financial assistance provided by:*

**UNIVERSITY GRANTS COMMISSION, NEW DELHI – 110 002**

**MRP(S)/0589/13-14/KLCA 008/ UGC – SWRO Dated 28<sup>th</sup> March, 2014**

**Principal Investigator:**

**Dr. TESSY PAUL. P.**



**DEPARTMENT OF BOTANY  
CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA  
THRISSUR DISTRICT- 680 125, KERALA, INDIA**

**2016**



**Dr. TESSY PAUL P. M.Sc., M.Phil., Ph.D.**

**Associate Professor & HOD, Department of Botany,**

**Christ College (Autonomous), Irinjalakuda,**

**Thrissur District – 680 125,**

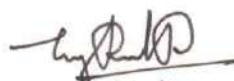
**Kerala State, India.**

**Phone: 9446233104**

**E-mail: tessyjohnt@gmail.com**

## Certificate

This is to certify that the work presented in the UGC Minor Research Project entitled *“Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala”* has been carried out by me in the Department of Botany, Christ College (Autonomous), Irinjalakuda, Thrissur District, Kerala.



**Dr. Tessa Paul P.**

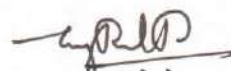
**Principal Investigator**

**Dr. TESSY PAUL P.**  
Associate Professor &  
Head of the Department of Botany  
Christ College (Autonomous)  
Irinjalakuda-680 125

*Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala*

## DECLARATION

I hereby declare that the UGC Minor Project entitled "*Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala*" is a work done by me in the Department of Botany, Christ College (Autonomous), Irinjalakuda, Thrissur District, Kerala and I thank University Grants Commission, for the financial assistance provided.



**Dr. Tessa Paul P.**

Principal Investigator

**Dr. TESSY PAUL P.**  
Associate Professor &  
Head of the Department of Botany  
Christ College (Autonomous)  
Irinjalakuda-680 125

## ACKNOWLEDGEMENT

*I express my gratitude to the Management, Principal and Staff of Christ College (autonomous), Irinjalakuda, especially to my colleagues in the Department of Botany, for their constant encouragement.*

*I sincerely thank Prof. Joshy K. Simon, Former HOD, Department of Botany and Mr. Antony Francis, non-teaching staff of the Department of Botany, for the help and assistance during the period of this study.*

*I am grateful to the University Grants Commission (UGC) for extending financial support as a minor research project to this endeavour.*

*The library facilities extended by the Central Marine Fisheries Research Institute, Cochin, Mahatma Gandhi University, Kottayam, University of Calicut, Tenjipalam, Calicut and Cochin University of Science and Technology, Ernakulam, are gratefully acknowledged.*

*I am deeply indebted to my beloved parents, my husband and sons, for their encouragement, support and timely and invaluable assistance, without which I would not have completed this work.*

*Above all I bow my head before God Almighty for the never-ending blessings showered on me to carry out this work successfully.*

*Tessy Paul P.*

## ABSTRACT

The present work on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala is a comprehensive and systematic analysis of the aquatic flora. The analysis of aquatic biodiversity was conducted in thirty two ponds of Thrissur district, Kerala, for a period of two years from April 2014 to March 2016.

The water samples from sixteen ponds were collected and the parameters such as Temperature, pH, dissolved oxygen (DO) turbidity, conductivity, total hardness, calcium hardness, magnesium hardness, total dissolved solids (TDS), chloride and salinity were analyzed in the laboratory as per the standard methods. The diversity and the community structure of these freshwater resources were different because of the different hydrological conditions of the selected ponds studied.

The identification of the algal taxa up to the species level was carried out with the help of keys and descriptions given by standard publications and the photomicrographs were taken. The algal flora of the thirty two selected ponds of Thrissur district, Kerala, comprised 114 genera and 602 taxa belonging to eight classes namely Chlorophyceae, Xanthophyceae, Chrysophyceae, Cryptophyceae, Bacillariophyceae, Euglenophyceae, Dinophyceae and Cyanophyceae.

The taxonomic analysis revealed that the phytoplankton of the study area belonged to six divisions namely Chlorophyta, Chrysophyta, Bacillariophyta, Euglenophyta, Pyrrophyta and Cyanophyta. Out of the 602 taxa, 151 taxa are new reports to Kerala and 228 taxa are new additions to the algal flora of Thrissur district, Kerala.

