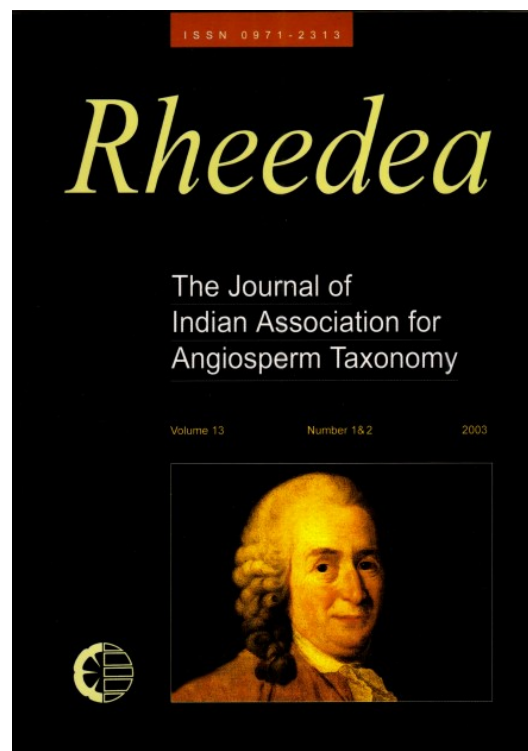




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# On the Identity of and Sterility in *Nymphaea rubra* Roxb. ex Andrews (Nymphaeaceae)

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## Abstract

*Nymphaea rubra* Roxb. ex Andrews has been interpreted differently by various authors after the name was validly published by Andrews in 1808. The diagnostic characters given in different Floras are also at variance. A study of literature, herbarium holdings and fresh materials collected proves that *N. rubra* is a sexually reproducing species unlike reported earlier. These reports wrongly emphasized sterility in this species and suggested propagation exclusively through vegetative means. This widely distributed species was excluded in a number of Floras since its distinctive characters were less known and unverifiable in herbarium specimens. It is conspecific neither with *N. nouchali* Burm. f. nor with *N. pubescens* Willd. A review of presentation of *N. rubra* in Indian Floras is provided together with a key to the species in southern India.

**Keywords:** *Nymphaea rubra*, *Nymphaea nouchali*, *Nymphaea pubescens*, Sterility, Fruit set

## Introduction

The taxonomic treatment of species of *Nymphaea* L. appears very difficult due to variations in flower colour, hybridization and ploidy in different species (Mitra and Subramanyam, 1983). Roxburgh (1832) in his *Flora Indica* dealt with six species viz.: *N. rubra* Roxb., *N. lotus* Willd., *N. versicolor* Roxb., *N. cyanea* Roxb., *N. esculenta* Roxb. and *N. stellata* Willd. Hooker f. and Thomson (1855, 1872) lumped these six species into two, viz.: *N. lotus* (= *N. pubescens* Willd.) and *N. stellata* Willd. (= *N. nouchali* Burm. f.), the rest including *N. rubra* were reduced to varieties. Prain (1903), Conard (1905) and Biswas and Calder (1954), and maintained *N. rubra* as a separate species for its distinctive red coloured flower. Mitra (1990, 1993) recognised a total of six species for India, which included *N. alba* L., *N. candida* K. Presl, *N. tetragona* Georgi (all distributed in Kashmir and the last one extended to the E. Himalayas), *N. nouchali* Burm. f., *N. pubescens* Willd. and *N. rubra* Roxb. ex Andrews (all distributed in the plains and warmer parts).

Mitra and Subramanyam (1983) reported that this species never produced fruit in W. Bengal and Barisal district (Bangladesh) and was restricted to permanent ponds. In view of the purported sterility, they were initially hesitant to consider *N. rubra* a distinct taxonomic entity but later treated at par with other sexually reproducing species (Mitra, 1993).

Material of *N. rubra* in flower was collected during October 2000 from a temple pond near Cheranmahadevi in Tirunelveli district, Tamil Nadu. There were collections in fruit from the said site and another shallow pond near Puliurai in the same district during January 2000, and much later from some other districts of Tamil Nadu (*vide* specimens cited) and Andhra Pradesh.

