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Intrusion of Aquatic Invasive Plant *Echinodorus cordifolius* L. in Bangladesh

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ABSTRACT

The present study's findings confirm the introduction of *Echinodorus cordifolius* L. in Bangladesh. The plant was found to compete with the natural flora in the Jessore district with *Eichhornia crassipes*, *Colocasia esculenta*, *Enhydra fluctuans*, *Bacopa monnieri*, *and Ficus hispida*. Throughout the study period, it was reported from 16 districts of Bangladesh, viz. Rajshahi, Pabna, Mymensingh, Jessore, Naogaon, Chapainawabganj, Joypurhaat, Rangpur, Dinajpur, Dhaka, Chittagong, Comilla, Tangail, Khulna, Rajbari and Sylhet as an ornamental plant. The plant has gained popularity among aquatic gardeners and aquarium hobbyists. The *Ex situ* cultivation of the plant was carried out outdoors. In the aquarium, it revealed the plant has the adaptive capacity to undergo flowering around the year and carry vegetative as well as sexual reproduction outdoors. In the aquarium, it exhibited vegetative propagation. It was found to grow and reproduce at a temperature range from 6-44 °C and a pH range from 7.8-9.0. The plant is detected as invasive and a significant threat to Bangladesh's aquatic and marshy plant diversity. Safeguarding should be undertaken to stop the spread of this plant by creating awareness, and its production should be carried out in a confined manner by the concerned growers.

Keywords: Aquatic; Alien; Invasive; Plant; *Echinodorus*; Adaptation; Biodiversity threats; Distribution; Morphology; Reproduction; Bangladesh.

1. Introduction

Bangladesh is a subtropical riverine country. Nearly 80% of the country is inundated yearly due to floods and rainfall. There are numerous waterbodies, ditches, wetlands, floodplains, canals, natural and artificial lakes, ponds, haors, baors, and coastal wetlands, including characteristics of mangrove wetlands. These waterbodies endow with rich, spectacular aquatic vegetation. Meaningfully, the national flower is aquatic, a white water lily (Shapla), *Nymphaea pubscens* L.

Historically, it is documented that *Eichhornia crassipes*, an aquatic plant, was introduced as an ornamental plant that has turned itself into one of the country's most invasive aquatic plants. It has become so widespread that rivers, wetlands, ponds, and even lowlands are filled with this plant. The government and private sector have undertaken several initiatives, such as producing bio-fertilizers as fodder for cows and preparing floating beds in wetlands for vegetable cultivation. Even very recently, 2 export-oriented factories have been established using this nuisance plant as raw material to produce different products for export in 14 other countries in the world.

Eichhornia crassipes is still continuously damaging local aquatic biodiversity. Till now, a total of 42 plant species have been recorded to be introduced in Bangladesh according to Afrin et al. (2010) and Mukul et al. (2021). Among these are mostly timber-yielding, fast-growing tree species, and seven different aquatic plants growing in freshwater, alien species. The present study was initiated 2 years ago during a visit to Jessore district of Bangladesh. The plant was accidentally noticed thriving, along with a few other common marshy plants. On the spot, it was identified as something new belonging to the family Alismataceae. Linhart and Grant (1996) and Kawecki and Ebert (2004) stated that a population is deemed to have evolved local adaptation when resident individuals in that population produce phenotypes with higher relative performance than conspecific individuals transplanted from other habitats.

1.1 Study Objectives

Present study was targeted to: a) Identify the plant concerned up to species level, b) Taxonomic description of the taxa, c) Study the life cycle of the plant in *Ex situ* condition in marshy soil, aquatic and in aquarium condition, d) Reveal the occurrence, distribution all over the country, e) Identify any potential threat to aquatic plant diversity by the newly found member of the family Alismataceae, and f) Find out the cause of introduction of this alien species in Bangladesh.

2. Materials and Methods

A sufficient number of plant specimens were collected from the spot and taken to the laboratory with care. Some plants were kept in *Ex-situ* condition in the MZAH conservation unit for further study, and the rest were brought to the laboratory. Herbariums were prepared with care by following the methodology of Maden (2004). The specimen was identified by consulting existing literature, and a voucher specimen was sent to the Bangladesh National Herbarium and also conserved in MZAH aquatic herbarium. Finally, it was confirmed as a new report for Bangladesh. During the field visit, it is to be mentioned that people nearby were asked about the occurrence of plants in the region. 2 of the respondents reported this is a widespread plant growing in aquariums of the hobbyists. pH, water, and air temperature values were recorded by pH meter (Model: Hanna) and digital thermometer (Model: Hanna).