Chlorophyceae was the major group comprised 284 taxa (47.18%) belonging to 51 genera of which 175 taxa belonging to 16 genera were desmids (29.07%). Bacillariophyceae was represented by 112 taxa (18.6%) belonging to 21 genera,



Cyanophyceae represented by 113 taxa (18.77%) belonging to 31 genera and Euglenophyceae represented by 85 taxa (14.12%) belonging to 5 genera. Dinophyceae (0.5% with 3 taxa belonging to 2 genera), Cryptophyceae (0.33% with 2 taxa belonging to 1 genus), Xanthophyceae (0.17% with 1 taxon belonging to 1 genus) and Chrysophyceae (0.33% with 2 taxa belonging to 2 genera) were also found in the study area.

Out of the one hundred and fourteen genera found in the study area, forty-four were pollution tolerant. During the present investigation thirty nine algal species tolerant to organic pollution were identified from the selected ponds and are indicators of pollution in the ponds of Thrissur and the deteriorated nature of the water. Thus the present study indicate that the ponds studied from Thrissur district, Kerala were showing the signs of pollution.

During the period of study 41 macrophytes were identified which comes under 35 genera belonging to 24 families including Pteridophytes. 46.34% of total plant species that were recorded fall into the category of marshy land, followed by 19.51% submerged hydrophytes, 12.2% emergent hydrophytes, 12.2% free floating hydrophytes and 9.7% attached floating hydrophytes. Prominently represented plant family is Poaceae and other dominant families are Hydrocharitaceae, Onagraceae and Asteraceae.

This work will be useful for analyzing the biodiversity of the phytoplankton and the macrophytes in the ponds of Thrissur district, Kerala. The present investigation reported 151 taxa as new additions to the algal flora of Kerala.

**Keywords:** Physico-chemical parameters, freshwater algae, phytoplankton, macrophytes, pond, Thrissur District, Kerala.

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**DEPARTMENT OF BOTANY**  
**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**  
**THRISSUR DISTRICT - 680 125, KERALA, INDIA**

## **Publications from the project**

Title of Research Project:

*Studies on the ecology, biodiversity and systematic assessment of freshwater phytoplankton and macrophytes in the perennial ponds of Thrissur district, Kerala*

Name of the Principal Investigator:

**Dr. TESSY PAUL. P.  
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**Algal diversity of Guruvayur Temple Pond, Thrissur District, Kerala****P. Tessy Paul and Anu P.K.****Department of Botany, Christ College (Autonomous), Irinjalakuda, Thrissur - 680125, Kerala, India.****E-mail : tessyjohnt@gmail.com****Corresponding Author****P. Tessy Paul****Department of Botany, Christ  
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Kerala, India.****E-mail : tessyjohnt@gmail.com****Article History****Received on 15 July, 2016;****Received in revised form****26 July 2016; Accepted****26 August, 2016****Abstract**

The present study explores the algal diversity of Guruvayur Sree Krishna temple pond, Thrissur district, Kerala from March to May 2014. In Kerala, the temple ponds are used for bathing and washing and are having ritual and sacred values. During the present study forty one algal species coming under twenty genera were recorded from the Guruvayur Sree Krishna temple pond. Of these twenty belonging to Chlorophyceae (48.8%), eight under Euglenophyceae (19.5%), six each under Bacillariophyceae (14.6%) and Cyanophyceae (14.6%), and one belong to Dinophyceae (2.5%). In the Guruvayur temple pond the Chlorophycean members were more diverse followed of Euglenophycean members. *Scenedesmus* was the diverse genera with seven species followed by *Pediastrum* with five species and *Schroederia* and *Phacus* represented by three species each. Fifteen pollution tolerant algal species were identified from this pond during the period of study. The turbidity and conductivity were not within the permissible limits. The present study indicates that the Guruvayur temple pond studied from Thrissur district, Kerala was showing the signs of pollution.

**Keywords :** Temple pond, algae, phytoplankton, Guruvayur, Thrissur, Chlorophyceae, Euglenophyceae, Bacillariophyceae and Kerala

**Introduction**

Guruvayur is an important pilgrim centre of Thrissur district, Kerala and is one of the most important places of worship for Hindus of Kerala. It is often referred to as "Bhuloka Vaikunta". Its main attraction is the Sree Krishna temple, which is considered as the Dwaraka of the South, located in the town of Guruvayur in Kerala, India. An investigation has been made into the algal diversity with physico-chemical parameters of the pond of the Sree Krishna temple, Guruvayur, Thrissur district, Kerala.

