ISSN 2449-8866

Current Life Sciences

Research Article

Fagaceae contribution to floral wealth of Himalaya: Checklist on diversity and distribution in North-eastern states of India

Bikarma Singh[1]*, Bishander Singh[2]

[1] CSIR-Indian Institute of Integrative Medicine, Jammu-Tawi, J&K State, India

[2] Veer Kuwar Singh University, Arrah, Bhojpur, India

*Corresponding author: Bikarma Singh; E-mail: drbikarma@iiim.ac.in

Received: 16 May 2016; **Revised submission:** 27 June 2016; **Accepted:** 13 July 2016

DOI: http://dx.doi.org/10.5281/zenodo.57840

ABSTRACT

Fagaceae members are represented by the deciduous and the evergreen economically important woody plants, having the most centre of diversity in tropical Southeast Asia. While investigating the diversity and distribution of Fagaceae, 35 species were recorded growing in different agro-climatic habitat of tropical, subtropical and temperate regions of Northeastern states in India. The genus *Quercus* investigated to be the most diverse group represented by 14 species, followed by *Lithocarpus* (11 species) and *Castanopsis* (9 species). State-wise, Arunachal Pradesh recorded the highest number of taxa (30 species) followed by Assam (27 species), Meghalaya (24 species), Sikkim (19 species), Nagaland (15 species), Manipur (12 species), Tripura (5 species) and Mizoram (4 species). This investigation reveals that the Northeastern states forms a transition zone of the Fagaceae members and have floral affinity with Greater Himalaya, Central Himalaya and Lesser Himalaya.

Keywords: Diversity; Distribution; Fagaceae; North-eastern States; India.

1. INTRODUCTION

Currently the Plant List (http://www.theplant list.org) included accepted names of 9 genera under the family Fagaceae, *viz*. *Castanea* Mill., *Castanopsis* (D. Don) Spach, *Chrysolepis* Hjemquist, *Cyclobalanopsis* (Lozano, Hdz-C. & Henao) Nixon & Crepet, *Fagus* L., *Lithocarpus* Blume, *Notholithocarpus* P.S. Manos, C.H. Cannon & S.H. Oh, *Quercus* L., and *Trigonobalanus* Forman, and these are represented by 1,101 taxa globally distributed [1]. Out of these, *Castanea* comprised of 9 species, *Chrysolepis* (2 spp.), *Cyclobalanopsis* (2 spp.), *Fagus* (11 spp.), *Notholithocarpus* (1 spp.), *Castanopsis* (140 spp.), *Lithocarpus* (336 spp.), *Quercus* (597 spp.), and *Trigonobalanus* (3 spp.). Fagaceae as a whole is important from commercial and economic point of view. The member taxa are characterized by the alternate simple leaves with pinnate venation, catkin inflorescence, flowers mainly unisexual and fruit are nuts produced in involucre bract called cupule or cup [2-6]. Besides these, the mechanism of pollination is also unique in Fagaceae. The most members usually dominates the temperate forests of Southeast Asia regions, however, the species diversity is also distributed evenly between the tropical and subtropical regions

of Central America, Southern Continental Asia and Malayan Archipelago [7, 8].

Community diversity of Fagaceae indicate that *Quercus*, *Lithocarpus* and *Castanopsis* are the most dominant climax tree species of the moist temperate forests of Himalaya, where about 55-60 species are distributed between 700-3200 m elevations [9, 10]. Northeastern states in India is globally recognized as a part of two biodiversity hotspots: Himalayas and Indo-Myanmar (formerly Indo-Burma), and these geographic belts has a long history of focal point of floristic attraction for many botanists and horticulturists. Geographically these regions are divided into eight states (*viz*., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura), and are surrounded by neighboring countries like China, Nepal and Bhutan in north, east by Myanmar and Bangladesh in south-west. These regions are characterized by undulating topography, and there is a wide gap in climatic parameters such as difference in altitude, rainfall, temperature and wide variations in soil conditions [11, 12]. These regions are important reservoir of several high altitude endemic flora and fauna, and explored by the botanists of international and national origins; however, there are still several interior regions where no floristic works have been carried out till to-date due to tough terrains and cut off barriers from snows and glaciers.

