

14/7/18

Annexure-X

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI-110 002

ASSESSMENT CERTIFICATE

(To be submitted with the proposal)

It is certified that the proposal entitled "Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West Bengal" [Ref No. F.N 42-917/2013 (SR) dated 13.03.2013] by Prof. Amal Kumar Mondal, PI, of Department of Botany & Forestry, Vidyasagar University, Midnapore and Dr. Sanjukta Mondal Parui, Co-PI, of Post Graduate Department of Zoology, Lady Brabourne College, Kolkata has been assessed by the two Members expert committee consisting the following members for submission to the University Grants Commission, New Delhi for financial support under the scheme of Major Research Project (MRP-UGC).

Details of Expert Committee:

Sl No.	Name of Expert	Name of Department	Signature with date
1.	Dr. Sobhan Kumar Mukherjee	Retd. Professor, Department of Botany, University of Kalyani, Kalyani-741235	<i>Sobhan K. Mukherjee</i> Dr. Sobhan K. Mukherjee Retd. Professor Department of Botany, University of Kalyani Kalyani, Nadia, Pin-741235, W.B. 9432224984, sobhankr@gmail.com
2.	Prof. Chandan Sengupta	Department of Botany, Kalyani University, Kalyani	<i>Chandan Sengupta</i> DR. CHANDAN SENGUPTA Professor Department of Botany University of Kalyani Kalyani-741 235, West Bengal

The Proposal is as per the guidelines

(REGISTRAR/PRINCIPAL)

Registrar Seal

Vidyasagar University
Midnapore-721102



12/8/18

Annexure – XI
Final Report Assessment / Evaluation Certificate
(Two Members Expert Committee Not Belonging to the Institute of Principal Investigator)

It is certified that the final report of Major Research Project entitled “Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West Bengal” [Ref No. F.N 42-917/2013 (SR) dated 13.03.2013] by **Prof. Amal Kumar Mondal**, PI, of Department of Botany & Forestry, Vidyasagar University, Midnapore and **Dr. Sanjukta Mondal Parui**, Co-PI, of Post Graduate Department of Zoology, Lady Brabourne College, Kolkata has been assessed by the committee consisting the following members for final submission of the report to the UGC, New Delhi under the scheme of Major Research Project.

Comments/Suggestions of the Expert Committee: Annexure 1

Name & Signatures of Experts with Date

Name of Expert	Name of Department	Signature with Date
Dr. Shovon Mukherjee	Retd. Professor, Department of Botany, Kalyani University, Kalyani	<i>Sobhan K. Mukherjee</i> 18.06.2018 Dr. Sobhan K. Mukherjee Retd. Professor Department of Botany, University of Kalyani Kalyani, Nadia, Pin-741235, W.B. 9432224984, sobhankr@gmail.com
Prof. Chandan Sengupta	Department of Botany, Kalyani University, Kalyani	<i>Chandan Sengupta</i> Dr. CHANDAN SENGUPTA Professor Department of Botany University of Kalyani

Kalyani - 741 235, West Bengal

It is certified that the final report has been uploaded on UGC-MRP portal on... **16/7/2018**

It is also certified that final report, Executive summary of the report, Research documents, monograph academic papers provided under Major Research Project (MRP) have been posted on the website of the **University/College**.

[Signature]
16/07/18

(Registrar/Principal)Seal
Registrar

Vidyasagar University
Midnapore-721102



REPORT REGARDING THE PROJECT PROPOSAL ENTITLED "DIVERSITY OF ANT PLANT INTERACTIONS: PROTECTIVE EFFICACY IN SPECIES WITH EXTRA FLORAL NECTARINES (EFNS) IN THE FLORA OF MIDNAPORE, WEST BENGAL" [Ref No. F.N 42-917/2013 (SR) dated 13.03.2013] BY PROF. AMAL KUMAR MONDAL AND DR. SANJUKTA MONDAL PARUI, CO-PI, OF POST GRADUATE DEPARTMENT OF ZOOLOGY, LADY BRABOURNE COLLEGE, KOLKATA UGC MAJOR RESEARCH PROJECT IN THE DEPARTMENT BOTANY AND FORESTRY OF YOUR UNIVERSITY.