**Materials and Methods**

The water samples for the analysis of algal diversity and water quality were collected twice monthly from March to May 2014. The water quality parameters analyzed were temperature, turbidity,

conductivity, pH, acidity, alkalinity, total dissolved solids, total hardness, dissolved oxygen and chloride as per the standard instruments and methods (Trivedi and Goel, 1986; APHA, 1998). The collected algal samples were fixed in 4% formalin solution for further analysis. The algae were identified with the help of monographs and standard publications (Desikachary, 1959; Philipose, 1967; Prescott, 1982; Sarode and Kamat, 1984). The pollution tolerant algae found in the study area were analyzed according to Palmer (1969).

**Results and Discussion**

The results of physico-chemical parameters analyzed were given in Table 1. Water quality affects the abundance, species composition and stability of physiological conditions of the indigenous population of aquatic organisms (APHA, 1998). The turbidity and



Table - 1. Fluctuations of physico-chemical parameters

Sl. No	Parameters	Range	Mean $\pm$ SD	Permissible limit (BIS, 1991)
1	Temperature °C	23.3 - 26.3	25.47 $\pm$ 1.10	-
2	Turbidity NTU	7.9 - 26.3	16.35 $\pm$ 6.20	2.5
3	Conductivity mho/cm	321 - 648	478.67 $\pm$ 137.06	250
4	pH	6.4 - 7.4	6.83 $\pm$ 0.42	6.5 - 8.5
5	Acidity mg/L	5 - 25	15.67 $\pm$ 7.07	-
6	Alkalinity mg/L	25 - 121	89 $\pm$ 35.94	200
7	TDS mg/L	208 - 460	362 $\pm$ 98.16	500
8	Hardness mg/L	72 - 175	126.67 $\pm$ 34.56	300
9	DO mg/L	3.2 - 3.6	3.33 $\pm$ 0.16	-
10	Chloride mg/L	5.68 - 15.9	11.15 $\pm$ 4.05	200

Table - 2. Diversity of algae in Sree Krishna temple pond, Gurnuvayur

Sl. No	Name of algal Species	March	April	May
	<b>Class : Chlorophyceae</b>			
1	<i>Scenedesmus acuminatus</i> (Lagerheim) Chodat	+	-	-
2	<i>Scenedesmus bijugatus</i> (Turpin) Kuetzing forma <i>parvus</i> (G.M. Smith) Philipose	+	-	-
3	<i>Scenedesmus bijugatus</i> (Turpin) Kuetzing var. <i>bicellaris</i> (Chodat) Philipose	-	+	-
4	<i>Scenedesmus bijugatus</i> (Turpin) Kuetzing forma <i>irregularis</i> Wille	+	-	-
5	<i>Scenedesmus bijugatus</i> (Turpin) Kuetzing var. <i>graevenitzii</i> (Bernard) Philipose	+	-	-
6	<i>Scenedesmus dimorphus</i> (Turpin) Kuetzing	+	-	-
7	<i>Scenedesmus quadricauda</i> (Turpin) Brebisson var. <i>bicaudatus</i> Hansgirg	+	-	-
8	<i>Pediastrum simplex</i> Meyen var. <i>duodenarium</i> (Bailey) Rabenhorst	+	-	-
12	<i>Pediastrum simplex</i> Meyen var. <i>simplex</i> Komarek	+	-	-
9	<i>Pediastrum ovatum</i> (Ehr.) A. Braun.	+	-	-
11	<i>Pediastrum simplex</i> Meyen	+	-	+
10	<i>Pediastrum tetras</i> (Ehr.) Ralfs var. <i>tetraodon</i> (Corda.) Hansgirg	-	+	-
13	<i>Tetraedron muticum</i> (A. Braun.) Hansgirg	-	+	-
14	<i>Schroederia indica</i> Philipose	+	-	+
15	<i>Schroederia setigera</i> (Schroeder) Lemmermann	-	-	+
16	<i>Schroederia planctonica</i> (Skuja) Philipose	-	+	-
17	<i>Oedogonium</i> sps	+	-	-
18	<i>Cosmarium maculatifforme</i> Schmidle	+	-	-
19	<i>Cosmarium manipurence</i> Bruhl et Biswas	+	-	-
20	<i>Protococcus viridis</i> Agardh	+	-	-
	<b>Class: Bacillariophyceae</b>			
21	<i>Melosira granulata</i> (Ehr.) Ralfs	+	+	+
22	<i>Cyclotella meneghiniana</i> Kuetz.	-	-	+