A few questions cropped up while examining this material for its identity.

- How do we explain the presence of fruits in *N. rubra* contrary to the report of Mitra and Subramanyam (1983) that it is a sterile species?
- Is this the first report of fruit setting in the species? If not, who are the earlier workers who reported it?
- Do the present collections represent true *N. rubra* as the plants reproduce sexually unlike reported by Mitra and Subramanyam (1983)?
- Lastly, how do plants of *N. rubra* of southern India differ from that of W. Bengal besides the noted sterility in the latter?

## Results

Based on a study of literature and materials available, the following summary of observations is presented.

- Andrews (1808) described fruits as "berry many-celled, with many seeds in each cell" and stressed the specific status of this taxon. Roxburgh (1832: 576) described, "berries, spherical and from ten to twenty-celled".
  - This was mentioned by both Sims (1810) and Roxburgh (1832). Roxburgh also cited the 'Telung' name "Yerra-kalwa". Both "Yerra-kalwa" (red *Nymphaea*) and "Yerra kalwakai" (fruit of red *Nymphaea*) are known for their valued tubers and fruits. The former is eaten either raw or roasted and the latter after being parched. Thus, the description of *N. rubra* by Roxburgh is possibly based on specimens collected from coastal Andhra Pradesh. Elliot (1859) compiled a list of plants essentially collected by Roxburgh in the *Telung districts* of northern areas (Srikakulam, Vizianagaram and Visakhapatnam districts) in which he mentioned *N. rubra* as well.
  - Wight and Arnott (1834) reported its presence in tanks and ditches in Tanjore (Tamil Nadu). Mitra and Subramanyam (1983) claimed its occurrence only in permanent ponds. Biswas and Calder (1954) stated that *N. rubra* grew in the same habitats as that of *N. lotus* (= *N. pubescens* Willd.) which grew in pools and jheels (temporary ponds) in all warmer parts. Three of the collections during this investigation are from shallow ponds or shallow irrigation channels adjacent to railway tracks.
  - Fruiting occurs under water between December and January in Tamil Nadu. Conard (1905) also referred to fruits and seeds of *N. rubra* but expressed his misgivings about the presence of true *N. rubra* in British India. Conard's studies were confined to specimens from Bengal which were sterile and this must have prompted him to doubt whether true *N. rubra* occurred in this country. Though his contention is valid, Roxburgh (1832) unambiguously stated its occurrence and fruit set in India. Kanjilal *et al.* (1934) stated that fruit set from September to November. Mitra and Subramanyam (1983) stated that intensive search for fruiting material in different herbaria proved futile.
  - Besides, de Candolle (1824), Wight and Arnott (1834), Prain (1903, 1905), Haines (1921) and Kanjilal *et al.* (1934) never once mentioned about the sterility or the decaying of flowers without fruit setting. They all treated it either as a distinct species or as a variety of *N. lotus* or *N. pubescens*.
  - Pullaiah and Chennaiah (1997) who referred to the sterility in this species merely quoted Mitra and Subramanyam (1983) and Mitra (1993). They also cited 'Tamara' as the vernacular name which in fact applies to *Nelumbo nucifera* and not to *N. rubra*. Saxena and Brahmam (1994) too enumerated it from Orissa after merely citing Mitra (1993). Based on the reported sterility, Cooke (1996) went further and synonymized it under *N. pubescens* and treated it as a cultivated race.
- The illustrations by both Andrews (1808) and Sims (1810) are devoid of fruits; that of Wight (1840) also lacked fruit and seed. Wight attributed this lapse to his own failure to notice at the time of making the drawing and his inability to get sufficiently ripe fruits at a later date when the figure was prepared for the press and, not to sterility in the species. It is necessary to mention another slip of Wight. In his illustration the stamens (including anthers) were colored yellow, though this species was known to be distinguished by its red stamens (including anthers). Roxburgh however, presented the cross section of the fruit in his icones (no. 657, see Fig. 1a).
- Mitra (1993) stated that filaments of nearly inner  $\frac{2}{3}$  of stamens exhibiting a dark purplish band without near the base as a distinctive spot character of *N. rubra*. This character could not be verified in the specimens from Tamil Nadu determined as *N. rubra* by Mitra. The mention of berries by Roxburgh (1832), their cross section in the illustration (icone no. 657) and the mention of seeds by Andrews (1808) and Conard (1905) would convince one that *N. rubra* is fertile.
  - The collections made by the authors (P.V. and T.J.S.R.) prove that *N. rubra* is a sexually reproducing species like *N. nouchali* and *N. pubescens* and produces viable seeds. The W. Bengal populations may be sterile due to some local factors. Mitra and Subramanyam's (1983) report pertains to plants of W. Bengal.
  - The authors have also reason to believe that even in W. Bengal there is fruit setting in *Nymphaea rubra* as one collection from this State (Rajpur, 29 September 1898, *Diakumar s.n.*) says in a note under field notes, that ripe fruits are capped by persistent filaments though the specimens are devoid of fruits.
- Though Andrews validly published the name *N. rubra*, he did not add anything to the diagnostic