COMMENTS

1. **Suitability of the Proposal 'Diversity of Ant Plant Interactions: Protective Efficacy in Species with Extra Floral Nectarines (EFNs) in the Flora of Midnapore, West Bengal'.**

The project is suitable for this programme, because studied material are easily available and plenty in number.

2. **Competence of the investigators**

Principal Investigator has profound knowledge regarding the proposed research areas, since he has already completed related works for many years.

3. **Facilities available in the host institution**

Host Institute will only provide Laboratory space, Furniture, Internet and Library facilities and all other facilities available in the Department.

4. **Objectives and relevance**

It is fit with the work and satisfactory

5. **Methods and work plan**

These are appropriate and up to the mark

6. **Alterations and improvements recommended**

Not necessary

7. **Outcome of the project**

It is absolutely suitable with the objectives. The results have given a vantage point from which one can gain a rational view on the ant-plant interaction and

how this contributes to the protective efficacy in the plant species having these extrafloral nectaries.

8. User/ Industry interaction, if any

Results of the outcome of the work can be helpful to the user as well as industrial entrepreneurs.

9. Grading in 1 to 10 scale

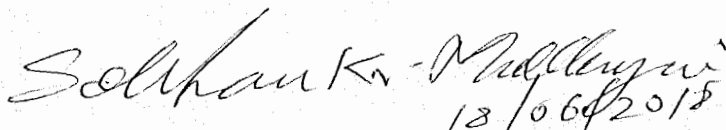
Rank of the work is nine (9)

10. Recommendations

There is no doubt that **Prof. Amal Kumar Mondal** and **Dr. Sanjukta Mondal Parui**, Co-PI, of Post Graduate Department of Zoology, Lady Brabourne College, Kolkata, should be awarded for financial assistance under the UGC Major Research Project.

I assume that **Prof. Amal Kumar Mondal** and **Dr. Sanjukta Mondal Parui**, may get the financial assistance under the **UGC Major Research Project fellowship** for his extremely profound knowledge regarding this field of research work.

With my best compliments,


(Dr. Sobhan Kr. Mukherjee) 12/06/2015

Dr. Sobhan Kr. Mukherjee
Retd. Professor
Department of Botany, University of Kalyani
Kalyani, Nadia, Pin-741235, W.B.
9432224984, sobhankr@gmail.com

Retd. Professor, Taxonomy and Biosystematics Laboratory

Department of Botany, University of Kalyani, Kalyani-741 235

Ph: 09432224984 ; 033 2592 6917

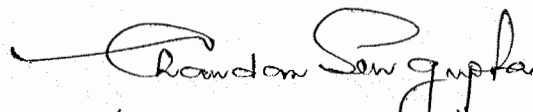
E mail : sobhankr@yahoo.com ; sobhankr@gmail.com

12/12/16

Report on evaluation of the Final Report of the UGC Major Research Project entitled "**Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West Bengal**" [Ref No. F.N 42-917/2013 (SR) dated 13.03.2013] by **Prof. Amal Kumar Mondal**, PI, of Department of Botany & Forestry, Vidyasagar University, Midnapore and **Dr. Sanjukta Mondal Parui**, Co-PI, of Post Graduate Department of Zoology, Lady Brabourne College, Kolkata

The report has been evaluated and recommended for submission to UGC from the following points of view:

- The work done under the mentioned project has been according to the proposed plan of work and towards achieving the objectives.
- Substantial amount of field work has been done to record the details of the structural morphology of the extrafloral nectarines and the behavior of ants during the patrolling supporting their role in the defensive mechanism.
- Supportive experimental work has been deployed to support the nutritional role of biochemical constituents in attracting several classes of visitors.
- The materials and methods include details of the approach taken on the field for studying the plant-ant interaction and the experiments done on biochemical analysis of the extrafloral nectaries.
- The results and conclusion gives a clear overview of the work done and strongly reflects on how this contributes to the protective efficacy in the plant species having these extrafloral nectaries.



(Prof. Chandan Sengupta)
Department of Botany,
Kalyani University, Kalyani

Dr. CHANDAN SENGUPTA
Professor
Department of Botany
University of Kalyani
Kalyani-741 235, West Bengal

12/8/14

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI -110002

Utilization Certificate

Certified that the grant of RS.13,76,233 (Rupees Thirteen lakh seventy six thousand two hundred thirty three only) received from the University Grants Commission under the scheme of support for Major Research Project entitled "Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West-Bengal." provide UGC letter No. F.N. 42-917/2013 (SR) dated 14.03.13 has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission. The pending grant of RS. 72,743 (Rupees Seventy two thousand seven hundred forty three only) will not received till 31.03.2017.

