

Status documentation of *Dioscorea* L. (Dioscoreaceae) in Meghalaya: an approach towards food security

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Abstract

Root tuber of different species of *Dioscorea* L., commonly called as yam provide staple food crop for over 100 million people in the humid and subhumid tropics. Out of around 600 spp. of *Dioscorea*, about 50 species including few varieties has been reported from India. So far there is no well documented report on *Dioscorea* from Northeast India, which constitute an important part of Himalaya Biodiversity Hotspot. This article reports the status of 16 species of *Dioscorea* in the Northeast Indian state of Meghalaya. Three of these species (*D.alata*, *D.bulbifera* and *D.esculenta*) are commonly cultivated. Genetic improvement of cultivated yams is imperative since many wild relatives are available and at the same time mass cultivation of such edible species will assist in future food security programs.

Key words: *Dioscorea*, conservation, food security, Meghalaya, India

INTRODUCTION

Dioscorea L. is an important and commercially potential monocotyledonous genus, including over 600 species (Coursey 1967), is the largest genus of Dioscoreaceae distributed in tropical and subtropical regions of the world. Of these, seven species constitute the most important staple yams, but many of the wild yams are also important food plants. It is a pan-continental genus, found in Africa, India, Southeast Asia, Australia and tropical America (Jayasurya 1984), with about 630 scientifically described taxa. Species of *Dioscorea* is important both taxonomically and economically. Several species of *Dioscorea* are staple food for many tribal people. There are about 50 species found in India (Anonymous 1952) and many of these are found in Northeast India. Apart from the sporadic reports like Baishya *et al* (2002) and Saikia *et al* (2008) the status of the genus in Northeast India is not properly explored. The present report is to explore the status of *Dioscorea* in Meghalaya. The economic values of all the species growing in Meghalaya also recorded with special reference to their food value. A key to the easy identification of Meghalayan species of the genus is also provided.

Study area

Meghalaya, one of the 8 states of Northeastern region of India, lies between 25°5' N and 26°10' N latitude and 89°47' E and 92°47' E longitude covering an area of 22,429 sq km (Fig. 1). It is surrounded on the north and east by the state of Assam, on the west partly by Assam and partly by Bangladesh and the entire south by Bangladesh. The region has rich tropical and subtropical vegetation. It also receives the highest rainfall in the world. Several species of *Dioscorea* grow luxuriantly in wild habitat. During this study several localities were surveyed and specimens were collected.

MATERIALS AND METHODS

Field survey was conducted during October 2007 to December 2008. Appropriate specimens were collected and were processed into mounted herbarium sheets following the method of Jain & Rao (1977). Some interesting species are introduced to Botanical garden NEHU for further study. These specimens were identified with the help of literature (Hooker 1892; Prain & Burkill 1908; Rao & Verma 1973) and consulting the ASSAM herbarium. All the voucher specimens were deposited in the Herbarium of Botany Department, NEHU, Shillong. For understanding the status of each species

