Template/Pro forma for Submission

NMHS-Himalayan Institutional Fellowship Grant

FINAL TECHNICAL REPORT (FTR)

NMHS Reference No.:	**GBPNI/NMHS-2017-18/HSF-08**	**Date of Submission:**	3	1	1	2	2	0	2	1
			d	**d**	**m**	**m**	**y**	**y**	**y**	**y**

FELLOWSHIP TITLE (IN CAPITAL)

SYSTEMATICS AND CONSERVATION OF INDIAN ORCHIDS WITH SPECIAL EMPHASIS TO HIMALAYAN SPECIES

Sanctioned Fellowship Duration: *from* (**28.03.2018**) *to* (**31.03.2021**).

Extended Fellowship Duration (if applicable): *from* (**01.04.2021**) *to* (**31.12.2021**).

***Submitted to*:**

Er. Kireet Kumar
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National Mission on Himalayan Studies, GBP NIHE HQs
Ministry of Environment, Forest & Climate Change (MoEF&CC), New Delhi
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***Submitted by*:**
Dr. D.K. Agrawala
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Botanical Survey of India
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GENERAL INSTRUCTIONS:

1. The Final Technical Report (FTR) has to be commenced from the date of start of the Institutional Fellowship (as per the Sanction Order issued at the start of the Fellowship) till its completion. Each detail has to comply with the NMHS Sanction Order.
2. The FTR should be neatly typed (in Arial with font size 11 with 1.5 spacing between the lines) with all details as per the enclosed format for direct reproduction by photo-offset process. Colored Photographs (4-5 good action photographs), tables and graphs should be accommodated within the report or should be annexed with captions. Sketches and diagrammatic illustrations may also be given giving step-by-step details about the methodology followed in technology development/modulation, transfer and training. Any correction or rewriting should be avoided. Please give information under each head in serial order.
3. Training/ Capacity Building Manuals (with detailed contents of training programme, technical details and techniques involved) or any such display material related to fellowship activities along with slides, charts, photographs should be sent at the NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora 263643, Uttarakhand. In all Knowledge Products, the Grant/ Fund support of the NMHS should be duly acknowledged.
4. The FTR Format is in sync with many other essential requirements and norms desired by the Govt. of India time-to-time, so each section of the NMHS-FTR needs to duly filled by the Fellowship Coordinator/ PI and verified by the Head of the Implementing Institution/ University.
5. Five (5) bound hard copies of the NMHS-Institutional Fellowship Final Technical Report (FTR) and a soft copy should be submitted to the **Nodal Officer, NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora, Uttarakhand** *via* e-mail nmhspmu2016@gmail.com.

The FTR is to be submitted into following two parts:

Part A – Cumulative Fellowship Summary Report

Part B – Comprehensive Report

Following Financial and other necessary documents/certificates need to be submitted duly signed and verified along with Final Technical Report (FTR):

Annexure I	Consolidated and Audited Utilization Certificate (UC) & Statement of Expenditure (SE), including interest earned for the last Fiscal year including the duly filled GFR-19A (with year-wise break-up)
Annexure II	Consolidated Interest Earned Certificate
Annexure III	Consolidated Manpower Certificate and Direct Benefit Transfer (DBT) Details showing the education background, i.e. NET/GATE etc. qualified or not, Date of joining and leaving, Salary paid per month and per annum (with break up as per the Sanction Order and year-wise).
Annexure IV	Details and Declaration of Refund of Any Unspent Balance as Real-Time Gross System (RTGS) in favor of NMHS GIA General
Annexure V	Details of Technology Transfer and Intellectual Property Rights developed.

NMHS-Final Technical Report (FTR) *template*

NMHS- Institutional Himalayan Fellowship Grant

DSL: *Date of Sanction Letter Completion*

2	8	0	3	2	0	1	8
d	d	m	m	y	y	y	y

DFC: *Date of Fellowship*

3	1	1	2	2	0	2	1
d	d	m	m	y	y	y	y

Part A: CUMULATIVE SUMMARY REPORT

(to be submitted by the Coordinating Institute/Coordinator)

1. Details Associateship/Fellowships

1.1 Contact Details of Institution/University

NMHS Fellowship Grant ID/ Ref. No.:	**GBPNI/NMHS-2017-18/HSF-08**
Name of the Institution/ University:	BOTANICAL SURVEY OF INDIA
Name of the Coordinating PI:	Dr. DINESH KUMAR AGRAWALA
Point of Contacts (Contact Details, Ph. No., E-mail):	Dr. A.A. Mao, E-mail: aamao@bsi.gov.in; aamao2008@gmail.com Dr. Dinesh Kumar Agrawala, Mob: 9475583216, E-mail: drdkbsi@gmail.com; dk.agarwal76@gov.in Dr. Rijupalika Roy, Mob: 9432133493, e-mail: rijupalikaroy@gmail.com

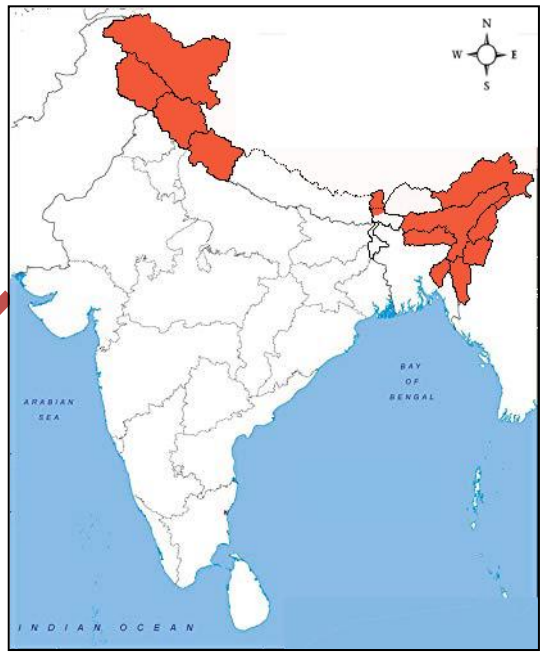
1.2 Research Title and Area Details

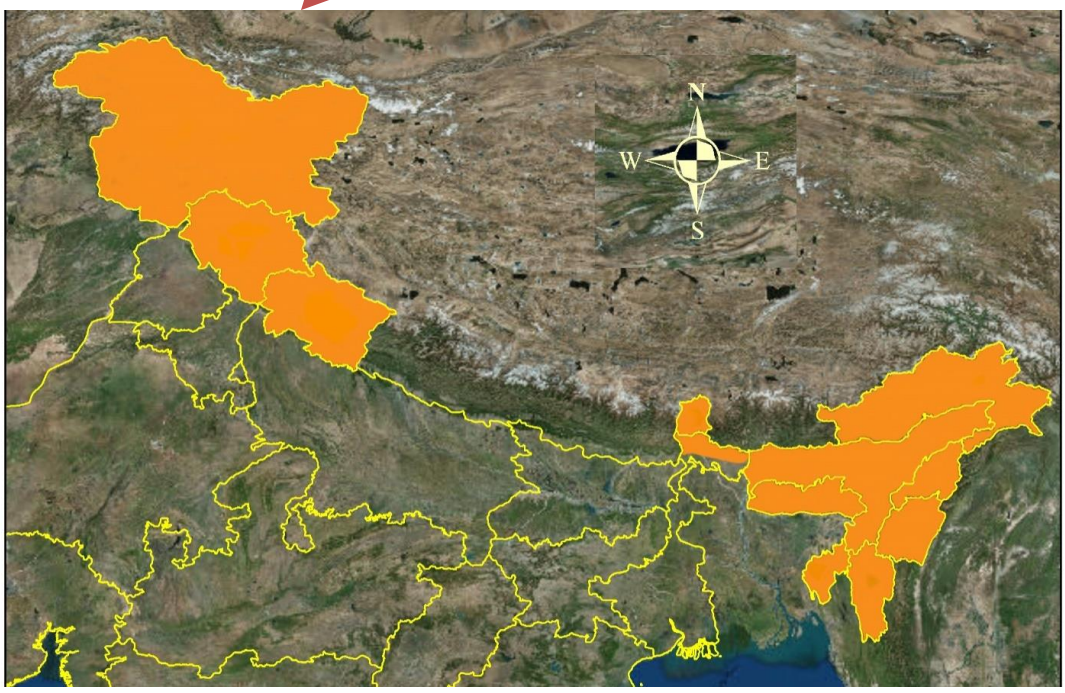
i.	Institutional Fellowship Title:	**Systematics and conservation of Indian orchids with special emphasis to Himalayan species**					
ii.	IHR State(s) in which Fellowship was implemented:	**Sikkim**					
iv.	Scale of Fellowship Operation	Local:		Regional:		Pan-Himalayan:	✓

iii.	Study Sites covered (*site/location maps to be attached*)	Throughout India with special emphasis to Himalayan states (Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttarakhand, West Bengal [Darjeeling]) (Study area attached below).
v.	Total Budget Outlay (Crore) :	INR first sanction + arrear amount [10200696/- + 583440/-]

Study area:

In the present study the Himalayan orchid species were studied. As Indian Himalayan Region (IHR) harbors almost 80% of the total orchid diversity of the country, emphasis was given to the region.