23	<i>Cyclorella striata</i> (Kuetz.) Grun.	+	+	-
24	<i>Synedra ulna</i> (Nitz.) Ehr.	+	-	-
25	<i>Gomphonema lanceolatum</i> Ehr.	-	-	+
26	<i>Nitzschia palea</i> (Kuetz.) W. Smith	-	+	-
	<b>Class : Cyanophyceae</b>			
27	<i>Chroococcus indicus</i> Zeller	+	-	-
28	<i>Chroococcus minimus</i> (Keissler) Lemm.	-	+	-
29	<i>Merismopedia minima</i> Beck	+	+	-
30	<i>Merismopedia punctata</i> Meyen	+	-	-
31	<i>Oscillatoria perornata</i> Skuja	-	+	+
32	<i>Oscillatoria princeps</i> Vaucher ex Gomont	+	+	-
	<b>Class : Euglenophyceae</b>			
33	<i>Euglena gracilis</i> Klebs	-	+	+
34	<i>Euglena proxima</i> Dangard	-	+	-
35	<i>Phacus orbicularis</i> Huebner	+	-	+
36	<i>Phacus pleuronectes</i> (Muell.) Dujardin	+	+	-
37	<i>Phacus pyrum</i> (Ehr.) Stein	+	-	-
38	<i>Lepocinclis fusiformis</i> (Carter) Lemmermann	-	+	+
39	<i>Lepocinclis ovum</i> Ehr. var. <i>major</i> (Haber-pestal) Conr.	-	+	+
40	<i>Trachelomonas volvocina</i> Ehr.	-	+	+
	<b>Class : Dinophyceae</b>			
41	<i>Peridinium cincta</i> var. <i>tuberosum</i> (Meunier) Lindermann	-	+	-

conductivity were not within the permissible limits (BIS, 1991).

During the present study 41 algal species under 20 genera were encountered in Sree Krishna temple pond, Guruvayur, Kerala (Table - 2). Of these twenty belonging to Chlorophyceae (48.8%), eight under Euglenophyceae (19.5%), six each under Bacillariophyceae (14.6%) and Cyanophyceae (14.6%), and one belong to Dinophyceae (2.5%). The Chlorophyceae formed the diverse group followed by Euglenophyceae (Fig.- 1).

*Scenedesmus* was the diverse genera with seven species in the Guruvayur temple pond followed by *Pediastrum* with five species and *Schroederia* and *Phacus*, represented by three species each. *Peridinium cincta* var. *tuberosum* (Meunier) Lindermann was the

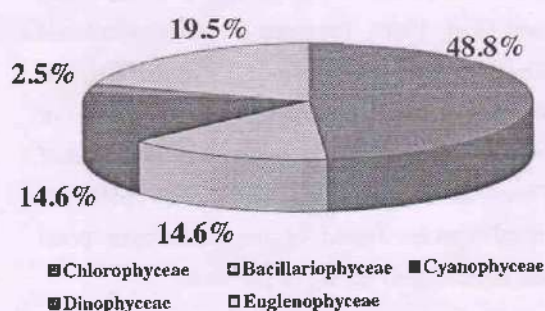


Fig. - 1. Algal diversity of Guruvayur temple pond

Dinophycean member and are found during April (Table - 2).

Arulmurugan *et al.* (2010) have studied 37 temple tanks in Thrissur and Palakkad districts of Kerala and reported 61 species of freshwater algae. Ajayan *et al.* (2013) reported 38 phytoplankton genera from



Ananthapura temple lake of Kasargod, Kerala. Baruah and Kakati (2012) described 45 species of phytoplankton from a Gopeswar temple pond of Assam and Shakila and Natarajan (2012) described 20 species of phytoplankton from the temple pond of Thiruporur, Chennai.

During the present investigation fifteen pollution tolerant algal species (Palmer, 1969) were identified from the Guruvayur temple pond. They are *Cyclotella meneghiniana* Kuetz., *Euglena gracilis* Klebs, *Euglena proxima* Dangard, *Lepocinclis ovum* (Ehr.), *Melosira granulata* (Ehr.) Ralfs, *Nitzschia palea* (Kuetz.) W. Smith, *Oscillatoria princeps* Vaucher ex Gomont, *Phacus pleuronectes* (Muell.) Dujardin, *Phacus pyrum* (Ehr.) Stein, *Scenedesmus acuminatus* (Lagerheim) Chodat, *Scenedesmus dimorphus* (Turpin) Kuetzing, *Scenedesmus quadricauda* (Turpin) Brebisson, *Synedra ulna* (Nitz.) Ehr., *Tetraedron muticum* (A. Braun.) Hansgirg and *Trachelomonas volvocina* Ehr.

