

The Liverwort and Hornwort flora of Hoollongapar Gibbon Sanctuary, Jorhat (Assam) -1

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ABSTRACT

A survey based, preliminary, alphabetically arranged checklist of hepatics of Hoollongapar Gibbon Sanctuary of Assam is presented including 17 taxa reported for the first time in the sanctuary area. Relevant details of all the 27 species along with their distribution are also provided.

Key – words: Bryophytes/Liverworts/Assam/Jorhat/Gibbon Wildlife sanctuary

INTRODUCTION

The Hoollongapar Gibbon Sanctuary or Gibbon Wildlife Sanctuary or Hoollongapar Reserve Forest (abbreviated HGWLS hereafter), the home of India's only gibbons – the hoolock gibbons, is an isolated protected area of evergreen forest located in Jorhat, Assam, India and was constituted in 1997. The sanctuary covers an area of 19.49 km² (Chetia and Kalita, 2012). The forest is classified as "Assam plains alluvial semi-evergreen forests" with some wet evergreen forest patches (Champion and Seth, 1968). The sanctuary is completely surrounded by tea gardens and a few villages near to forest as fringe village (Madhupur, Gobindpur and Bhogpur). The area falls under Indo-Burma Biodiversity Hotspot situated at an elevation of 100-120 m (Chetia and Kalita, 2012). The average rain fall is about 249 cm (Ghosh, 2007) and the avg. temperature varies from 5 °C (min.) to 38 °C (max.) (Chetia and Kalita, 2012).

Though the area is rich in diversity of various plant groups, however, most studies so far have been focused on Angiosperms. The bryophytes on the other hand, had remained neglected so

far as far as the study of their diversity and distribution in the area is concerned. Recently, some studies on bryophytes of the present political territory of Assam, India have come up and reported several bryophytes from Southern part of Brahmaputra River (Barukial and Gogoi, 1998; Barukial *et al.*, 2002a, 2002b; Barukial, 2011a, 2011b, Barbhuiya and Singh, 2012). Most recently, Singh and Barbhuiya (2012) reported several liverworts and hornworts from Assam and also showed distribution of 12 taxa in GWLS, which attracted us for the further exploration. To strengthen the knowledge of liverworts of the area, collection in the area have been made, which revealed presence of 27 taxa including one species of Anthocerotae and 26 of Hepatics in the area, constituting a preliminary report of Liverworts and Hornwort of HGWLS.

MATERIALS AND METHODS

The specimens were collected from various substrates including soil, trunk bases, fallen logs, and leaves in HGWLS. Moist specimens were air dried, kept in brown paper envelope and preserved in herbarium RFRI. Slides of whole mount as well as plants parts and sections were mounted in aqueous glycerin, labeled and stored for further studies, wherever found necessary. Taxonomic treatment of Schuster (1984) was followed for the identification, classification and preparation of the final list of various taxa.

RESULTS

1. *Heteroscyphus argutus* (Nees, Reinw. & Blume) Schiffn. in Oesterr. Bot. Z. 60: 172 (1910). [Geocalycaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca. 126 m; 29.12.2011, P. K. Verma and Party, 125/2011 (RFRI).

Ecology: Plant growing in rough mats on Polyporus as well as on buttress of the trees.

Range of Distribution : Australia, New Zealand, Papua New Guinea, and Hawaii, INDIA, Indonesia, Malaysia, Nepal, China, Japan, Korea, Vietnam and other tropical warm temperate regions (see, Pocs and Ninh, 2005; Srivastava and Srivastava; 2002)

Very common species not only in India but also in Brahmaputra valley and has recently been documented from Borail Wild Life Sanctuary of Assam (Barbhuiya and Singh, 2012).

2. *Heteroscyphus hyalinus* (Steph.) S.C. Srivast. & A. Srivast., Indian Geocalycaceae 118 (2002). [Geocalycaceae]

Ecology: Plants growing on the bark of trees.

Range of Distribution: Endemic to India.

Specimens examined: Assam: Jorhat, HGWLS; alt ca. 125 m; 23.11.2012, P. K. Verma and Party, 236/2012 (RFRI).