SIGNATURE OF THE
PRINCIPAL INVESTIGATOR
Prof. Anjali K. Mondal
Principal Investigator
UGC-MRP-Project
Department of Botany & Forestry
Vidyasagar University
Midnapore - 721102

[Signature]
18/06/18
REGISTRAR/PRINCIPAL
(SEAL)
Registrar
Vidyasagar University
Midnapore-721102



STATUTORY AUDITOR
(SEAL)
[Signature]
ALODHA & CO. Chartered Accountants
302/205

SIGNATURE OF THE
CO-INVESTIGATOR
S. Mondal (Parui)
(Dr. S. Mondal Parui)

DR. SANJUKTA MONDAL (PARUI)
Associate Professor in zoology, WBES
Department of Zoology
LADY BRABOURNE COLLEGE,
KOLKATA-700 017


✓ 12/5/18

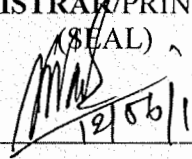
Annexure-V

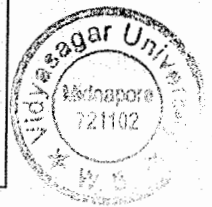
UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI -110002


Utilization Certificate

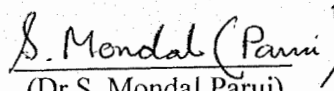
Certified that the grant of RS. 3,26,433 (Rupees Three lakh twenty six thousand four hundred thirty three only) received from the University Grants Commission under the scheme of support for Major Research Project entitled "Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West-Bengal." provide UGC letter No. F.N. 42-917/2013 (SR) dated 14.03.13 has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University Grants Commission.

SIGNATURE OF THE
PRINCIPAL INVESTIGATOR

12/5/18
Prof. Amal Kumar Mondal
Principal Investigator
UGC-MRP-Project
Department of Botany & Forestry
Vidyasagar University
Midnapore - 721102

✓
REGISTRAR/PRINCIPAL
(SEAL)

12/5/18
(Dr. J.K. Nandi)
Registrar
Vidyasagar University
Midnapore-721102



STATUTORY AUDITOR
(SEAL)


SIGNATURE OF THE
CO-INVESTIGATOR

(Dr.S. Mondal Parui)

DR. SANJUKTA MONDAL (PARUI)
Associate Professor in zoology, WBES
Department of Zoology
LADY BRABOURNE COLLEGE,
KOLKATA-700 017

18/12/18

Annexure-VIII
UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI -110002

Annual/Final Report of the work done on the Major Research Project

1. Project Report No. 1st /2nd /3rd /Final: Final report
 2. UGC Reference No. F.: N. 42-917/2013(SR) dated 14th March, 2013
 3. Period of Report from: March 2015-March 2017
 4. Title of the Research Project: Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West-Bengal.
 5. (a) Name of the Principal Investigator – Prof. Amal Kumar Mondal
(b) Deptt. – Botany & Forestry
(c) University/College where work has progressed- Vidyasagar University
 6. Effective date of starting of the project: 01/07/2013
 7. Grant approved and Expenditure incurred during the period of the report.
 - a. Total amount approved- Rs. 14, 00,000
 - b. Total expenditure- Rs. 13, 76,233
- c. Report of the Work done: (Please attach a separate sheet) (Annexure-I)
- i. Brief objective of the project:
 - a) Understanding the diversity of extrafloral nectarines (EFNs) in the Flora of Midnapore, West Bengal.
 - b) Detailed morphological description of the extrafloral nectaries.
 - c) To study the ant-plant interaction between plant species, the ratio of ant patrolling ratio and frequency with abundance of the ant species present in the plant community.
 - d) Identify the protein dynamics within the extrafloral nectaries in different plant species.
 - ii. Work done so far and result 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):
 1. Ghosh, D., Mondal, A.K. and Mondal, S. 2015. Morphology, anatomy, ultrastructure and ant-patrolling of extrafloral nectaries (EFNS) in three species of Mimosaceae. *International Journal of Current Research*, 7 (5): 15505-15508.