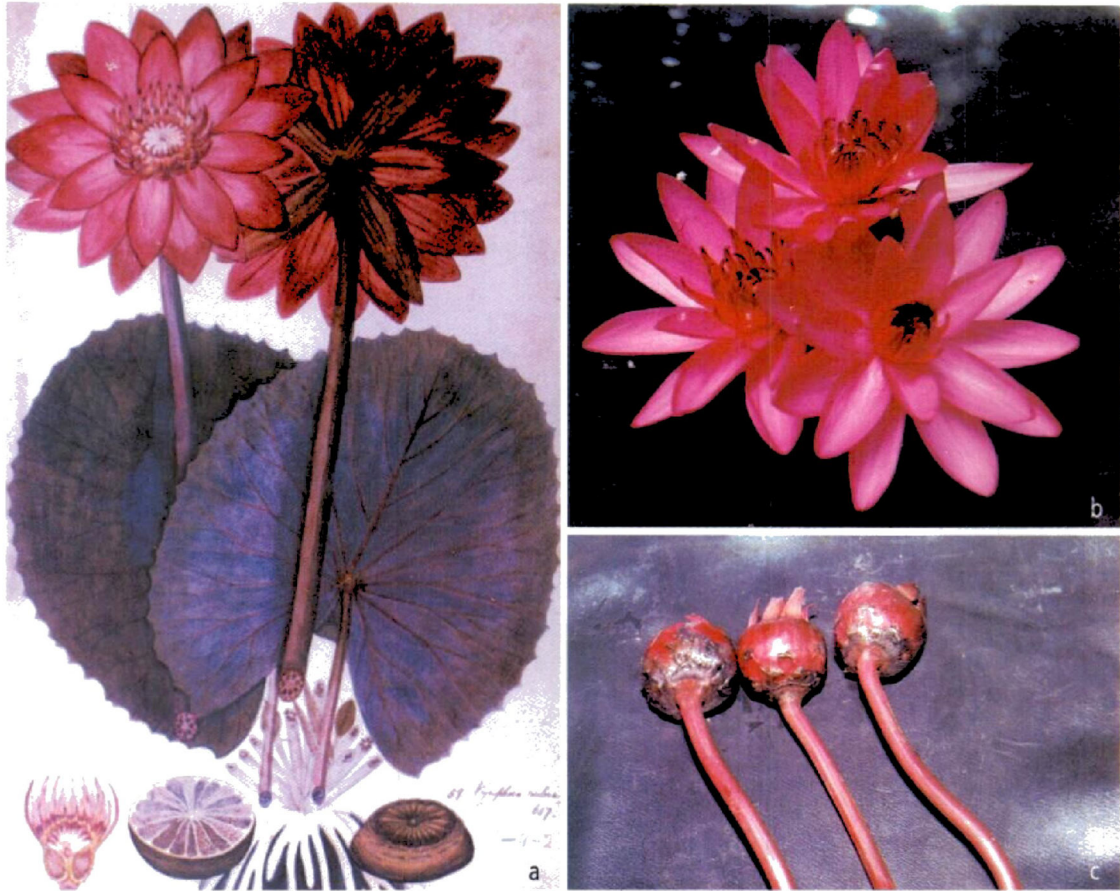


Figure 1. *Nymphaea rubra* Roxb. ex Andrews – a. Roxburgh icone no. 657 (courtesy Botanical Survey of India, Howrah). b. Flowers. c. Fruits.

