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APPENDIX 1

Plate 45 A & B- Landscape of Cachar district

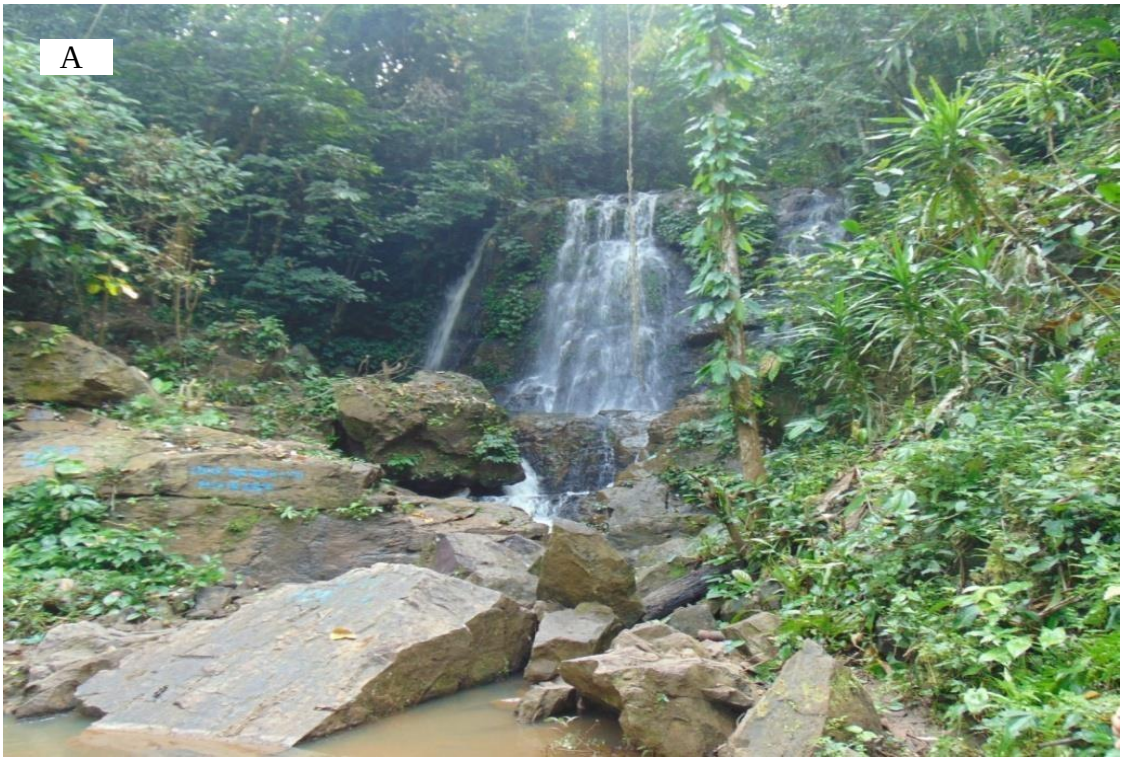

Plate 46 A & B- Forest foothills of Haflong, Dima Hasao

Plate 47 A- Road inside Bherjan-Borajan-Padumoni Wildlife Sanctuary, Tinsukia, Assam
B- Stream flowing inside Kakoi Reserve Forest, Lakhimpur, Assam

Plate 48. A & B- Moist habitat of the species. A- Habitat of *Ophiorrhiza mungos* along the water stream. B- Habitat of *Ophiorrhiza ochroleuca* along the mountain

APPENDIX 2

PUBLICATIONS

1. Bhuyan B & Baruah S. (2022). On the extended distribution of two species of Ophiorrhiza L. (Rubiaceae) from the state of Assam. Plant Science Today. 9(4):1085-1089.

2. Bhuyan B & Baruah S. (2021). Occurrence of vivipary in *Ophiorrhiza rugosa* Wall. Journal of threatened taxa. 13(8): 19189-19190.

3. Bhuyan B, Baruah S & Mehmud S. (2021). *Ophiorrhiza recurvipetala* (Rubiaceae) sp. nov. from Assam India. Nordic Journal of Botany. 39(3): 1-4

4. Bhuyan B & Baruah S. (2023). Taxonomy of *Ophiorrhiza fasciculata* D. Don (Rubiaceae), a lesser known species of Assam. Advanced Botany (Volume-4), Akhinik Publications, Delhi. ISBN 978-93-5570-795-6.

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APPENDIX 3

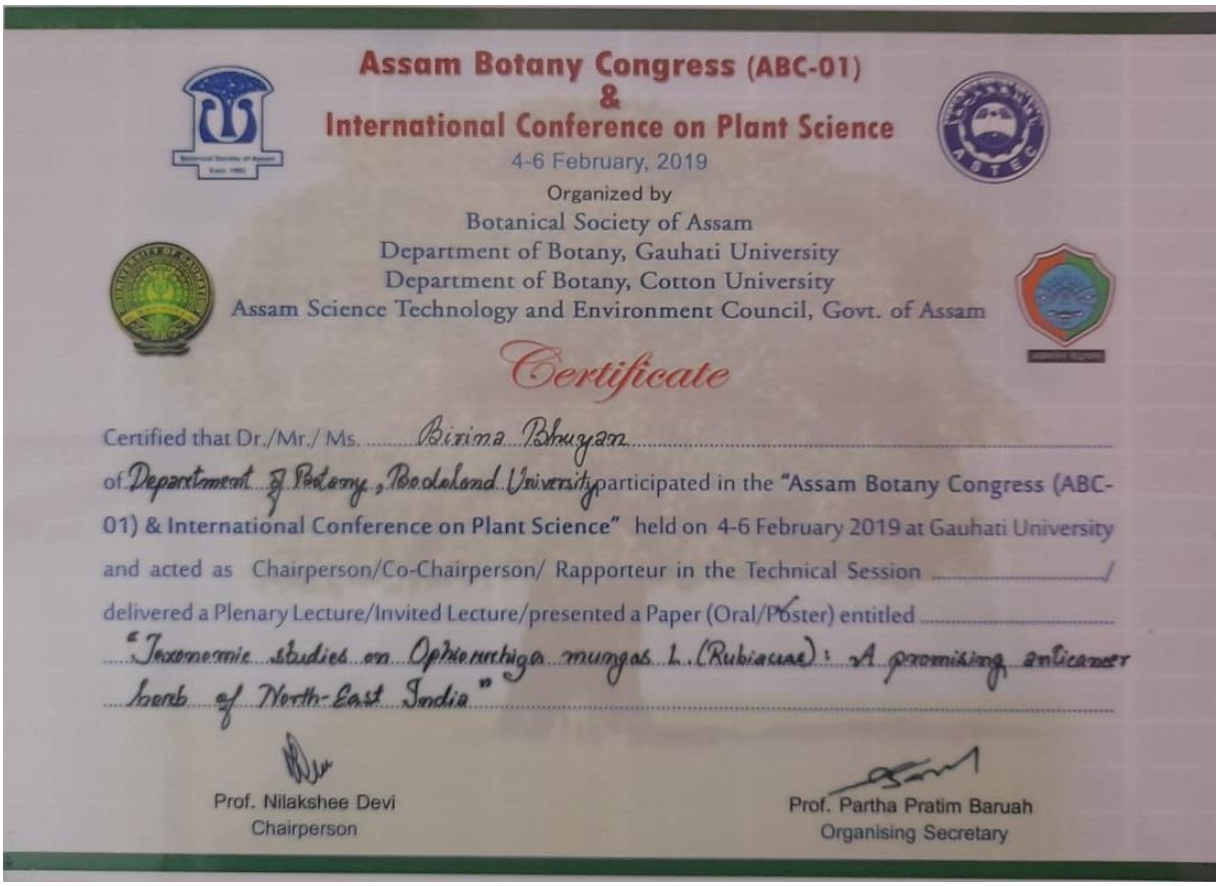
SEMINARS AND WORKSHOPS

1. Presented a Poster entilted "Taxonomic studies on *Ophiorrhiza mungos* L. (Rubiaceae): A promising anticancer herb of North- East India" in International conference on Plant Science held on 4-6 February 2019 in Gauhati University, Assam, India.
2. Presented a paper (oral) entitled "Comparative floral morphology of certain species of *Ophiorrhiza* L. (Rubiaceae) occuring in Assam" in National seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and North-East India held on 21-22 February 2022 jointly organized by Department of Botany, Rajib Gandhi University, East Himalayan Society of Spermatophytes Taxonomy and Botanical Survey of India.