1.3 Details Himalayan Research /Project Associates/Fellows inducted

Type of Fellowship	Nos.	Work Duration	
		From	To
Research Associates	1	1a. **Dr. Samiran Pandey** 17.12.2018 1b. **Dr. Rijupalika Roy** 14.10.2019	23.08.2019 (resigned) 31.12.2021
Sr. Project Fellow	6	1. **Dr. Musadiq Hussain Bhatt** 28.7.2021 2. **Ms. Shreyasi Nayak** 27.7.2020 3. **Ms. Sanchayita Sengupta** 01.8.2020 4. **Mr. Sayak Chakraborty** 01.8.2020 5. **Mr. Shuvadip Sarkar** 01.8.2020 6. **Ms. Oindrila chakraborty** 19.3.2021	31.12.2021 31.12.2021 31.12.2021 31.12.2021 31.12.2021 31.12.2021
Jr. Project Fellows	6	1. **Mr. Aazhivaendhan G.** 13.7.2018 2. **Ms. Shreyasi Nayak** 27.7.2018 3. **Ms. Sanchayita Sengupta** 01.8.2018 4. **Mr. Sayak Chakraborty** 01.8.2018 5. **Mr. Shuvadip Sarkar** 01.8.2018 6. **Ms. Oindrila chakraborty** 19.3.2019	Resigned on 17.7.2020 26.7.2020 31.7.2020 31.7.2020 31.7.2020 18.3.2021
Project Fellows	NIL		

2. Research Outcomes

2.1. Abstract (not more than 1000 words) (it should include background of the study, aim, objectives, methodology, approach, results, conclusion and recommendations based on the institutional fellowship proposal sanctioned under the NMHS).

Since ages orchids have remained the central dogma of plant research. They are one of the largest families of flowering plants and have established themselves in almost all topography except the Arctic and Antarctic region. Due to this wide range of distribution and a constant interaction of climatic factors leading to high adaptability, they encompass high variation resulting to 1263 taxa under 155 genera of which 308 are endemic. They are considered to be most evolved ones with almost 28000 accepted names. In India the family has established its representatives from sea level at coastal plains to high mountain ranges of alpine Himalaya. Apart from research, orchids contribute largely in economy due to vibrantly coloured, ornamented flowers, high self-life, compatibility for hybridization and even for medicinal importance. In spite of its several significant role, some Indian orchid groups are poorly addressed for its taxonomic studies including diversity analysis, distribution, morpho-molecular characterization, affinities and threat assessment. Aiming the gap areas the present work addresses the arenas like taxonomy, morpho-molecular characterisation, species richness map and germplasm conservation.

***Background*:**

Orchids are the fascinating group of flowering plants belonging to one of the largest families of angiosperms. They are considered to be the most advanced flowering plants with incredible range of diversity in shape, size, colour of their flowers. Ancient Indian literatures including the Vedic scriptures mention the genus *Vanda* having beautiful flowers. The family that has stepped in the living world in the last cretaceous, presently holds approximately 28,000 species under 736 genera according to current estimate (Sushil K. Singh & al., 2019). Orchids are one of the widely distributed plants that concentrate mostly in three regions of the world, i.e., Tropical America, Indo-Malaya and the Himalaya. Indian Himalayan Region (IHR) consists of more than 80% of orchid flora. Orchids have served mankind since ages. It has now become a multi-million dollar industry due to its long self-life, vibrant flowers. In spite of huge contributions comprehensive data for orchid wealth of country is lacking for certain reasons like constant discovery of new taxa, new distributional records, continuous change in taxonomic concepts leading to splitting and merging, publication of new species resulting from misconception or misapplication of the concept of constancy, variability and polymorphism,

inclusion of species not known from India, exclusion of species well known from India, inclusion of species which were not validly published, repetition of the name of same species under different genera. Many institutes or individuals are involved in orchid research which results in orchid flora/list/pictorial guide etc. Effect of climate change is quite visible in orchids in the form of habitat or phenophase shifting. They inhabit fragile ecosystem and are sensitive to microclimate. Orchids are also dependent on pollinators and mycorrhizae for viable seed production and their germination. Understanding life cycle of orchids helps in solving many complexes and proposes conservation measures. With this background the present project was proposed under broad title “Systematics and conservation of Indian orchids with special emphasis to Himalayan species”.

Till date there are nearly 972 orchid species with their lower taxa recorded from Indian Himalayan Region. Many of them like the genus *Coelogyne*, *Cymbidium*, *Dendrobium*, *Goodyera*, *Habenaria*, *Oberonia*, *Paphiopedilum*, *Zeuxine* have been studied by earlier workers in form of revisionary studies. Nearly 631 species and lower taxa were not addressed for detailed taxonomic study. This gap area was addressed through this project to obtain exact orchid wealth of the country. For convenience list of orchid species reported from Indian Himalayan Region have been provided here.

1. *Acampe ochracea*
2. *Acampe papillosa*
3. **Acampe papillosa* var. *flava*
4. *Acampe rigida*
5. *Acanthephippium striatum*
6. *Acanthephippium sylhetense*
7. *Acriopsis indica*
8. *Acriopsis liliifolia*
9. *Aerides crassifolia*
10. *Aerides falcata*
11. *Aerides multiflora*
12. *Aerides odorata*
13. *Aerides rosea*
14. *Agrostophyllum brevipes*
15. *Agrostophyllum callosum*
16. **Agrostophyllum flavidum*
17. **Agrostophyllum myrianthum*
18. *Agrostophyllum planicaule*
19. **Amitostigma pathakianum*
20. *Amitostigma puberulum*
21. *Androcorys angustilabris*
22. *Androcorys gracilis*
23. *Androcorys jaffreyana*
24. *Androcorys josephi*
25. **Androcorys kalimpongensis*
26. *Androcorys monophylla*
27. *Androcorys pugioniformis*
28. *Ania angustifolia*
29. *Ania penangiana*
30. *Ania viridifusca*
31. *Anoectochilus brevilabris*
32. *Anoectochilus roxburghii*
33. *Anthogonium gracile*
34. *Aphyllorchis alpina*
35. *Aphyllorchis montana*
36. *Aphyllorchis vaginata*
37. *Apostasia nuda*
38. *Apostasia odorata*
39. *Apostasia wallichii*
40. *Appendicula cornuta*
41. *Arachnis flos-aeris*
42. *Arachnis labrosa*
43. *Arachnis labrosa* var. *zhaoi*
44. **Arachnis senapatiana*
45. *Arundina graminifolia*
46. *Arundina graminifolia* var. *revoluta*
47. *Ascocentrum ampullaceum*
48. *Ascocentrum curvifolium*
49. *Ascocentrum semiteretifolium*
50. *Bhutanthera albomarginata*
51. *Bhutanthera alpina*
52. **Biermannia arunachalensis*
53. *Biermannia bimaculata*
54. **Biermannia jainiana*
55. **Biermannia quinquecallosa*
56. *Brachycorythis acuta*
57. *Brachycorythis galeandra*
58. *Brachycorythis helferi*
59. **Brachycorythis iantha*
60. *Brachycorythis obcordata*
61. *Bulbophyllum affine*
62. *Bulbophyllum ambrosia*
63. *Bulbophyllum amplifolium*
64. *Bulbophyllum andersonii*
65. *Bulbophyllum apodum*
66. **Bulbophyllum appendiculatum*
67. **Bulbophyllum arunachalense*
68. *Bulbophyllum bifurcatoflorens*
69. *Bulbophyllum bisetum*
70. *Bulbophyllum blepharistes*
71. *Bulbophyllum candidum*
72. *Bulbophyllum capillipes*
73. *Bulbophyllum careyanum*
74. *Bulbophyllum cariniflorum*
75. *Bulbophyllum caudatum*
76. *Bulbophyllum cauliflorum*
77. **Bulbophyllum cherrapunjeensis*
78. **Bulbophyllum chyrmangensis*
79. **Bulbophyllum cornu-cervi*
80. *Bulbophyllum crabro*
81. *Bulbophyllum crassipes*
82. *Bulbophyllum cupreum*
83. *Bulbophyllum cylindraceum*
84. *Bulbophyllum delitescens*
85. *Bulbophyllum depressum*
86. *Bulbophyllum dickasonii*
87. *Bulbophyllum disciflorum*
88. *Bulbophyllum dissitiflorum*
89. *Bulbophyllum elassonotum*
90. *Bulbophyllum elatum*
91. *Bulbophyllum emarginatum*
92. *Bulbophyllum eublepharum*
93. *Bulbophyllum forresti*
94. *Bulbophyllum gamblei*