Data collected from consultation of literatures shows sporadic published works on the family Fagaceae from India and elsewhere in the world [2, 6, 13-19]. Previous studies and the most recent treatment for Indian flora suggested that there is no exhaustive work published on this family as such from Northeastern states. Keeping in mind the documentation and conservation of economic important plants of India, the present investigation was planned and carried out to assess the diversity and distribution of Fagaceae plants of Northeastern states of India. Attempts have been made to provide data on the current scenario with respect to diversity and distribution of different species of Fagaceae from eight NE states.

2. MATERIALS AND METHODS

Field exploration tours were undertaken between 2009 and 2015, and plant vouchers were collected through expeditious walks on the studied fragment. Collections of an individual tree with unique features matched with previously described taxa in Fagaceae. Fertile samples were collected and dried following usual herbarium procedures in plant collection mentioned by Jain and Rao [20]. Plants were identified by matching the collected samples with authenticated vouchers deposited at different herbaria (ASSAM, RRLH, GU), following specialized literatures in the form of monographs and revisionary works, and also taking advice from subject specialists. The voucher samples were deposited at ASSAM and GU. The presented data is based on the field collection, observations in forest, and species names were crossed checked from regional literatures.

3. RESULTS

Fagaceae inventory from Northeast India resulted in 4 genera and 35 species. The genus with the highest number of species inventorized were *Quercus* (14 species), followed by *Lithocarpus* (11 species), and *Castanopsis* (9 species). The lowest number of species is represented by the genus *Castanea* which is only 1 species. As per State-wise representation, Arunachal Pradesh has the highest number of taxa (30 species), followed by Assam (27 species), Meghalaya (24 species), Sikkim (19 species), Nagaland (15 species), Manipur (12 species), Tripura (5 species) and Mizoram (4 species). The species recorded includes *Castanea sativa* Mill., *Castanopsis armata* Spach, *Castanopsis argentea* A.DC., *Castanopsis castanicarpa* Spach, *Castanopsis echinocarpa* Miq., *Castanopsis indica* A.DC., *Castanopsis lanceifolia* (Roxb.) Hickel & A.Camus, *Castanopsis kurzii* (Hance) S.N.Biswas, *Castanopsis purpurella* (Miq.) N.P.Balakr., *Castanopsis tribuloides* (Sm.) DC., *Lithocarpus dealbatus* (Hook.f. & Thomson ex Miq.) Rehder, *Lithocarpus elegans* (Blume) Hatus & Soepandmo, *Lithocarpus fenestrata* (Roxb.) Rehder, *Lithocarpus kamengii* K.C.Sahni & H.B.Naithani, *Lithocarpus listeri* (King) Grieson & D.G.Long, *Lithocarpus milroyii* (Purkay.) Barnett, *Lithocarpus pachyphylla* (Kurz.) Rehder, *Lithocarpus polystachya* Rehder, *Lithocarpus truncata* Rehder, *Lithocarpus xylocarpa* (Kurz) Markgr., *Lithocarpus wrayii* (King) A. Camus, *Quercus acutissima* Carruth., *Quercus*

griffithii Hook.f. & Thomson ex DC., *Quercus glauca* Thunb., *Quercus helferiana* A.DC, *Quercus kamroopii* D.Don, *Quercus lamellosa* Sm., *Quercus lanata* Sm., *Quercus leucotrichophora* A.Camus, *Quercus olla* Kurz., *Quercus oxyodon* Miq., *Quercus rex* Hemsl., *Quercus semecarpifolia* Sm., *Quercus semiserrata* Roxb., *Quercus thomsoniana* A.DC. The details of state-wise species diversity and distribution is presented in Table 1. While investigation, it was recorded that *Lithocarpus kamengii* and *Quercus rex* are two important endemic woody plants of Arunachal Pradesh. *Quercus olla* is endemic to Assam. Three species *viz.*, *Lithocarpus milroyii*, *Quercus leucotrichophora* and *Quercus lanata*, are endemic to both Arunachal Pradesh and Sikkim, as it share same altitude distribution. *Castanopsis tribuloides, Lithocarpus dealbatus, Lithocarpus fenestrata, Quercus lamellosa* are the most common Fagaceae members distributed throughout Northeastern states in Himalaya. Some species are presented on the photos 1-6.

Photo 1. *Quercus griffithii* Hook.f. & Thomson ex DC.

Photo 2. *Castanopsis indica* A. DC.

Photo 3. *Lithocarpus dealbatus* Rehder.

Photo 4. *Lithocarpus fenestrata* (Roxb.) Rehder.

Photo 5. *Castanopsis tribuloides* (Sm.) DC.