3. Participated in Fourth Botanical Nomenclature Course conducted by Botanical Survey of India, Shillong from 27th to 31st January 2020.

4. Participated in online course on Basic of Ecological Niche modelling (ENM) held from 19th June to 20th June 2021, organised by Chatur Ullu Lab, Pune.

5. Participated in 3 days online workshop on Species Distribution Modelling using Maxent held from 11th March to 13th March 2022, organised by Biologia Life Science, Maharastra.



Assam Botany Congress (ABC-01)
&
International Conference on Plant Science
4-6 February, 2019
Organized by
Botanical Society of Assam
Department of Botany, Gauhati University
Department of Botany, Cotton University
Assam Science Technology and Environment Council, Govt. of Assam

Certificate

Certified that Dr./Mr./ Ms. Birina Bhuyan
of Department of Botany, Bodoland University participated in the "Assam Botany Congress (ABC-01) & International Conference on Plant Science" held on 4-6 February 2019 at Gauhati University and acted as Chairperson/Co-Chairperson/ Rapporteur in the Technical Session ...../ delivered a Plenary Lecture/Invited Lecture/presented a Paper (Oral/Poster) entitled "Taxonomic studies on Ophiorrhiza mungos L. (Rubiaceae): A promising anticancer herb of North-East India"

Prof. Nilakshee Devi
Chairperson

Prof. Partha Pratim Baruah
Organising Secretary

Fig 15: Certificate of Poster presentation in International Conference

National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and North-East India
&
Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHHST)
Jointly organized by
DEPARTMENT OF BOTANY, RAJIV GANDHI UNIVERSITY
EAST HIMALAYAN SOCIETY FOR SPERMATOPHYTE TAXONOMY
BOTANICAL SURVEY OF INDIA

CERTIFICATE

This is to Certify that **Ms. Birina Bhuyan** of **Bodoland University, Kokrajhar, Assam** presented a paper (ORAL) entitled "***Comparative Floral morphology of certain species of Ophiorrhiza L. (Rubiaceae) occurring in Assam (India)***" in National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and Northeast India & Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHSST), scheduled on February 21-22, 2022.

(Dr. Tonlong Wangpan)
Organizing Secy.

(Prof. Sumpam Tangjang)
Organizing Chairman

(Prof. Saket Kushwaha)
Vice-Chancellor, RGU

Fig 16: Certificate of oral presentation in National Seminar

भारत सरकार / GOVERNMENT OF INDIA

पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय / Ministry of Environment, Forest & Climate Change

भारतीय वनस्पति सर्वेक्षण / Botanical Survey of India

पूर्वी क्षेत्रिय केन्द्र / Eastern Regional Centre

शिलांग / Shillong – 793003

भारतीय वनस्पति सर्वेक्षण
BOTANICAL SURVEY OF INDIA

प्रमाण पत्र / CERTIFICATE

प्रमाणित किया जाता है कि श्री/सुश्री/डॉ / This is to certify that Mr/Mrs/Dr *Birina Bhuyan*

ने 27 से 31 जनवरी, 2020 तक भारतीय वनस्पति सर्वेक्षण द्वारा आयोजित " पादप नामकरण पाठयक्रम " में भाग लिया तथा व्याख्यान, अभ्यास सम्बंधी अन्य प्रशिक्षण को सफलतापूर्वक पूरा किया / has participated in the "Botanical Nomenclature Course" organized by Botanical Survey of India from 27 - 31 January, 2020 and successfully completed the course comprising Lectures, Exercises and Assignments.

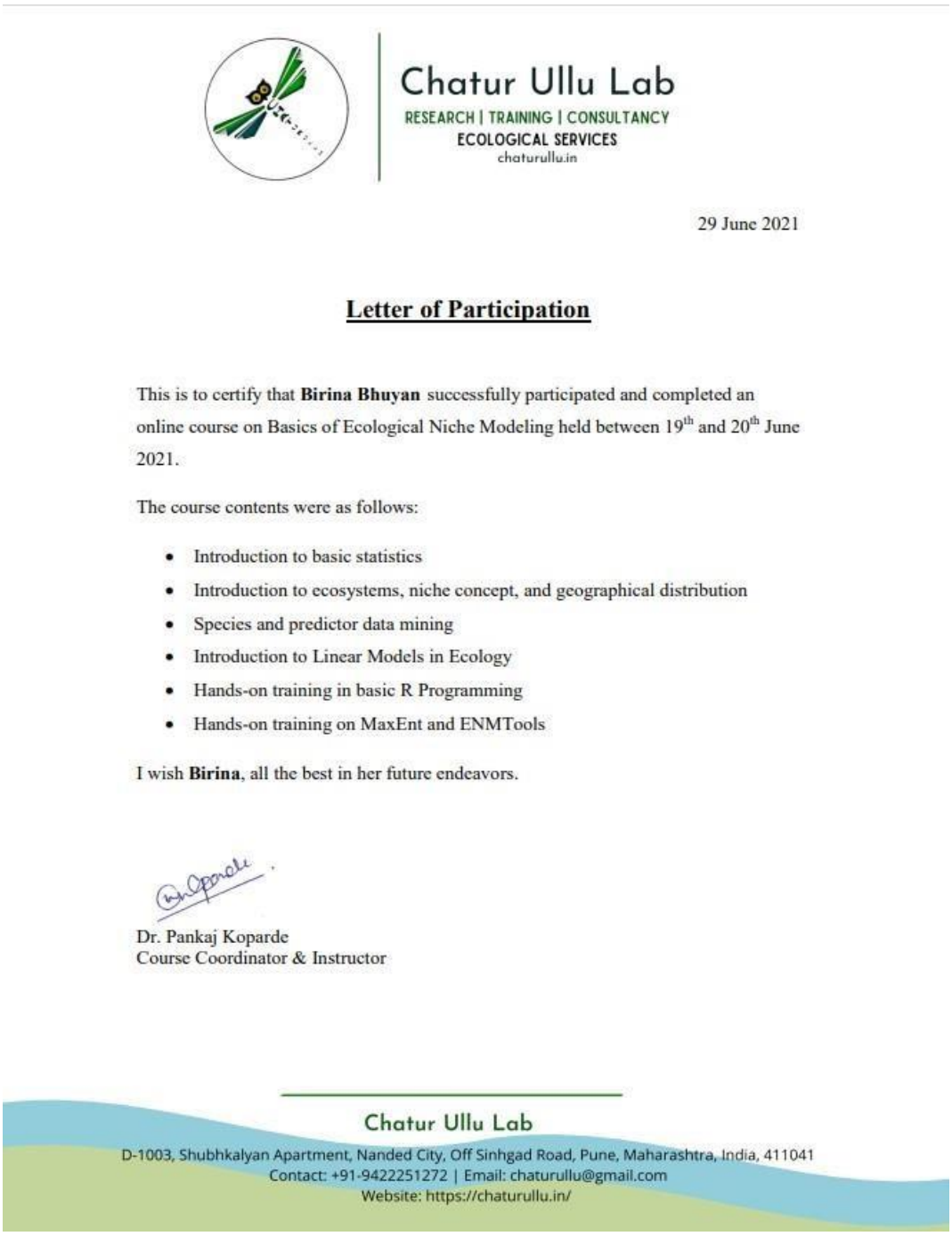
Kanchi N. Gandhi
Dr KANCHI N. GANDHI
Senior Nomenclature Registrar
& Course Director
Harvard University Herberia
Cambridge, USA

Dr P. LAKSHMINARASIMHAN
Course Coordinator
Ex-Joint Director
Botanical Survey of India

Dr NRIPEMO ODYUO
Head of Office
Botanical Survey of India
Eastern Regional Centre
Shillong

Dr ASHIHO A. MAO
Director & Convenor
Botanical Survey of India
Kolkata

Fig 17:Certificates of ‘Botanical Nomenclature Course’ Workshop.