The algal genera *Euglena*, *Scenedesmus*, *Navicula* and *Nitzschia* are found in organically polluted water (Trivedi and Goel, 1986). Presence of pollution tolerant algae like *Melosira*, *Oscillatoria*, *Pediastrum* and *Scenedesmus* has been considered as indicative of enriched waters, thus providing evidence of pollution of water (Tessy and Sreekumar, 2008). The pollution tolerant algal species found in the Guruvayur pond indicate the deteriorated nature of the water.

### Conclusion

During the present investigation, 41 algal taxa belonging to 20 genera are recorded from the Guruvayur Sree Krishna temple pond and they come under Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae and Dinophyceae. In the Guruvayur temple pond the Chlorophycean members were more diverse followed by Euglenophycean members.

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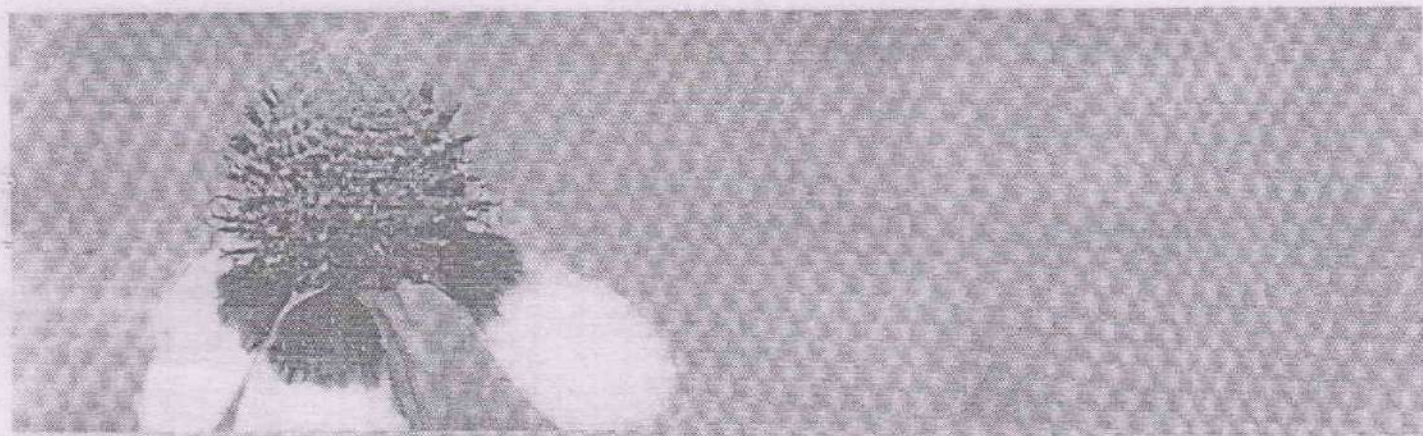
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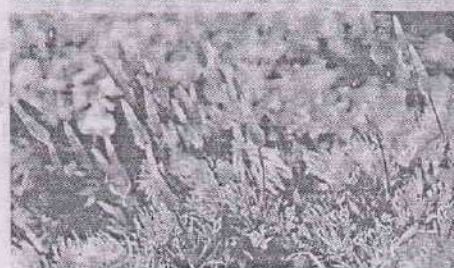





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**BLUE GREEN ALGAE OF KODALMANIKYAM AND  
KODUNGALLUR TEMPLE PONDS, THRISSUR DISTRICT,  
KERALA**

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**ABSTRACT**

The environmental quality of Koodalmanikyam and Kodungallur temple ponds in Thrissur district, Kerala are analysed in the present study with respect to the blue green algal diversity. The samples are preserved in 4% formalin solution and the blue green algae were identified with the help of ICAR monograph and publications on blue green algae. The temperature, conductivity, pH, dissolved oxygen, total dissolved solids, salinity and biochemical oxygen demand were analysed as per the standard methods. During the present investigation 54 species of blue green algae belonging to 17 genera were recorded. 40 species belonging to 14 genera were recorded from Koodalmanikyam temple pond and from Kodungallur temple pond 15 species belonging to 6 genera were recorded. The pollution tolerant blue green algal genera found in Koodalmanikyam temple pond are *Phormidium*, *Anabaena*, *Lyngbya* and *Oscillatoria* and that found in Kodungallur temple pond are *Microcystis* and *Oscillatoria* and the present study indicates that these two famous temple ponds are showing the signs of water pollution.