Photo 6. *Quercus glauca* Thunb.

4. DISCUSSION

Several species of Fagaceae members are commercial important timber bearing tree species growing mainly in broad-leaved evergreen and mixed mesophytic forests. Oak wood is useful as timber and used for specialized construction of pillars, woodworking and cooperage. White oak timber is the principle wood used by the wine and liquor industry for construction of barrels. As per literature (http://dept.ca.uky.edu), the bark of Mediterranean oak is used as natural cork in Spain, Portugal and Morocco. The *Castanea* species are used as edible nuts in many countries. Species of *Fagus* used as hedge in European countries and some are also cultivated for this purpose.

Chemical analysis through HPLC-MS studies shows that *Quercus* are main constituent of phenolic compounds such as ellagic acid, gallic acid, protocatechuic acid, salicylic acid, eriodictyol, naringenin, quinic acid and hydroxyphenyllactic acid. Chemical analysis shows that nuts of *Quercus* and *Lithocarpus* contain copious amounts of water soluble tannin, which reported to be responsible for decrease in food intake, hampers growth rate, and therefore, such fruits are not considered to be safe for human consumption.

Table 1. State-wise distribution of Fagaceae in Northeastern states of India.

Sl. No.	Name of species	State-wise distribution							
		Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
1.	*Castanea sativa* Mill.	-	+	-	+	-	-	+	-
2.	*Castanopsis armata* Spach	+	+	-	+	+	-	+	+
3.	*Castanopsis argentea* A.DC.	+	+	-	+	-	+	-	-
4.	*Castanopsis castanicarpa* Spach	+	+	+	-	-	-	-	-
5.	*Castanopsis echinocarpa* Miq.	+	+	+	+	-	+	-	-
6.	*Castanopsis indica* A.DC	+	+	-	+	-	-	+	+
7.	*Castanopsis lanceifolia* (Roxb.) Hickel & A.Camus	+	+	+	+	-	-	+	-
8.	*Castanopsis kurzii* (Hance) S.N.Biswas	+	+	-	+	+	-	-	-
9.	*Castanopsis purpurella* (Miq.) N.P.Balakr.	+	+	-	+	-	+	+	-
10.	*Castanopsis tribuloides* (Sm.) DC.	+	+	+	+	-	+	+	+
11.	*Lithocarpus dealbatus* (Hook.f. & Thomson ex Miq.) Rehder	+	+	-	+	+	+	+	-
12.	*Lithocarpus elegans* (Blume) Hatus & Soepandmo	+	+	+	+	-	+	+	+
13.	*Lithocarpus fenestrata* (Roxb.) Rehder	+	+	-	+	-	+	+	-
14.	*Lithocarpus kamengii* K.C.Sahni & H.B.Naithani	+	-	-	-	-	-	-	-
15.	*Lithocarpus listeri* (King) Grieson & D.G.Long	+	+	-	+	+	-	-	-
16.	*Lithocarpus milroyii* (Purkay.) Barnett	+	+	-	-	-	-	-	-
17.	*Lithocarpus pachyphylla* (Kurz.) Rehder	+	+	+	-	-	+	+	-
18.	*Lithocarpus polystachya* Rehder	-	+	+	+	-	-	-	-
19.	*Lithocarpus truncata* Rehder	-	+	+	-	-	+	-	-
20.	*Lithocarpus xylocarpa* (Kurz) Markgr.	+	+	+	+	-	+	-	-
21.	*Lithocarpus wrayii* (King) A.Camus	+	+	-	+	-	-	-	-
22.	*Quercus acutissima* Carruth.	+	-	-	-	-	-	+	-
23.	*Quercus griffithii* Hook.f. & Thomson ex DC.	+	-	+	+	-	-	+	-
24.	*Quercus glauca* Thunb.	+	-	-	+	-	+	+	-
25.	*Quercus helferiana* A.DC	+	+	+	-	-	-	-	-
26.	*Quercus kamroopii* D.Don	+	+	-	+	-	+	+	-
27.	*Quercus lamellosa* Sm.	+	+	+	+	-	+	+	-
28.	*Quercus lanata* Sm.	+	-	-	-	-	-	+	-
29.	*Quercus leucotrichophora* A.Camus	+	-	-	-	-	-	+	-
30.	*Quercus olla* Kurz.	-	+	-	-	-	-	-	-
31.	*Quercus oxyodon* Miq.	+	-	-	+	-	+	-	-
32.	*Quercus rex* Hemsl.	+	-	-	-	-	-	-	-
33.	*Quercus semecarpifolia* Sm.	+	+	-	+	-	-	-	-
34.	*Quercus semiserrata* Roxb.	+	+	-	+	-	+	+	+
35.	*Quercus thomsoniana* A.DC	-	+	-	+	-	-	+	-
	Total	30	27	12	24	4	15	19	5