The species is new report from HGWLS. However, it has already been reported from Assam (Barbhuiya and Singh, 2012) and several east Himalayan localities (Dey *et al.*, 2009; Singh & Nath, 2007; Singh *et al.*, 2010).

3. *Solenostoma tetragonum* (Lindenb.) R. M. Schust. ex Vána et D.G. Long, Nova Hedwigia 89: 509 (2009). [Jungermanniaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca. 127m; 14.08.2011, P. K. Verma and Party, 197/2012 (RFRI).

Ecology: Plant terrestrial, in small tufts, very rare.

Range of Distribution: Asia, Australia (Vana and Long, 2009; Alam, 2006).

The species is frequently growing in several patches of eastern Himalayas and now first time reported from Brahmaputra valley of Assam. The species is frequently found in outer edges of HGWLS.

4. *Plagiochila bantamensis* (Reinw. et al.) Montagne in d'Orbigny, Voy. Amer. Merid. 7, Bot. (2): 82 (1839). [Plagiochilaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca. 123 m; 02.12.2012, P. K. Verma and Party, 135/2011 (RFRI).

Ecology: Plants epiphytic, in fan like forms.

Range of Distribution: China, Fiji, Japan, Papua New Guinea, the Philippines, Indonesia, Kampuchea, Malaysia, Melanesia, Singapore, Sri Lanka, Sulawesi, Vietnam (So, 2001) and India: Nicobar Islands and Assam (Verma *et al.*, 2012).

The species is new addition in Indian mainland bryoflora and has recently been reported from HGWLS by Verma *et al.*, 2012. Earlier this species was reported from Nicobar Island of India as well as other Asiatic countries (Rawat and Srivastava, 2007).

5. *Plagiochila flexuosa* Mitt., J. Proc. Linn. Soc. 5: 94 (1861). [Plagiochilaceae]

Specimens examined: Assam: Jorhat, HGWLS, alt. ca. 127 m; 29.11.2011, P. K. Verma and Party, 126A/2011 (RFRI).

Ecology: Plants epiphytic, in fan like forms.

Range of Distribution: Oriental region: Asia – Bhutan, China, INDIA, Nepal, Sri Lanka, Taiwan, Thailand, Vietnam, Japan (Lai *et al.*, 2008; So, 2001; Rawat and Srivastava, 2007).

The species is a new addition to liverwort flora of Assam as it was earlier reported from several localities of Eastern Himalayas and Western Ghats of India (Rawat and Srivastava, 2007).

6. *Frullania ericoides* (Nees) Mont., Ann. Sci. Nat. Bot., ser. 2, 12: 57 (1839). [Jubulaceae]

Specimens examined: Assam: Jorhat, HGWLS alt. ca. 130 m; 05.06.2012, P. K. Verma and Party, 155/2012 (RFRI).

Ecology: Plants epiphytic, growing in form of smooth mats.

Range of Distribution : Australia, New Caledonia, Papua New Guinea, Arabian Peninsula; Africa – Angola, Ascension Island, Annobon, Bioko (Fernando Po), Burundi, Cameroon, Central African republic, Congo, Cape Verde Isl., Ethiopia, Gambia, Guinea, Kenya, Madagascar, Malawi, Mozambique, Nigeria, Principe, Reunion, Rwanda, Seychelles, South Africa, Sierra Leone, Scotia, Tanzania, Togo, Uganda, Zaire, Zambia, Zimbabwe, Canada, United State of America, Brazil, Venezuela, Galapagos Isl.; Antilles, Caribbean Isl., Mexico, Bhutan, INDIA, Indonesia (Borneo, Java, Sumatra), Nepal, Philippines, Southern China, Taiwan, Vietnam, Korea, Japan; Europe (see Nath and Asthana, 1998; Srivastava and Alam, 2002; Wang *et al.*, 2011).

The species is frequently growing in several patches of eastern Himalayas as well as in Brahmaputra valley of Assam (see Barbhuiya and Singh, 2012)

7. *Lopholejeunea sikkimensis* Steph., Sp. Hepat. 5: 87 (1912). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS alt. ca. 127 m; 29.12.2011, P. K. Verma and Party, 126B/2011 (RFRI).

