Our Nature (2007)5:31-36

Species Diversity of Hornworts (Anthocerotae: Bryophyta) in Lowland Nepal with an account of *Foliocerus assamicus* D.C. Bhardwaj, a new report to the country

Nirmala Pradhan[1] and Sanu Devi Joshi[2]

[1.] *Natural History Museum, Tribhuvan University, Swayambhu, Kathmandu, Nepal.*
[2.] *Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal*

Received: 15. 11.2007, Accepted: 11.12.2007

Abstract

Anthocerotae (Hornwort) is a primitive and less familiar class of Bryophyta which comprises two families with eight species in Nepal. This paper deals with six species of two families which are reported from below 1000 m elevation across Terai belt of Nepal. *Folioceros assamicus* D.C. Bhardwaj is a new report to the country. Status category of every mentioned species has also been provided.

Keywords: Diversity, Hornworts, Terai, New report, Nepal

Introduction

Anthoceros (Hornworts) is a globally distributed genus. It has a characteristic horn-shaped sporophyte and is the smallest known group of bryophytes. Hornworts resemble some liverworts (Hepatics) mainly in gametophytic structure but differ in other respects. These plants bear a large, algae-like chloroplast in each thallus cell which is absent in other land plants (Proskauer, 1951). Instead of generating spores on capsule top, this plant generates spores inside the green horn-like stalk. After maturation the spores are released instantly by splitting out the stalk. The dark colored spore of *Anthoceros* easily distinguishes *Phaeoceros* which produces yellow spores.The Anthocerotae differs from other bryophytes in certain features. The thallus has homogeneous structure with simple rhizoids. Antheridia are situated in chambers which are sunk in the thallus. Archegonia are also immersed with their jacket cells and are indistinguishable from the surrounding tissues.

The thallus of *Anthoceros* grows as a dark green and irregular rosette about 1-3 cm in diameter. It may be either prostrate attached to the soil or erect with the support of surrounding vegetations. In some population bulbils (tubers) are evident especially in late spring season. They may persist after the old thallus dies off in summer (Proskauer 1948, 1951). Antheridial cavity contains 1-7 antheridia at the dorsal surface behind the apex. Archegonia are embedded behind it.

All bryophytes show the same type of life cycle which possibly arose independently in different groups. (Clarke and Duckett, 1979). The genus *Anthoceros* was first established by Micheli as early as 1729 and later was adopted by Linnaeus (1753).

About 330 species of this family are described in the world (Smith, 1996) of them eight species occur in Nepal (Pradhan, 2000). Four genera and five species of Anthocerotae and one species of Noththylaceae have been reported from Terai region below 1000 m of elevation.

Origin of Anthocerales

The cladistic analyses suggest the origin of Anthocerales probably before the Devonian period and can be considered as one of the oldest lineages of plants. The delicate hornworts may not have been easily preserved which might explain the absence of a Paleozoic record. However, it seems puzzling that their spores, which would be much more likely to be preserved, are not encountered either (Hyvonen and Piippo, 1993). A brief overview of the Anthocerotae with reference to New Zealand species was studied by Campbell (1981) who recorded only one family from this group.

Materials and methods

Simple methodology was adapted to collect specimens in the field. A simple knife was used to peel off specimens from tree barks, moist ground floor and other substratum. The collected materials were dried at room temperature and placed carefully in simple hand made paper envelopes. All the essential field data were noted down including locality, date of collection, altitude etc. Various relevant literature (Hasegawa, 1983, 1984, 1991; Asthana and Nath, 2002; Zhu and So, 1996) were consulted for identification work. All the collected materials are deposited at Natural History Museum in Kathmandu.

Results

Six species belonging to two families are described below.

Anthocerotaceae

1. *Anthoceros chambensis* Kashyap, *J. Bomb. Nat. Hist. Soc*. **25**: 281 (1917); Shrestha, *J. Nat. Hist. Mus.* **1**(2-4): 184 (1977); Pradhan, *Mats. Checklist Bryo. Nep.*: 1 (2000); Kattel, *Liverworts Nep.*: 11 (2002).

Dioecious. Thalli thick, fleshy, dark green, 15 mm long and 5 mm wide with smooth walled rhizoids. Sporophytes about 20-25 mm long; Involucre tubular which surrounds the capsule at the base, pseudo-elaters are light brown, long and branched.

Status: Moderately common

SPECIMENS EXAMINED: **C. Nepal:** ***Nawalparasi***, Triveni, 190 m, 7.11.2004, Pradhan Pn 429b (NHM). ***Nuwakot***, Trisuli, 545 m, 22.03.1977, Shrestha 10 (NHM!).