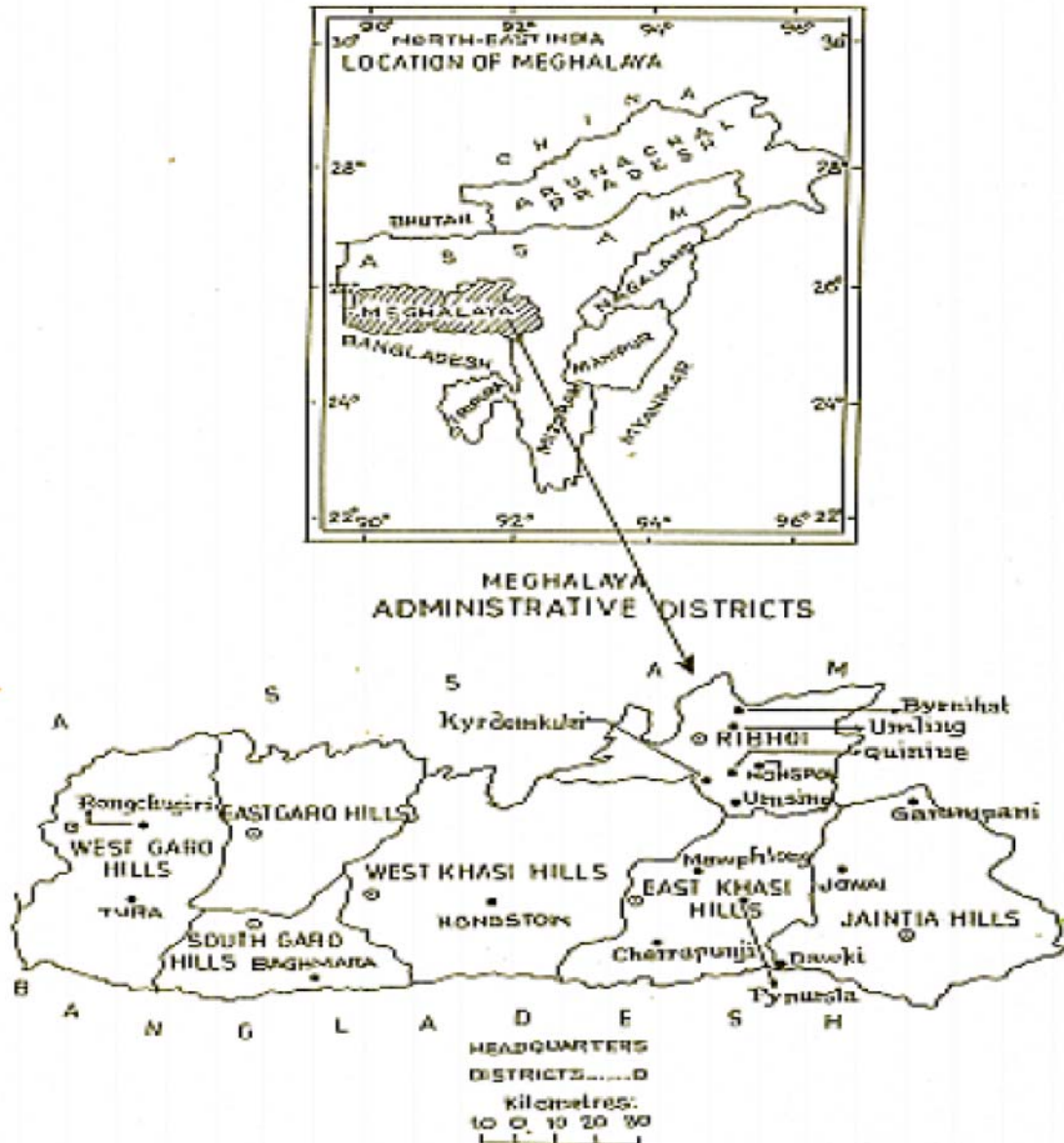


Fig. 1: Location map of study area.

in the world and in India redlists of IUCN and Botanical Survey of India were consulted. Status of the recorded species in Meghalaya was determined out based on our field work and earlier records on the genus from the state (Balakrishnan 1983; Joseph 1982). Economic aspect of the genus is based on our local survey and literatures cited below.

RESULTS

Taxonomy and status of genus *Dioscorea* in Meghalaya

Dioscorea L. is characterized by tubers stalked or not, elongated to globose, bearing superficial rootlets (sometimes armed). Stem climbing, twining to left or right, with or without recurved prickles, axillary bulbils often present. Dioecious. Male flowers borne singly or in clusters on spikes; spikes

aggregated along leafless axes, axes axillary and terminal, or in axillary fascicles; stamens 6 or 3 alternating with staminodes; female flowers with bifid stigma and inferior 3-celled ovary, narrowly ellipsoid, locules each with 2 ovules, style short, stout; stigmatic ridges 3. Capsule broadly 3-winged, shortly stipitate, dehiscent from apex, sometimes reflexed. Seeds 2 in each cell, compressed, with a large membranous wing; albumen compressed, fleshy or hard, 2-laminated; embryo between the blades; cotyledons suborbicular.