95. **Bulbophyllum gracilipes*
96. *Bulbophyllum griffithii*
97. *Bulbophyllum guttulatum*
98. *Bulbophyllum gymnopus*
99. *Bulbophyllum gyrochilum*
100. *Bulbophyllum helenae*
101. *Bulbophyllum hirtum*
102. *Bulbophyllum hymenanthum*
103. *Bulbophyllum interpositum*
104. **Bulbophyllum jainii*
105. **Bulbophyllum jejosephii*
106. *Bulbophyllum khasyanum*
107. *Bulbophyllum kingii*
108. **Bulbophyllum kipgenii*
109. *Bulbophyllum leopardinum*
110. **Bulbophyllum leptanthum*
111. *Bulbophyllum lobbii*
112. *Bulbophyllum loherianum*
113. *Bulbophyllum longiflorum*
114. *Bulbophyllum macraei*
115. **Bulbophyllum manabendrae*
116. **Bulbophyllum manipurense*
117. *Bulbophyllum medioximum*
118. *Bulbophyllum moniliforme*
119. *Bulbophyllum muscicola*
120. *Bulbophyllum nasutum*
121. **Bulbophyllum nodosum*
122. *Bulbophyllum oblongum*
123. **Bulbophyllum obrienianum*
124. *Bulbophyllum odoratissimum*
125. *Bulbophyllum odoratissimum* var. *racemosum*
126. *Bulbophyllum ornatissimum*
127. *Bulbophyllum parviflorum*
128. *Bulbophyllum pectinatum*
129. *Bulbophyllum pecnicillium*
130. *Bulbophyllum picturatum*
131. **Bulbophyllum piluliferum*
132. *Bulbophyllum polyrrhizum*
133. *Bulbophyllum propinquum*
134. *Bulbophyllum protractum*
135. *Bulbophyllum pteroglossum*
136. *Bulbophyllum purpureofuscum*
137. *Bulbophyllum putidum*
138. *Bulbophyllum reichenbachianum*
139. *Bulbophyllum repens*
140. *Bulbophyllum reptans*
141. *Bulbophyllum retusiusculum*
142. *Bulbophyllum rigidum*
143. *Bulbophyllum rolfei*
144. *Bulbophyllum roseopictum*
145. *Bulbophyllum rothschildianum*
146. *Bulbophyllum roxburghii*
147. *Bulbophyllum rufinum*
148. **Bulbophyllum sarcophylloides*
149. *Bulbophyllum sarcophyllum*
150. *Bulbophyllum scabratum*
151. *Bulbophyllum secundum*
152. *Bulbophyllum spathulatum*
153. *Bulbophyllum striatum*
154. *Bulbophyllum sunipia*
155. *Bulbophyllum tortuosum*
156. *Bulbophyllum trichocephalum*
157. **Bulbophyllum trichocephalum* var. *wallongense*
158. *Bulbophyllum tricorne*
159. *Bulbophyllum tridentatum*
160. *Bulbophyllum triste*
161. *Bulbophyllum umbellatum*
162. *Bulbophyllum viridiflorum*
163. *Bulbophyllum wallichii*
164. *Bulbophyllum xylophyllum*
165. *Bulbophyllum yoksunense*
166. *Bulleyia yunnanensis*
167. *Calanthe alismifolia*
168. *Calanthe alpina*
169. *Calanthe biloba*
170. *Calanthe brevicornu*
171. *Calanthe ceciliae*
172. *Calanthe clavata*
173. *Calanthe davidii*
174. *Calanthe densiflora*
175. *Calanthe griffithii*
176. *Calanthe hancockii*
177. *Calanthe herbacea*
178. **Calanthe keshabii*
179. **Calanthe lyroglossa*
180. *Calanthe mannii*
181. *Calanthe masuca*
182. *Calanthe odora*
183. *Calanthe plantaginea*
184. *Calanthe puberula*
185. *Calanthe sylvatica*
186. *Calanthe tricarinata*

187. *Calanthe triplicata*
188. *Calanthe trulliformis*
189. **Calanthe uncata*
190. *Calanthe whiteana*
191. **Calanthe yuksomnensis*
192. *Cephalanthera damasonium*
193. *Cephalanthera longifolia*
194. *Cephalantheropsis obcordata*
195. *Ceratostylis himalaica*
196. *Ceratostylis radiata*
197. *Ceratostylis subulata*
198. *Chamaegastrodia asraoa*
199. *Chamaegastrodia shikokiana*
200. *Cheirostylis griffithii*
201. **Cheirostylis gunnarii*
202. *Cheirostylis moniliformis*
203. *Cheirostylis pusilla*
204. **Cheirostylis sessanica*
205. *Cheirostylis tabiyahanensis*
206. **Cheirostylis tippica*
207. *Cheirostylis yunnanensis*
208. *Chiloschista lunifera*
209. *Chiloschista parishii*
210. *Chiloschista usneoides*
211. *Chrysoglossum assamicum*
212. *Chrysoglossum ornatum*
213. **Cleisocentron pallens*
214. *Cleisomeria pilosulum*
215. *Cleisostoma appendiculatum*
216. *Cleisostoma aspersum*
217. *Cleisostoma discolor*
218. *Cleisostoma duplicilobum*
219. *Cleisostoma filiforme*
220. *Cleisostoma linearilobatum*
221. *Cleisostoma paniculatum*
222. *Cleisostoma racemiferum*
223. *Cleisostoma rolfeanum*
224. *Cleisostoma simondii*
225. *Cleisostoma striatum*
226. *Cleisostoma subulatum*
227. **Cleisostoma tricallosum*
228. *Cleisostoma williamsonii*
229. **Coelogyne albolutea*
230. **Coelogyne arunachalensis*
231. *Coelogyne assamica*
232. *Coelogyne barbata*
233. *Coelogyne calcicola*
234. *Coelogyne corymbosa*
235. *Coelogyne cristata*
236. *Coelogyne fimbriata*
237. *Coelogyne flaccida*
238. *Coelogyne fuliginosa*
239. *Coelogyne fuscescens*
240. **Coelogyne ghatakii*
241. *Coelogyne griffithii*
242. **Coelogyne hajrae*
243. **Coelogyne hitendrae*
244. *Coelogyne holochila*
245. *Coelogyne longipes*
246. *Coelogyne micrantha*
247. *Coelogyne nitida*
248. *Coelogyne occulata*
249. *Coelogyne ovalis*
250. **Coelogyne pantlingii*
251. **Coelogyne pempahisheyana*
252. **Coelogyne pendula*
253. *Coelogyne prolifera*
254. *Coelogyne punctulata*
255. *Coelogyne raizadae*
256. *Coelogyne rigida*
257. *Coelogyne schultesii*
258. *Coelogyne stricta*
259. *Coelogyne suaveolens*
260. *Coelogyne trinervis*
261. *Coelogyne viscosa*
262. *Collabium chinense*
263. *Corallorhiza trifida*
264. *Corybas himalaicus*
265. **Corybas purpureus*
266. *Corymborkis veratrifolia*
267. *Cremastra appendiculata*
268. *Crepidium acuminatum*
269. **Crepidium aphyllum*
270. *Crepidium biauritum*
271. *Crepidium calophyllum*
272. *Crepidium josephianum*
273. *Crepidium khasianum*
274. *Crepidium mackinnonii*
275. **Crepidium maximowiczianum*
276. **Crepidium meghalayensis*
277. *Crepidium purpureum*
278. **Crepidium saprophytum*
279. *Cryptochilus luteus*
280. *Cryptochilus sanguineus*

281. *Cryptostylis arachnites*
282. *Cymbidium aloifolium*
283. *Cymbidium bicolor* subsp. *obtusum*
284. *Cymbidium cochleare*
285. *Cymbidium concinnum*
286. *Cymbidium cyperifolium*
287. *Cymbidium cyperifolium* var. *szechuanicum*
288. *Cymbidium dayanum*
289. *Cymbidium devonianum*
290. *Cymbidium eburneum*
291. *Cymbidium elegans*
292. *Cymbidium ensifolium subsp. haematodes*
293. *Cymbidium erythraeum*
294. *Cymbidium gammieanum*
295. *Cymbidium goeringii*
296. **Cymbidium hengbungense*
297. *Cymbidium hookerianum*
298. *Cymbidium insigne*
299. *Cymbidium iridioides*
300. *Cymbidium lancifolium*
301. *Cymbidium lowianum*
302. *Cymbidium macrorhizon*
303. *Cymbidium mastersii*
304. *Cymbidium munronianum*
305. *Cymbidium nanulum*
306. *Cymbidium sinense*
307. *Cymbidium tigrinum*
308. **Cymbidium whiteae*
309. *Cypripedium cordigerum*
310. *Cypripedium elegans*
311. *Cypripedium himalaicum*
312. *Cypripedium tibeticum*
313. *Cyrtosia javanica*
314. *Cyrtosia nana*
315. *Dactylorhiza hatagirea*
316. *Dactylorhiza kafiriana*
317. *Dactylorhiza umbrosa*
318. *Dactylorhiza viridis*
319. *Dendrobium acinaciforme*
320. *Dendrobium aduncum*
321. *Dendrobium amoenum*
322. *Dendrobium anceps*
323. *Dendrobium angulatum*
324. *Dendrobium aphyllum*
325. **Dendrobium arunachalense*
326. **Dendrobium assamicum*
327. *Dendrobium bellatulum*
328. *Dendrobium bensoniae*
329. *Dendrobium bicameratum*
330. *Dendrobium brymerianum*
331. *Dendrobium capillipes*
332. *Dendrobium cariniferum*
333. *Dendrobium chapaense*
334. *Dendrobium chrysanthum*
335. *Dendrobium chryseum*
336. *Dendrobium chrysotoxum*
337. *Dendrobium crepidatum*
338. *Dendrobium cretaceum*
339. *Dendrobium crystallinum*
340. *Dendrobium cumulatum*
341. *Dendrobium darjeelingense*
342. *Dendrobium delacourii*
343. *Dendrobium denneanum*
344. *Dendrobium densiflorum*
345. *Dendrobium denudans*
346. *Dendrobium devonianum*
347. *Dendrobium dickasonii*
348. *Dendrobium draconis*
349. *Dendrobium eriiflorum*
350. *Dendrobium falconeri*
351. *Dendrobium farmeri*
352. *Dendrobium fimbriatum*
353. *Dendrobium fimbriatum* var. *oculatum*
354. *Dendrobium formosum*
355. *Dendrobium gibsonii*
356. *Dendrobium gratiosissimum*
357. *Dendrobium griffithianum*
358. **Dendrobium herbaceum*
359. *Dendrobium heterocarpum*
360. *Dendrobium hookerianum*
361. *Dendrobium infundibulum*
362. *Dendrobium jenkinsii*
363. *Dendrobium keithii*
364. **Dendrobium khasianum*
365. *Dendrobium lindleyi*
366. *Dendrobium lituiflorum*
367. *Dendrobium longicornu*
368. *Dendrobium macrostachyum*
369. *Dendrobium mannii*
370. **Dendrobium miserum*
371. *Dendrobium moniliforme*