**KEYWORDS:** Blue green algae, Physico-chemical parameters, Pollution indicators, Temple pond, Kerala.

**INTRODUCTION**

Temple tanks are the reservoirs built as part of the Indian temples. Bathing in the sacred waters of these tanks is thought to cure disease and maladies. Arulmurugan *et al.* (2010) reported sixty one algal taxa from 37 temple tanks of Palakkad and Thrissur districts of Kerala of which 12 belong to Cyanophyceae (blue green algae). Maya *et al.* (2000), Prameela *et al.* (2001), Jose and Sreekumar (2005), Jose *et al.* (2008) and Ajayan *et al.* (2013) studied the algae from the temple ponds of Kerala. The study done by Arulmurugan *et al.* (2010) was the only report regarding the temple pond algae of Thrissur district, Kerala.

**MATERIALS AND METHODS**

The present study was conducted in two temple ponds in Thrissur district, Kerala, from February 2013 to July 2014. The temple ponds studied are Koodalmanikyam temple pond and Kodungallur temple pond and are famous temples in Thrissur district, Kerala.

The sample for the water analysis was collected during March, 2013 between 8 and 10a.m. The temperature, pH and dissolved oxygen were measured on the spot and other water quality parameters such as conductivity, total dissolved solids, salinity and biochemical oxygen demand were analysed in the laboratory as per the standard methods (APHA, 1998). The algal samples are preserved in 4% formalin solution and the photomicrographs are taken by research microscope with digital camera. The blue green algae in the water samples were identified with the help of ICAR monograph and publications (Desikachary, 1959; Anand, 1989; Perumal and Anand, 2008).

## RESULTS AND DISCUSSION

The water sample was analysed and the values obtained were given in Table 1. In natural systems, it has been shown that the warmer water temperatures do favour the cyanobacterial dominance in phytoplankton communities. The climate changes due to environmental factors have substantial effects on freshwater phytoplankton species composition and biomass, potentially favouring Cyanobacteria over other phytoplankton species (Carey *et al.*, 2012).

Table 1 Water quality parameters of temple ponds

Sl. No:	Parameters	Koodalmanikyam temple pond	Kodungallur temple pond
1	Temperature ( $^{\circ}$ C)	32	31.4
2	pH	8.7	9.15
3	Dissolved oxygen (mg/L)	4	3.8
4	Conductivity (S/m)	2.41	2.88
5	Total dissolved solids (ppm)	1.68	1.7
6	Salinity (ppt)	0.06	0.1
7	Biochemical oxygen demand(mg/L)	2.9	3

During the present investigation 54 species of blue green algae belonging to 17 genera were recorded from the two temple ponds studied (Table 2). These species comes under seven families which belong to four algal orders. The orders are Chroococcales, Pleurocapsales, Nostocales and Stigonematales. 40 species belongings to 14 genera were recorded from Koodalmanikyam temple pond and they comes under five families which belong to three algal orders. From Kodungallur temple pond 15 species belonging to 6 genera were recorded that comes under four families which belong to three algal orders (Table 2).



**Table 2 Blue green algae in the temple ponds**

Sl. No:	Name of Algae	Koodalmanikya m temple pond	Kodungallur temple pond
	Order: CHROOCOCCALES	Family: CHROOCOCCACEAE	
1	<i>Microcystis aeruginosa</i> Kutz	-	+
2	<i>Microcystis flos-aquae</i> Kirchner	-	+
3	<i>Microcystis marginata</i> Kutz.	-	+
4	<i>Microcystis orissica</i> West, W.	-	+
5	<i>Microcystis protocystis</i> Crow	-	+
6	<i>Microcystis pulverea</i> Forti	-	+
7	<i>Microcystis robusta</i> Nygaard	-	+
8	<i>Microcystis viridis</i> Lemm.	-	+
9	<i>Chroococcus minutus</i> Nag.	+	-
10	<i>Chroococcus turgidus</i> Nag.	+	-
11	<i>Aphanocapsa pulchra</i> Rabenh.	+	-
12	<i>Aphanocapsa roeseana</i> de Bary	+	-
13	<i>Aphanothece pallida</i> Rabenh.	+	-
14	<i>Aphanothece saxicola</i> Nag.	-	+
15	<i>Synechococcus aeruginosa</i> Nag.	+	-
16	<i>Synechocystis aquatilis</i> Sauv.	+	-
17	<i>Synechocystis crassa</i> Woronich	+	-
18	<i>Merismopedia tenuissima</i> Lemm.	+	+
	Order: PLEUROCAPSALES	Family: PLEUROCAPSACEAE	
19	<i>Myxosarcina spectabilis</i> Geitler.	-	+
	Family: HYELLACEAE		
20	<i>Hydrococcus rivularis</i> Kutz.	-	+
	Order: NOSTOCALES	Family: OSCILLATORIACEAE	
21	<i>Oscillatoria acuta</i> Bruhl et Biswas orth. mut Geitler	-	+
22	<i>Oscillatoria amphibia</i> Ag. ex Gomont	+	-

