

TAXONOMIC NOTES ON *NELUMBO* ADANS. WITH A NEW CULTIVAR 'GOMOTI' FROM BANGLADESH

MD. ABUL HASSAN, MD. ALMUJADDADE ALFASANE
AND MOHAMMAD ZASHIM UDDIN¹

Department of Botany, University of Dhaka, Dhaka-1000, Bangladesh

Keywords: Taxonomic notes; *Nelumbo*; New cultivar *Nelumbo nucifera* 'Gomoti'; Bangladesh.

Abstract

Living specimens of three colour forms (pink, white and yellowish white) of *Nelumbo nucifera* Gaertn. were observed in different natural habitats of Bangladesh and collected. Fresh specimens were studied in the field as well as in the laboratory. After detailed study it was concluded that the three colour forms available in Bangladesh belong to the same species, *Nelumbo nucifera* Gaertn. However, the yellowish white colour form, having many stamens petaloid, is considered as a new cultivar *Nelumbo nucifera* 'Gomoti' and reported here as the first lotus cultivar from Bangladesh.

Introduction

Nelumbo (lotus) belongs to the family Nelumbonaceae, which contains only one genus *Nelumbo* with only two species: *Nelumbo nucifera* Gaertn. and *Nelumbo lutea* Willd., which are popularly named as Asian lotus and American lotus, respectively. Being separated by the Pacific ocean, these two species differ in their external morphologies (petal colour and shape, leaf shape and plant size, seed shape and colour), though both of them have chromosome number $2n=16$ (Lin *et al.*, 2019). Appendage of Asian lotus is milky white, shape oval, whereas appendage of American lotus is bright yellow, shape sickle like (Zhang *et al.*, 2019).

Nelumbo is a perennial aquatic plant of stagnant water habitats with important value in horticulture, medicine, food, religion and culture. It is rich in germplasm and more than 2000 cultivars have been cultivated through hybridization and natural selection (Deng *et al.*, 2013; Zhang *et al.*, 2019). A new cultivar 'Jin Dieyu' with yellow-green colour has recently been published from China (Shi *et al.*, 2018).

Nelumbo is very unique in its triads leaf character as the creeping rhizome after a long internode gives a scaly leaf on the lower side, then one on the upper side, immediately followed by a foliage leaf with ochreate stipule, then a long internode again and so on. From the axil of the second scale leaf springs the flower, from that of foliage leaf, a branch (Willis, 1960). The genus is also unique in having milky latex, many free carpels arranged in 2-4 cycles, individually sunken in an elongated spongy obconical receptacle and single pendulous ovule.

Nelumbo also have some other unique features that distinguish it from other plant species. These features include (i) seed longevity (ii) leaf ultrahydrophobicity and (iii) floral thermoregulation (Lin *et al.*, 2019).

Asian lotus, also known as sacred lotus because of its significance in the religions of Buddhism and Hinduism, has a high variation in morphology at the population level with wider distribution range.

Nelumbo nucifera Gaertn. (Asian lotus) is the only species that occurs throughout Asia, Far East, South West Asia and Australia, which may be detailed as Bangladesh, Bhutan, China, India,

¹ Corresponding author, E-mail: zashim01@gmail.com

Indonesia, Japan, Korea, Malaysia, Myanmar, Nepal, New Guinea, Pakistan, Philippine, Russia (Far East), Sri Lanka, Thailand, Vietnam, South West Asia and Australia (Dezhi and Wiersema, 2001).

Basic colour forms of Lotus

American lotus (*Nelumbo lutea*) has a single colour form, yellow. Asian lotus (*Nelumbo nucifera*) has two basic colour forms: Pink (red) and white. White form is white because of the absence of anthocyanin biosynthesis. Through breeding and artificial selection many cultivars with mixed colour have been obtained on the purpose of increasing its ornamental value (Lin *et al.*, 2019).

Lotus cultivars include (i) few-petalled, (ii) semidouble-petalled, (iii) double-petalled, (iv) duplicate-petalled and (v) all double-petalled. Semidouble-petalled and all double-petalled are the resultants of stamen petaloid. There also exist pistil petaloid cultivars (Lin *et al.*, 2019)

Comparative transcription studies among petals, stamens petaloid and stamens through RNA sequence were conducted, which identified several candidate genes involved in stamen petaloid phenomenon (Lin *et al.*, 2019).