Key to the species

- 1a. Plant twinning to right; leaves simple; capsules not reflexed against spike axis 2
- 1b. Plant twining to left; leaves simple or compound; capsule reflexed 9
- 2a. Stem angled or ridged. 3
- 2b. Stem terete 5
- 3a. Stem angled; leaves opposite on thicker stem, often alternating towards end of stem; male flowers on zigzag axis *D. hamiltonii*
- 3b. Stem ridged or winged 4
- 4a. Stems 4 angled prominently winged; leaves opposite or rarely alternate *D. alata*
- 4b. Stems ridged, neither angular nor winged; lower leaves alternate, upper leaves opposite *D. belophylla*
- 5a. Plant (especially infl.) pubescent *D. puber*
- 5b. Plant glabrous 6
- 6a. Stem armed 7
- 6b. Stem unarmed; Leaves alternate, lanceolate to elliptic, ovate, 3 nerved; bulbils abundant *D. trinervia*
- 7a. Leaves alternate, 5 nerved, ovate, rounded or cordate at base *D. glabra*
- 7b. Leaves opposite or subopposite, 7 nerved, broadly ovate-cordate, acuminate or apiculate *D. wallichii*
- 8a. Leaves simple 9
- 8b. Leaves compound 11
- 9a. Stem armed; leaves alternate, cordate to broadly cordate with deep obtuse sinus, 9-13 nerved; petiole with small prickles *D. esculenta*
- 9b. Stem unarmed; leaves 7 nerved 10
- 10a. Petioles winged, bulbil abundant; petals and sepals linear, whitish, over 2 mm; capsules oblong in outline *D. bulbifera*
- 10b. Petioles unwinged, bulbil rare; petals and sepals inconspicuous, greenish, under 2 mm *D. deltoidea*
- 11a. Middle leaflet 3 costate; fertile stamens 6; capsules 4-6cm long *D. hispida*
- 11b. Middle leaflet 1 costate; fertile stamens 3; capsules 1-3 cm long 12
- 12a. Leaves 3 foliate; male flowering axis on leafless branches only; stem not prickly, bulbil not seen *D. arachidna*
- 12b. Leaves 3-7 foliate, male flowering axis axillary or on leafless branches; stem sometimes prickly, glabrous to villous; usually with bulbils 13
- 13a. Leaflets broadly oblanceolate or ovate; hairs red-brown or white; stem usually prickly; capsule apex slightly truncate *D. pentaphylla*
- 13b. Leaflets ovate-lanceolate, sometimes obovate; hairs white, capsule apex obtuse 14
- 14a. Stem villous when young; bulbils few or sometimes absent, hairy leaflets ovate-elliptic, the middle one upto 10 x 6 cm *D. kamoensis*
- 14b. Stem glabrous; bulbils numerous, in almost every leaf axil; leaflets lanceolate, glabrescent, the middle one upto 12x2.5 cm *D. melanophyma*

ENUMERATION

Through field survey and literature consultation the various species of *Dioscorea* were collected and identified. The 16 species recorded from Meghalaya are enumerated as follows:

Dioscorea alata L., Sp. Pl.: 1033. 1753; Hook. *f.* Fl. Brit. India 6: 296. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 201. 1973.

Distribution: Throughout tropical India and East & West Khasi hills, Garo hill district in Meghalaya; Bhutan.

Exsiccatae: Ri- Bhoi district, Nongpoh, Umling, *ca* 750 m, *Nilofer 030* dated 05.11.2007.

Dioscorea arachidna Prain & Burkill, J. As. Soc. Beng. n. s. 10: 21, 1914; Rao & Verma, Bull. Bot. Surv. India 15: 193. 1973.

Distribution: North-Eastern India, Khasi and Jaintia hills in Meghalaya; China.