372. *Dendrobium monticola*
373. **Dendrobium nareshbhadurii*
374. *Dendrobium nathanielis*
375. *Dendrobium nobile*
376. **Dendrobium normale*
377. *Dendrobium numaldeorii*
378. *Dendrobium ochreatum*
379. *Dendrobium pachyphyllum*
380. *Dendrobium palpebrae*
381. *Dendrobium parciflorum*
382. *Dendrobium parcum*
383. *Dendrobium parishii*
384. *Dendrobium peguanum*
385. *Dendrobium pendulum*
386. *Dendrobium porphyrochilum*
387. *Dendrobium praecinctum*
388. *Dendrobium primulinum*
389. *Dendrobium pulchellum*
390. *Dendrobium pycnostachyum*
391. *Dendrobium regium*
392. *Dendrobium ruckeri*
393. *Dendrobium salaccense*
394. **Dendrobium sessanicum*
395. *Dendrobium sinominutiflorum*
396. *Dendrobium sociale*
397. *Dendrobium stuposum*
398. *Dendrobium sulcatum*
399. *Dendrobium terminale*
400. *Dendrobium thyrsiflorum*
401. *Dendrobium tortile*
402. *Dendrobium transparens*
403. **Dendrobium tuensangense*
404. *Dendrobium vexabile*
405. *Dendrobium wardianum*
406. *Dendrobium watti*
407. *Dendrobium williamsonii*
408. *Dickasonia vernicosa*
409. **Didymoplexis himalaica*
410. *Didymoplexis pallens*
411. *Dienia cylindrostachya*
412. *Dienia muscifera*
413. *Dienia ophrydis*
414. *Diglyphosa latifolia*
415. *Diplomeris hirsuta*
416. **Diplomeris josephii*
417. *Diplomeris pulchella*
418. *Diploprora championii*
419. *Diploprora truncata*
420. *Disperis neilgherrensis*
421. *Dithrix griffithii*
422. *Epigeneium amplum*
423. **Epigeneium arunachalense*
424. *Epigeneium chapaense*
425. *Epigeneium fargesii*
426. *Epigeneium fuscescens*
427. *Epigeneium navicularis*
428. *Epigeneium rotundatum*
429. *Epigeneium treutleri*
430. *Epipactis gigantea*
431. *Epipactis helleborine*
432. *Epipactis mairei*
433. *Epipactis persica*
434. *Epipactis royleana*
435. *Epipactis veratrifolia*
436. *Epipogium aphyllum*
437. *Epipogium roseum*
438. *Eria acervata*
439. *Eria alba*
440. *Eria amica*
441. **Eria arunachalensis*
442. *Eria bambusifolia*
443. *Eria biflora*
444. *Eria bipunctata*
445. *Eria bractescens*
446. *Eria carinata*
447. *Eria clausa*
448. *Eria clavicaulis*
449. *Eria connata*
450. *Eria corneri*
451. *Eria coronaria*
452. **Eria crassicaulis*
453. *Eria cristata*
454. *Eria discolor*
455. *Eria excavata*
456. *Eria ferruginea*
457. **Eria glandulifera*
458. *Eria globulifera*
459. **Eria gloensis*
460. *Eria graminifolia*
461. **Eria hegdei*
462. *Eria javanica*
463. **Eria kamlangensis*
464. *Eria lacei*
465. *Eria lasiopetala*

466. **Eria lohitensis*
467. *Eria merguensis*
468. *Eria muscicola*
469. *Eria obesa*
470. **Eria occidentalis*
471. *Eria paniculata*
472. *Eria pannea*
473. *Eria pudica*
474. *Eria pulchella*
475. *Eria pumila*
476. *Eria pusilla*
477. **Eria reticosa*
478. **Eria sharmae*
479. *Eria spicata*
480. *Eria stricta*
481. *Eria sutepensis*
482. *Eria tomentosa*
483. *Eria vitata*
484. *Eriodes barbata*
485. *Eryrthrodes blumei*
486. *Eryrthrodes hirsuta*
487. *Eryrthrorchis altissima*
488. *Esmeralda cathcartii*
489. *Esmeralda clarkei*
490. *Eulophia bicallosa*
491. *Eulophia bracteosa*
492. *Eulophia dabia*
493. *Eulophia epidendraea*
494. *Eulophia explanta*
495. *Eulophia flava*
496. *Eulophia graminea*
497. *Eulophia herbacea*
498. **Eulophia kamarupa*
499. *Eulophia mackinnonii*
500. **Eulophia mannii*
501. *Eulophia obtusa*
502. *Eulophia ochreata*
503. *Eulophia pauciflora*
504. *Eulophia promensis*
505. **Eulophia santapaui*
506. *Eulophia spectabilis*
507. *Eulophia zollingeri*
508. **Flickingeria abhaycharanii*
509. *Flickingeria albopurpurea*
510. *Flickingeria bancana*
511. *Flickingeria fimbriata*
512. *Flickingeria fugax*
513. **Flickingeria hesperis*
514. *Flickingeria macraei*
515. *Flickingeria ritaeana*
516. *Galearis roborovskii*
517. *Galearis spathulata*
518. *Galearis tschiliensis*
519. *Galeola cathcartii*
520. *Galeola falconeri*
521. *Galeola lindleyana*
522. *Galeola nudiflora*
523. *Gastrochilus acutifolius*
524. *Gastrochilus affinis*
525. **Gastrochilus arunachalensis*
526. *Gastrochilus bellinus*
527. *Gastrochilus calceolaris*
528. **Gastrochilus carnosus*
529. *Gastrochilus dasypogon*
530. *Gastrochilus distichus*
531. **Gastrochilus garhwalensis*
532. *Gastrochilus inconspicuus*
533. *Gastrochilus intermedius*
534. *Gastrochilus linearifolius*
535. *Gastrochilus obliquus*
536. *Gastrochilus obliquus* var. *suavis*
537. *Gastrochilus pseudodistichus*
538. *Gastrochilus rutilans*
539. **Gastrochilus sessanicus*
540. **Gastrochilus sonamii*
541. **Gastrodia arunachalensis*
542. **Gastrodia dyeriana*
543. *Gastrodia elata*
544. *Gastrodia exilis*
545. *Gastrodia falconeri*
546. **Gastrodia mishmensis*
547. *Geodorum appendiculatum*
548. *Geodorum densiflorum*
549. **Geodorum laxiflorum*
550. **Geodorum recurvum*
551. *Goodyera biflora*
552. *Goodyera foliosa*
553. *Goodyera fumata*
554. *Goodyera fusca*
555. *Goodyera hemsleyana*
556. *Goodyera hispida*
557. *Goodyera procera*
558. *Goodyera recurva*
559. *Goodyera repens*