Chatur Ullu Lab
RESEARCH | TRAINING | CONSULTANCY
ECOLOGICAL SERVICES
chaturullu.in

29 June 2021

Letter of Participation

This is to certify that **Birina Bhuyan** successfully participated and completed an online course on Basics of Ecological Niche Modeling held between 19th and 20th June 2021.

The course contents were as follows:

- Introduction to basic statistics
- Introduction to ecosystems, niche concept, and geographical distribution
- Species and predictor data mining
- Introduction to Linear Models in Ecology
- Hands-on training in basic R Programming
- Hands-on training on MaxEnt and ENMTools

I wish **Birina**, all the best in her future endeavors.

Dr. Pankaj Koparde
Course Coordinator & Instructor

Chatur Ullu Lab
D-1003, Shubhkalyan Apartment, Nanded City, Off Sinhgad Road, Pune, Maharashtra, India, 411041
Contact: +91-9422251272 | Email: chaturullu@gmail.com
Website: https://chaturullu.in/

Fig 18: Certificate of Online workshop 1

Fig 19: Certificate of Online workshop 2

APPENDIX 4

ACHIEVEMENT

Awarded as **Best Oral Presenter** in a National seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and North-East India held on 21-22 February 2022 jointly organised by Department of Botany, Rajib Gandhi University, East Himalayan Society of Spermatophytes Taxonomy and Botanical Survey of India.

National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and North-East India

&

Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHHST)

Jointly organized by

DEPARTMENT OF BOTANY, RAJIV GANDHI UNIVERSITY
EAST HIMALAYAN SOCIETY FOR SPERMATOPHYTE TAXONOMY
BOTANICAL SURVEY OF INDIA

CERTIFICATE

This certificate is proudly presented to **Ms. Birina Bhuyan** of **Department of Botany, Bodoland University, Assam** for the **Best Oral Presenter** in National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and Northeast India & Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHSST), scheduled on February 21 – 22, 2022.

(Dr. Tonlong Wangpan)
Organizing Secy.

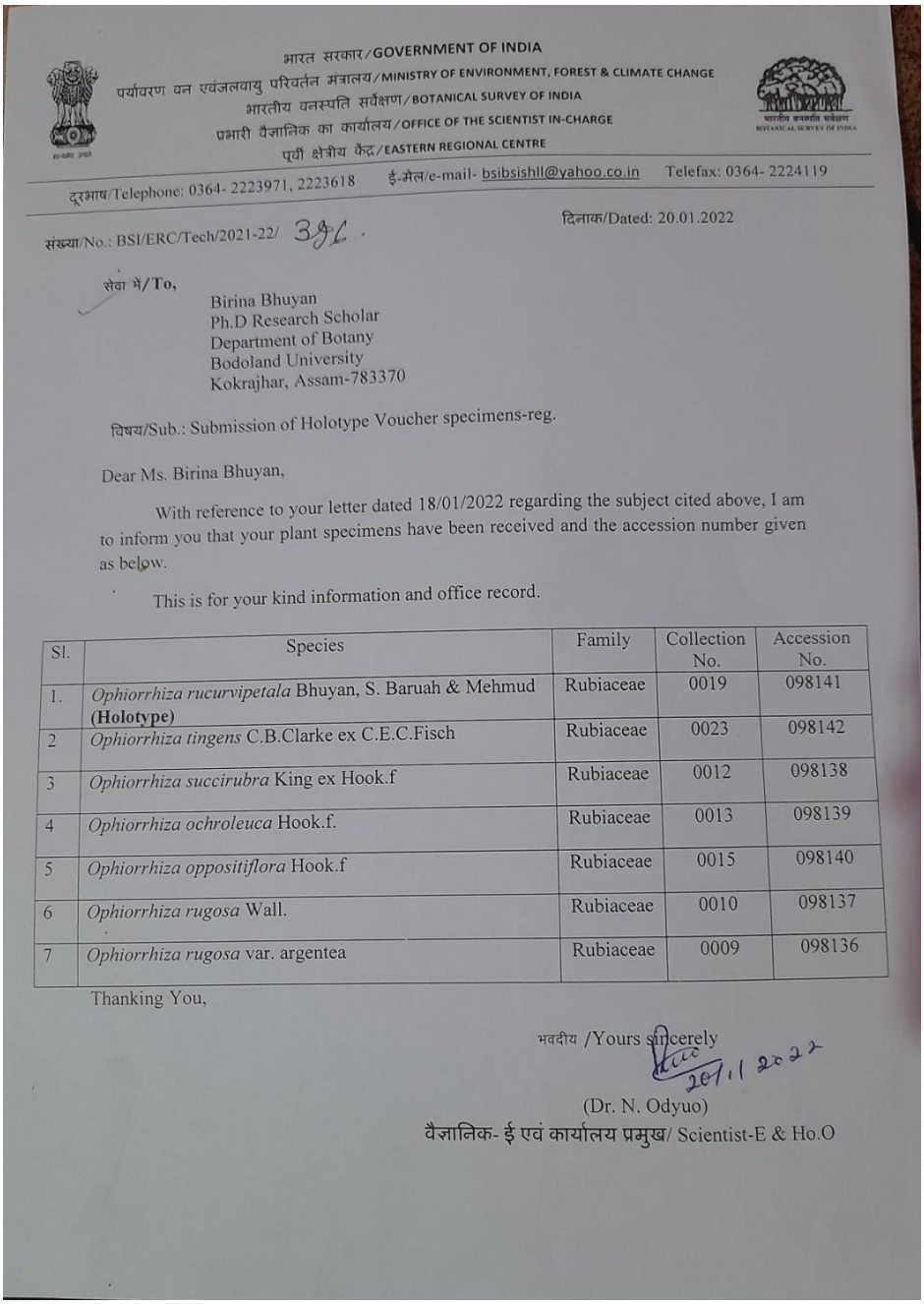
(Prof. Sumpam Tangjang)
Organizing Chairman

(Prof. Saket Kushwaha)
Vice-Chancellor, RGU

Fig 20: Certificate of Best Oral presentation

APPENDIX 5

SPECIMENS DEPOSITED IN ASSAM HERBARIUM



भारत सरकार/GOVERNMENT OF INDIA
पर्यावरण वन एवंजलवायु परिवर्तन मंत्रालय/MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
भारतीय वनस्पति सर्वेक्षण/BOTANICAL SURVEY OF INDIA
प्रभारी वैज्ञानिक का कार्यालय/OFFICE OF THE SCIENTIST IN-CHARGE
पूर्वी क्षेत्रीय केंद्र/EASTERN REGIONAL CENTRE

दूरभाष/Telephone: 0364- 2223971, 2223618 ई-मेल/e-mail- bsibsishll@yahoo.co.in Telefax: 0364- 2224119

संख्या/No.: BSI/ERC/Tech/2021-22/ 396 दिनाक/Dated: 20.01.2022

सेवा में/To,

Birina Bhuyan
Ph.D Research Scholar
Department of Botany
Bodoland University
Kokrajhar, Assam-783370

विषय/Sub.: Submission of Holotype Voucher specimens-reg.

Dear Ms. Birina Bhuyan,

With reference to your letter dated 18/01/2022 regarding the subject cited above, I am to inform you that your plant specimens have been received and the accession number given as below.

This is for your kind information and office record.