description presented by Roxburgh except a tabula. This figure was drawn from a plant in the collection of J. Vere's Kensington-Gore raised in a tub of water placed in a common hot-bed in the United Kingdom. Salisbury's illustration (1805) was also based on this plant. Sims (1810) too provided an illustration based on a plant which flowered in August 1810 in Kew Gardens introduced by Sir Joseph Banks. Thus, all the three illustrations were based on specimens cultivated in gardens. However, Wight's illustration was made on material from a natural population. Many regional Floras ignored the presence of *N. rubra* and some reduced it to a variety (Dunn, 1915; Srinivasan, 1983; Cooke, 1903; Matthew & Britto, 1983). There are a number of sheets in MH wrongly determined for *N. rubra* as *N. pubescens*, and *N. pubescens* as *N. nouchali*. Matthew and Britto (1983) distinguished *N. nouchali* Burm. f. and *N. stellata* Willd. based on presence or absence of indumentum, nature of leaf margin, sedal venation in sepal, nature of anthers and appendaged as well as nonappendaged stigmatic rays. The description and illustration (Matthew, 1982) presented by them for *N. nouchali* relates to that of *N. pubescens*. However, this was rectified later (Matthew, 1996). They also wrongly interpreted *N. stellata* as distinct

from *N. nouchali*. In some provincial Floras (Cooke, 1903; Gamble, 1915) *N. stellata* was synonymised under *N. nouchali*. The description of *N. stellata* Willd. (Willdenow, 1799) and Rheede's illustration (Hort. Malab. 11: 53. t. 27) cited thereunder show that it is conspecific with *N. nouchali* Burm. f. Hence, to synonymize *N. pubescens* Willd. – a species with leaves pubescent beneath, sinuate-dentate along margins and rounded lobes – under *N. nouchali* Burm. f. as done by Matthew and Britto (1983) is untenable. A key to the South Indian species and a detailed account on *N. rubra* are considered appropriate to resolve this confusion.

### Key to species

- 1a. Mature leaves entire-undulate, glabrous on both surfaces; stamens invariably yellow; anther connectives distinct and caudate; fruits green; sepals persistent in fruit; seeds vertically fine-lined.....*N. nouchali*
- 1b. Mature leaves sinuate-dentate, pubescent beneath; stamens yellow or red; anthers without connectives; fruits green or red; sepals not persistent in fruit; seeds vertically thick-lined.....2

- 2a. Leaves including petioles red when young, not punctate when mature; petals crimson red; stamens red; fruits and fruit stalks red.....*N. rubra*
- 2b. Leaves and petioles green when young; punctate when mature; petals white-rose to pale pink; stamens yellow; fruits and fruit stalks green.....  
.....*N. pubescens*

*Nymphaea rubra* Roxb. ex Andrews, Bot. Rep. 8 (104): t. 503. 1808; Sims, Bot. Mag. 31: 33. t. 1280. 1810; Roxb., Fl. Ind. 2: 576. 1832; DC., Syst. Nat. 2: 52. 1821 & Prodr. 1: 115. 1824; Wight & Arn., Prodr. 17. 1834; Wight, Ill. Indian Bot. 1: t. 10. 1840; Elliot, Fl. Andh. 1: 52. 1859; Prain, Beng. Pl. 1: 213. 1903; Conard, Publ. Carnegie Inst. Wash. 4: 199, Pl. 1 - 8. 1905; Biswas & Calder, Handb. Water, Marsh. Pl. India ed. 2, 20. 1954; R. L.