Habitat: Soil.

Distribution: Nepal (200-1600 m); India and Japan.

Note: There is no report in higher elevations.

2. *Anthoceros formosae* Steph., *Sp. Hepat.* **5**: 1002 (1964); Hasegawa, *J. Hatt. Bot. Lab.* **56**: 24-28 (1984); Jha *et al*., *J. Nat. Hist. Mus.* **9** (1-4): 66-68 (1985); D.G. Long and Grolle, *J. Hatt. Bot. Lab.* **68**: 384 (1990).

Anthoceros angustus Steph., *Taiwan Kushaku* **6**: 49 (1903).

A large patch of dark green thalli growing on humus soil. Sporophytes long, spores spherical and brown.

Status: Rare

SPECIMENS EXAMINED: **E. Nepal: *Morang***, Biratnagar, 72 m, 12.1982, Jha *et al. s.n.* (MMAC).

Habitat: Humus soil.

Distribution: Nepal (180 m); Bhutan, India (Darjeeling), South China (Taiwan) and South Japan·

3. *Anthoceros punctatus* L., *Sp. Plant*.: 1130 (1753); Shrestha, *J. Nat. Hist. Mus.* **1**(2-4): 184 (1977); Pradhan, *Mats.Checklist Bryo. Nep.*: 1 (2000); Kattel, *Liverwort Nep.*: 11 (2002).

Anthoceros crispulus (Montin) Douin, *Rev. Bryol*. **32**: 25 (1905).

Anthoceros fissus Steph, *Spec. Hep.* **5**: 1004 (1916).

Wrinkled-margin Hornwort; Dotted Hornwort (Eng.).

Monoecious. Thalli pale green, rosette, margin undulate, single perynoid in each cell along with *Nostoc* colonies. Antheridia globose about 100-150 µm in diameter, capsules 50 cm long, spores are blackish, 50 µm in diameter, pseudo elaters are pale white and thin walled.

Status: Rare

SPECIMENS EXAMINED: **C. Nepal: *Nawalparasi***, Tribeni, 200 m, 20.12.2004, Pradhan Pn 429 (NHM). ***Chitwan***, Amala Chuli, Upper Dang Gadhi, 1000-1250 m, 6.11.2004, Pradhan Pn 352, Pn 362 (NHM). ***Nuwakot***, Trisuli, 545 m, 22.03.1977, Shrestha (NHM).

Habitat: Soil.

Distribution: Nepal (200-1250 m); Japan, New Caledonia, North Africa, North America, Turkey and some European countries.

4. *Folioceros assamicus* D.C. Bhardwaj, *Geophytology* **1**(1): 10 (1971); Asthana and Nath, *J. Bryo.* **24** (4): 318-321 (2002).

Leafy Hornwort (Eng.).

Thalli dark green, dorsoventrally flattened, dichotomously branched into short strap-shaped branches of varying length. Thalli 10-15 mm long and 4-5 mm wide, margin deeply or less pinnately lobed with irregular and dentate margins. Ventral surface contains smooth walled rhizoids. Plants dioecious. Sporophytes on dorsal surface of the median region. Involucre solitary,

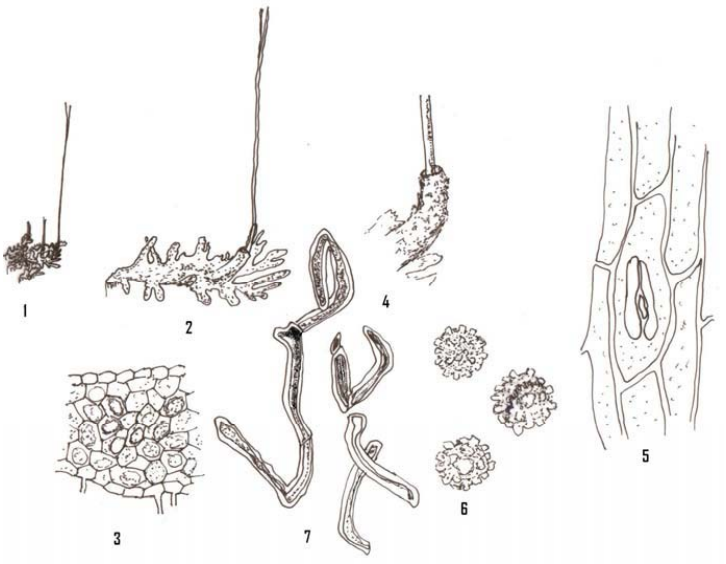

Figure 1. *Folioceros assamicus* D.C. Bhardwaj 1. habit of fertile plant; 2. fertile thallus with long capsule (x 3); 3. a portion of t.s. of thallus (x 36); 4. an involucre with a portion of a capsule (x 9); 5. epidermal layer of capsule wall with a stoma (x 800); 6. spores (x 357) and 7. elaters (x 448).