560. *Goodyera rubicunda*
561. *Goodyera schlechtendaliana*
562. *Goodyera schlechtendaliana* var. *robusta*
563. *Goodyera viridiflora*
564. *Goodyera vittata*
565. *Gymnadenia orchidis*
566. *Habenaria acuifera*
567. *Habenaria aitchisonii*
568. *Habenaria arietina*
569. *Habenaria clavigera*
570. *Habenaria commelinifolia*
571. *Habenaria dentata*
572. *Habenaria digitata*
573. *Habenaria diphylla*
574. *Habenaria edgeworthii*
575. *Habenaria ensifolia*
576. *Habenaria foliosa*
577. *Habenaria furcifera*
578. **Habenaria grandifloriformis*
579. *Habenaria intermedia*
580. *Habenaria khasiana*
581. *Habenaria latilabris*
582. *Habenaria longifolia*
583. *Habenaria malleifera*
584. *Habenaria mandersii*
585. *Habenaria marginata*
586. *Habenaria pantlingiana*
587. *Habenaria pectinata*
588. *Habenaria pelorioides*
589. *Habenaria plantaginea*
590. *Habenaria pubescens*
591. *Habenaria reniformis*
592. *Habenaria rhodocheila*
593. *Habenaria stenopetala*
594. *Habenaria trichosantha*
595. **Habenaria trifurcata*
596. *Habenaria viridiflora*
597. *Hemipilia cordifolia*
598. *Hemipilia purpureopunctata*
599. **Herminium kumauensis*
600. *Herminium lanceum*
601. **Herminium longilobatum*
602. *Herminium mackinnoni*
603. *Herminium monorchis*
604. *Herminium quinquelobum*
605. *Herpysma longicaulis*
606. *Hetaeria affinis*
607. *Hetaeria anomala*
608. *Holcoglossum amesianum*
609. *Holcoglossum himalaicum*
610. *Holcoglossum nagalandensis*
611. *Lechanorchis sikkimensis*
612. *Liparis acuminata*
613. *Liparis assamica*
614. *Liparis bistriata*
615. *Liparis bootanensis*
616. *Liparis caespitosa*
617. *Liparis cathcartii*
618. **Liparis chungthangensis*
619. *Liparis cordifolia*
620. *Liparis deflexa*
621. *Liparis delicatula*
622. *Liparis distans*
623. **Liparis dongchenii*
624. *Liparis elliptica*
625. *Liparis formosana*
626. *Liparis gamblei*
627. *Liparis gigantea*
628. *Liparis glossula*
629. *Liparis luteola*
630. **Liparis lydiae*
631. *Liparis mannii*
632. *Liparis nervosa*
633. *Liparis nervosa* var. *khasiana*
634. *Liparis odorata*
635. *Liparis perpusilla*
636. *Liparis petiolata*
637. *Liparis plantaginea*
638. *Liparis platyrachis*
639. *Liparis pygmaea*
640. *Liparis resupinata*
641. *Liparis rostrata*
642. **Liparis rupestris*
643. *Liparis somae*
644. *Liparis stricklandiana*
645. **Liparis tigerhillensis*
646. **Liparis torta*
647. *Liparis viridiflora*
648. *Liparis wrayi*
649. *Luisia antennifera*
650. *Luisia filiformis*
651. *Luisia macrotis*
652. *Luisia psyche*

653. *Luisia trichorrhiza*
654. **Luisia trichorrhiza* var. *flava*
655. *Luisia tristis*
656. *Luisia volucris*
657. *Luisia zeylanica*
658. *Micropera mannii*
659. *Micropera obtusa*
660. *Micropera pallida*
661. *Micropera rostrata*
662. **Myrmechis bakhimensis*
663. *Myrmechis pumila*
664. *Neogyna gardneriana*
665. *Neottia acuminata*
666. **Neottia alternifolia*
667. *Neottia brevicaulis*
668. *Neottia chandrae*
669. **Neottia confusa*
670. *Neottia dentata*
671. **Neottia dihangensis*
672. *Neottia divaricata*
673. **Neottia inayati*
674. *Neottia karoana*
675. *Neottia listeroides*
676. *Neottia longicaulis*
677. **Neottia mackinnonii*
678. **Neottia microglottis*
679. **Neottia nandadeviensis*
680. *Neottia ovata*
681. *Neottia pantlingii*
682. *Neottia pinetorum*
683. *Neottia tenuis*
684. *Nephelaphyllum cordifolium*
685. *Nephelaphyllum pulchrum*
686. *Nephelaphyllum sikkimensis*
687. *Nervilia concolor*
688. *Nervilia crociformis*
689. **Nervilia falcata*
690. *Nervilia gammieana*
691. **Nervilia gleadowii*
692. **Nervilia hookeriana*
693. *Nervilia infundibulifolia*
694. *Nervilia juliana*
695. **Nervilia khasiana*
696. *Nervilia mackinnonii*
697. *Nervilia macroglossa*
698. **Nervilia pangteyana*
699. *Nervilia plicata*
700. *Nervilia punctata*
701. *Oberonia acaulis*
702. **Oberonia angustifolia*
703. *Oberonia anthropophora*
704. **Oberonia arunachalensis*
705. *Oberonia bicornis*
706. **Oberonia bopannae*
707. *Oberonia brachystachys*
708. *Oberonia caulescens*
709. *Oberonia cavaleriei*
710. *Oberonia emarginata*
711. *Oberonia ensiformis*
712. *Oberonia falcata*
713. *Oberonia falconeri*
714. *Oberonia gammiei*
715. *Oberonia griffithiana*
716. *Oberonia helferi*
717. *Oberonia integerrima*
718. *Oberonia jenkinsiana*
719. **Oberonia jhae*
720. **Oberonia kamlangensis*
721. **Oberonia katakiana*
722. **Oberonia kingii*
723. **Oberonia lobulata*
724. *Oberonia longibracteata*
725. **Oberonia manipurensis*
726. *Oberonia mannii*
727. *Oberonia maxima*
728. *Oberonia mucronata*
729. *Oberonia obcordata*
730. *Oberonia pachyphylla*
731. *Oberonia pachyrachis*
732. *Oberonia prainiana*
733. *Oberonia pumilio*
734. *Oberonia pyrulifera*
735. **Oberonia raoi*
736. *Oberonia recurva*
737. **Oberonia ritaii*
738. *Oberonia rufilabris*
739. **Oberonia sulcata*
740. *Oberonia teres*
741. *Odontochilus clarkei*
742. *Odontochilus crispus*
743. *Odontochilus elwesii*
744. **Odontochilus grandiflorus*
745. *Odontochilus lanceolatus*
746. **Odontochilus tetrapterus*

747. *Odontochilus tortus*
748. *Oreorchis foliosa*
749. *Oreorchis foliosa* var. *indica*
750. *Oreorchis micrantha*
751. *Oreorchis patens*
752. *Otochilus albus*
753. *Otochilus fuscus*
754. *Otochilus lancilabius*
755. *Otochilus porrectus*
756. *Pachystoma pubescens*
757. *Panisea apiculata*
758. *Panisea demissa*
759. *Panisea panchaseensis*
760. *Panisea tricallosa*
761. *Panisea uniflora*
762. *Paphiopedilum charlesworthii*
763. *Paphiopedilum fairrieanum*
764. *Paphiopedilum hirsutissimum*
765. *Paphiopedilum insigne*
766. *Paphiopedilum spicerianum*
767. *Paphiopedilum venustum*
768. *Paphiopedilum villosum*
769. *Paphiopedilum wardii*
770. *Papilionanthe subulata*
771. *Papilionanthe teres*
772. *Papilionanthe uniflora*
773. *Papilionanthe vandarum*
774. *Pecteilis gigantea*
775. *Pecteilis henryi*
776. *Pecteilis susannae*
777. *Pecteilis triflora*
778. *Pelatantheria insectifera*
779. *Pennilabium labanyaeanum*
780. *Pennilabium proboscideum*
781. *Pennilabium struthio*
782. *Peristylus affinis*
783. *Peristylus biermannianus*
784. *Peristylus constrictus*
785. *Peristylus cubitalis*
786. *Peristylus densus*
787. *Peristylus duthiei*
788. *Peristylus elisabethae*
789. *Peristylus fallax*
790. *Peristylus goodyeroides*
791. *Peristylus gracilis*
792. *Peristylus hamiltonianus*
793. *Peristylus lacertifer*
794. *Peristylus lawii*
795. *Peristylus macrophylla*
796. *Peristylus mannii*
797. *Peristylus orbicularis*
798. *Peristylus parishii*
799. *Peristylus plantagineus*
800. *Peristylus prainii*
801. **Peristylus pseudophrys*
802. *Peristylus richardianus*
803. *Peristylus superanthus*
804. *Peristylus tipuliferus*
805. *Phaius flavus*
806. *Phaius luridus*
807. *Phaius mishmensis*
808. *Phaius nanus*
809. *Phaius tankervilleae*
810. *Phaius wallichii*
811. *Phalaenopsis braceana*
812. **Phalaenopsis cacharensis*
813. *Phalaenopsis cornu-cervi*
814. *Phalaenopsis deliciosa*
815. *Phalaenopsis difformis*
816. *Phalaenopsis fasciata*
817. *Phalaenopsis hygrochila*
818. *Phalaenopsis lobbii*
819. *Phalaenopsis malipoensis*
820. *Phalaenopsis mannii*
821. *Phalaenopsis parishii*
822. *Phalaenopsis pulcherrima*
823. *Phalaenopsis taenialis*
824. *Phalaenopsis yingjiangensis*
825. *Pholidota articulata*
826. *Pholidota convallariae*
827. *Pholidota imbricata*
828. **Pholidota katakiana*
829. *Pholidota pallida*
830. *Pholidota protracta*
831. **Pholidota pygmaea*
832. *Pholidota recurva*
833. *Pholidota undulata*
834. **Pholidota wattii*
835. *Phreatia albofarinosa*
836. *Phreatia elegans*
837. *Platanthera bakeriana*
838. *Platanthera bhutanica*
839. *Platanthera concinna*
840. *Platanthera dulongensis*