Usually a lotus flower is self-incompatible because the multiple stigmas of a receptacle mature ahead of the stamens in the same flower. Up-to-now, the majority of the lotus has stamens with a few exceptions such as ‘Guangyue Lou’, ‘Miracle’ and the three thousand petalled type Asian lotus cultivar ‘Qian Ban’. ‘Yiliang Qianban’ and ‘Zhizun Qiaban’ where the stamens are fully transformed into Petals (Zhange *et al.*, 2019).

Like in all other Asian countries only *Nelumbo nucifera* (Asian lotus) occurs in Bangladesh and it is usually found in two colour forms: Pink (Rose or Red) and white (Prain, 1903; Deb, 1983; Hassan, 2009). However, Khan and Halim (1979) stated its three colour forms: pink, white and rarely yellow.

In the present study an attempt was made to confirm taxonomic variation of lotus available in Bangladesh, and to confirm the presence of any cultivar in this country.

Materials and Methods

Last ten years (2011-2020) an attention was paid to find the variations in Lotus plants in Bangladesh. During this period of time, a number of visits were made in different localities of Bangladesh including Feni, Burichong of Cumilla, Gazipur, Baniachong *haor* of Habiganj, Sylhet, Shakhawa bazar of Netrokona, , Satchari, Bolakoir *beel* of Gopalganj, Ashurar *beel* of Dinajpur, Joydia *baor* of Jhenaidah, Munshiganj, Mymensingh, Noakhali, Kapsasia under Gazipur, Jahangirnagar University campus of Savar, Botanical garden and Purbachal of Dhaka. Besides, lotus were also located at different places namely, Gapla *beel* of Rupganj at Narayanganj, Saduptai of Gaibandha, Ghagutia *poddo beel* of Akhaura at Brahmanbaria, Chinidanga *beel* of Boraigram at Natore, Ichhamoti *poddo beel* of Norail, Vutiar *poddo beel* or Terokhada *poddo beel* of Khulna, Aandhar *poddo beel* of Faridpur, Gojaria *poddo beel* of Pangsha at Rajbari, Dirai *poddo beel* of Sunamganj, Baikka *beel* of Srimangal at Moulvibazar, Tajhat at Rangpur and Nilphamari in Bangladesh (personal communication). Traditional herbarium techniques were followed for the data collection (Hyland, 1972; Alexiades, 1996). Pink flower form was located in most of the above mentioned places and white colour form in Botanical garden, Kapsasia under Gazipur, Joydia *baor* of Jhenaidah, Chinidanga *beel* of Boraigram at Natore, Vutiar *poddo beel* or Terokhada *poddo beel* of Khulna, Bolakoir *beel* of Gopalganj, Ghagutia *poddo beel* of Akhaura at Brahmanbaria and Sylhet. Yellowish colour form was located only in Burichong of Cumilla. Fertile plant specimens of lotus were collected and processed using standard herbarium

techniques (Hyland, 1972). At least a total of 10 flowers for each colour group of lotus were studied and ranges of data were incorporated in the description. The Identification and updated nomenclature of the species were confirmed with standard literatures (Prain, 1903; Hook, f. 1872; Khan and Halim, 1979, 1987; Deb, 1983; Hassan, 2009). Voucher specimens were deposited at Dhaka University Salar Khan Herbarium (DUSH). Dissection of flowers was done in the Plant Taxonomy Laboratory of Dhaka University, examined carefully and the features were recorded and photography of all parts of plants was also made.

Results and Discussion

A detailed taxonomic description with photographs of the species based on the fresh and living specimens collected from different habitats from Bangladesh is given below:

Nelumbo nucifera Gaertn.

Nelumbo nucifera Gaertn., Fruct. 1: 73. t 19. f. 2 (1788). Van Royen in Nova Guinea II. 10 (8): 105 (1962); Subramnyam, Aqua. Angio.: 8 (1962); Khan and Halim, Flora of Bangladesh, No. 9: 4 (1979); Deb., Fl. Tripura. II: 124 (1983); Hassan, Ency. F and F, Bangladesh, Vol. 9: 296 (2009).