2. Jana, B.K. and Mukherjee, S.K. 2015. *Advancement in Plant Science*, Morphometric, ultrastructural study and anti-herbivore defense of EFNs in three species of *Cassia L.* in West Bengal, India. Lambert Academic Publishing, Germany.

iii. Has the progress been according to original plan of work and towards achieving the objective. If not. State reason: **Yes, the work has progresses according to original plan of work.**

iv. Please indicate the difficulties, if any, experienced in implementing the project: **No, difficulties experienced**

V. If project has been completed. Please indicate approximate time by which it is likely to be completed. A summary of the work done for the period (annual basis) may please be sent to the commission on a separate sheet.- **Annexure IX**

Vi. If the project has been completed. Please enclose a summary of the finding of the study. One bound copy of the final report of work done may also be sent to the University Grants Commission:-

1. The flora of Midnapore was found to have an outstanding diversity of EFNs. Five distinct kinds of EFN morphologies exist in the thirty one species of plants investigated which have been interpreted in relation to their morphological differentiation and specialization of EFNs.
2. Detailed morphological and anatomical studies have been done to characterize the EFNs. The two wild species of *Passiflora* containing cryptic EFNs have been identified for the first time. EFNs are highly variable in their position relative to the surface and in colour also. Elevating EFNs above the leaf level was found to play a very important role in ant attraction, EFN colour serve as a visual cue for ants to detect nectar.
3. Our investigation shows that small, cryptic EFNs are probably much more widespread than currently thought and mainly found ecologically wild plant species. Besides this, flattened, formless nectaries were also has ecological importance.
4. Histochemical tests were positive for numerous substances including polysaccharides, proteins, and lipids in different plant species. These compounds are considered nutritionally important to several classes of visitor, suggesting that ant species may play a mutualistic role in plant defense.
5. The high diversity of ant species were recorded in studied plant species. In the present study, the most frequent (*Monomorium sp*), the most abundant (*Tapinoma sp*), and

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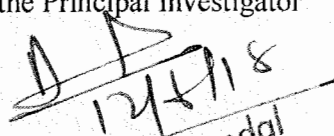
most aggressive species (*Technomyrmex* sp) were responsible for half of the attacks against simulated herbivores and for the displacements of nectar-thieving butterflies.

6. The secretion of nectar represents a common plant trait of high ecological, evolutionary and economic importance. Our results demonstrate that the nectary represents a metabolically independent organ, and that most synthetic processes that are required for production of important nectar components occur in the nectary itself. Therefore, we focused on the proteomic dynamics in the nectary tissue. The SDS-PAGE shows different banding pattern of different proteins was presents. The HPLC analysis shows different sugars present in the efns liquid.
7. So, the present study is one of a very few to investigate how EFN attributes such as gland morphology influences ant preference. Here we only considering the diversity of EFN-bearing organs and EFN morphologies in ecological studies of mutualistics interactions fully appreciate and understand the evolution, ecology and evolutionary role of both the EFN and the mutualisms in triggering lineage diversification.

Vii. Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as (a) Manpower trained (b) Ph.D. awarded (c) Publication of the result (d) other impact, if any:-

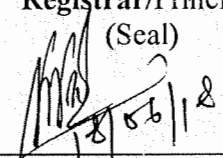
Two Publications & one Ph.D enrolled process going on.

Signature of the Principal Investigator


12/11/18

(Prof. A. K. Mondal)
Prof. A. K. Mondal
Principal Investigator
UGC-MRP Project
Department of Botany & Forestry
Vidyasagar University
Midnapore - 721102

Registrar/Principal
(Seal)