841. *Platanthera handel-mazzettii*
842. *Platanthera japonica*
843. *Platanthera leptocaulon*
844. *Platanthera nematocaulon*
845. *Platanthera pachycaulon*
846. *Platanthera sikkimensis*
847. *Platanthera stenantha*
848. *Platanthera urceolata*
849. **Pleione arunachalensis*
850. *Pleione grandiflora*
851. *Pleione hookeriana*
852. *Pleione humilis*
853. *Pleione lagenaria*
854. *Pleione maculata*
855. *Pleione praecox*
856. *Pleione saxicola*
857. *Pleione scopulorum*
858. *Podochilus cultratus*
859. *Podochilus khasianus*
860. *Pogonia japonica*
861. *Polystachya concreta*
862. **Pomatocalpa armigerum*
863. **Pomatocalpa bambusarum*
864. *Pomatocalpa spicatum*
865. *Pomatocalpa undulatum*
866. *Ponerorchis chrysea*
867. *Ponerorchis chusua*
868. *Ponerorchis cucullata*
869. **Ponerorchis renzii*
870. *Ponerorchis secundiflora*
871. *Propax elwesii*
872. *Propax fibuliformis*
873. *Propax gigantea*
874. *Pteroceras teres*
875. *Renanthera imschootiana*
876. **Rhomboda arunachalensis*
877. *Rhomboda lanceolata*
878. **Rhomboda longifolia*
879. **Rhomboda pulchra*
880. *Rhynchostylis retusa*
881. *Risleya atropurpurea*
882. **Robiquetia arunachalensis*
883. *Robiquetia spathulata*
884. *Robiquetia succisa*
885. *Saccolabiopsis pusilla*
886. **Sarcoglyphis arunachalensis*
887. **Sarcoglyphis manipurensis*
888. *Satyrium nepalense*
889. *Satyrium nepalense* var. *ciliatum*
890. *Schoenorchis fragrans*
891. *Schoenorchis gemmata*
892. *Smitinandia micrantha*
893. *Spathoglottis ixioides*
894. *Spathoglottis plicata*
895. *Spathoglottis pubescens*
896. *Spiranthes himalayensis*
897. *Spiranthes sinensis*
898. *Stereochilus hirtus*
899. **Stereochilus ringens*
900. *Stereosandra javanica*
901. **Stigmatodactylus paradoxus*
902. **Stigmatodactylus serratus*
903. **Taeniophyllum arunachalense*
904. **Taeniophyllum crepidiforme*
905. *Taeniophyllum glandulosum*
906. *Taeniophyllum retrospiculatum*
907. *Taeniophyllum stella*
908. *Tainia latifolia*
909. **Tainia megalanthum*
910. *Tainia minor*
911. *Tainia wrayana*
912. **Thelasis bifolia*
913. *Thelasis khasiana*
914. *Thelasis longifolia*
915. *Thelasis pygmaea*
916. *Thrixspermum centipeda*
917. **Thrixspermum crassilabre*
918. **Thrixspermum indicum*
919. **Thrixspermum musciflorum*
920. *Thrixspermum paucilorum*
921. *Thrixspermum pygmaeum*
922. *Thrixspermum saruwatarii*
923. *Thunia alba*
924. *Thunia alba* var. *bracteata*
925. *Thunia alba* var. *marshalliana*
926. *Tipularia cunninghamii*
927. *Tipularia josephi*
928. **Trachoma coarctatum*
929. *Trichoglottis ramosa*
930. *Trichotosia dasyphylla*
931. *Trichotosia pulvinata*
932. *Trichotosia velutina*
933. *Tropidia angulosa*
934. *Tropidia curculigoides*

935. *Tropidia namasiae*
936. *Tropidia pedunculata*
937. *Uncifera acuminata*
938. *Uncifera lancifolia*
939. *Uncifera obtusifolia*
940. *Vanda alpina*
941. *Vanda bensonii*
942. *Vanda bicolor*
943. *Vanda coerulea*
944. *Vanda coerulescens*
945. *Vanda cristata*
946. *Vanda griffithii*
947. **Vanda jainii*
948. *?*Vanda motesiana*
949. *Vanda pumila*
950. *Vanda tessellata*
951. *Vanda testacea*
952. *Vandopsis gigantea*
953. *Vandopsis undulata*
954. *Vanilla aphylla*
955. *Vanilla borneensis*
956. *Vrydagzynea viridiflora*
957. *Yoania japonica*
958. *Yoania prainii*
959. *Zeuxine affinis*
960. *Zeuxine agyokuana*
961. *Zeuxine clandestina*
962. *Zeuxine flava*
963. *Zeuxine glandulosa*
964. *Zeuxine goodyeroides*
965. *Zeuxine gracilis*
966. *Zeuxine grandis*
967. **Zeuxine lindleyana*
968. *Zeuxine longilabris*
969. *Zeuxine membranacea*
970. *Zeuxine nervosa*
971. *Zeuxine reflexa*
972. *Zeuxine strateumatica*

Objectives/ Aim:

- Inventorization of orchids of Indian Himalayan region and find the occurrence, distribution pattern and affinities.
- Complete morphological characterization in consultation with Type, Protologue, live and herbarium specimens.
- Solve the taxonomy, nomenclature and decode the species complex (if any) with evidence from morphology, molecular biology and cytology.
- Confirm the presence of endemics, near endemics and less known species in their known localities and predict the likely habitat with habitat modelling technique.
- Assess the threat status by applying IUCN criteria and categories and propose effective conservation measure.
- Develop distribution and species richness map.
- Germplasm collection and ex-situ conservation.

Methodology(ies): Certain methodologies were adopted against each objective.

- A thorough literature survey was done for complete inventorization of orchids in the Himalayan region. The literature survey produced a comprehensive data on distribution, occurrence, habitat preferences and phonological data.
- Field surveys conducted to selected regions of IHR for studying orchids in their natural habitat.
- Samples were collected for further macro-morphological study. Samples collected in vegetative condition were reintroduced in the campus and with the advent of flowers they were studied.

- Herbarium materials were studied to tabulate the distributional records, phenology in detail and also the range of variation in morphological characters. Protologues, Type specimens and authentic specimens were given importance to solve the taxonomic, nomenclatural and typification related problems.
- Taxon datasheet prepared following the IUCN guidelines. The threats were assessed based on the IUCN guidelines regarding IUCN categories.
- Distribution data recorded from literatures and herbarium records were tabulated in excel sheet. Geo-coordinates are assigned for each location from Google Earth. Latitudes and longitudes were converted to decimal points where required. Mapping was done with the help of Arc GIS software and in Geo CAT platform.
- Less known species were selected from the allotted group.
- Live specimens collected from field and rescued from disturbed habitat condition were reintroduced in SHRC campus for ex-situ conservation.

Approach:

The work is based on techniques used in plant taxonomy. This includes literature survey, study of herbarium materials, study and collection of live samples, study of type materials and protologues, decision regarding solving nomenclatural and typification problems. Data generated from primary and secondary sources are gathered and arranged for further study. Data obtained from secondary sources are verified and compiled. Analysis of all sort of data obtained after accumulation from both primary and secondary sources finally leads to a comprehensive document.

Results:

Completion of the work leads to working list of 631 species of the sub-family Vanilloideae, Orchidoideae and Epidendroideae. It provides glance on distribution of all these species in present Indian circumscription, preferences to habitats, altitudinal range and also phenology. Taxonomic treatments have been addressed for all the species including their lower ranks. This includes protologue citation, updated literature citations, solving ambiguity in identification, detailed description, working key for easy identification, voucher specimens examined for 631 species. Detailed study based on both macro and micro morphological characters were done which enabled to solve 24 species complexes. Literature and field surveys could enlist 210 less known species, many of which are known from historic records and 115 endemic species. Field surveys being a very important part to understand the orchids in their natural habitats recorded some species for the first time for the country from IHR. Many rarely occurring species have been collected after a long time or from the locality that extends the distributional range. 650 specimens representing more than 250 species have been introduced or re-established as a part of ex-situ conservation in rescue centres or orchidarium of Sikkim Himalayan Regional Centre and Central National Herbarium, BSI. Distribution map prepared for 490 species. As orchids are on high demand in trade both nationally and internationally, they are also under much pressure of exploitation. IHR holds huge number of orchid

species contributing largely in orchid diversity. On contrary, this leads to threats to quite a large number of orchid species. Thus, threat status has been assessed pertaining to IUCN guidelines for 490 species that are growing in IHR. The document also provides recommendation for 490 IHR species of the allotment for better conservation strategy and prospects.

Conclusion:

Orchids are one of the important bioresource and studied round the globe. Since ages many workers have targeted various groups to resolve botanical curiosity, record medicinal aspects, decipher horticultural properties, and catalyse trade and business in many aspects. Yet, many of them are under-studied or hold ambiguity in identity or are not given enough importance overlooking the threats. This study aims in resolving these gap areas, targeting some research questions. Thus, the proposed study has 7 objectives that look towards fulfilling these gap areas. Detailed study of the targeted group brings in forefront exact scenario of orchid members growing in IHR. Solved taxonomic and nomenclatural ambiguity with present distributional range within the country, phonological records, key characters for easy identification, detailed morphological description, assigned threat categories based on IUCN guidelines helps to develop further study in a multidisciplinary approach. Field surveys conducted in IHR reconfirms the presence of less known species, confirms the presence of many species from unknown localities thus extending its distribution and in cases records species for the very first time from the country. Utilizing modern techniques, the data that has been developed definitely helps in better understanding the allotted group. Distribution maps prepared cast the range of occurrence as well as the strength of the species within the country at a glance. IHR being a part of the hotspot regions itself attract attention in global aspects. Thus, knowledge on orchid diversity contributes largely in the biodiversity records of the region. As orchids are dependent on pollinators, thus maintaining an orchid species actually maintains the biodiversity of the region including the people directly or indirectly dependent on it. After understanding the factual scenario of the allotted groups and also taking into account the threats, some recommendations have been provided that not only helps in conserving the orchids through ex-situ or in-situ measures but also by sustainable utilization of the natural resources that also satisfies the global targets. To conclude, this document can be a baseline source for further orchid research in multidisciplinary dimensions.