Ecology: Plants growing in smooth mats as an epiphytic population on angiospermic trees.

Range of Distribution: INDIA, Nepal (Awasthi *et al.*, 2000)

The species is a new addition to liverwort flora of Assam as it was earlier reported from several localities of Eastern Himalayas and Western Ghats of India (Awasthi *et al.*, 2000).

8. *Ptychanthus striatus* (Lehm. et Lindenb.) Nees, Naturg. Eur. Leberm. 3: 212 (1838). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS alt. ca. 120 m.; 14.08.2012, P. K. Verma and Party, 198/2012 (RFRI).

Ecology: Plants epiphytic as well as epiphyllous, growing in fan like life form on trunk of angiospermic trees.

Range of Distribution: Australia, Papua New Guinea; Africa –Burundi, Cameroon, Kenya, Ethiopia, Malawi, Madagascar, Mozambique, Rwanda, South Africa, Tanzania, Uganda. Asia – Cambodia, China, INDIA, Indonesia; Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Sulawesi, Taiwan, Thailand, Vietnam, Korea, Japan (Awasthi and Srivastava, 1987; Thiers and Gradstein, 1989; Gradstein, 1991).

The species is a new addition to liverwort flora of Assam as it was earlier reported from several localities of eastern Himalayas and Western Ghats of India (Awasthi and Srivastava, 1987). However, it is very rare in HGWLS.

9. *Cheilolejeunea imbricata* (Nees) S. Hatt., Misc. Bryol. Lichenol. 1 (14): 1 (1957) [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca. 127 m; 23.11.2012, P. K. Verma and Party, 232/2012 (RFRI).

Ecology: Plants epiphyllous as well as corticolous, growing in smooth mats on tree trunks.

Range of Distribution : China, Bonin Isl., Papua New Guinea, INDIA, Indonesia, , Philippines, Taiwan, Thailand. Japan, Korea (Asthana *et al.*, 2005; Verma, 2005, Singh, and Nath, 2007; Zhu and So, 2001, Manju *et al.*, 2007).

The species has recently been reported by Singh and Barbhuiya (2012) as *Cheilolejeunea trapezia*, and they doubted the presence of the *C. imbricata* in Indian liverwort flora, however, they did not provide any reason the same. Further, on our own observation, we would like to still treat it as *C. imbricata*.

10. *Cheilolejeunea mariana* (Gottsche) B. Thiers & Gradst. in Mem. New York Bot. Gard. 52: 75 (1989). [Lejeuneaceae]

Range of Distribution: Australia, INDIA, sub-Saharan Africa, including the East African Islands (Robinson, 1964; Wigginton, 2002).

Earlier reported from Western Ghats of India (Daniels, 2010), this species has recently been reported from HGWLS by Singh and Barbhuiya (2012), however, could not be collected by authors, hence listed here on the basis of Singh and Barbhuiya (2012).

11. *Rectolejeunea olivacea* (Steph.) S.C. Srivast. & A. Agarwal, The Bryologist 89 (3): 195-199 (1986). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS alt ca. 122m; 14.08. 2012, P. K. Verma and Party, 195/2012 (RFRI).

Ecology: Plants epiphytic, growing in fan like forms.

Range of Distribution: Africa, INDIA (Srivastava and Agarwal, 1986).

The species is a new addition to liverwort flora of Assam and has earlier been reported from Western Ghats of India (Srivastava and Agarwal, 1986). However, it is very rare in HGWLS as only three plants in a single accession were collected from the locality.

12. *Microlejeunea punctiformis* (Taylor) Spruce, In: Steph., Sp. Hep. 5: 832 (1915). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca 127 m; 29.12.2011, P. K. Verma and Party, 126C/2011 (RFRI).

Ecology: Plants corticolous, growing as thread like forms in diffuse patches on the main tree trunk.

Range: India, Japan, India, China, Thailand, Vietnam (Verma, 2005).