3. Result and Discussion

We searched to verify this information in the aquarium shops of Dhaka, Rajshahi, Khulna, Chittagong, and Jessore and found it was correct it is known as the arrowhead plant or sword plant. New plant aquarist greatly appreciates it for its high adaptive characteristics. It is easy to grow and maintain and gives a vibrant green color in aquarium conditions. According to Rataj, (1978), *Echinodorus* has a cultivation history dating back to the early twentieth century. Similarly, Kasselmann, (2001) commented *Echinodorus* is one of the most popular ornamental plants in aquaria. After a short production boom in South America, a large-scale production began in Southeast Asia, Europe, and USA (Lehtonen and Rodrı´guez Are´valo, 2005), which supports our findings in Bangladesh. It was also reported to be grown in a nursery and found to be grown and sold in plant nurseries. The plant was on sale in Brikkhomela (The Largest fair for selling trees, and plants) organized in different districts like Dhaka, Rajshahi, and Chittagong. The plant is sold in many shops selling aquarium items and accessories.

To establish we cultured the plant in both aquarium and *Ex-situ* conditions. Finally, with morphology, the flowering and fruiting stage it was identified as *Echinodorus cordifolius* L. Search continued for its distribution within Bangladesh. The plant was reported from major 20 districts of Bangladesh (Figure 1). Only in Jessore, it was growing in nature competing with *Colocasia esculenta, Eichhornia crassipes, Enhydra fluctuans, Bacopa monneri, and Ficus hispida.* If strict guidelines for growing *Echinodorus cordifolius* L. are not provided to the hobbyists/growers soon it could turn into a massive problem for our aquatic biodiversity. It has all the characteristics of becoming invasive in Bangladesh. Daehler (1998) recognized that the family Alismataceae is over-represented by invasive plants, confirming threats of invasion of *Echinodorus cordifolius* L. in Bangladesh.

Echinodorus coridifolius L. has a highly adaptive nature of growing e.g., can grow in different types of soils, different regimes of temperature and water quality;

- capable of growing successfully in submerged and emergent form;
- grows throughout the year in natural conditions and aquariums;
- grows in temperature ranging from 6-44 °C;
- grows in a pH range 7.8-9.0;
- can grow in scorching summer days and in foggy winter months;
- also reproduce sexually as well as asexually around the year;
- naturally found growing in Jessore district;
- reported from 16 districts in Bangladesh (Figure 2) as ornamental plants in water gardens and aquariums;
- in natural conditions, it was found to compete successfully with *Eichhornia crassipes*, *Colocasia esculenta*, *Enhydra fluctuans*, *Bacopa monneri and Ficus hispida*.

Taxonomic Description of the taxa concerned are as follows:

3.1. Systematic Position

Kingdom: Plantae

Order: Alismatales

Family: Alismataceae

Genus: *Echinodorus*

Species: *Echinodorus cordifolius* L.

English name: Amazon sword

Local name: Sword plant

Habit: Emerged, floating-leaved, or seasonally submerged.

3.2. Description

The plants are perennial, growing emerged, floating-leaved, or seasonally submerged, leaves glabrous to stellate-pubescent; rhizomes present or absent; stolon absent; corms absent; tubers absent; roots not septate; leaves petiolate; petioles triangular, rarely terete; blade with translucent markings as dots or lines present or absent, linear to lanceolate to ovate, base attenuate to cordate, margins entire or undulating, apex obtuse to acute. Inflorescences racemes of 1-18 whorls, arching to decumbent, emerged; bracts coarse, apex obtuse to acute, surfaces smooth or papillose along veins. Flowers bisexual, sub-sessile to pedicellate; bracts subtending pedicels, subulate to lanceolate; pedicels ascending to recurved; receptacle convex; sepals 3, recurved to spreading, herbaceous to leathery, sculpturing absent; petals 3, white, entire; stamens 9-25; filaments linear, glabrous; pistils 15-250 or more,

spirally arranged on a convex receptacle, forming head, distinct; ovules 1; style terminal or lateral. Fruits are plump, often longitudinally ribbed, sometimes flattened, rarely abaxially keeled, abaxial wings absent, lateral wings absent, and glands often present.