Note: + sign indicates present and – sign indicates not found

Similarly, *Castanea sativa* analysis shows gallic acid, protocatechuic, vanillic, syringic, ferulic, ellagic, aldehydes protocatechuic, vanillic, syringic, coniferylic, sinapic, and coumarin scopoletin.

Northeastern states of India is well explored from floristic points of view [21-28], and many of the published literatures highlighted the economic importance of Fagaceae members. Nuts of *Castanea sativa*, *Castanopsis indica*, *Castanopsis purpurella*, *Castanopsis tribuloides* and *Lithocarpus xylocarpus* comes as wild edible plants or NTFP of tribal people of Himalaya and nuts are commercially sold at local market. The most common *Castanopsis indica* has medicinal potential. Ethnobotanical point of view, a decoction of the leaves of *Castanopsis indica* is applied to treat stomach disorders and skin infections, grinded powder of its leaves used to cure indigestion and resin obtained from plants is useful in curing diarrhea; bark paste is used to control chest pain [29-30]. Bioactivity shows that ethanol (50%) extract from stem bark of *Castanopsis indica* have anticancer activity in KB cancer cell and phostidylserine targeting antibody system [31]. Similarly, there are several other species under the family which has tremendous potential as a source of medicine and as for food.

Seeing the potential of economic uses, and from conservation point of view, there is urgent need to conserve the natural occuring species of Fagaceae because they form a keystone species for climax community. Many life of wild population of mammals like monkey and birds heavily depends on wild edible fruits available in forests. *Lithocarpus milroyii*, *Quercus leucotrichophora*, and *Quercus lanata* recorded to occur rarely in nature and their distribution is restricted to few forest pockets only. *Lithocarpus kamengii* and *Quercus rex* are two economically important endemic trees of Himalayas and such species needs special attention. Further research considering parameters related to ecology and conservation would be a great service to the society.

ACKNOWLEDGEMENT

Authors are grateful to Director IIIM, and Deputy Director ASSAM herbarium for the necessary facilities and for encouragement.

AUTHORS' CONTRIBUTION

Both the authors carried out the R&D work associated with Fagaceae. The first author planned the study, corrected the manuscript and authenticated the voucher samples. The second author helped in field work, identification of plant samples and manuscript preparation. The final manuscript has been read and approved by both authors.

TRANSPARENCY DECLARATION

The authors declare no conflict of interest and no funding agency for this article.

REFERENCES

1. TPL. The Plant List, a working list of all known plant species. Version1.1, released in September 2013. http://www.theplantlist.org (accessed 16.04. 2016).
2. Biswas SN. Nomenclatural changes in *Castanopsis spach* (Fagaceae). Bull Bot Surv India. 1969; 11(1-2): 189-190.
3. Anonymus. Fagaceae (family) - Magnoliophyta, Magnoliopsida, Fagales. http://www.boldsystems.org/index.php/TaxBrowser_Taxonpage?taxid=101008 (accessed 27.06.2016).
4. Soepadmo E. Fagaceae. Flora Malesiana Series I, Volume 7 (2). Rijksherbarium, Hortus Botanicus, Leiden University, Leiden, The Netherlands, 1972.
5. Phengklai C. Three new species and a new variety of Fagaceae from Thailand. Thai Forest Bull. 2004; 32: 115-122.
6. Hooker JD. The Flora of British India. L. Reeve & Com., Ltd., Ashford, Kent (5), 1890.
7. Manos PS, Zhou ZK, Cannon CH. Systematic of Fagaceae: phylogenetic tests of reproductive trail evolution. Int J Pl Sci. 2002; 162(6): 1361-1779.
8. Strijk JS, Sirimongkol S, Rueangruea S, Ritphet N, Chamchuroon V. *Lithocarpus orbicarpus* (Fagaceae), a new species of Stone Oak from Phang Nga province, Thailand. PhytoKeys. 2014; 34: 33-46.
9. Singh Bikarma, Roy D, Barbhuiya HA, Daimary R. Note of *Quercus griffithii* Hook.f. & Thomson ex Miq.: an interesting wild economic plants of North-East India. J Non-Timber Forest Prod. 2009; 16(3): 205-206.
10. Kanjilal UN, Kanjilal PC, De RN, Das A. Flora of Assam. Government Press, Shillong. 1940; 4: 304-325.