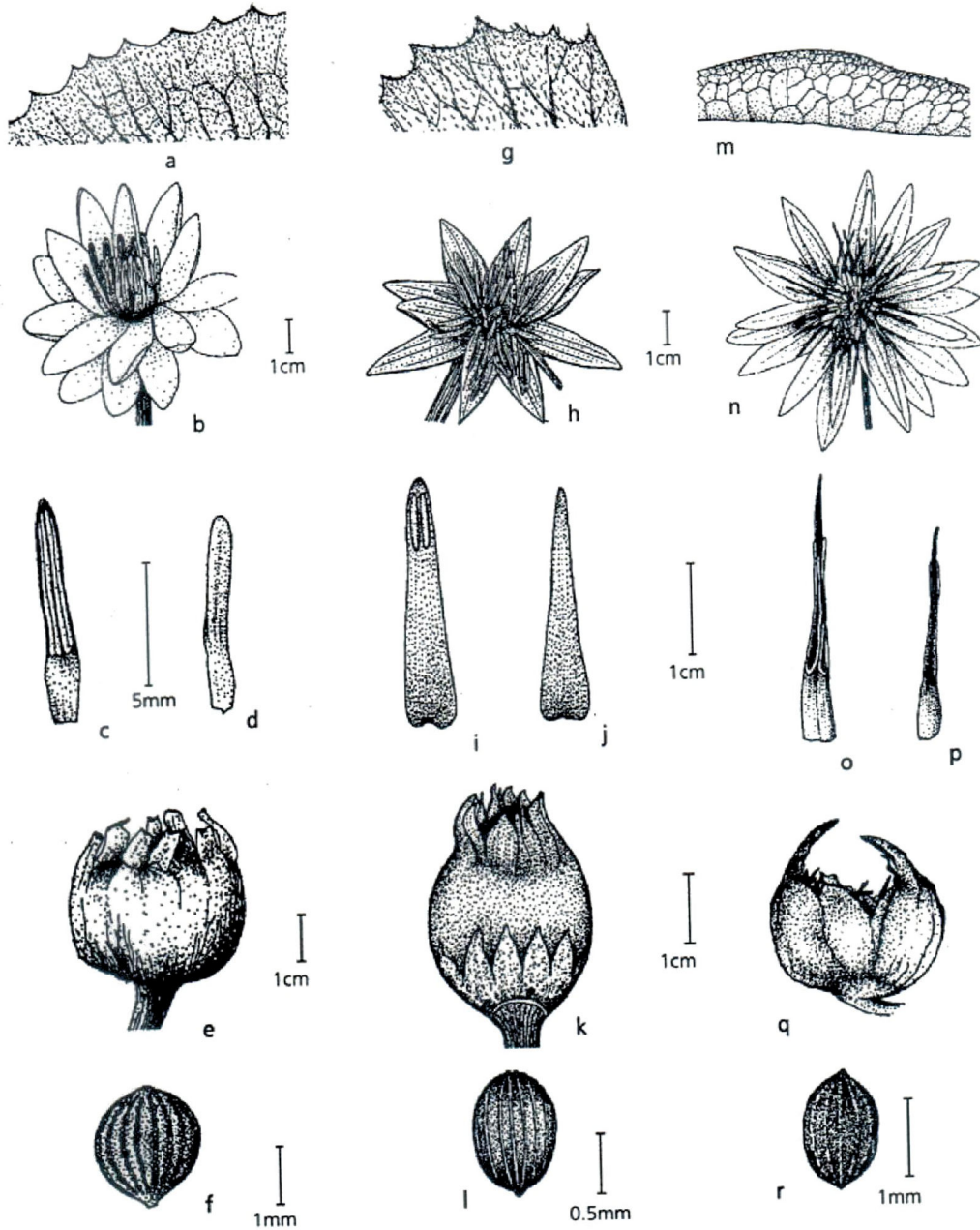


Figure 2. *Nymphaea pubescens* Willd. - a. Leaf, lower surface; b. Flower; c. Stamen, adaxial view; d. Stamen, abaxial view; e. Fruit; f. Seed. *N. rubra* Roxb. ex Andrews. g. Leaf, lower surface; h. Flower; i. Stamen, adaxial view; j. Stamen, abaxial view; k. Fruit; l. Seed. *N. nouchali* Burm. f. m. Leaf, lower surface; n. Flower; o. Stamen, adaxial view; p. Stamen, abaxial view; q. Fruit; r. Seed.