Sl.	Species	Family	Collection No.	Accession No.
1.	*Ophiorrhiza rucurvipetala* Bhuyan, S. Baruah & Mehmud **(Holotype)**	Rubiaceae	0019	098141
2	*Ophiorrhiza tingens* C.B.Clarke ex C.E.C.Fisch	Rubiaceae	0023	098142
3	*Ophiorrhiza succirubra* King ex Hook.f	Rubiaceae	0012	098138
4	*Ophiorrhiza ochroleuca* Hook.f.	Rubiaceae	0013	098139
5	*Ophiorrhiza oppositiflora* Hook.f	Rubiaceae	0015	098140
6	*Ophiorrhiza rugosa* Wall.	Rubiaceae	0010	098137
7	*Ophiorrhiza rugosa* var. argentea	Rubiaceae	0009	098136

Thanking You,

भवदीय /Yours sincerely

20/1/2022

(Dr. N. Odyuo)
वैज्ञानिक- ई एवं कार्यालय प्रमुख/ Scientist-E & Ho.O

Fig 21 Deposited herbarium specimens with accession numbers.

APPENDIX 6

PERMISSION

Permission letter from Assam State Biodiversity Board and Principal Chief Conservator of Forest (WL) and Chief Wildlife Warden, Assam (Fig &)

ASSAM STATE BIODIVERSITY BOARD
ARANYA BHAWAN, 2nd FLOOR
PANJABARI, GUWAHATI-781037
www.asbb.gov.in

ABB/Permission/2012/172

Tel- 0361- 2333917; Fax: 2333788
Email: assambioboard@gmail.com
Date: 02/09/2019

From: **Shri K. S. P. V. Pavan Kumar**, IFS
Additional PCCF (P & D) &
Member Secretary-ASBB
Panjabari, Guwahati.

To: Ms. Birina Bhuyan,
Research Scholar, Department of Botany,
Bodoland University,
Kokrajhar.

Sub: Permission for access to bio-resources (*Ophiorrhiza* Linn.) of Assam.

Ref: Your application dated 16/08/2019.

Dear Ms. Bhuyan,

In inviting a reference to the above, this is to convey approval of the Assam State Biodiversity Board for your research study entitled "Studies on Taxonomy and Distribution of genus *Ophiorrhiza* Linn. (Rubiaceae) of Assam". This permission is subject to fulfilment of following conditions:

i. The permission is for a period of three years as indicated in the application w.e.f. 02/09/2019.

ii. The permission granted is for survey purposes and is subject to other clearances from concerned authorities of Forest Department, Assam for Protected Areas.

iii. The permission is applicable only at intended study sites as mentioned in the application i.e. all Reserve Forests, Wildlife Sanctuaries and National Parks of Assam.

iv. Collection of samples shall be done with due permission from the Forest Department, Assam & with utmost care so as to cause no/ least harm to the flora.

v. The data on availabilities of the *Ophiorrhiza* Linn. (Rubiaceae) in the specified PAs shall be shared with the Board for inclusion in 'People's Biodiversity Registers (PBRs)' of respective Biodiversity Management Committees (BMCs).

vi. In case of any intended IPR/Commercial use of the research findings, a fresh application shall be made in terms of the provision of the Biological Diversity Act-2002 and Assam Biodiversity Rules-2010.

vii. As the Research Project involves biological resources, the obligations under the 'Biological Diversity Act 2002' as applicable shall be complied by the Researcher.

viii. The outcome of the research study must be shared with the Board after completion.

In the event of violation of any of the conditions stipulated above, the permission shall be liable to be withdrawn.

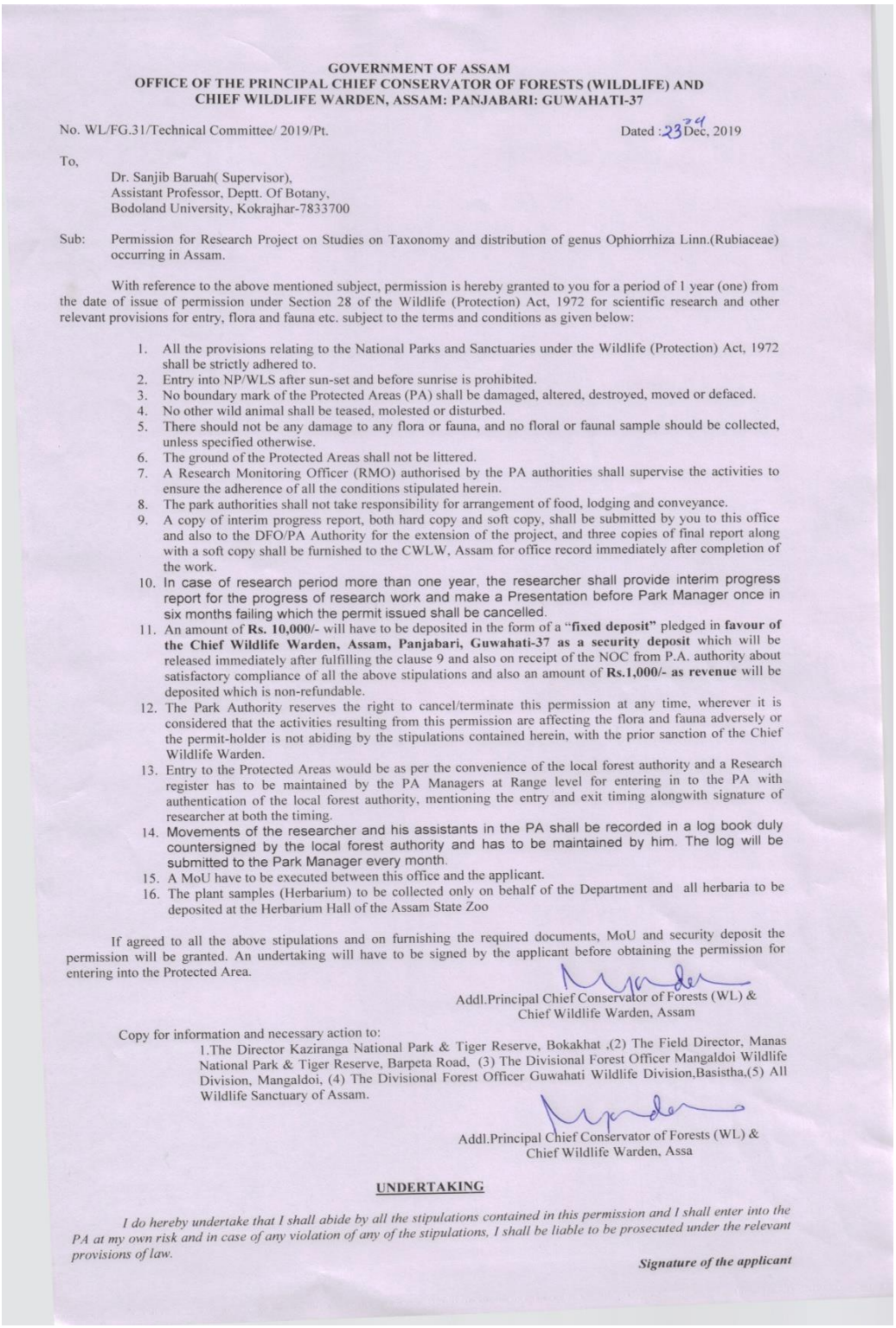
Yours faithfully,

02/09/2019

(K. S. P. V. Pavan Kumar, IFS)
i/c Member Secretary, ASBB

Copy for information to the Principal Chief Conservator of Forests, Wildlife, Assam.