cavernous with small lamellae on the outer surface. Capsules dark green, erect, 3-5 cm long and 0.2 mm wide. Spores spherical with short tubular projections, pseudo-elaters dark brown, thick walled and measuring 225-285 µm long and 6-7 µm wide. Dehiscence of spores and elaters by opening of two valves (Figure 1).

Status: Rare, **New to Nepal.**

SPECIMENS EXAMINED: **C. Nepal: *Bara***, Hetauda- Amlekhgunj, 600 m, 27° 35.475'N; 84° 47.814'E, 26. 11.2004, Pradhan c 394 (NHM).

Habitat: Soil covered rock.

Distribution: Nepal (600 m); Asia, Africa, India and Southern Japan.

5. *Phaeoceros laevis* (L.) Prosk., *Bull. Torrey Bot. Club.* **78**: 347 (1951); Nog. and Inoue, *Bull. Nat. Sci. Mus.* **9** (3): 378 (1966); Pradhan and Joshi, *Proc. WCB*: .(2003), in Press.

Anthoceros laevis L., *Sp. Pl.* **2**: 1139 (1753).

Phaeoceros laevis sp. *laevis* (L.) Prosk., *Rapp. et Comm.VIII Congr. Int. Bot. Paris*

14-16: 69 (1954).

Phaeoceros miyakeanus Schiffn., *Oesterr. Bot. Zeitschr.* **49**: 391(1899).

Smoth Hornwort (Eng.)

Autoecious. Thalli generally dark green and appears as rosette. Cells with large chloroplast but lacks oil bodies. Antheridial cavity with 2-5 antheridia, capsules generally 15-40 mm long, involucres fleshy which surround the tubular capsule, spores yellowish brown.

Status: Common

SPECIMENS EXAMINED: **W. Nepal:** ***Kanchanpur***, Mangalshera, RSWR, 190 m, 06.01.2001, Pradhan *et al.* 45 (NHM, NBRI), 47 (NHM, NBRI), 48 (NHM). ***Dang***, Sishne Khola, 760 m, 09.11.2001, Pradhan 290 (NHM). **C. Nepal:** ***Bara,*** Pathlaiya to Amlekhjung, 200 m, 26.11.2004, Pradhan *et al*. c 507 (NHM); Agricultural farm, Kalaiya, 200 m, 26.11.2004, Pradhan c 508 (NHM). ***Parsa***, Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 506 (NHM). ***Makwanpur,*** Vindraban Garden-Hetauda, 320 m, 04.12.2004, Pradhan *et al.* c 506 (NHM); Way to Daman, 1000 m, 29.11.2004, Pradhan *et al.* c395 (NHM). ***Chitwan,*** Simal Dhap, 300 m, 20.12. 2003, Pradhan Pn 259 (NHM); **E. Nepal:** ***Morang***, Belbari, 180 m, 23.11.2003, Pradhan *et al.* e 326 (NHM); **E. Nepal:** Dumure, 1000 m, 04.1963, Yoda 11947 (TNS).

Habitat: Forest floor, Soil (intermingled with *Pallavicinia lyellii*, pn 260).

Distribution: Nepal (190-1000 m); California, China, East Asia, Formosa, Japan, Korea, North and South Africa, North America, Mexico, Philippines, South Europe and Turkey.

Notes: This species is very common below 1000 m elevation.

Notothyladaceae

6. *Notothylas levieri* Schiffn., *Sp. Hep*. **5**: 1021(1917); Hattori in Hara, *Fl. E. Him.* **1**: 503 (1966); Grolle, *Khumbu Himal*, Bd. 6, Lfg.: 119 (1974); Pradhan, *Mats. Checklist Bryo. Nep.:* 1 (2000); Pradhan, *J. Nat. Hist. Mus.* **20**: 27 (2001), Kattel, *Liverworts Nep.*: 11 (2002).

Dioecious. Thalli thin, delicate and yellowish green to dark green. Capsules dark green, ellipsoidal or bullet shaped about 1 mm long. Spores are generally dark brown, variable in shapes, usually spherical and 45 µm in diameter.