Mitra & Subr. Bull. Bot. Surv. India 24: 83. 1983; R. L. Mitra in M. P. Nayar *et al.*, Fasc. Fl. Ind. 20: 20. 1990; R. L. Mitra in B. D. Sharma *et al.*, Fl. India 1: 432. 1993; H. O. Saxena & Brahmam, Fl. Orissa 1: 46. 1994; Pullaiah & Chennaiah, Fl. Andhra Pradesh 1: 78. 1997; N. P. Singh & Karthk., Fl. Maharashtra 1: 186. 2000. - Type: Andrews, Bot. Rep. t. 503.

*Castalia magnifica* Salisb. in Hook., Parad. Lond. 1: t. 14. 1805. -Type: Parad. Lond. 1: t. 14. *Nymphaea magnifica* (Salisb.) Conard, Rhodora 18: 120. 1916, non Gilg 1908. *N. lotus* sensu Hook. f. & Thomson, Fl. Ind. 1: 241. 1855 & in Hook. f., Fl. Brit. India 1: 114. 1872, non L. 1753, *uterque p.p. quoad syn. N. rubra*; T. Cooke, Fl. Bombay 1: 25. 1903, *p.p.*; Duthie, Fl. Gangetic Plains 1: 33. 1903, *p.p.*; Haines, Bot. Bihar & Orissa 1: 21. 1921, *p.p. incl. var. rubra* (Roxb. ex Andrews) Haines; Kanjilal *et al.*, Fl. Assam 1: 64. 1934, *p.p. N. pubescens* sensu Dunn in Gamble, Fl. Madras 1: 34. 1915 *p.p. non Willd.* 1798. *N. nouchali* sensu Subr., Aquat. Ang. 6. 1962, *p.p. non Burm. f.* 1768. (Fig. 1b, c; Fig. 2g-l).

*Large perennial herb*; rhizomes irregular, stoloniferous. *Juvenile leaves* membranous, subulate in the beginning, turning hastate and sagittate later, dark red and submerged; mature leaves floating on long green petioles, lamina suborbicular, sinuate-dentate along margins, faintly fleshy, glabrous above, downy beneath; olive green above and glaucous without spots beneath, to 25 x 16 cm; lobes diverging; veins impressed above and raised beneath; petiole attachment to lamina subpeltate-peltate. *Flowers* usually solitary on long naked red scapes, 9 - 10 cm across when in bloom; disk fleshy; sepals 4, uniseriate, ovate-lanceolate, acute, green with faint pink tinge outside, cream or pale pink inside, veined, c. 5.5 x 1 cm; petals 12 - 15 in 4 - 5 series, crimson red or dark red, gradually turning into petaloid stamens, c. 5 x 2 cm, adnate to disk; stamens 30, in 3 - 4 series, rimming the disk, outer ones with petaloid filaments, longer, c. 3 x 0.8 cm, inner ones shorter, c. 1.5 x 0.3 cm; anthers of outer filaments short, of inner filaments long, distinct, erect, dehiscing longitudinally, introrse; connectives not prolonged; carpels 16 - 20, membranaceous with equal number of locules arranged radially around the central core in the fleshy disk, the adjacent walls of carpels fused into one, and together forming a many-loculed ovary; ovary topped by the connate curved radiating and furrowed stigmas forming a cup-shaped depression, stigmas free, slightly bulged on the other end, pale yellow in the cup portion, dark pink in the free ends; ovules very numerous, arising all over the septa, anatropous. *Berries* globose, c. 4 cm, crowned by persistent filaments, retracting and ripening under water,

breaking irregularly; seeds numerous, minute, elliptic-globose, sea-green, attached to partitions, resting in a pulp, enclosed in a gelatinous bell-shaped transparent aril, surface lined with tubercles in longitudinal rows, c. 3 x 1.5 mm.