Fig 22 Permission copy received from Assam State biodiversity Board



GOVERNMENT OF ASSAM
OFFICE OF THE PRINCIPAL CHIEF CONSERVATOR OF FORESTS (WILDLIFE) AND CHIEF WILDLIFE WARDEN, ASSAM: PANJABARI: GUWAHATI-37

No. WL/FG.31/Technical Committee/ 2019/Pt. Dated : 23/24 Dec, 2019

To,

Dr. Sanjib Baruah(Supervisor),
Assistant Professor, Deptt. Of Botany,
Bodoland University, Kokrajhar-7833700

Sub: Permission for Research Project on Studies on Taxonomy and distribution of genus Ophiorrhiza Linn.(Rubiaceae) occurring in Assam.

With reference to the above mentioned subject, permission is hereby granted to you for a period of 1 year (one) from the date of issue of permission under Section 28 of the Wildlife (Protection) Act, 1972 for scientific research and other relevant provisions for entry, flora and fauna etc. subject to the terms and conditions as given below:

1. All the provisions relating to the National Parks and Sanctuaries under the Wildlife (Protection) Act, 1972 shall be strictly adhered to.
2. Entry into NP/WLS after sun-set and before sunrise is prohibited.
3. No boundary mark of the Protected Areas (PA) shall be damaged, altered, destroyed, moved or defaced.
4. No other wild animal shall be teased, molested or disturbed.
5. There should not be any damage to any flora or fauna, and no floral or faunal sample should be collected, unless specified otherwise.
6. The ground of the Protected Areas shall not be littered.
7. A Research Monitoring Officer (RMO) authorised by the PA authorities shall supervise the activities to ensure the adherence of all the conditions stipulated herein.
8. The park authorities shall not take responsibility for arrangement of food, lodging and conveyance.
9. A copy of interim progress report, both hard copy and soft copy, shall be submitted by you to this office and also to the DFO/PA Authority for the extension of the project, and three copies of final report along with a soft copy shall be furnished to the CWLW, Assam for office record immediately after completion of the work.
10. In case of research period more than one year, the researcher shall provide interim progress report for the progress of research work and make a Presentation before Park Manager once in six months failing which the permit issued shall be cancelled.
11. An amount of **Rs. 10,000/-** will have to be deposited in the form of a "**fixed deposit**" pledged in **favour of the Chief Wildlife Warden, Assam, Panjabari, Guwahati-37 as a security deposit** which will be released immediately after fulfilling the clause 9 and also on receipt of the NOC from P.A. authority about satisfactory compliance of all the above stipulations and also an amount of **Rs.1,000/- as revenue** will be deposited which is non-refundable.
12. The Park Authority reserves the right to cancel/terminate this permission at any time, wherever it is considered that the activities resulting from this permission are affecting the flora and fauna adversely or the permit-holder is not abiding by the stipulations contained herein, with the prior sanction of the Chief Wildlife Warden.
13. Entry to the Protected Areas would be as per the convenience of the local forest authority and a Research register has to be maintained by the PA Managers at Range level for entering in to the PA with authentication of the local forest authority, mentioning the entry and exit timing alongwith signature of researcher at both the timing.
14. Movements of the researcher and his assistants in the PA shall be recorded in a log book duly countersigned by the local forest authority and has to be maintained by him. The log will be submitted to the Park Manager every month.
15. A MoU have to be executed between this office and the applicant.
16. The plant samples (Herbarium) to be collected only on behalf of the Department and all herbaria to be deposited at the Herbarium Hall of the Assam State Zoo

If agreed to all the above stipulations and on furnishing the required documents, MoU and security deposit the permission will be granted. An undertaking will have to be signed by the applicant before obtaining the permission for entering into the Protected Area.

Addl.Principal Chief Conservator of Forests (WL) &
Chief Wildlife Warden, Assam

Copy for information and necessary action to:
1.The Director Kaziranga National Park & Tiger Reserve, Bokakhat ,(2) The Field Director, Manas National Park & Tiger Reserve, Barpeta Road, (3) The Divisional Forest Officer Mangaldoi Wildlife Division, Mangaldoi, (4) The Divisional Forest Officer Guwahati Wildlife Division,Basistha,(5) All Wildlife Sanctuary of Assam.

Addl.Principal Chief Conservator of Forests (WL) &
Chief Wildlife Warden, Assa

UNDERTAKING

I do hereby undertake that I shall abide by all the stipulations contained in this permission and I shall enter into the PA at my own risk and in case of any violation of any of the stipulations, I shall be liable to be prosecuted under the relevant provisions of law.

Signature of the applicant

Fig 23 Permission copy received from Principal Chief Conservator of Forest (WL) and Chief Wildlife Warden, Assam

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RESEARCH ARTICLE

On the extended distribution of two species of *Ophiorrhiza* L. (Rubiaceae) from the States of India

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Abstract

Ophiorrhiza L. (1753: 150) is a pantropical, herbaceous genus distributed with high diversity in South East Asia. Here, 2 members of genus *Ophiorrhiza*, *Ophiorrhiza brunonis* var. *johnsonii* Hook. f. reported as a new record for North East India and *Ophiorrhiza fasciculata* D. Don for the flora of Assam. Detailed taxonomic descriptions, coloured photographs are provided here for the easy identification of the taxa. Distribution map of the species is also provided.

Keywords

Ophiorrhiza brunonis var. *johnsonii*, *Ophiorrhiza fasciculata*, new report, Assam, North-East India

Introduction

Ophiorrhiza L. is a potential medicinally important genus widely distributed in the South East Asia, West Pacific, South China, North Australia and New Guinea. (1-3). The members of genus contain Camptothecin (CPT), an indole alkaloid with anticancer properties also used in the treatment of snake poison, wounds, ulcers, leprosy, breast, ovarian cancer etc (4, 5). It is a taxonomically complicated genus consisting *c.* 321 species worldwide, 5 varieties and 1 subspecies (6-9). At present, 47 species and 9 varieties of the genus have been recorded from India and out of them, 21 species and 1 variety have been reported from North-East India (10). Recently, few new species of genus were discovered from North-Eastern states of India (11-13).

During the survey from the month of October to December 2021, the authors have collected few specimens of *Ophiorrhiza* from the forests of Jatinga, Halflong, Assam and from road side at Cherrapunji, Meghalaya. On careful observation and critical examination of the species with perusal of literature (2, 3, 10, 14, 15) and consultation of herbarium available at GBIF and deposited at different herbaria ASSAM, CAL, E, K, MPU, BR (acronym following Thiers 2018) the collected specimen from Halflong was identified as *O. fasciculata* D. Don and the specimens collected from Cherrapunji was identified as *O. brunonis* var. *johnsonii* Hook. f. Of these, *O. fasciculata* is reported here as a new distribution record to the Flora of Assam and *O. brunonis* var. *johnsonii* Hook.f. as the first record for North- East India (Image 1 & Image 2). The voucher specimens are submitted in Bodoland University Botanical Herbarium (BUBH), Kokrajhar, Assam for future reference.