The species is a new addition to liverwort flora of Assam and earlier has been reported from several localities of eastern Himalayas and Western Ghats of India (Verma and Srivastava, 2011). It is very common distribution in HGWLS.

13. *Microlejeunea ulicina* (Taylor) Steph. in Hedwigia 29: 88 (1890). [Lejeuneaceae]

Range of Distribution: Africa- Ivory Coast; U.S.A., Canada; South America- Brazil, Chili; Japan; Azores, Britain, France, Italy, Luxembourg, Madeira, Canary Isl., INDIA (Verma, 2005).

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey.

14. *Leptolejeunea epiphylla* (Mitt.) Steph., Sp. Hepat. 5: 380 (1983). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca 118 m; 14.08.2012, P. K. Verma and Party, 195/2012 (RFRI).

Ecology: Plants epiphytic, growing as thread like forms in diffuse as well as in compact patches on angiospermous tree.

Range of Distribution : Asia: China, French Polynesia (Moorea), Gulf of Guinea Islands, INDIA, Philippines, Malaysia, sub-Saharan Africa, Uganda, Vietnam (Hodgetts, 2012, Wigginton, 2002).

The species is not only a new addition to liverwort flora of Assam but also to mainland Indian territory as it was earlier reported from Nicobar Island of India (Dey and Singh, 2010). The species is very common in distribution in HGWLS.

15. *Leptolejeunea elliptica* (Lehm. & Lindenb.) Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1 (3): 126 (1895). [Lejeuneaceae]

Range of Distribution: China, Taiwan, INDIA and Pan-tropical in distribution (see also Zhu and So, 2001)

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey.

16. *Cololejeunea latilobula* (Herzog) Tixier, Bryophyt. Biblioth. 27: 156 (1985). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS, alt. ca. 120 m.; 14.08.2012, P. K. Verma and Party, 198/2012 (RFRI).

Ecology: Plants epiphytic, growing in fan like forms.

Distribution: Africa–Burundi, Malawi, Nigeria, Reunion, Tanzania, Uganda, Zaire, Zimbabwe; Asia- China, Laos, Myanmar, Vietnam (see Asthana and Srivastava, 2003 Verma, 2010).

The species has recently been collected from HGWLS by Singh and Barbhuiya (2012) and also reported from several localities of eastern Himalayas, Western Himalaya, Western Ghats as well as in Central India. The species is frequent in distribution.

17. *Cololejeunea lanciloba* Steph. in Hedwigia 34: 250 (1895). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS –ca. 130m; 14.09.2012, P. K. Verma and Party, 195/2012 (RFRI).

Ecology: Plants epiphyllous, on leaves of angiosperms trees.

Range of Distribution : China, Japan, Philippines, Indonesia, INDIA, Bangladesh, Thailand, Cambodia, Malaysia, Polynesia, Australia, New Caledonia, Africa (Asthana and Srivastava, 2003).

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and also reported from several localities of eastern Himalayas and Western Ghats of India. The species is very frequent in distribution.

18. *Cololejeunea trichomanis* (Gottsche) Steph. in Hedwigia 34: 252 (1895). [Lejeuneaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca 128 m; 14.09.2012, P. K. Verma and Party, 198/2012 (RFRI).

Ecology: Plants epiphytic as well as epiphyllous, growing on angiosperms trees and leaves.

Range of Distribution: Australia, Indonesia, Japan, Cambodia, Laos, Malaysia, Thailand, Vietnam, China, Philippines, Korea, Nepal, INDIA (Asthana and Srivastava, 2003).

The species is very frequent in distribution and has also recently been collected from HGWLS by Singh and Barbhuiya (2012).

19. *Cololejeunea furciculobulata* (Berrie & Jones) R. M. Schust., Nova Hedwigia Beih. 9:178 (1963). [Lejeuneaceae]

Specimen examined: Indo-Burma Biodiversity Hotspot: **India**, Assam: Jorhat, HGWLS, ca. 120 m, 05.06.2012, P. K. Verma 176/2012 (RFRI).

Ecology: Plants epiphytic (epiphyllous), growing in fan like forms.

Range of Distribution : Nigeria, Tanzania, Madagascar, INDIA (Asthana and Srivastava, 2003).