3.3. Distribution

Jashore (In natural habitat), reported from Rajshahi, Pabna, Mymensingh, Jessore, Naogaon, Chapainawabganj, Joypurhaat, Rangpur, Dinajpur, Dhaka, Chittagong, Comilla, Tangail, Khulna, Rajbari and Sylhet districts of Bangladesh as an ornamental aquatic plant. Introduced to India from Mexico. Native to Mexico, West Indies, Central America, South America (as far south as Paraguay), the southeastern United States (Texas to Florida and as far north as Iowa), North America, China.

4. Conclusion

The present study reveals that *Echinodorus cordifolius* is well adapted to Bangladesh's environment. It successfully competes with *Eichhornia crassipes* (the most invasive plant in Bangladesh) and other local flora. Due to its ornamental value, it is adored and collected by hobbyists in large numbers. This led to wide distribution of the plant throughout the country within a short period. The plant was found to grow naturally, in marshy soil, in aquatic conditions and completed the vegetative and sexual reproduction as well as in *Ex-situ* conditions (within MZAH conservation unit). During the period of research, it was successfully grown in the aquarium within the laboratory. It can grow on sandy loamy, loamy and clayey soil. The optimum temperature range was 6-44 °C, pH requirement range was 7.8-9.0 was recorded in the study.

5. Recommendations

- Plant quarantine laws should be enforced;
- Posters and leaflets can be produced and distributed to create awareness in educational institutions, to the nursery and to the vendors of aquarium shops to restrict the plant sale and production mentioning its invasiveness by concerned herbariums e.g., BNH and MZAH including other relevant government agencies;
- Aquarium hobbyists and growers should grow and cultivate the concerned plant in a restricted manner;
- Monitoring the spread of this plant should be undertaken to stop the distribution of this plant.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this study.

References

[1] Acevedo-Rodríguez, P., & Strong, M.T. (2012). Catalogue of seed plants of the West Indies. Smithsonian Contributions to Botany, 98: 1–1192.

[2] Daehler, C.C. (1998). The taxonomic distribution of invasive angiosperm plants: ecological insights and comparison to agricultural weeds. Biological Conservation, 84(2): 167–180.

[3] Flora of North America Editorial Committee (2000). Flora of North America North of Mexico. Oxford University Press, New York, Oxford, 22: 1–352.

[4] Haynes, R.R., & Burkhalter, J.R. (1998). A new species of Echinodorus (Alismataceae) from the United States of America. Castanea, 63: 180–182. https://plants.usda.gov/home/plantprofile?symbol=ecco3.

[5] Haynes, R.R., & Holm-Nielsen, L.B. (1994). The Alismataceae. Flora Neotropica, Monograph, 64: 1–112.

[6] The International Plant Names Index and World Checklist of Vascular Plants (2024). Published on the Internet at https://powo.science.kew.org/.

[7] Kasselmann, C. (2001). Echinodorus, die beliebtesten Aquariep-flanzen. Ettlingen, Dähne Verlag, Pages 172.

[8] Kawecki, T.J., & Ebert, D. (2004). Conceptual issues in local adaptation. Ecology Letters, 7(12): 1225–1241. doi: 10.1111/j.1461-0248.2004.00684.x.

[9] Lehtonen, S. (2009). On the origin of Echinodorus grandiflours (Alismataceae) in florida ("E. floridanus"), and its estimated potential as an invasive species. Hydrobiologia, 635: 107–112. doi: 10.1007/s10705-009-9903-9.

[10] Lehtonen, S., & Rodrı´guez Are´valo, L.A. (2005). Notes on aquarium plant production in Peruvian Amazonia. Ethnobotany Research & Applications, 3: 209–214.

[11] Linhart, Y.B., & Grant, M.C. (1996). Evolutionary significance of local genetic differentiation in plants. Annual Review of Ecology and Systematics, 27(1): 237–277.

[12] Maden, K. (2006). Plant Collection and Herbarium Techniques. Our Nature, 2(1): 53–57. https://doi.org/10.3126/on.v2i1.327.

[13] Mukul Sharif, A., Sayed, M.A., Khan, A., & Uddin, M.B. (2021). Invasive Alien Species of Bangladesh. In Invasive Alien Species: Observations and Issues from Around the World, Volume 2: Issues and Invasions in Asia and the Pacific Region, First Edition, John Wiley & Sons Ltd.

[14] Oduor Ayub, M.O., Leimu, R., & Kleunen, K.V. (2016). Invasive plant species are locally adapted just as frequently and at least as strongly as native plant species. J of Ecol., 104: S957–968. https://dx.doi.org/10.1111/1365-2745.12578.