Exsiccatae: Jaintia hills district, Mawkyndur, *Nilofer 050* dated 07.05.2008.

Dioscorea belophylla (Prain) Haines, For. Fl. Chota Nagpur: 530. 1910; Burkill & Prain, Ann. Roy. Bot. Gard. Cal. 14: 302. 1936; Hook. *f.*, Fl. Brit. India 6: 294. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 199. 1973.

Distribution: North-East India, Umpling, Shillong Peak area in Meghalaya; Bhutan, Bangladesh.

Exsiccatae: Ri- Bhoi district, Umling *ca* 750 m, *Nilofer 036* dated 16.11.2007.

Dioscorea bulbifera L., Sp. Pl.: 1033. 1753; Hara, Fl. East Himal.: 419. 1966; Hook. *f.*, Fl. Brit. India 6: 295. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 207. 1973.

Distribution: Throughout tropical and subtropical regions of India, East Khasi hills, West Garo hills in Meghalaya; China, Burma.

Exsiccatae: East Khasi hills district, Umshing, alt. 1930 m, *Nilofer 031* dated 10.11.2007.

Dioscorea deltoidea Wallich *ex* Hook. *f.*, Fl. Brit. Ind. 6: 291. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 196. 1973.

Distribution: Temperate Himalaya including Khasi Hills in Meghalaya; Afghanistan, Bhutan.

Exsiccatae: East Khasi Hills, Kyrdemkulai, *Myrthong 3183*.

Dioscorea esculenta (Loureiro) Burkill, Gard. Bull. Str. Setll. 1: 396. 1917; Rao & Verma, Bull. Bot. Surv. India 15: 196. 1973.

Distribution: Tropical moist regions of India, Garo hills, East Khasi Hills and Jaintia hills in Meghalaya; Bhutan, China.

Exsiccatae: East Khasi hill district, Barapani, *Nilofer 043* dated 20.11.2007.

Dioscorea glabra Roxburgh, Fl. Ind. 3: 803. 1832; Hook. *f.*, Fl. Brit. India 6: 294. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 199. 1973.

Distribution: Tropical and subtropical Himalayan region and East Khasi hills and Ri-bhoi district in Meghalaya; South-Eastern Asia, Nepal.

Exsiccatae: Barapani area, *ca* 900 m, *Nilofer 033* dated 16.11.2007.

Dioscorea hamiltonii Hook. *f.*, Fl. Brit. India 6: 295. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 200. 1973.

Distribution: Tropical regions in India extending up to subtropical regions and in Cherrapunji and Nongpoh area in Meghalaya; China, Bhutan.

Exsiccatae: Ri-Bhoi district, Nongpoh, *ca* 750 m, *Nilofer 034* dated 16.11.2007.

Dioscorea hispida Dennstaedt, Schluss. Hort. Malab. 33. 1818; *D. daemona* Roxburgh, Fl. Ind. 3: 805. 1832; Hook. *f.*, Fl. Brit. India 6: 289. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 193. 1973.

Distribution: Tropical forests in India and Garo hills and Nongpoh area in Meghalaya; New Guinea, Burma.

Exsiccatae: East Khasi Hills, *Nilofer 048* dated 21.12.2007.

Dioscorea kamooneensis Kunth, Enum. Pl. 5: 395. 1850; Hook. *f.*, Fl. Brit. India 6: 290. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 194. 1973.

Distribution: Tropical and subtropical regions in India and East Khasi hill and Jaintia district in Meghalaya; China, Bhutan.

Exsiccatae: Jaintia Hills, Garumpani, Jarain, *Nilofer 052* dated 18.10.2008.

Dioscorea melanophyma Prain & Burkill, Prain & Burkill, J. Asiatic Soc. Beng. S. 4: 452. 1908; Rao & Verma, Bull. Bot. Surv. India 15: 196. 1973.

Distribution: tropical India extending up to subtropical regions and Khasi and Jaintia hill district in Meghalaya; China, Bhutan.