The species is a new addition to Indo-Burma biodiversity Hotspot, as earlier it was reported from Western Ghats of India (Asthana and Srivastava, 2003). The species is moderate in distribution.

20. *Cololejeunea floccosa* (Lehm. & Lindenb.) Schiffn., Consp. Hepat. Arch. Ind.: 243 (1898). [Lejeuneaceae]

Range of Distribution: Philippines, Japan, Celebes, Taiwan, China, Indonesia, Malayan peninsula, Vietnam, Thailand, Cambodia, Laos, Malaysia, Sri Lanka, Sierra Leon, Ivory Coast, Madagascar (Zhu and So, 2001, Asthana and Srivastava, 2003, Singh and Barbhuiya, 2012).

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey.

21. *Cololejeunea desciscens* Steph. in Hedwigia 34: 248 (1895). [Lejeuneaceae]

Range of Distribution: INDIA

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey. Earlier, it was reported from Andaman (Singh *et al.*, 2006).

22. *Cololejeunea kashyapii* Udar & G. Srivast. in Geophytology 15: 64 (1985). [Lejeuneaceae]

Range of Distribution: Endemic to India (Asthana & Srivastava, 2003).

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey. *Cololejeunea kashyapii* is an endemic species, reported earlier from Karnataka and Kerala (Asthana & Srivastava, 2003; Manju *et al.*, 2012).

23. *Cololejeunea serrulata* Steph. in Hedwigia 34: 252 (1895). [Lejeuneaceae]

Range of Distribution: China (Yunnan), Vietnam and India (Zhu and So, 2001; Dey *et al.*, 2011).

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey. Earlier, Dey *et al.* (2011) reported the species in India for first time from Arunachal Pradesh.

24. *Cololejeunea siangensis* G. Asthana & S.C. Srivast. in Bryophyt. Biblioth. 60: 57 (2003). [Lejeuneaceae]

Range of Distribution: Endemic to India (Asthana and Srivastava, 2003).

The species has recently been reported from HGWLS by Singh and Barbhuiya (2012) and listed on the basis of same as it could not be collected in present survey. Earlier, the species was reported from its type locality, Arunachal Pradesh, only (Asthana and Srivastava, 2003).

25. *Pallavicinia lyellii* (Hook.) Carruth, Nat. Arr. Brit. Pl. 1: 685, 775 [errata] (1821). [Pallaviciniaceae]

Specimens examined: Assam: Jorhat, HGWLS; *alt. ca.* 130 m; 14.08.2012, P. K. Verma and Party, 197/2012 (RFRI).

Ecology: Plants growing as a semiaquatic population in mat forms.

Range of Distribution: Africa, Asia, Europe, North America, South America, Australia, INDIA (Srivastava, 1961; Bates, 1993, Singh and Singh, 2009).

This species is new to bryoflora of HGWLS, however, recently reported from different localities of Assam (by Barbhuiya and Singh, 2012) and several localities of eastern Himalayas and Western Ghats of India (Singh and Nath, 2007; Alam, 2006). The species is very frequent in distribution.

26. *Marchantia subintegra* Mitt. in J. Proc. Linn. Soc., Bot. 5: 125 (1861). [Marchatiaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca.130; 14.08.2012, P. K. Verma and Party, 198/2012 (RFRI).

Ecology: Plants epiphytic, growing in fan like forms, very rare.

Range of Distribution: India, Nepal

The species is new to HGWLS and very frequent in distribution.

27. *Folioceros paliformis* D. K. Singh in Bull Bot. Surv. India 29: 176 (1987). [Anthocerotaceae]

Specimens examined: Assam: Jorhat, HGWLS; alt. ca. 127 m; 02.01.2012, P. K. Verma and Party, 130/2012 (RFRI).

Ecology: Plants epiphytic, growing in fan like forms.

Range of Distribution: Endemic to India (Asthana and Nath, 1999; Singh, 1987; Singh, 2002).

The species is new to HGWLS, though earlier reported from other localities of Assam (Singh and Barbhuiya, 2012). The species is very frequent in distribution.