Status: Rare

SPECIMENS EXAMINED: E. Nepal: *Morang*, Panchkanya, 200 m, 07.1983, Jha *et al. s.n.* (MMAC). ***Sunsari***, Koshi Tappu, 180 m, 24.12.2003, Pradhan e 400 (NHM).

Habitat: Soil.

Distribution: Nepal (200-2200 m); India (Kumaon Himalaya).

Discussion

The genus *Foliocerос* is distinguishable from *Anthoceros* in having narrowly elongated thin walled elaters (Bharadwaj,

1971); both the genera have similar black spores with the thalli containing lucune within them. Hasegawa (1988) regarded *Foloceros* as a subgenus of *Anthoceros*. *Folioceros* has the narrowest distribution range among the six genera of the world and it occurs only in tropical and subtropical region of the world (Hasegawa, 1984). *Foloceros grandulosus* (Lehm. and Lindenb.) D.C. Bhardwaj = *Anthoceros grandulosus* Lehm. and Lindenb. was previously recorded at Bir Gaun Dingla of east Nepal at 1150 m elevation (Pradhan, 2000).

Notothylas is an isolated and interesting genus of hornwort which comprises seven species in Asia (Hasegawa, 1979). Only one species is reported in Nepal so far. The distribution of *Anthoceros chambensis* Kashyap and *Anthoceros punctatus* L. is found in central region only. *Anthoceros formosae* Steph. is recorded from a single locality of Morang district, east Nepal. *Notothylas levieri* Schffn. is a rare species and appears in rainy season. Its report comes from central and western terai besides the eastern Morang and Sunsari districts. *Anthoceros chambensis* Kashyap is recorded only from tropical region.

Acknowledgements

We are thankful to the Head, Central Department of Botany, Tribhuvan University for providing laboratory facilities. We would like to acknowledge to the Chief of Natural History Museum, Tribhuvan University for provision of research facilities. Dr. David Long, Royal Botanical Garden, Edinburgh, UK and Dr. Virendra Nath, National Botanical Research Institute, Lucknow, India are highly appreciated for providing related literature for this work concerned. Thanks go to Dr. Mohan Siwakoti, Natural History Museum for his kind co-operation.

References

Asthana, A.K. and V. Nath 2002. SEM study of the sporoderm pattern of the hornwort *Folioceros assamicus* D.C. Bhard., *Journ. of Bryol. 24(4)*: 318-321.

Bharadwaj, D. C. 1971. On *Folioceros*, a new genus of Anthocerotales. *Geophytology 1*: 6-15.

Campbell, E.O.1981. Notes on some Anthocerotae of New Zealand. *Tuatara 25 (1)*: 1-13.

Clarke, G.C.S. and J. G. Duckett (Editors) 1979: Bryophyte Systematics. Academic Press, London.

Hasegawa, J. 1979. Taxonomical studies on Asian Anthocerotae I. *Acta Phytotax. Geobot.* 30*(1-3)*: 15-30.

Hasegawa, J. 1983. Taxonomical studies on Asian Anthocerotae III. Asian species of *Megaceros*. *Journ. Hattori Bot. Lab. 54*: 227-240.

Hasegawa, J. 1984. Distribution of Japanese species of Anthocerotae. *Journ. Hattori Bot. Lab. 56*: 21-28.

Hasegawa, J. 1988. A proposal for a new system of the Anthocerotae, with a revision of the genera. *Journ. Hattori Bot. Lab. 64*: 87-95.

Hasegawa, J. 1991. Taxonomy of *Phaeoceros laevis* subsp. *carolinianus* and its allied taxa in Japan and its adjacent region. *Journ. Hattori Bot. Lab. 69*: 101-106.

Hyvonen, J. and S. Piippo. 1993. Cladistic analysis of the hornworts (Anthocerotophyta). *J. Hattori Bot. Lab. 74*: 105-119.

Linnaeus, K. V. 1753: Species Plantarum II, Stockholm.

Pradhan, N. 2000. Materials for a Checklist of Bryophytes of Nepal. The Natural History Museum, London.

Proskauer, J. 1948: Studies on the morphology of *Anthoceros* 1. *Annals of Botany N.S. 12*: 237-265.

Proskauer, J. 1951. Studies on Anthocerotales. III. *Bull. Torrey Bot. Club 78*: 331-349.

Smith, A.J.E. 1996. The Liverworts of Britain and Ireland. Cambridge University Press, 334-337 pp.

Zhu, R. L. and M.L. So. 1996. Mosses and Liverworts of Hong Kong 2. Heavenly People Depot.