Recommendations:

1. The result of this project provides **comprehensive account** on selected members of the Sub-family Vanilloideae, Orchidoideae and Epidendroideae of India with special emphasis to Indian Himalayan Region. Through this project, it was found that nearly 10% of species are directly utilized either as ornamental or medicinal purposes. It is recommended to use or domesticate the remaining species which have tremendous prospects for ornamental as well as medicinal purposes.

2. It has been observed that significant number of species are known from few or historic reports. Their existence at present is questionable. There may be many reasons for these species remaining

obsolete in the wilderness. Species specific survey is recommended for **relocation and conservation** of these lesser known species.

3. While conducting the Red List Assessment as per IUCN criteria, majority of these species were assigned various threat categories (Critically Endangered [CR], Endangered [EN], Vulnerable [Vu]). Habitats of these species in the Himalayan region are recommended for protection. Some of the non-protected areas in the Himalayan region which are highly rich in orchid diversity are recommended for declaration of **orchid conservatories** or **reserve forests** or **orchid rich habitats**. These orchid rich habitats are Aru valley, Baisaran forest area, Betaab valley, Budwan, Drangg in Jammu and Kashmir; Trijuginarayan, Chopta, Phata, Mandal area in Uttarakhand; Sangrah-Churdhar in Himachal Pradesh; Andherikhola in Sikkim; stretches along Teesta river at NH 10 from Singtam to Siliguri, Tintek-Rakdong at outskirt of Fambonglho Wildlife Sanctuary, Dalapchen, Rorathang-Rongli, Yumsandong, Thangu, Shipgyer-Singhik, Tinchim, stretches along Hee-Burmeok-Uttarey; Doimara, Yachuli, Wakro, Siiro, Hunli, Myodia adjoining in Arunachal Pradesh; Nongstoin, Nongriat, Noh kali kai of Meghalaya; Khonoma-Kivikhu-Punebada in Nagaland; Reiek tlang, Tanhril of Mizoram.

4. Highly useful species are recommended for **bio-prospection** and **genomic profiling**.

5. **Epiphyte rehab centres** are to be established at various localities, specific to the zones where tourist footfalls are more. **Orchid based tourisms** can be promoted where local orchid diversity could be displayed. Orchid trails can be arranged for enthusiast tourists.

6. Promoting **community livelihood** is recommended by taking orchids as one of the important bio-resource.

2.2. Objective-wise Major Achievements

S. No.	Cumulative Objectives	Major achievements (in bullets points)
1.	Inventorization of orchids of Indian Himalayan region and find the occurrence, distribution pattern and affinities.	A working list of 631 species prepared based on the allotment. A separate list prepared for orchids of IHR from the allotment.
2.	Complete morphological characterization in consultation with Type, Protologue, live and herbarium specimens.	Detailed morphological description prepared for 631 species considering type, protologue, herbarium data and studying live specimens. 631 data sheets were prepared.
3.	Solve the taxonomy, nomenclature and decode the species complex (if any) with evidence from morphology, molecular biology and cytology.	24 complexes could be identified and solved from the allotment leading towards finalizing the strength of orchids in IHR.

4.	Confirm the presence of endemics, near endemics and less known species in their known localities and predict the likely habitat with habitat modelling technique.	Endemic species enlisted: 115 Less known species enlisted: 210 The distribution of each species and their varieties were confirmed through herbarium, literature and field survey. Each location was geo-referenced. Likely habitat could not be predicted due to lack of data as tours were hampered due to pandemic outbreak.
5.	Assess the threat status by applying IUCN criteria and categories and propose effective conservation measure.	Threat status assessed for 490 species. The assessments were of global perspective for endemics and Indian perspective for non-endemics. Conservation measures proposed and recommended for each species.
6.	Develop distribution and species richness map.	Distribution map prepared for 490 species emphasizing the Himalayan orchids.
7.	Germplasm collection and ex-situ conservation.	650 specimens were introduced in rescue centre and campus of Sikkim Himalayan Regional Centre, BSI and Central National Herbarium, BSI, Howrah.

2.3. Outputs in terms of Quantifiable Deliverables*

S. No.	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations made, if any, and Reason thereof:
1.	Complete inventory of orchid species	• Completion of work • Number of species	Complete inventory prepared for 631 species	
2.	Digital database on target orchid group	• Number of species addressed • Number of specimens included	Database prepared for 631 species based on herbarium data recorded. Location data have been geo-referenced carrying out further objectives.	
3.	Morpho-molecular characterization of all species	• Number of species	Morphological characterization done for 631 species	Molecular characterization could not be carried out due to pandemic situation.
4.	Long standing problems on many species complex will be solved.	• Number of species complexes identified • Number of species complexes solved	24 species complexes have been solved based on macro morphological characters.	
5.	Inventory of Endemics	• Number of	115 species were	

	and less known species.	species known from IHR	identified to be endemic. 210 species are less known from the region.	

(*) As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. Strategic Steps with respect to Outcomes (in bullets)

S. No.	Particulars	Number/ Brief Details	Remarks/ Enclosures
1.	New Methodology developed:	Back Bulb Cutting	The propagation of orchids through inactive pseudobulbs can be regenerated through abiotic stress in this method.
2.	New Models/ Process/ Strategy developed:	2 orchid rehab/rescue centre [1 at SHRC, BSI, Gangtok 1 at CNH, BSI, Shibpur, Howrah] Vertical farming of orchids	Orchid species rescued from disturbed habitats like fallen trunks, decaying woods, detached from tree trunks were re-established. They have successfully flowered in rescue centre. Vertical farming offers a new tool for value addition and conservation of orchids
3.	New Species identified:	• **First authentic collection** of specimen done from IHR: *Hemipilia purpureopunctata*, *Pleione saxicola*, *Odontochilus clarkeii*, *Dactylorhiza kafiriana*, *Bulbophyllum picturatum* • **New record for India**: *Stereochilus erinaceous* • **New distributional record**: *Hemipilia purpureopunctata, Phraetia albofarinosa* • **New merging**: *Aphyllorchis gollani* under *aphyllorchis alpina*, *Phalenopsis arunachalensis* under *Phalenopsis braceana* • **Ambiguous identity solved**: *Epipactis gigantia* (Indian collection) = *Epipactis royleana, Chilochista lunifera* (Indian collection)= *Chilochista parishii*, *Bulbophyllum helene* (Indian collection)= *Bulbophyllum nodosum*	

S. No.	Particulars	Number/ Brief Details	Remarks/ Enclosures
4.	New Database established:	• Distributional data tabulated for all Indian orchid species reported till 2019. • Comprehensive data on 490 species of IHR have been documented.	
5.	New Patent, if any:	NIL	
	I. Filed (Indian/ International)	—	
	II. Granted (Indian/ International)	—	
	III. Technology Transfer (if any)	—	
6.	Others, if any:	IUCN Red list assessment done for 490 species from IHR.	Assessment mentioned in the comprehensive part of FTR

3. Technological Intervention

S. No.	Type of Intervention	Brief Narration on the interventions	Unit Details (No. of villagers benefited / Area Developed)
1.	Development and deployment of indigenous technology	—	
2.	Diffusion of High-end Technology in the region	—	
3.	Induction of New Technology in the region	—	
4.	Publication of Technological / Process Manuals	—	

	Others (if any)	Taxonomic studies done after gathering all available data sets from both herbarium and live specimens. Macro and micro morphological characters of species studied and recorded based on standard techniques. Illustrations prepared using recent software. Distribution mapping done through Arc GIS and Geo CAT. Red list assessment done as per to IUCN guidelines.	

4. New Data Generated over the Baseline Data

S. No.	New Data Details	Existing Baseline	Additionality and Utilisation of New data (*attach supplementary documents*)
1.	Distribution data set prepared for 632 species		Details provided in appendix 1 of each Project Fellow
2.	Detailed taxonomic account prepared for 490 taxa		Details provided in appendix 1 of each Project Fellow
3.	Distribution map prepared for 490 taxa		Details provided in appendix 1 of each Project Fellow
4.	Threat status has been analyzed for 490 taxa		Details provided in appendix 1 of each Project Fellow

5. Linkages with Regional & National Priorities (SDGs, INDC, etc.)/ Collaborations

The recent study can help in attaining many of the national and international targets by contributing either directly or indirectly.