[15] Rataj, K. (1978). Alismataceae of Brazil. Acta Amazon, 8: 5–51.

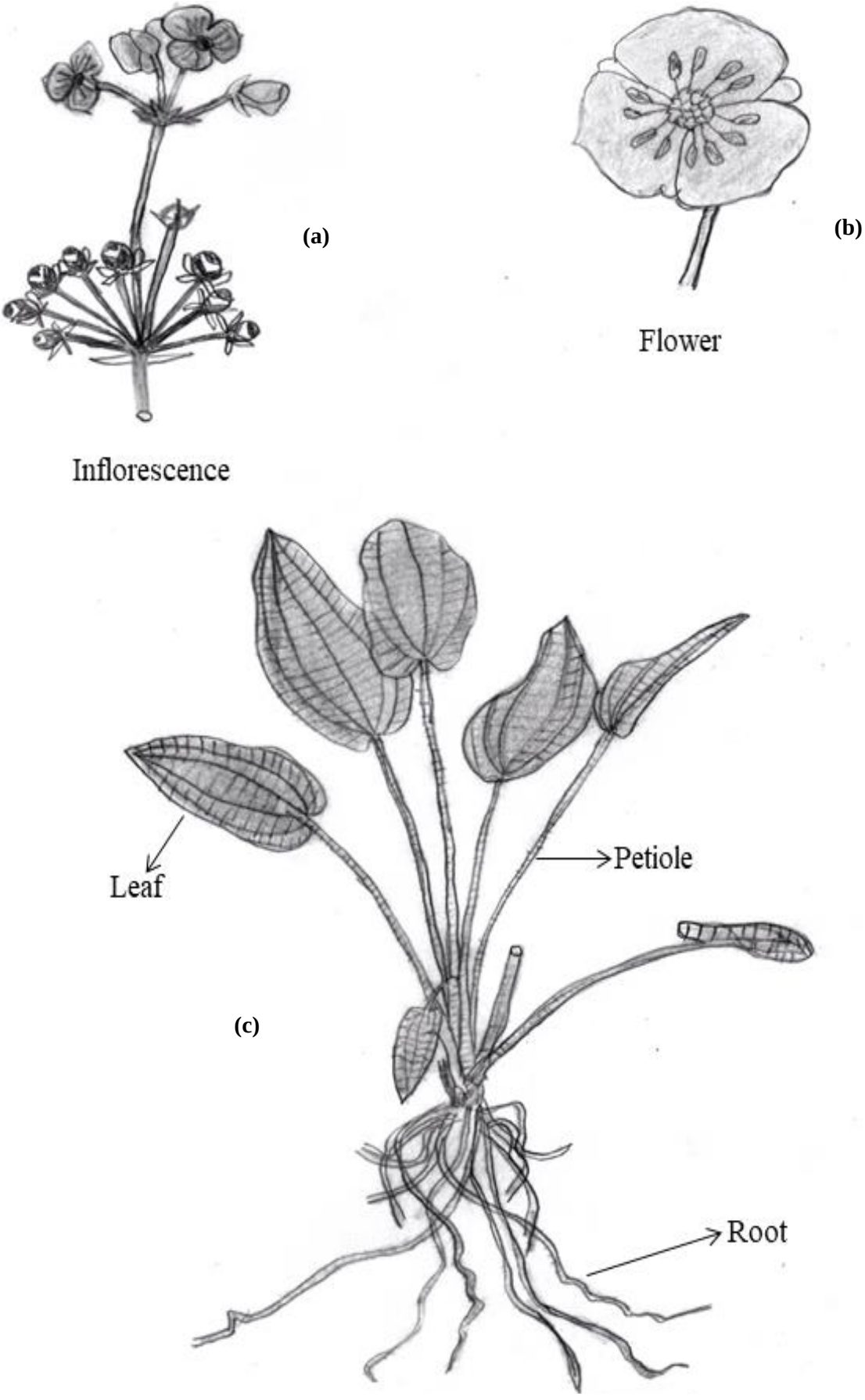

Figure 1. Handdrawing showing *Echinodorus cordifolius* L. (a) Inflorescence, (b) Flower, and (c) Whole Plant.

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Figure 2. Map showing the distribution of *Echinodorus cordifolius* in 16 districts of Bangladesh.