11. Singh B. Arboreal Flora of Nokrek Biosphere Reserve. Thesis (unpublished), Gauhati University, Assam, India, 2012.
12. Singh B. Himalayan orchids: distribution and taxonomy. Write & Print Publications, New Delhi, India, 2015.
13. Deb DB. The Flora of Tripura State. R.K. Jain, Today & Tomorrow's Printer and Publishers, New Delhi, India. 1981; 1: 200-203.
14. Balakrishnan NP. Flora of Jowai, Meghalaya. Botanical Survey of India, Howrah, India, 1983.
15. Haridasan K, Rao RR. Forest Flora of Meghalaya. Bishen Singh Mahendrapal Singh. Dehradun, India. 1987; 2: 854-864.
16. Grierson AJC, Long DG. Flora of Bhutan. Royal Botanic Garden, Edingburgh (London) and the Royal Govt. of Bhutan. 1983; 1(1): 75-82.
17. Giri GS, Pramanik A, Chowdhery HJ. Materials for the Flora of Arunachal Pradesh. Botanical Survey of India, Salt Lake City, Kolkata, India. 2008; 2: 427-434.
18. Barik SK, Pandey HN, Tiwari BK, Singh B. Sacred Groves of Meghalaya: a scientific and conservation perspective. Regional Centre-National Afforestation and Eco-Development Board, Ministry of Environment and Forest, Govt. of India, 2006.
19. Manos PS, Stanford AM. The historical biogeography of Fagaceae: Tracking the tertiary history of temperate and subtropical forests of the Northern Hemisphere. Int J Pl Sci. 2001; 162: S77-S93.
20. Jain SK, Rao RR. A handbook of field and herbarium methods. Today and Tomorrow's Printer Publisher, New Delhi, India, 1977.
21. Hajra PK. Nature conservation in Khasi folk beliefs and taboos. In: Glimpses of India ethnobotany. Jain SK, ed. Oxford & IBH Publishing Co, New Delhi. 1981; 149-152.
22. Singh B, Shanpru R. Ethnobotanical plants in sacred forests of Meghalaya. Ann For. 2010; 18: 270-282.
23. Singh B, Borthakur SK. Phenology and geographic extension of lycophyta and fern flora in Nokrek Biosphere Reserve in eastern Himalaya. Proc Natl Acad Sci India Sect B Biol Sci. 2014; 85: 291-301.
24. Singh B, Borthakur SK, Phukan SJ. A survey of ethnomedicinal plants utilized by the indigenous people of Garo Hills with special reference to the Nokrek Biosphere Reserve (Meghalaya), India. J Herbs Spices Med Pl. 2014; 20: 1-30.
25. Singh B, Singh VN, Sinha BK, Phukan SJ, Borthakur SK. *Harpullia arborea* (Blanco) Radlk. - a new record to Meghalaya. J Non-Timber Forest Prod. 2011; 18(3): 237-238.
26. Dey S, Das R, Singh Bikarma, Das A. *Christisonia keralensis* Erady - a new record for North-east India. Indian J Forest. 2010; 33(4): 623-624.
27. Singh B, Singh VN, Sinha BK, Phukan SJ, Borthakur SK. The genus *Bauhinia* L. (Caesalpinaceae) in Nokrek Biosphere Reserve, Meghalaya. Phytotaxonomy. 2010; 10: 17-23.
28. Roy D, Singh B. *Tibouchina semidecandra* Cong. (Melastomaceae): a rare, little known ornamental plant escape in Meghalaya. J Econ Tax Bot. 2010; 34(2): 398-400.
29. Malla B, Chhetri RB. Indigenous knowledge on ethnobotanical plants of Kavrepalanchowk District. J Sci Eng Tech. 2009; 5: 96-109.
30. Joshi K, Joshi R, Joshi AR. Indigenous knowledge and uses of medicinal plants in Macchegaun, Nepal. Indian J Trad Knowl. 2011; 10: 281-286.
31. Pant P, Rastogi RR. Castonopsone and castonopsol two new triterpenoids from *Castanopsis indica*. Phytochem. 1977; 17: 1787-1789.