23	<i>Oscillatoria boryana</i> Bory ex Gomont	+	-
24	<i>Oscillatoria curviceps</i> Ag. ex Gomont.	+	-
25	<i>Oscillatoria limnetica</i> Lemm.	+	-
26	* <i>Oscillatoria limosa</i> Ag. ex Gomont	+	-
27	<i>Oscillatoria margaritifera</i> Gomont.	-	+
28	<i>Oscillatoria perornata</i> Skuja	+	-
29	* <i>Oscillatoria princeps</i> Vaucher ex Gomont	+	-
30	<i>Oscillatoria simplicissima</i> Gomont	+	-
31	<i>Oscillatoria subbrevis</i> Schmidle	+	-
32	<i>Oscillatoria vizagapatensis</i> Rao, C. B.	+	-
33	<i>Oscillatoria willei</i> Gardner em. Drouet	-	+
34	<i>Phormidium ambiguum</i> Gomont	+	-
35	<i>Phormidium retzii</i> (Ag.) Gomont	+	-
36	<i>Phormidium stagnina</i> Rao, C. B.	+	-
37	<i>Phormidium tenue</i> (Menegh.) Gomont	+	-
38	<i>Lyngbya aestuarii</i> Liebmvar. <i>constricta</i> Ghose	+	-
39	<i>Lyngbya birgei</i> Smith, G. M.	+	-
40	<i>Lyngbya ceylanica</i> Wille var. <i>constricta</i> Frey	+	-
41	<i>Lyngbya confervoides</i> C. Ag. ex Gomont	+	-
42	<i>Lyngbya hieronymusii</i> Lemm.	+	-
43	<i>Lyngbya magnifica</i> Gardner	+	-
44	<i>Lyngbya martensiana</i> Menegh. ex Gomont	+	-
45	<i>Lyngbya putealis</i> Mont. ex Gomont	+	-
46	<i>Lyngbya sordida</i> Gomont	+	-
Family: NOSTOCACEAE			
47	<i>Anabaena anomala</i> Fritsch	+	-
48	<i>Anabaena sphaerica</i> Bornet et Flahault	+	-
49	<i>Anabaena torulosa</i> Lagerh. ex Born. et Flah.	+	-
50	<i>Anabaena volzii</i> Lemm.	+	-



51	<i>Pseudanabaena consticta</i> (szafer) Lauterhorn	+	-
52	<i>Aulosira prolifica</i> Bharadwaja	+	-
Family: SCYTONEMATACEAE			
53	<i>Tolypothrix tenuis</i> Johs. Schmidt em.	+	-
Order: STIGONEMATALES		Family: STIGONEMATACEAE	
54	<i>Camptylonema indicum</i> Schmidle	+	-

\* Pollution tolerant species, + Present, - Absent

In Koodalmanikyam temple pond, the blue green algae comes under three orders namely Chroococcales, Nostocales and Stigonematales (Table 3). In Kodungallur temple pond, the blue green algae comes under three orders namely Chroococcales, Nostocales and Pleurocapsales (Table 3). In Kodungallur temple pond low diversity of blue green algae was observed and it was due to the massive bloom of *Microcystis aeruginosa* Kutz. Low amount of dissolved oxygen was noted in Kodungallur pond, which had a significant effect in reducing the other cyanobacterial population.

**Table 3 Distribution pattern of blue green algae under algal orders**

Sl. No:	Name of algal order	No: of species	
		Koodalmanikyam temple pond	Kodungallur temple pond
1	Chroococcales	9	10
2	Pleurocapsales	0	2
3	Nostocales	30	3
4	Stigonematales	1	0
	<b>Total</b>	<b>40</b>	<b>15</b>

The physico-chemical changes in the environment may affect particular species and induce the growth and abundance of other species, which leads to the succession of several species in a course of time (Muthukumar *et al.*, 2007). In any ecosystem, not a single species grows independently and indefinitely, because all the species are interlinked and has cyclic transformation of nutrients. The collective dominance by the species of blue green algae was due to their capacity to grow in turbid water and low light intensity.