S. No.	Linkages /collaborations	Details	No. of Publications/ Events Held	Beneficiaries

1.	Sustainable Development Goals (SDGs)	Human lifescape is dependent on natural resources. 30% of earth surface is covered by forests that provide habitat to innumerable species which combat climate change by removing impurities from environment. Inspite of declaring many forest regions to be protected, biodiversity loss is a common issue of the era and is caused not only by developmental activity but also by improper utilization and unwise trading. Orchids are not exception to these threats. Having high habitat preferences, sentisivity to climate, altitude and pollinators they are restricted mostly in IHR and other parts of the country with similar climatic conditions. Orchids are well-known for beautiful flowers round the globe. Thus trade in orchid and related research have gained pace recently. But exploitation of wild orchids without re-establishing them has put threats to many of them them. Through this project life cycle of orchids, especially those growing in IHR is thoroughly studied. This helps in protecting them by conserving their natural habitat. Furthermore, orchids that is either rescued or observed in a protected environment or care unit, could be re-established in natural habitats. This work has identified the regions other than protected areas which can be designated as orchid rich areas. All these outcomes meet sustainable goals of UNDP by conserving mountain ecosystem and reducing degradation of natural habitats. Terrestrial and epiphytic orchids both can directly contribute in conserving ecosystems and bring deforestation at halt if the regions enriched with orchids or brought under conservation goals. Orchids which have tangible effect on human life (economic, medicinal, horticultural aspects) can promote fair and equitable sharing of benefits arising from utilization of genetic resources that is acceptable internationally through SDG (Goal 15). Involvment of local people in fulfilling the sustainable goals by using orchid resources will help them financially and also reduce the threat of trafficking or exploitation of orchids.		

2.	Climate Change/INDC targets	Data generated in recent years can be tallied with past which can provide a clear indication of shifting of habitats of orchids or change in phenology.		
3.	International Commitments	Orchids are involved in trades since many years. CITES is directly involved in controlling unruly trade. Such document deciphers the traits that can be incorporated through modern techniques. This in return will channelize the trade in more scientific manner keeping the wilderness undisturbed.		
4.	National Policies	The outcome of this work contributes in knowing the diversity and distribution of orchid species not so far addressed especially in IHR. This identifies regions outside the protected areas that are rich in orchids. Decisions can be taken in declaring those regions as orchid rich regions. In multiple ways this will help in national policy making or strengthening existing ones.		
5.	Other collaborations	Multiple institutional approaches/ collaboration are required for high resolution characterization. Better characterization will lead to accurate identification and that has direct impact on utilization, trade and conservation.		

6. Financial Summary (Cumulative)*

*Please attach the **consolidated and audited Utilization Certificate (UC) and Consolidated and *Year-wise* Statement of Expenditure (SE)** separately:

Please refer **Annexure I** including the details.

7. Quantification of Overall Research Progress

S. No.	Parameters		Total (Numeric)	Attachments* with remarks
1.	IHR State(s) Covered:		*12*	
2.	Fellowship Site/ LTEM Plots developed:		*Sikkim*	
3.	New Methods/ Model Developed:		*2*	*Back bulb cutting* *Vertical farming*
4.	New Database generated:		*7*	
5.	Types of Database generated:	*A comprehensive data prepared on orchids of Indian Himalayan Region accumulating data from available literatures, herbarium materials, field survey, study of live specimens, interacting with locals.*		*This depicts the distributional range, altitude, coordinate points of the location, phenology, present status of availability of the species in its natural habitat.*

6.	No. of Species Collected:	*282*	
7.	New Species identified:	*01*	*New record to India: 1*
8.	Scientific Manpower Developed (PhDs awarded/ JRFs/ SRFs/ RAs):		*Ph.D. registered = 5* *RA =1, SPF=6, JPF=1*
9.	No. of SC Himalayan Researchers benefited:		*NIL*
10.	No. of ST Himalayan Researchers benefited:		*NIL*
11.	No. of Women Himalayan Researchers empowered:	*04*	*04*
12.	No. of Knowledge Products developed:	*08*	
13.	No. of Workshops participated:	*03*	
14.	No. of Trainings participated:	*01*	
15.	Technical/ Training Manuals prepared:		*NIL*
	Others (if any):		*International symposium=1* *Annual conference=1* *Consortium=2* *Webinars attended during pandemic outbreak*

***** Please attach the soft copies of supporting documents word files and data files in excel. Files attached in appendix portion.

8. Knowledge Products and Publications*

S. No.	Publication/ Knowledge Products	*Number*		*Total Impact Factor*	*Remarks/* Enclosures**
		National	International		
1.	Journal Research Articles/ Special Issue (Peer-reviewed/ Google Scholar)		7		
2.	Book Chapter(s)/ Books:				NA
3.	Technical Reports/ Popular Articles	2			
4.	Training Manual (Skill Development/ Capacity Building)				NA
5.	Papers presented in Conferences/ Seminars		13		
6.	Policy Drafts (if any)				NA
7.	Others (specify)				NA

*Please append the list of KPs/ publications (with impact factor and URL link details) with due Acknowledgement to NMHS.

Provided in Appendix 2 of each research fellow.

**Please provide supporting copies of the published documents.

9. Recommendation on Utility of Research Findings, Replicability and Exit Strategy

9.1 Utility of the Fellowship Findings

S. No.	*Research Questions Addressed*	*Succinct Answers (within 150–200 words)*
1.	Preparing checklist with synonyms and distributional records through literature	A working checklist has been prepared taking into account all the relevant literatures including recent publications for 631 species.

	survey.	Names placed as synonyms are also reflected in the document. Distributional records are finalized from available literatures, herbarium records and field survey for all allotted taxa.
2.	Studying the Protologues, Types and herbarium specimens/images	Protologue forms the basis of taxonomic study. This can lead towards solving both taxonomic and nomenclatural problems. This again provides clue for old type specimens. Type specimens were traced in different Indian and foreign herbaria to have a concept of the concerned taxon. Wherever the necessity of selecting a type was felt necessary action was taken complying with ICN. Herbarium specimens are huge reservoir of distributional range, phenology, and availability of the specimen even morphological characters. Authentic photo/image/illustration often provides detailed morphological characters.
3.	Solving the taxonomy, nomenclature and decode the species complex (if any) with evidence from morphology, molecular biology and cytology.	24 species complexes were identified and solved based on morphological data set from live specimens, herbarium specimens, authentic illustrations, photo, literatures.
4.	Confirmation of the presence of endemics, near endemics and less known species in their known localities and predict the likely habitat with habitat modelling technique.	115 species were identified to be endemic. 210 species are less known from the region. Rare orchids that have been traced in its natural habitat are: *Pleione saxicola*, *Cymbidium tigrinum*, *Bulbophyllum picturatum*, *Odontochilus clarkei*, *Stereochilus erinaceus*, *Porpax fibuliformis*, *Eria musicola*, *Dactylorhiza kafiriana*, *Neottia alternifolia*, *Neottia listeroides*, *Neottia pinatorum*, *Neottia tenuis*, *Epipactis persica*, *Gastrodia exilis*, *Gastrodia dyeriana*
5.	Assessment of the threat status by applying IUCN criteria.	Threat status was assessed for 490 orchid species based on IUCN criteria.
6.	Development of distribution and species richness map.	Distribution map was prepared for 490 orchid species.
7.	Germplasm collection and ex-situ conservation.	approximately 650 live specimens collected from different regions of Indian Himalayan Region were introduced in Sikkim Himalayan Regional Centre, BSI and Pergola, Central National Herbarium, BSI. A plant rescue and care unit prepared to re-establish the rescued plants from in and around Sikkim and Darjeeling Himalaya.

9.2 Recommendations on Replicability and Exit Strategy:

Particulars	Recommendations
Replicability of Fellowship, if any Exit Strategy:	*Please describe the Exit Strategy of the fellowship, self-sustaining and benefitting the stakeholders and target communities*: Under this project a database on distribution of Indian orchids reported till 2019 has been prepared. Comprehensive data set is prepared for each 600 Indian orchids that include citations, synonyms, detailed morphological data, distribution, habitat, phenology, exsicata. Distributional records obtained were geo-referenced for all IHR species. Distribution maps are prepared for all IHR species from the allotment. Threat status has been assessed and threat categories have been assigned for IHR species from the allotment pertaining to IUCN guidelines. Field tours conducted in different regions of IHR could spot many interesting and rare orchids of the region. A huge number of germplasm has been maintained in SHRC, BSI, Gangtok and some at CNH, BSI, Shibpur, Howrah. This can facilitate further study on Himalayan orchids and also reintroduction of many of them in their natural habitat. A new method of propagating orchids through back bulb cutting proves beneficial. Vertical gardening is another tool for effective growth and propagation of orchids and also its conservation. As through the project regions rich in orchid diversity could be identified in IHR, the places outside protected areas can be marked for their conservation. Sustainable utilization of the wild orchids in structured way can fulfill sustainable developmental goals. IHR having heavy tourist footfall per year can use orchids as another interesting and curious component to attract tourists simultaneously developing alternate livelihood for locals. Economically and medicinally important orchids can be assayed for their chemical properties for further drug development and can be cultivated contributing in country's economy. Species can also to assessed for using them in horticultural, an important prospect of revenue generation of the country.

11/11/2022

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NMHS Fellowship Scheme
जीबीपीएनआई/एनएमएचएस-2017-18/एचएसएफ-08
GBPNI / NMHS-2017-18/HSF-08

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11/11/2022

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Place: Kolkata
Date: 11/11/2022