Discussion

The HGWLS is an important sanctuary as far as the conservation point is concerned. With an small area of about 20 km², the area is under extreme pressure of anthropogenic activities in and around the sanctuary (Chakraborty and Gupta 2005). Bryophytes are extremely sensitive for such activities and the resulting change in the habitat. Though the area is primarily meant for the conservation of Gibbons, yet entire habitat and every component of the ecosystem needs to be investigated and conserved for a successful conservation programme. The bryophytes, being the primary land colonizer and effective pollution indicator, play a major role in ecosystem functioning. The present attempt to study the minute surface flora will not only help understand the plant components and their diversity but will also help future workers to plan various conservation programmes (see also Gradstein, 1992).

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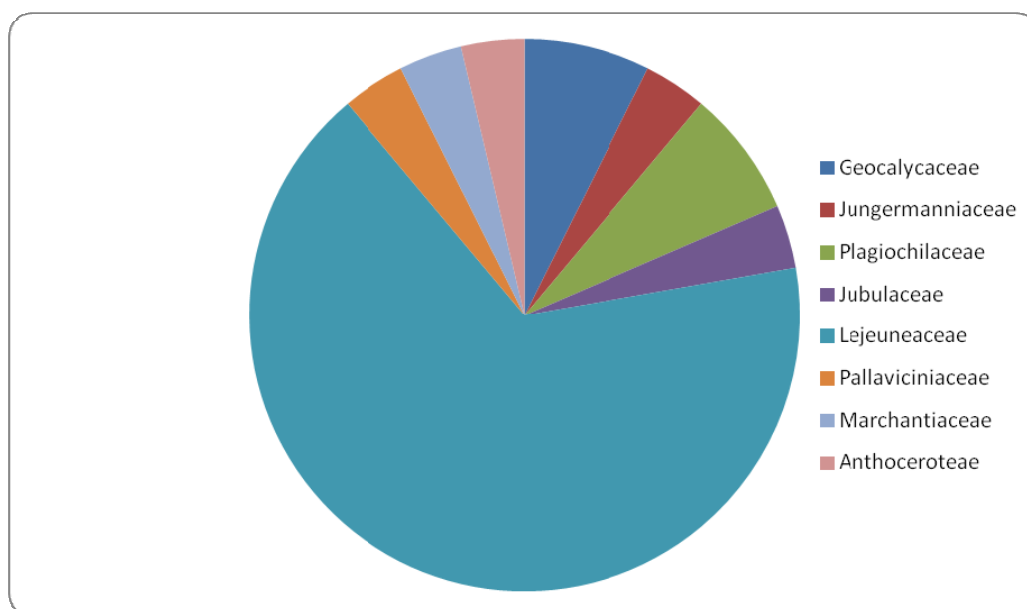


Fig. 1. Pie Digramme showing total number of species in different families of Liverworts and Hornwort of HGWLS