*Flowering & Fruiting*: Throughout the year but profuse during rains (July-October); January-June.

*Distribution*: India (throughout the plains), Sri Lanka, Myanmar, Malaysia, Thailand, Laos, Cambodia, Vietnam, Indonesia and the Philippines (Mitra, 1993).

*Specimens Examined* (all in MH unless indicated otherwise): **Andhra Pradesh**, Chittore District: S.V.U. Campus, Tirupati, 13.8.88, D. Ranga Charuyulu 2176; Visakhapatnam District: Near Srungavarapukota, 150 m, 4.9.1960, N.P. Balakrishnan 11033; W. Godavari District: Gudukulanka, sea level, 23.1.1958, K. Subramanyam 5080 (determined as *N. pubescens*). **Assam**: Digboi - Jorhat 11.7.59, G. Panigrahi 19012 (determined as *N. nouchali*). **Bihar**: Dharampur Kaldam, Santal Village, 15.12.57, G. Panigrahi 11805. **Tamil Nadu**, Madurai District: near Poyakarai, Alagar Hills, 166 m, 20.9.1957, K. Subramanyam 4291 (identified as *N. pubescens*); Madras city, Appalankulam tank, Guindy Deer Park, sea level, A.N. Henry 45615 (determined as *N. pubescens*); Thanjavur District: Muthupet, 10 m, 19.9.1965, K. Ramamurthy 25874; Nannilam to Aduthurai, 50 m, 28.1.1978, K. Ramamurthy 53630; Tirunelveli District: Kalakad, 16.9.1916, s. coll. 13101; Temple tank, Cheranmahadevi, 3.11.2000, P. Venu 111794, Puliarai, 17.1.2001, T.J.S. Rajakumar 936, Puliarai, 17.3.2001, T.J.S. Rajakumar 978; Tiruchirapalli District: Puthur, Keelavannar pettai, 6.3.2001 P. Venu 112232, Ponds near railway track, Uttamarkovil, sea level, 6.3.2001, P. Venu 112233. **Madhya Pradesh**, Bastar District: Kondagaom, Dangadamunda lake, 767 m, 19.11.1958, K. Subramanyam 7209 (determined as *N. pubescens*). **Maharashtra**, Bombay, near Mahalargam station, October 1902, G.A. Ryan 195 (determined as *N. lotus*) (BSI); Poona, near Poona tank, October 1982, s. coll. 842 (BSI). **W. Bengal**, 24 Paraganas District: Nandipara, Mojilpur, 28.10.1906, Kalkaprasad & others 27288 (CAL), Mojilpur, Nandipara, 28.10.1906, Kalkaprasad & others 27293 (CAL), Barasat, Kadamtagachi, 15.1.1907, I.H. Burkill 27294 (CAL), Rajpur, 29.9.1898, Diakumar s.n. (CAL), Diara Village, 26.4.1962, M.K. Ghosh 1342 (2 sheets) (CAL), Indian Botanic Garden, 1.6.1972, P.K. Hajra s.n.; Midnapore District: Midnapore, June 1909, J.D. Naskar s.n., Shahpur, near Tollyganj, 26.10.1906, L. M. Ghosh 24858 (CAL); Howrah District: Janardan lake, 10.10.22, P.M. Debbarmann s.n., Denlia, 13.5.1963, S.S.R. Bennet 373; Hooghly District: Polba Village (Bandel) near Mogra, 15.11.1962, M.K. Ghosh 818 (CAL); Burdwan District: Kanchannagar, Burdwan, 6.5.1960, A.K. Dutta 120 (CAL), Amta, October

1952, G.N. Naskar s.n., Chandan nagar, 29.12.67, Ambir Sen 267 (CAL); Purulia District: Matha, 12.9.1964, K.C. Malick 129 (CAL), Kulilapal forest, 20.5.1963, U. Chatterjee 165 (CAL). **Madhya Pradesh**, Raigarh District: Sarangarh to Magarmati, 3.2.1974, N.C. Rathakrishnan 19657 (CAL).

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