Synonyms: *Nymphaea nelumbo* L., Sp. Pl. 511 (1753); *Nelumbo indica* Poir. In Lamk., Encycl. 4: 543 (1797); *Nelumbium speciosum* Willd., Sp. Pl ed. 4.2 (2): 1258 (1799); Roxb., F. Ind.: 116 (1872); Wight and Arn. Prod. 1: 16 (1834); Hook. f., Fl. Brit. Ind. 1:116 (1872); Prain, Beng. Pl.: 214 (1903); Heinig, Enum.: 40 (1907); Kanjilal *et al.*, Fl. Assam 1 (1): 65 (1934).

Large aquatic herb with milky latex, perennating by stout creeping rhizome. Leaves orbicular, peltate, of young plants floating, of older plants raised above the water surface. Petioles prickly, as long as the water depth, stipules ochreate, laminae large, size variable, glaucous with waxy coating on the upper surface, entire. Peduncles as long as the petioles, prickly. Sepals 4, cauducous. Tepals large, 11-15 in number. Stamens numerous with sterile white appendage. Carpels free, many, embedded singly in cavities of the receptacle, arranged in 2-4 cycles, ovule solitary, pendulous. Fruits of separate nuts. Flowering and fruiting: April to October, Chromosome $2n=16$ (Fedorov, 1969; Lin *et al.* 2019).

Short description of three colour forms available in Bangladesh.

- (a) **Pink** (most common) (Fig. 1)
 Petioles and peduncles armed with scattered prickles. Sepals 4, cauducous. Petals 11-18, large, up to 12 cm long. Stamens 300-377, filaments yellowish, anther yellow, appendage white. Carpels 13-22 in two to three cycles. Stamens petaloid none except in one flower recently collected from Parbatipur.
- (b) **White** (less common) (Fig. 2)
 Petioles and peduncles armed with prickles. Sepals 4, cauducous. Petals 11-15, large, up to 11 cm long. Stamens 219-300, filaments white, anther yellow, appendage white. Carpels 9-18 in three cycles. Stamens petaloid none.
- (c) **Yellowish-white** (only restricted to a single location): **Cultivar *Nelumbo nucifera* 'Gomoti'** (Fig. 3)
 Petioles and peduncles armed with prickles. Sepals 4, cauducous. Petals 11-15, up to 11cm long. Stamens 236-315. Carpels 8-16, in two to three cycles. Number of stamens petaloid 18-60.

Number of stamens petaloid up to 60, vary from flower to flower. The more distant it is from the centre, the more petaloid it is. The peripheral ones are almost like smaller petals. It is now known that II MADS-box genes and one APETALA2 (AP2) gene are specifically involved in the stamen petaloid phenomenon (Lin *et al.*, 2019).