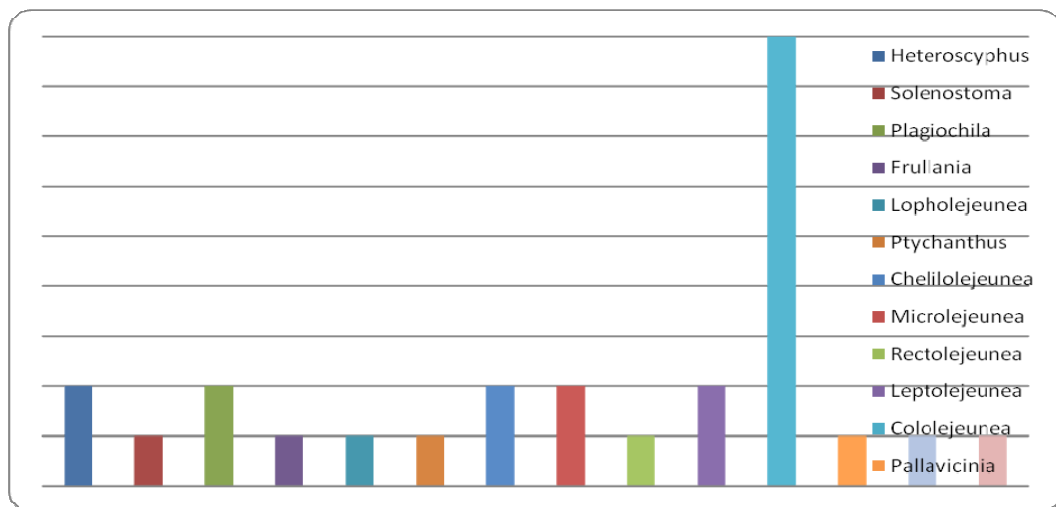


Fig. 1. Histogramme showing total number of species under different genus of Liverworts and Hornwort of HGWLS

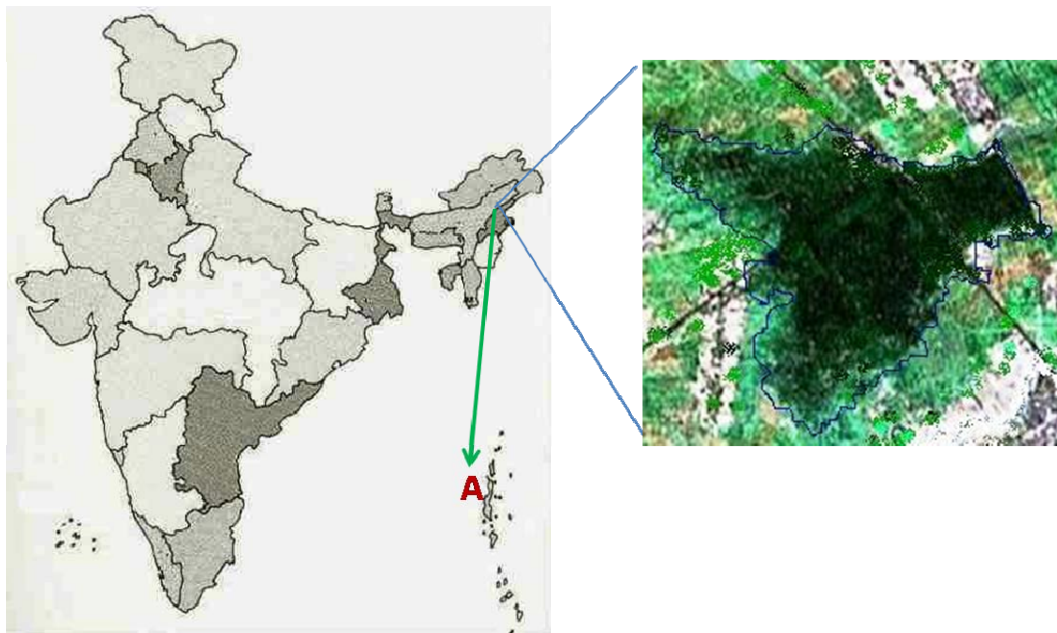


Figure: 3. Map of India Showing the Hoolongapar Gibbon Wildlife Sanctuary (A), Jorhat, Assam with enlarge view.



Figure 4 (1-9): . 1. The view of Gibbon Wildlife Sanctuary, showing last ape of India (Hollock Gibbon), 2. *Heteroscyphus argutus*, growing as xylocolous population, 3,4. *Plagiochila flexuosa*, 5. *P. banatmensis*, 6. *Frullania ericoides*, growth habit, 7. Same, enlarge view, 8. *Leptolejeunea epiphylla*, 9. *Chelilolejeunea imbricata* (all Photomicrograph taken by PKV).



Figure 5 (10-18): 10. *Heteroscyphus argutus*, 11. *Microlejeunea punctiformis*, 12. *Cololejeunea furciculobulata*, 13. *Rectolejeunea olivacea*, 14. A pure patch of *Solenostoma tetragonum*, 15. Same, enlarge view, 16. *Pallavicinia lyalii*, 17. A pure patch of *Marchantia subintegra*, 18. Same, enlarge view (all Photomicrograph taken by PKV).