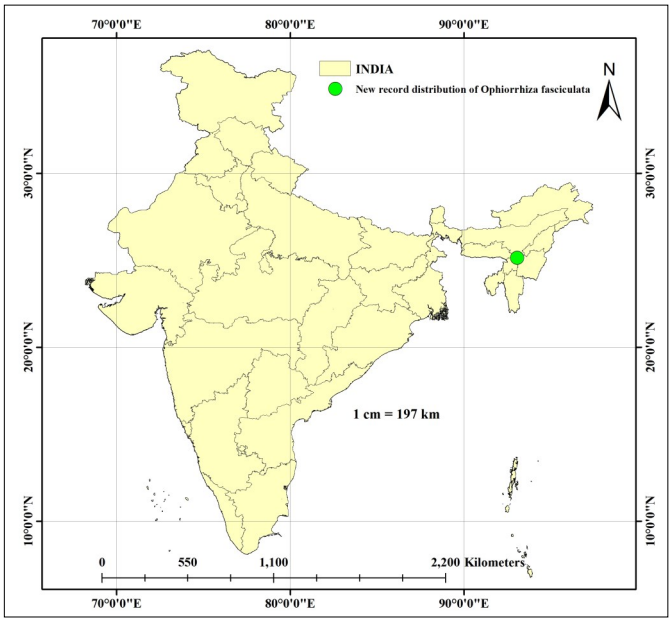

Image 1. Map showing the new distribution record of *Ophiorrhiza fasciculata.*

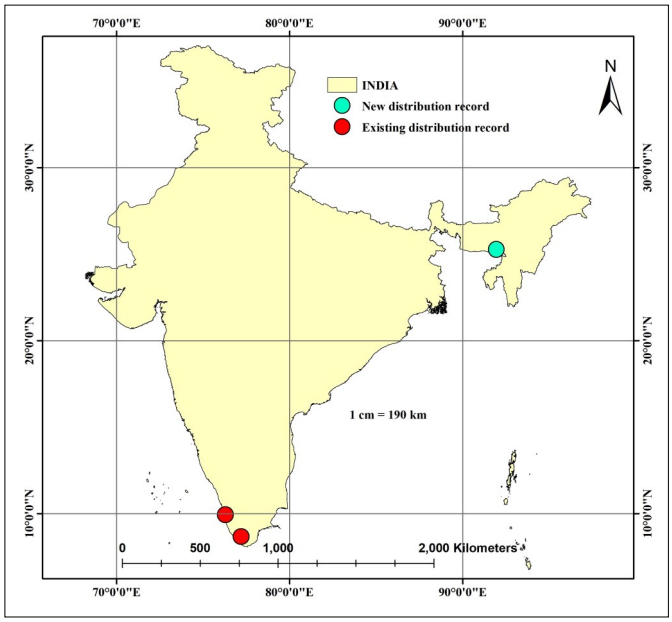

Image 2. Map showing the new distribution record of *Ophiorrhiza brunonis* var. *johnsonii.*

Taxonomic treatment

Ophiorrhiza brunonis var. *johnsoni* Hook. f

Hook.f., Fl. Brit. Ind. 3:80. 1880; Deb & Mondal, Bull. Bot. Surv. India 39 (1-4): 34. 1997; Akhilesh *et al*. in Rheedea 31 (4): 307-310, 2021.(Fig. 1).

Perennial Herb, 20-30 cm, high, stem woody at base, rusty pubescent, terete, green when young, brownish green on maturity; internodes 1.5-5 cm long. Leaves 5-12×3-4cm, ovate-elliptic, broadly acuminate at apex, subattenuate at base, small hair in lamina, furfuraceous above, margin hairy, pale beneath, puberulous; primary vein distinct beneath, puberulous, secondary veins 10-12 on either side, puberulous, raised beneath. Stipule subu-

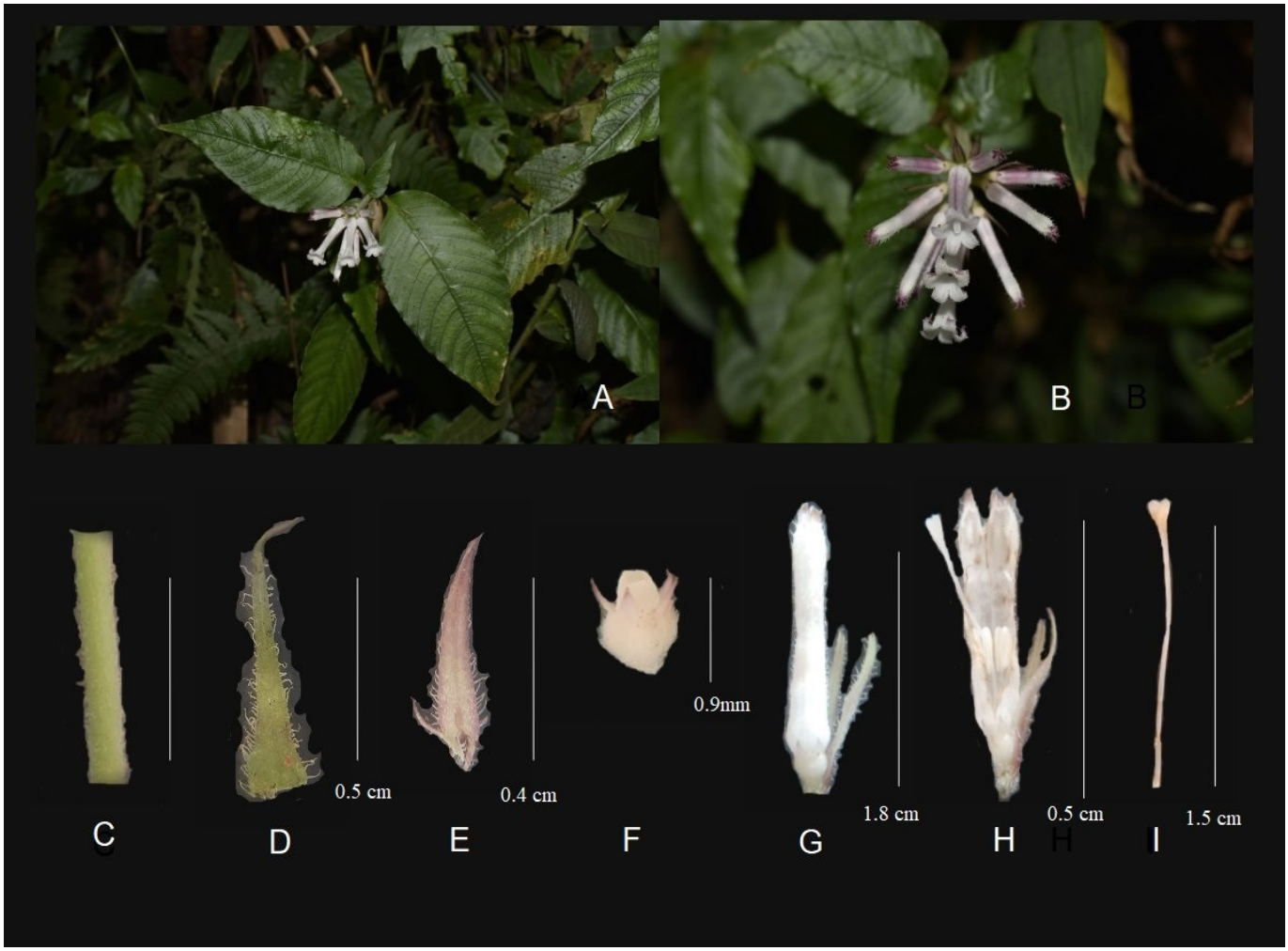

Fig. 1. *Ophiorrhiza brunonis* var. *johnsonii.* **A**. Habit, **B**. Inflorescence, **C**. Pubescent stem, **D**. Stipule, **E**. Bracts, **F**. Calyx, **G**. Flower bud with bracts, **H**. Split open flower, **I**. Long style.

late, base broad, margin hairy, pinkish green, bifid, 0.4—0.6 cm long, persistent. Petiole 0.5-1cm long, slender, puberulous. Inflorescence terminal, 0.8-1cm across; peduncle 2-2.5 cm long, pubescent, slender; bracts lanceolate, margin hairy, 0.4-0.5 cm long, pinkish brown, persistent; bracteoles in pairs, c. 0.4 cm long, pinkish, persistent, subulate, margin hairy. Flowers pinkish white, 1.9-2 cm, long, hairy outside; Calyx lobe subulate with broad base, apex acuminate, pinkish, 0.8-1mm × 0.4-0.5 mm, pubescent. Corolla tube c.1.5 cm long, pubescent, infundibuliform, rusty villous hair ring below the corolla lobe within, prominently veined outside, apex acute, spreading; corolla lobes c. 0.3 × 0.2 cm, slightly curved inward, pubescent, ovate. Stamen inserted near the base of the corolla tube; adnate, filament c. 0.2 cm long; anther c. 0.3 cm long, creamy white; Ovary c.1.5 cm long, style filiform, c. 1.3 cm long, glabrous, stigma 2 lobed, c. 0.2 cm long (Fig. 1).