Exsiccatae: Upper Shillong, *Myrthong 2985*.

Dioscorea orbiculata Hook. *f.*, 6: 292. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 197. 1973.

Distribution: Tropical and subtropical regions of Northeast India, Khasi hills in Meghalaya; Sumatra, Malaya Peninsula.

Exsiccatus: East Khasi Hills, *Nilofer 051* dated 10.10.2008.

Dioscorea pentaphylla L., Hook. *f.*, Fl. Brit. India 6: 289. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 193. 1973.

Distribution: throughout India in Himalayas and in Andaman Island, widely distributed in Meghalaya; Wetter part of tropical Asia.

Exsiccatus: Ri-Bhoi district, Nongpoh, *ca 750 m, Nilofer 038* dated 28.11.2007.

Dioscorea puber Blume, Enum. Pl. Java 1: 21. 1927; Rao & Verma, Bull. Bot. Surv. India 15: 199. 1973; *D. angiunea* Roxburgh, Fl. India 3: 803. 1832; Hook. *f.*, Fl. Brit. India 6: 293. 1892.

Distribution: Tropical and sub-tropical regions of India, Jaintia hills and East Khasi hills in Meghalaya; Bhutan.

Exsiccatus: Ri-Bhoi district, Nongpoh, *ca. 750 m, Nilofer 037* dated 28.11.2007.

Dioscorea trinervia Roxburgh *ex* Prain & Burkill, J. Asiatic Soc. Beng. n.s. 10: 32. 1914; Rao & Verma, Bull. Bot. Surv. India 15: 197. 1973.

Distribution: Tropical regions of India, Khasi hill and Ri-Bhoi district in Meghalaya.

Exsiccatae: Ri-Bhoi district, Nongpoh, *ca. 750 m, Nilofer 039* dated 28.11.2007.

Dioscorea wallichii Hook. *f.*, Fl. Brit. India 6: 295. 1892; Rao & Verma, Bull. Bot. Surv. India 15: 200. 1973.

Distribution: tropical areas in India and East- Khasi hill district in Meghalaya; Burma.

Exsiccatus: Kyrdemkulai, *Myrthong 2999*.

DISCUSSION

The present investigation of *Dioscorea* L. has recorded the occurrence of its 14 species in the state of Meghalaya, India. While, in one hand, it is one economically important genus, at the same time, identification of its highly overlapping species quite often create confusion specially in the field condition.

Food and Economic aspect

Yams (*Dioscorea* spp.) constitute a staple food crop for over 100 million in the humid and subhumid tropics. Tuberos root-stock of several species is edible and is counted next to potato in its food

Plate I



Figs. A - D: A. *Dioscorea* spp. in the habitat; B. *Dioscorea alata* L.; C & D. *Dioscorea bulbifera* L.

value. In fact, species like *D. alata*, *D. esculenta* and *D. bulbifera* are the most worldwide cultivated true yams for their tubers which are rich source of starch that form an important dietary supplement. Apart from starch the root tubers of *Dioscorea* also contain protein, fats, fibers and among minerals nutrients Potassium, Sodium, Phosphorus, Calcium, Magnesium, Copper, Iron, Manganese, Zinc

and Sulphur containing amino acids (Bhandari *et al.* 2003). “Diosgenin” is a pharmacologically active component of *Dioscorea* obtained from its root-stock which is one of the most costly and important steroidal drug used worldwide. This dietary PEs (plant estrogens) of *Dioscorea* can provide wide range of health benefits including protection against development of some cancers, osteoporosis, cardiovascular disease, nephritis, asthma, diabetes, used in preparation of contraceptives and in the treatment of various genetical disorders (Sharma 2004). Edible species along with other medicinal uses of *Dioscorea* found in Meghalaya are presented in Table 1.

Table 1. Edible and useful species of *Dioscorea* growing in Meghalaya.