18/11/18

(Dr. J.K. Nandi)
Registrar
Vidyasagar University
Midnapore-721102



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12/8/16

Annexure-IX
UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI -110002

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: Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West-Bengal.
2. Name and address of the Principal Investigator: Prof. Amal Kumar Mondal,
Department of Botany & Forestry,
Vidyasagar University, Mid-721102
3. Name and address of the Institution: Vidyasagar University, Midnapore-721102
4. UGC approval letter No. and Date: Ref. No. F.N. 42-917/2013 (SR) dated 14.03.13
5. Date of Implementation:
6. Tenure of the project: Three Years
7. Total grant allocated: 13,76,233
8. Total grant received: 13,76,233
9. Final Expenditure: 13,76,233
10. Title of the Project: Diversity of ant-plant interactions: Protective efficacy in species with extrafloral nectarines (EFNs) in the flora of Midnapore, West-Bengal.
11. Objectives of the Project:
 - a) Understanding the diversity of extrafloral nectarines (EFNs) in the Flora of Midnapore, West Bengal.
 - b) Detailed morphological description of the extrafloral nectarines with their distribution with GPS.
 - c) To study the ant-plant interaction between plant species, we study the ant patrolling ratio and frequency with abundance of ant species present in the plant community.
 - d) Besides this identify the protein dynamics within the extrafloral nectarines in different plant species.
12. Whether Object were achieved: Yes, Achieved as plan wise.
 - a) First Year: Field study and Morphological description of the plants with EFNs were studied.

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- b) Second Year: Anatomical and histochemical studies of extrafloral nectary tissues were done.
- c) Third Year: Completed all the studies and field visit as well as molecular studies of liquid secretion from EFNs were studied.

13. Achievements from the Project: This work is a great value in India, i.e, histochemical identification, detailed morphological description, protein dynamics and ant-plant interactions would not be performed earlier.

14. Summary of the Findings:

- The outstanding diversity of EFNs has thus fascinated scientists for centuries. Five distinct kind of EFN morphologies exist in thirty one species of plants which we here interpreted in relation to their morphological differentiation and specialization of EFNs.
- Thus detailed morphological and anatomical studies are necessary to characterize them. However, the two wild species of *Passiflora* containing cryptic EFNs has not been identified previously. EFNs are highly variable in their position relative to the surface and in colour also. Elevating EFNs above the leaf level may play a role in ant attraction, especially if EFN colour serves as a visual cue for ants to detect nectar.
- In particular small, cryptic EFNs are probably much more widespread than currently thought and mainly found ecologically wild plant species. Besides this, flattened, formless nectaries were also has ecological importance.
- Histochemical tests were positive for numerous substances including polysaccharides, proteins, and lipids in different plant species. These compounds are considered nutritionally important to several classes of visitor, suggesting that ant species may play a mutualistic role in plant defense.
- The high diversity of ant species were recorded in studied plant species. In the present study, the most frequent (*Monomorium* sp), the most abundant (*Tapinoma* sp), and most aggressive species (*Technomyrmex* sp) were responsible for half of the attacks against simulated herbivores and for the displacements of nectar-thieving butterflies.
- The secretion of nectar represents a common plant trait of high ecological, evolutionary and economic importance. Our results demonstrate that the nectary represents a metabolically independent organ, and that most synthetic processes that are required for production of important nectar components occur in the

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nectary itself. Therefore, we focused on the proteomic dynamics in the nectary tissue. The SDS-PAGE shows different banding pattern of different proteins was presents. The HPLC analysis shows different sugars present in the efns liquid.

- So, the present study is one of a very few to investigate how EFN attributes such as gland morphology influences ant preference. Here we only considering the diversity of EFN-bearing organs and EFN morphologies in ecological studies of mutualistics interactions fully appreciate and understand the evolution, ecology and evolutionary role of both the EFN and the mutualisms in triggering lineage diversification.

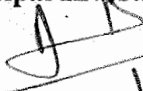
15. Contribution to the Society: It has a moderate contribution because it just related with animal society about food and herbivory interaction between ant- plant community.

16. Whether any Ph.D. enrolled/produced out of the Project: Ph.D enrolled (Sl. No. 1122 on 2.1.18 and effect from 22.7.2015.

17. No. of Publications out of the Project:

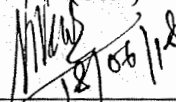
1. Ghosh, D., Mondal, A.K. and Mondal, S. 2015. Morphology, antomy, ultrastructure and ant-patrolling of extrafloral nectaries (EFNS) in three species of Mimosaceae. *International Journal of Current Research*, 7 (5): 15505-15508.
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Principal Investigator


12/10/18
(Prof. A.K. Mondal)
Prof. Amal Kumar Mondal
Principal Investigator
UGC-MRP Project
Department of Botany & Forestry
Vidyasagar University
Midnapore - 721102

(Dr. S. Mondal (Parui))

Registrar/Principal
(Seal)


12/10/18
(Dr. J.K. Nandi)
Registrar
Vidyasagar University
Midnapore-721102