Habitat

Found in the moist shady areas, near streams, along the forest roadsides and on hilly slopes.

Flowering

August- December

Fruiting

December- February

Distribution

Endemic to India (14), it has been found in Cochin, Chemunji hills in Agasthyamala Biosphere Reserve, Kerala. (Image 1).

Specimen examined

India, Meghalaya, Shillong, Cherrapunji, 22-12-2021, *B. Bhuyan BB0030* (BUBH).

Notes

Ophiorrhiza brunonis var. *johnsonii* resembles with *O. brunonis* in most of the characters but differs in having puberulous stem, long and pubescent corolla tube, villous within at middle of corolla tube, style as long as the corolla tube, in contrast to *O. brunonis* has glabrous stem, short and glabrous corolla tube, villous below the corolla lobes within, styles 1/3rd as long as corolla tube. *Ophiorrhiza brunonis* var. *johnsonii* Hook.f. is an endemic species reported from India (16). It was first collected by Rev. Johnson in between 1860-1865 from Cochin, Kerela. Hooker (14) described the species based on Johnson collection. The revisionary work on *Ophiorrhiza* (10) included it as a variety based upon the original specimen collected by Johnson. Recently, the variety was rediscovered after a lapse of more than 140 years from Chemunji hills in Agasthyamala Biosphere Reserve, Kerala (16). Scrutiny of the literature revealed that other than the present collec-

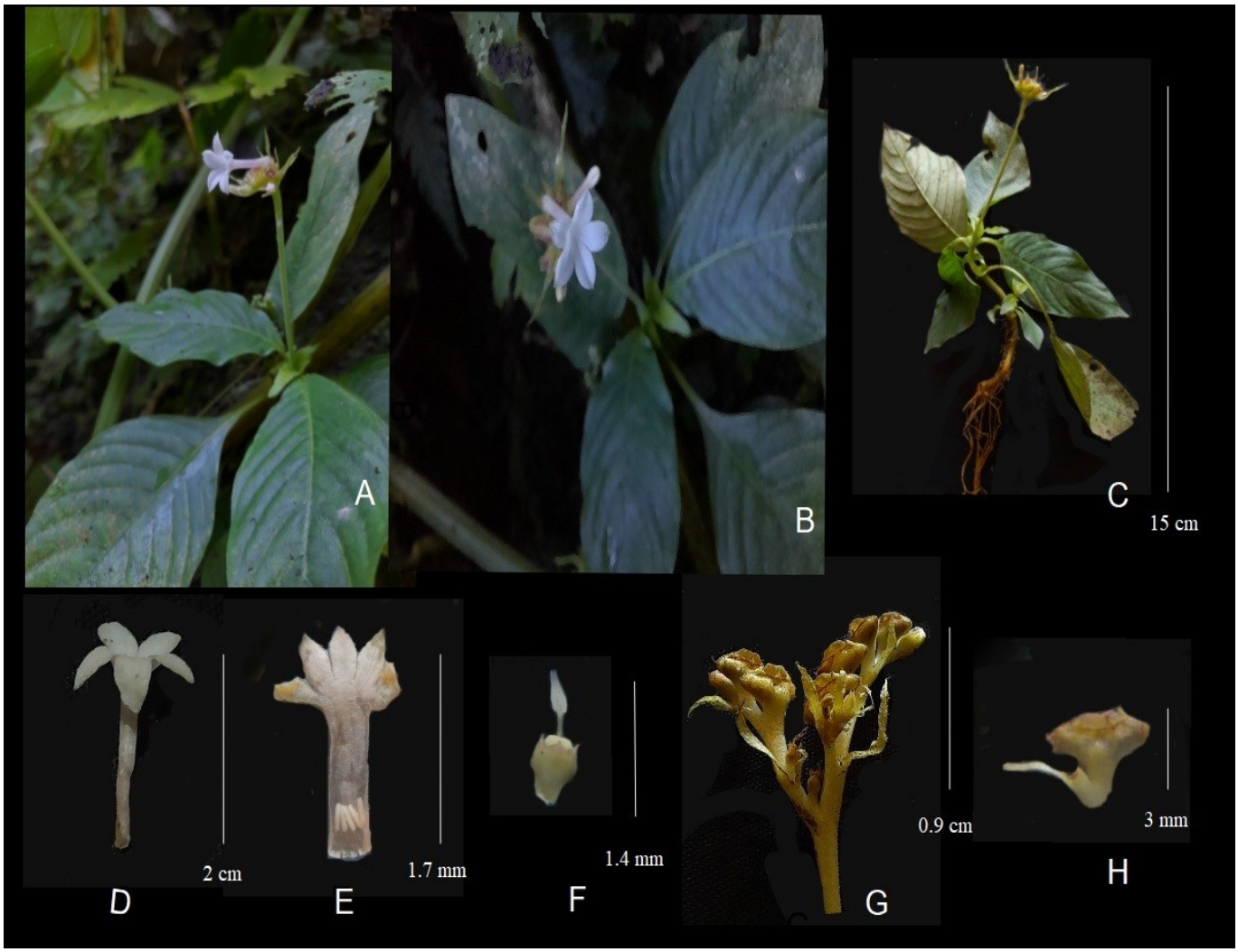

Fig. 2. *Ophiorrhiza fasciculata*. **A-B**. Habit, **C**. Plant showing long peduncle, **D**. Single flower, **E**. Split open flower, **F**. Short style, **G**. Inflorescence showing capsules with long bracts, **H**. Single capsule.

tion of the species from Meghalaya, there is no previous report of the variety from the states of North-East India.

O. fasciculata. D. Don

D. Don, Prodr. 136. 1 825 (Type: Nepal, Suembu, 22.6.1802, Buchanon s.n. BM. CAL). DC. Prodr. 4:416.1830. (Fig. 2).

Perennial herb, 10-30 cm tall; stems erect, woody at base, branched, pubescent. Leaves 3-13 × 2-5.5 cm long, ovate-lanceolate, acute apex, tapering at base, glabrous above, pubescent on the nerves beneath, membranous; lateral nerves 5-15 on either side; petioles 1-4 cm long, slender, pubescent; stipules 3-12 mm long, lanceolate with broad base, acute, entire, pubescent. Inflorescence terminal, fascicled, 1-4 cm across, 3-5 branched, pubescent; peduncles 2-8 cm long, elongating in fruit, slender, pubescent. Flowers 1.5-2 cm long, white, bracts persistent, 0.5-1 cm long, lanceolate, pubescent, pinkish; bracteoles persistent, 0.3-0.6 cm long, narrowly lanceolate, pubescent, pinkish; pedicels 0.1-0.2 cm long, pubescent. Hypanthium obovoid, pubescent. Calyx lobe ovate, acute at apex, pubescent; Corolla tube 1.3-1.8 cm long, infundibuliform; tube slender, puberulous outside, glabrous; lobes 1.5-2.25 × 1.25-1.75 mm, broadly ovate-oblong, acute. Stamens adnate to the base of corolla or slightly above, inserted; filaments 1.4 -1.7 mm long; anthers 1.6-1.7 mm long, linear oblong. Ovary 1.5×1.25 mm, obovoid; style 1.25-1.5 mm long; stigma 2-lobed, 1.8-2.3 mm long, glabrous. Capsule 1.5-3.5 × 4-8.5 mm, pubescent, locules ovate with straight tip. Seeds, 5-6-angular, brown. (Fig. 2).

Habitat

The species was found growing on the forest foothill of Jatinga, Halflong, Diama Hasao district of Assam.

Flowering & Fruiting

Flowering and fruiting observed in the month of November.

Distribution

Western Himalaya, Myanmar, Nepal, Bhutan, Sikkim, West Bengal, Orissa, Khasi hills and Mizo hills.