Figure 3. (a) Opposite side of the leaf, (b) front side of the leaf, (c) opposite side of the leaf from aquarium, (d) front side of the leaf from aquarium, (e) bisexual flower, (f) massive growth in Ex-situ condition, (g) widespread of *Echinodorus cordifolius* in natural condition, (h) reproduction parts & arrangement of stamens.

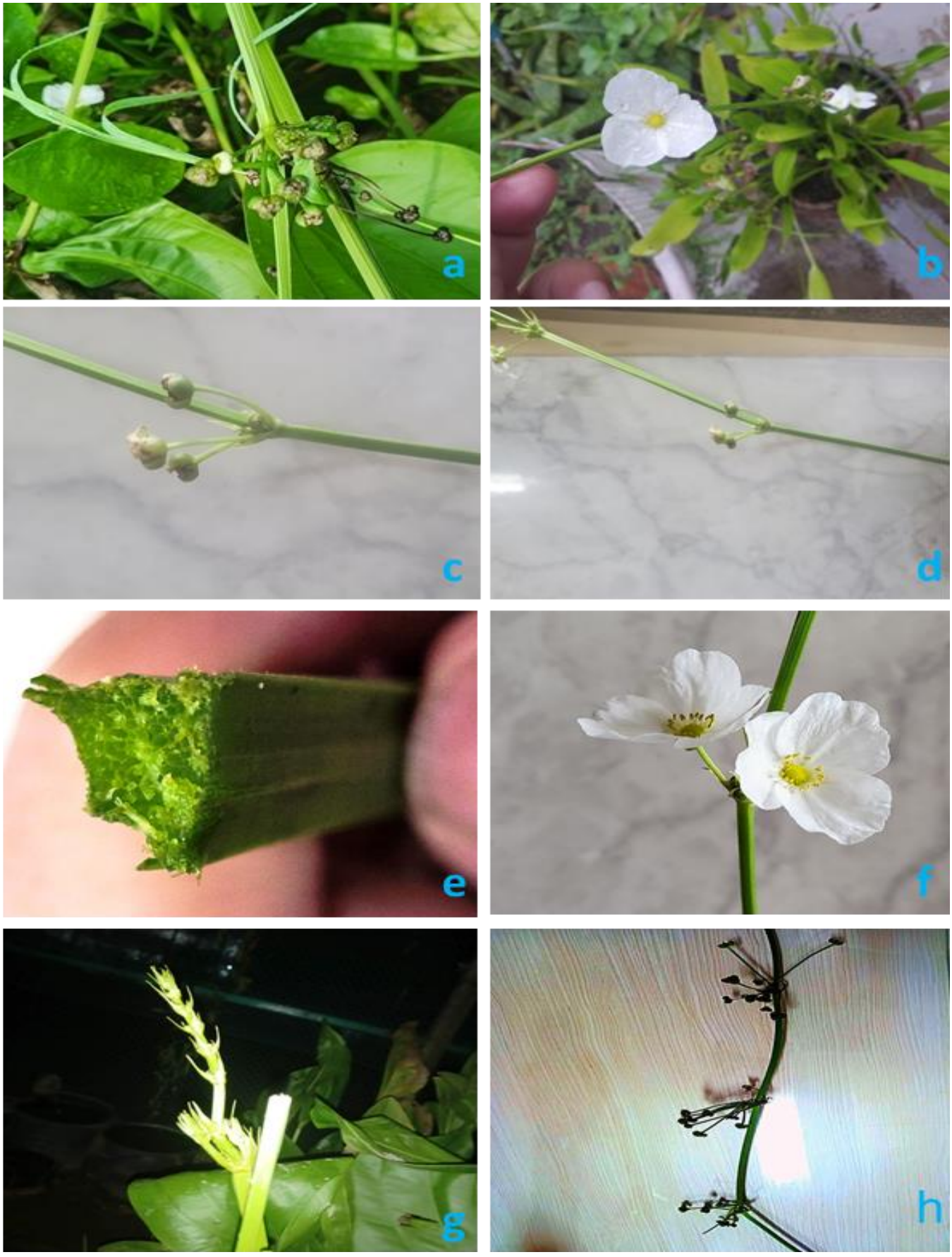

Figure 4. (a) Inflorescence in outdoor, (b) whole plant, (c) inflorescence before blooming, (d) inflorescence, (e) triangle petiole, (f) flower in bloom, (g) initiation of inflorescence, and (h) inflorescence after blooming.