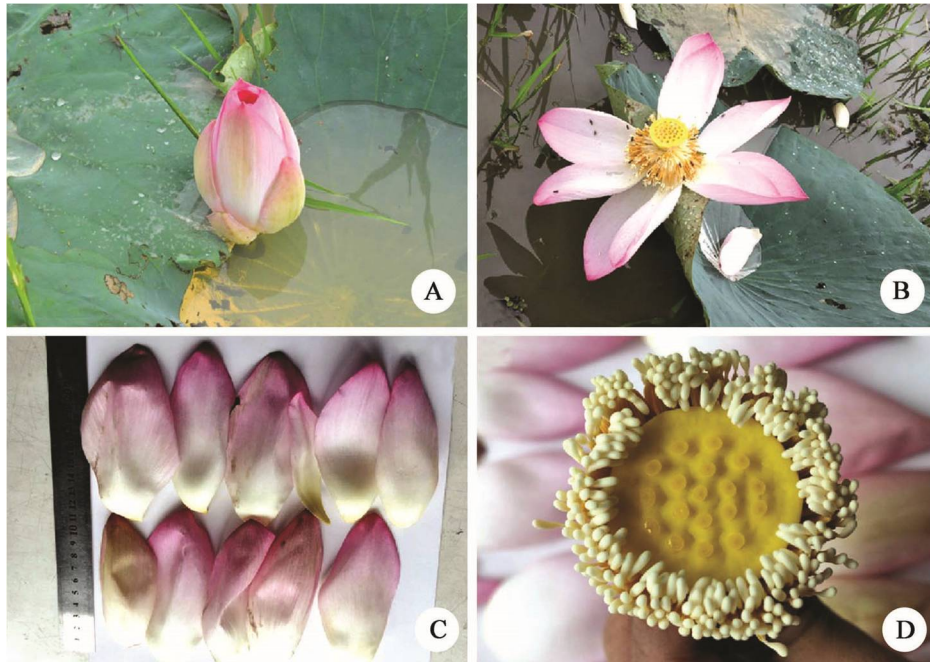


Fig. 1. Flower phenotype of *Nelumbo nucifera*, Pink flower. A. flower bud; B. A fully opened flower; C. Petals, adaxial view; D. Top view of receptacle with stamens and carpels.

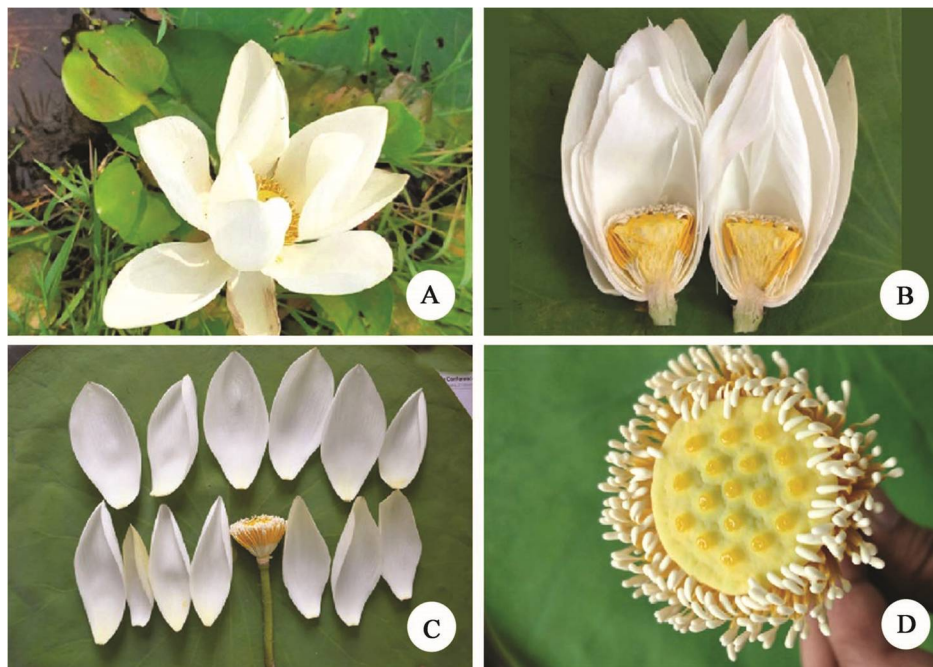


Fig. 2. Flower phenotype of *Nelumbo nucifera*, White flower. A. An opened flower; B. L.S. of a flower; C. Structure of petals, abaxial view; D. Top view of receptacle with stamens and carpel.