Specimen examined

India, Assam, Dima Hasao district, Halflong, Jatinga forest, 25.11410° N, 93.03795° E, ± 794 m 04 November 2021, *B.Bhuyan BB0026* (BUBH).

Notes

O. fasciculata was mentioned in the flora of Assam (15) without description and the author refers Flora of British India Vol. III (1882) for description. In the flora of British India by Hooker (14) mentioned *O. fasciculata* from Khasia, Sikkim and Bhutan. However, it is to be mentioned that the Khasi hills was once in the integral part of erstwhile Assam. On scrutiny of revision work on genus *Ophiorrhiza* L. Rubiaceae in Indian subcontinent by Deb and Mondal (10) mentioned the distributional record of *O. fasciculata* from different states but not from Assam. Barooah and Ahmed 2014, do not include *O. fasciculata* in their book (17).

Acknowledgements

The first author is grateful to Assam Biodiversity Board and Principal Chief Conservator of forest for granting permission to survey in forest of Assam. The first author would like to thank Mr. Sanswrang Basumatary for his help and suggestions.

Authors contributions

SB and BB prepared the manuscript for correspondence in the journal. BB had collected and identified the plant species. All the authors read and approved the manuscript.

Compliance with ethical standards

Conflict of interest: The authors have no competing interest.

Ethical issues: None.

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§§§

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https://doi.org/10.11609/jott.6218.13.8.19189-19190
#6218 | Received 24 May 2020 | Final received 07 July 2021 | Finally accepted 09 July 2021

OPEN ACCESS

NOTE

Occurrence of vivipary in *Ophiorrhiza rugosa* Wall. (Rubiaceae)

Birina Bhuyan [1] & **Sanjib Baruah** [2]

[1,2] Department of Botany, Bodoland University, Kokrajhar, Assam 783370, India.
[1] birinabhuyan305@gmail.com, [2] sanjibbaruah9@gmail.com (corresponding author)

Ophiorrhiza rugosa Wall. (Family Rubiaceae), a highly valuable medicinal herb and a potential source of Campothecin (CPT) used as an anticancer alkaloid producing plant (Gharpure et al. 2010). There are many natural varieties of *O. rugosa* Wall., which are now considered as strong candidates for the CPT (Hsiang et al. 1985; Vineesh et al. 2007).

Vivipary is the process-by which seeds germinate within the fruits followed by embryo development before the seeds are dispersed from the parent plant. Vivipary has been considered as a precocious germination, relatively unusual phenomenon in angiosperms (Farnsworth 2000).

Here, we report an unusual occurrence of the viviparous germination of seeds of *Ophiorrhiza rugosa* in the wild. This rare phenomenon was observed during the field visit to Karbi Anglong District, Assam in the last week of May 2019. The sites were located in 25.954^{0}N and 92.603^{0}E, at 128m. The rainy season in this area is with 90% of the rainfall during April–June (60–70 days). On an average, the area receives 1,400–2,000 mm of rainfall; and the soil is clayey loam.

The authors observed an occurrence of the true viviparous germination in the plant growing on hill slopes (Image 1). The plant is fully grown and contains the mature capsules. The capsules of the plant contain two halves and the seedlings were growing within the halves. The germination of seeds was epigeal and one capsule contains an average of 4–5 seedlings (Image 2D). Of the total seeds in a capsule, 75% showed viviparous germination. The species which show viviparous germination were collected during a period of almost continuous rainfall in the region. The location of plant was along the sloppy mountain where splash water could easily accommodate the capsule which might be triggered the germination inside the capsule. We presume that due to continuous precipitation and splashing of water from the stream resulting in inducing vivipary in the species. It has been suggested that vivipary is a specialized feature of evolutionary and biological importance that ensures survival of plant (Cota-Sanchez 2004). The results may be useful in large-scale propagation to meet increasing CPT demand and conservation of this valuable medicinal herb.

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Image 1. The collection site of the plant.

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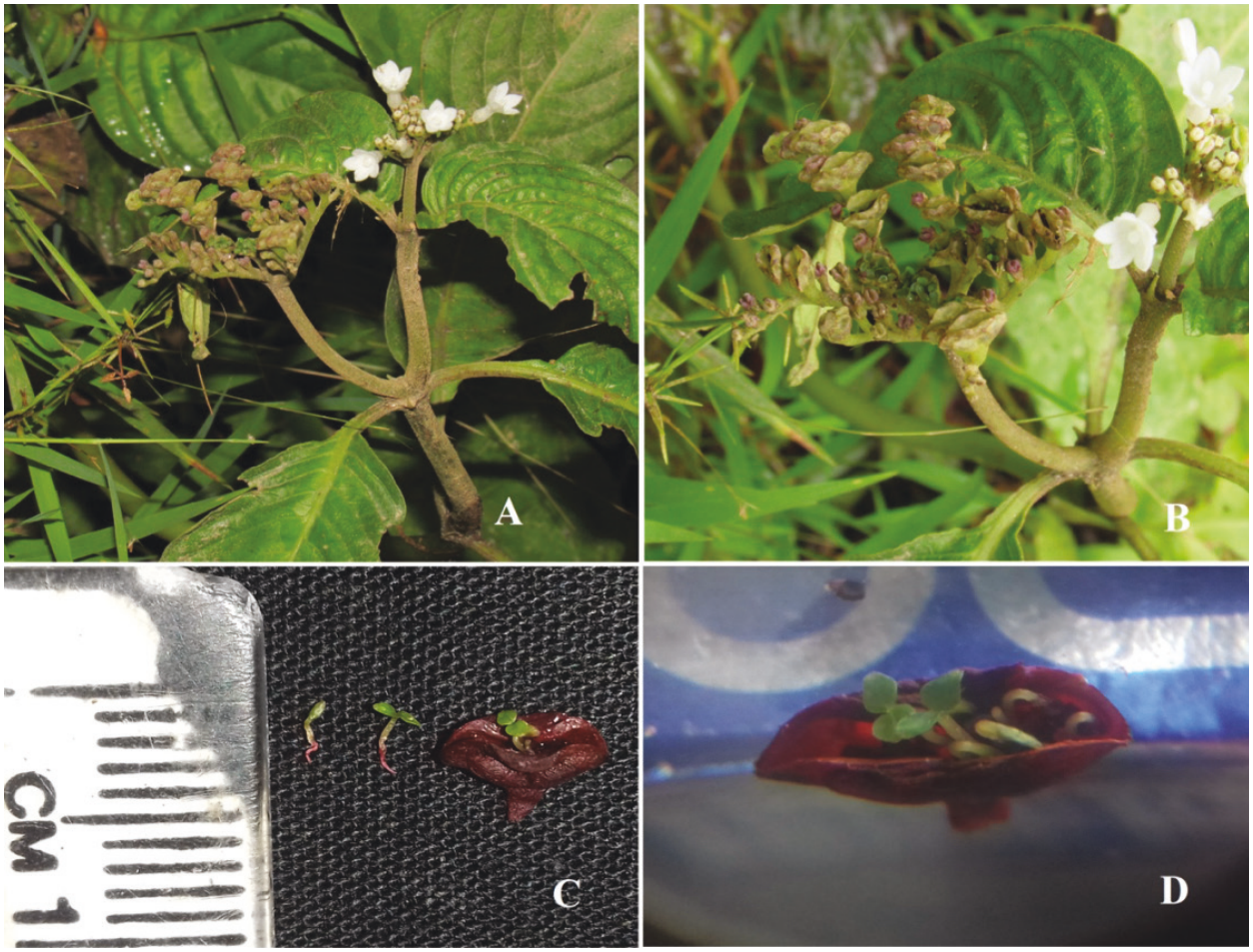

Image 2. Viviparous germination in *Ophiorrhiza rugosa* Wall: A—plant with inflorescence | B—fruits with viviparous germination | C—viviparous seedlings | D—viviparous seedlings arising from single capsule. © Birina Bhuyan.