*Oscillatoria limosa* Ag. ex Gomont and *Oscillatoria princeps* Vaucher ex Gomont are the pollution tolerant species (Palmer, 1969) identified from the Koodalmanikuum temple pond. *Phormidium*, *Anabaena*, *Lyngbya* and *Oscillatoria* are the pollution tolerant blue green algal genera found in Koodalmanikyam temple pond and *Microcystis* and *Oscillatoria* are found in Kodungallur temple pond. Thus the present study indicates that the two famous temple ponds studied from Thrissur district, Kerala, are showing the signs of pollution.



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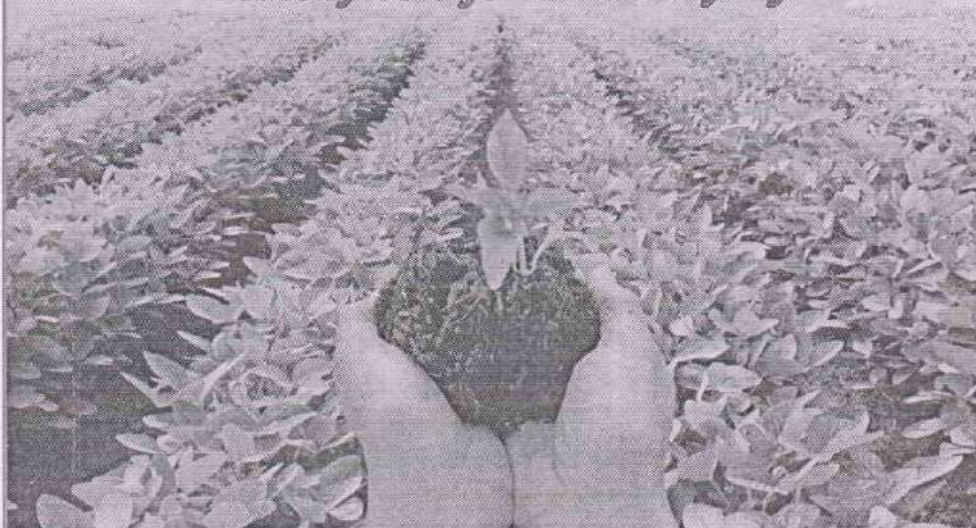
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**Temple Pond Algae of Thrissur District, Kerala:  
A Review**

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The temple ponds are used for bathing and washing and are having ritual and sacred values. Temple devotees use the holy water for washing their limbs and sometimes they make a holy dip into the water. The present paper is a comparative account of the algal diversity of three famous temple ponds of Thrissur district, Kerala. The temple ponds studied are Guruvayur Sree Krishna temple pond, Irinjalakuda Koodalmanikyam temple pond and Kodungallur temple pond. The algal samples collected were preserved in 4% formalin solution and the algae was identified with the help of ICAR monographs and the publications on algae. During the present study 41 algal species were recorded from the Guruvayur Sree Krishna temple pond. Of these twenty species belong to Chlorophyceae (48.8%), eight under Euglenophyceae (19.5%), six each under Bacillariophyceae (14.6%) and Cyanophyceae (14.6%), and one belong to Dinophyceae (2.5%). In Guruvayur temple pond the Chlorophyceae members were more diverse followed by Euglenophyceae. From the Koodalmanikyam temple pond 76 algal species were recorded and in this temple pond the Cyanophyceae members were more diverse followed by Bacillariophyceae. Of these forty species come under Cyanophyceae (52.6%), twenty-six under Bacillariophyceae (34.2%), nine species belong to Chlorophyceae (11.9%), and one belongs to Euglenophyceae (1.3%). The Kodungallur temple pond comprises 39 algal species and in this temple pond the Bacillariophyceae members were more diverse followed by Cyanophyceae members. Of these sixteen species come under Bacillariophyceae (41%), fifteen under Cyanophyceae (38.5%), five belong to Euglenophyceae (12.8%) and three species belong to Chlorophyceae (7.7%). The study documented one hundred and thirty seven taxa of freshwater algae from these temple



ponds. All these three ponds showed pollution tolerant algal species and that indicates the signs of pollution.

**Keywords:** Algal diversity, Temple pond, Guruvayur Sree Krishna temple, Irinjalakuda Koodalmanikyam temple, Kodungallur temple, Kerala.