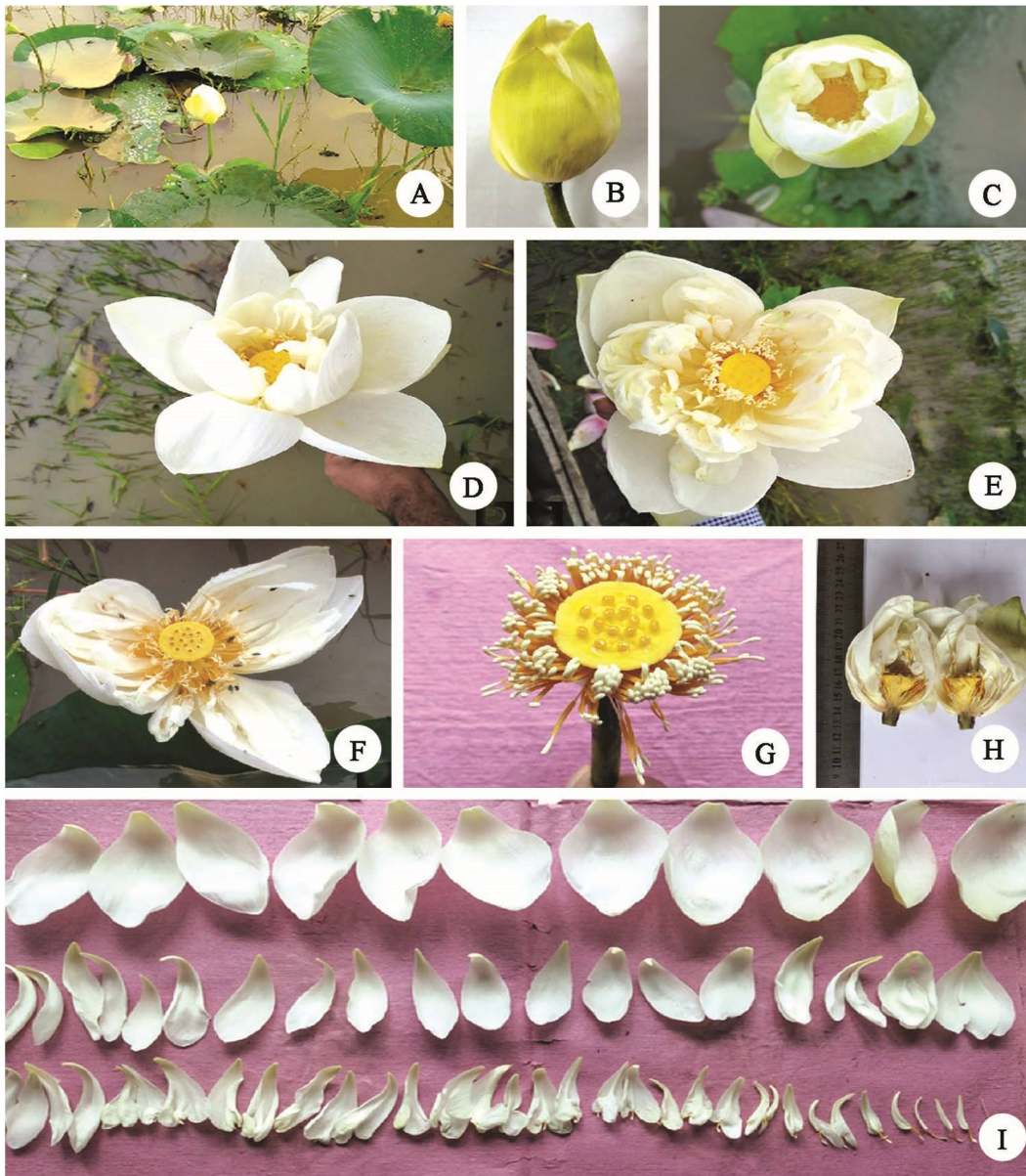


Fig. 3. Flower phenotype of *Nelumbo nucifera* 'Gomoti', Yellowish-white. A-B. A flower bud; C. An unopened flower bud; D. Side and top view of a flower; E. Top view of a flower; F. An opened flower with receptacle; G. Side and top view of receptacle with stamens and carpels; H. L.S. of a flower; I. Stamens petaloid.

The yellowish white lotus does not belong to American lotus because this has all other characteristics distinctive of Asian lotus.

Considering all facts it may be concluded that the yellowish white form growing and maintained in Burichang area of Bangladesh for about last hundred years may be considered as a

new cultivar of *Nelumbo nucifera* that we have named here as ‘Gomoti’. It is the first report of lotus cultivar from Bangladesh.

In the present investigation no unarmed specimen of any colour form could be recognized, although some authors (Prain, 1903; Subramanyam, 1962) described lotus as unarmed and some authors (Khan and Halim 1979, 1987) described this as smooth or armed.

Most of the previous authors (Deb, 1983; Prain, 1903; Khan and Halim, 1979, 1987) stated that the petals gradually passing into stamens but in the present investigation no specimen of White form have the petals gradually passing to stamens, only one specimen of Pink form seen to have petals passing to stamens. However, all the specimens of Yellowish-white form examined have the petals passing to stamens. In the light of the present knowledge petals passing to stamens is not true, but the phenomenon is reverse, stamens transforming to petals.