Species	Part used	Uses/potential uses
<i>Dioscorea alata</i>	Tuber/ bulbil	Tuber is Edible,boiled and cooked(5,9,12);Boiled bulb is taken orally twice a day for 15 days to cure piles and gonorrhoea(7); Tuber is also taken orally for treatment of piles and leprosy(6).
<i>Dioscorea arachnida</i>	Tuber	Tuber is cooked and eaten(1,4)
<i>Dioscorea belophylla</i>	LeavesTuber	Boiled and cooked tuber is edible, (12, 4); fresh leaves juice is given to drink to treat jaundice, to treat mumps, fresh leaves extract in hot water is taken twice daily (11).
<i>Dioscorea bulbifera</i>	Tuber	Boiled and cooked tuber is edible, (1, 12); one teaspoonful of tuber powder is given orally with water as single dose once only to cure abdominal pain (10).
<i>Dioscorea deltoidea</i>	Tuber/young leaves & stems	Tuber are useful as uterine sedative, haemostatic, diueretic and expectorant. The herbs is used to expel worms from the body (3).
<i>Dioscorea esculenta</i>	Tuber	Boiled and cooked tuber is edible (5)
<i>Dioscorea glabra</i>	Tuber	Boiled and cooked tuber is edible, (2)
<i>Dioscorea hamiltonii</i>	Tuber	Boiled and cooked tuber is edible (4, 12)
<i>Dioscorea hispida</i>	Tuber	Boiled and cooked tuber is edible (4)
<i>Dioscorea pentaphylla</i>	Tuber, flowers young shoot	Taken as vegetables (5) tubers are boiled and eaten (1); Leaf & paste mixed with mustard oil is rubbed on the effected part to treat rheumatism (11).
<i>Dioscorea puber</i>	Tuber, Bulbil	Tuber is eaten (4, 12); tuberous rhizome and Bulbil are cooked and given to cure colic pain (8)
<i>Dioscorea trinervia</i>	Tuber	Tuber is edible, boiled and cooked (4,12)
<i>Dioscorea wallichii</i>	Tuber	Boiled and cooked tuber is edible (4,9)

[1. Borthakur 1996; 2.Elanchezian *et al.* 2007; 3. Hamayun 2007; 4. Jain 1991; 5.Kulkarni & Kumbhojkar1993; 6.Lalfakzuala *et al.* 2007; 7. Mahato & Choudhury 2005; 8. Pandey & Rout 2006; 9. Prasad *et al.* 2002; 10. Punjani 2007; 11. Rahman *et al.* 2007; 12. Sinha 1996]

All the 16 species documented so far from this region are distributed in wild habitat. Out of this 16 species of *Dioscorea*, *D. deltoidea* is endangered and also included in IUCN red list due to over-exploitation for its economically important medicinal value. Despite of availability of 13 edible species in this region, only 2 are used as edible food. There is no proper mass cultivation or conservation of such species in this region. *D. alata*, *D. bulbifera* and *D. pentaphylla* grow luxuriantly within pine forests of Meghalaya. Pine trees provide leave litter humus and conveniently support for climbing. The hill slopes in Barapani and Nogpoh are with plenty of siblings of *Dioscorea* spp., with a density of 3-7 species per sq. m area. However due clearing of forests and landslides during heavy rain these natural habitats are severely depleted. Considering the economic aspect of this crop it is required to conserve the germplasm of the genus. Molecular level studies on wild species will surely help in improving the edible species. Yams are easily cultivated crop suitable in loamy humus soil, readily propagated by top or underground tubers and can be harvested within a year.

From the market survey conducted in the study it was found that the price of 1 kg of Yam tuber cost about Rs.10 – 20. Therefore introduction of mass cultivation and conservation of such species will be benefitting. All such efforts in long run will establish food security of our poor people.

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Plate II



Figs. E - H: E. *Dioscorea pentaphylla* L.; F. *Dioscorea trinervia* Roxburgh; G. Male inflorescence of *D. trinervia*; H. Bulbils of *D. trinervia*.

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