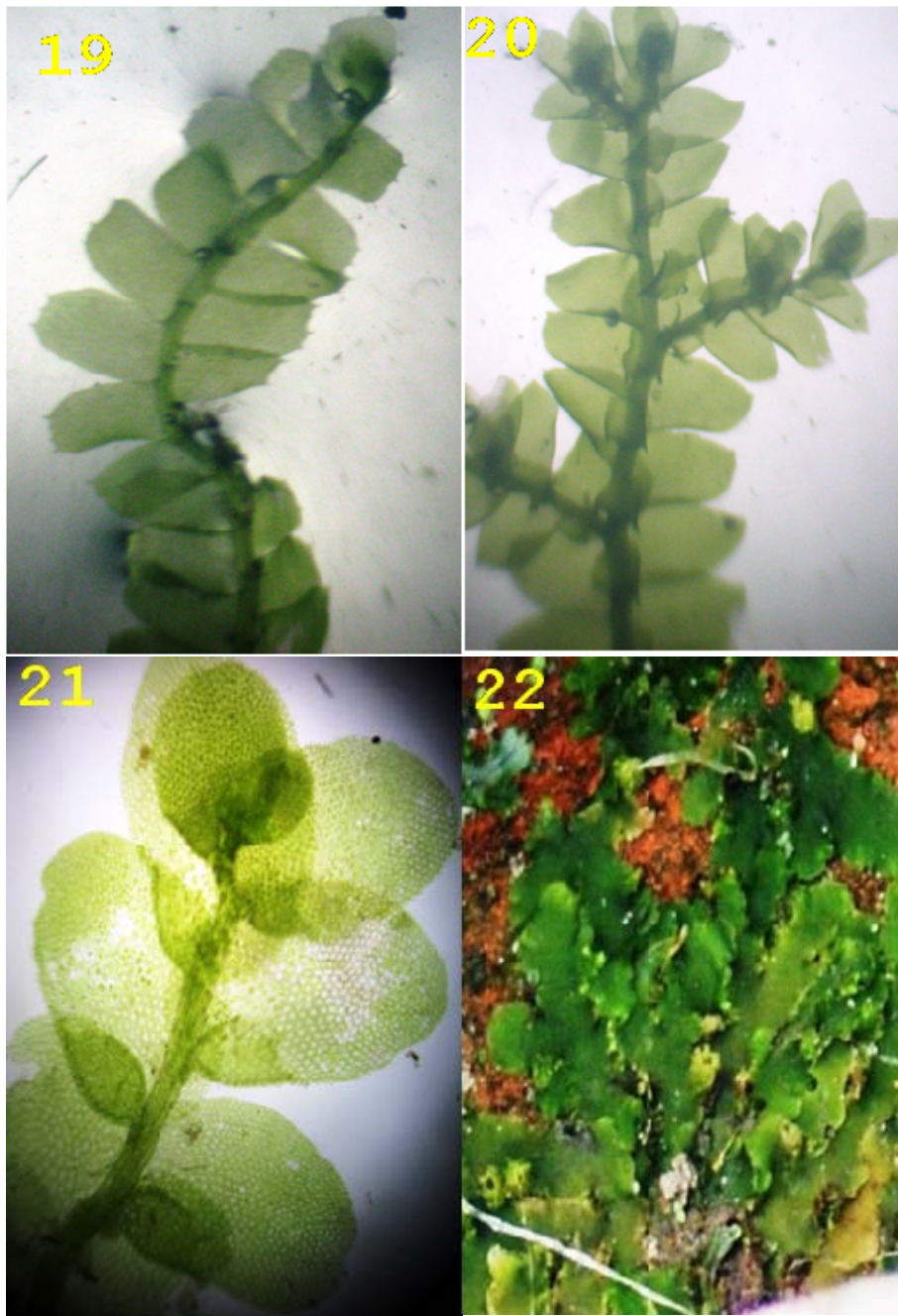


Figure 6 (19-22): 19. *Heteroscyphus hyalinus*, 20. *Ptychanthus striatus*, 21. *Cololejeunea trichomanis*, 22. *Folioceros paliformis* (all Photomicrograph taken by PKV).