The more is the number of stamens petaloid, the more advance the flower is. Flowers with sepals, petals, stamens and carpels are primitive than those with stamens petaloid. Therefore, it is very much essential to collect all forms of *Nelumbo nucifera* from all over the country covering all the locations of occurrence and to ascertain their taxonomic status. Specimens with unarmed petioles and peduncles, if there is any, should be compared with those with armed ones. The population of lotus species have been disappearing gradually from the natural habitats of the country because of eating of seeds and rhizomes and even the petals by the local people, filling of wetlands and non-awareness of its importance.

Acknowledgement

The authors are very much grateful to Mr. Carlos Magdalena (Research Assistant of living collection and sustain of lotus from all over the world, Royal Botanic Garden, Kew, London) for his critical comments and kind suggestion to name the yellowish white colour form as a new cultivar of *Nelumbo nucifera*.

References

- Alexiades, M.N.(ed.).1996. *Selected Guidelines for Ethnobotanical Research: A Field Manual*. The New York Botanical Garden, New York.
- Deb, D.B. 1983. The Flora of Tripura State. Voll. 2. Today and Tomorrow Printers and Publishers”. pp. 123-127.
- Deng, J., Chen, S., Yin, X.J., Wang, K., Liu, Y.L., Li, S.H. and Yang, P.F. 2013. Systematic qualitative and quantitative assessment of anthocyanins, flavones and flavonols in the petals of 108 lotus (*Nelumbonucifera*) cultivars. *Food Chem.* **139**: 307–312.
- Fedorov, A.A. 1969. Chromosome numbers of flowering plants. Leningrad, USSR: Academy of Natural Sciences of the USSR, 927 pp.
- Hassan, M.A. 2009. Nelumbonaceae In: Ahmed, Z.U., Hassan, M.A., Begum, Z.N.T., Khondker M. Kabir S.M.H., Ahmed, M. And Ahmed A.T.A (eds.) *Encyclopaedia of Flora and Fauna Bangladesh*. Vol. **9**. Angiosperms: Dicotylens (Magnoliaceae – Punicaceae). Asiatic Society Bangladesh, Dhaka. pp. 296-297.
- Hook. F. 1872. *Flora of British India*. L. Reeve & Co. Ltd. Kent, England, Vol. **1**: 116.
- Hyland, B.P.M.1972. A technique for collecting botanical specimens in rain forest. *Flora Malesiana Bulletin* **26**: 2038–2040.
- Khan, M.S. and Halim, M. 1987. *Aquatic Plants of Bangladesh*. Bangladesh National Herbarium. BRAC.
- Khan, M.S. and Halim, M. 1979. *Flora of Bangladesh*. No 9. Nymphaeaceae. Bangladesh National Herbarium, BARC.
- Lin, Z., Zhang, C., Cao, D., Damaris, R.N. and Yang, P. 2019. The Latest Studies on Lotus (*Nelumbonucifera*)-an Emerging Horticultural Model Plant, *Int. J. Mol. Sci.* 2019, **20**, 3680; doi:10.3390/ijms20153680.
- Dezhi, L. F. and Wiersema, J.H. 2001. *Nelumbonaceae*. *Flora China* **6**: 114.
- Prain, D. 1903. *Bengal Plants*. Vol. 1.1. Bishen Singh Mahendra Pal Sing, 23-A, New Connaught Place, Dehra Dun-248001. India: 212.
- Shi, N., Liu, X., Du, F., Chang, Y., Li, N., Ding, Y. and Dongrui Yao, D. 2018. ‘Jin Dieyu’: A New Cultivar of Lotus with Large, Yellow-green, Duplicate-layered Flowers. *Hort Science*, **53**(5):732–733.

- Subramanyam, K. 1962. Aquatic Angiosperms. CSIR, New Delhi (Reprint 1974).
- Willis, J.C. 1960. Flowering plants and Ferns. Cambridge at the University Press. p. 445.
- Zhang, D., Chen, Q., Liu, Q., Liu, F., Cui, L., Shao, W., Wu, S., Xu, J. and Tian, D. 2019. Histological and Cytological Characterization of Anther and Appendage Development in Asian Lotus (*Nelumbo nucifera* Gaertn.) Int. J. Mol. Sci. **20**(5), 1015; <https://doi.org/10.3390/ijms20051015>.

(Manuscript received on 3 July 2020; revised on 12 November 2020)