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Taxonomic revision of genus *Potamogeton* (Potamogetonaceae) in Kashmir Himalaya, India

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Abstract: *Potamogeton* L. (Potamogetonaceae) is one of the diverse genera of aquatic plants. Owing to its reduced floral morphology and high phenotypic plasticity, the genus has remained taxonomically challenging. This study presents taxonomic revision of *Potamogeton* in Kashmir Himalaya, based on comprehensive field collections made over the last decade (2010–2020), supplemented with investigations on earlier herbarium collections. During the present study, aquatic habitats across the Kashmir Himalaya were surveyed, and 15 study sites were selected for detailed sampling spanning an elevation gradient of 1595 to 2180 m asl. The study records 12 *Potamogeton* species in the region, with detailed morphological characterization, identification key, line drawings, and photographs. The three species, namely, *P. amblyophyllus* C.A. Meyer, *P. berchtoldii* Fieber, and *P. trichoides* Cham. & Schltdl. are the first-time reports from this region, while the latter two species are new distribution records for India as well. Overall, the study brings clarity to the taxonomy of *Potamogeton* - the largest aquatic genus in Kashmir Himalaya, and the findings have practical implications in the sustainable management and restoration of aquatic ecosystems in this Himalayan region, with learnings for neighboring regions.

Key words: *Potamogeton* species, taxonomy, morphology, first report, Kashmir Himalaya.

Introduction

Globally, Potamogetonaceae (Pondweed family) comprises *c.* 80 species and 105 hybrids classified into three genera: *Potamogeton* L., being the largest with 72 species and 99 hybrids, *Stuckenia* Börner with 7 species and 6 hybrids, and monotypic *Groenlandia* J.Gay (Kaplan, 2008; Kaplan et al., 2013). However, some authors include six genera in the family, namely *Althenia* F.Petit, *Groenlandia* J.Gay, *Lapilaena* J.Drumm. ex. Harv., *Zannichellia* L., *Stuckenia* Börner, and *Potamogeton* L. with 110 species (Christenhusz & Byng 2016). On the other hand, the exclusion of family Zannichelliaceae from Potamogetonaceae has been argued by various authors on the basis of distinctive morphology and phylogenetic relationship among the genera (Aykurt et al., 2020). Watson and Dallwitz (1992) reported that these two families differ in 45 characters, representing conspicuous features of vegetative and floral morphology as well as embryology and cytology. On the basis of these features, treatment of Zannichelliaceae as a phenotypically clearly defined family, distinct from the traditionally delimited Potamogetonaceae has been advocated (Aykurt et al., 2020).

The family include exclusively aquatic plants, mostly perennial herbs with leaves alternate or nearly opposite, alike or dimorphic, inflorescence a capitate spike, terminal or axillary, peduncles surrounded by a sheath at the base; flowers tetramerous, small, bisexual, and fruit drupe- or achene-like (Wiegleb & Kaplan, 1998). *Potamogeton* is distinguished from *Stuckenia* mainly on the basis of nature of peduncle and lower ploidy level (generally diploid or tetraploid) and from *Groenlandia* in possessing two flowers per spike, drupe-like fruit and monobasic nature;

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x=15 (Les & Haynes, 1996; Holub, 1997; Haynes et al., 1998; Kaplan et al., 2013). Although the genus shows cosmopolitan distribution, but the highest number of its species occur in the Northern Hemisphere (Lindqvist et al., 2006). The precise number of *Potamogeton* species occurring in different continents and regions of the world is quite inconsistent and the phytogeographical patterns are still obscure (Wiegleb, 1988; Wiegleb & Kaplan, 1998).

Taxonomically, *Potamogeton* is challenging due to its high species diversity, reduced morphology, extensive vegetative plasticity, high intra- and inter-population variations, propensity for hybridization in sympatric populations and polyploidization (Les et al., 2009; Ganie et al., 2014; Choi et al., 2023). Coupled with these attributes, the reduced floral morphology limiting the number of taxonomic characters suitable for the species delimitation (Preston & Croft, 1997; Kaplan & Stepanek, 2003; Kaplan et al., 2009; Kaplan, 2010) has led to apparent taxonomic complexities in the genus. From the Indian subcontinent, various numbers of *Potamogeton* species have been reported by different workers. Earlier, Hooker (1894) reported 10 species of the genus from the Indian subcontinent. However, in recent times, the number of species reported from India has been highly variable: 6 spp. (Cook, 1996), 16 spp. (Kothari, 2001) and 7 spp. (Chowdhury et al., 2015). In fact, the majority of these species reported from India occur in the Western Himalaya.

Stewart (1972) reported 12 species of the genus from Kashmir, including the north-western parts of Pakistan. Subsequently, Kak (1990) reported 14 species from the Kashmir Himalaya, which includes the main valley and its side mountains. Nonetheless, taxonomically, the majority of these reported species have been poorly and inconsistently characterized, thus making their occurrence in the region highly doubtful and identification extremely difficult. This necessitates a thorough taxonomic revision of the genus *Potamogeton* in the Kashmir Himalaya. Therefore, the present study was aimed to address the following objectives: (i) to revise the taxonomy of *Potamogeton* based on fresh material collected over the last decade and examination of earlier herbarium material, (ii) to provide a detailed taxonomic description for each species, illustration and field photographs, and (iii) to prepare a taxonomic key for aid in field identification.

Materials and methods

Study area

The Kashmir Himalaya is a region located in the north-western part of the Himalayan biodiversity hotspot in India (Dar & Khuroo, 2020). The region is located between 33°20′ N–34°54′ N latitude and 73 ° 55′ E–75 ° 35′ E longitudes, covering an area of 42,241 sq. km (Ganie et al., 2016). The study area harbors a network of glaciated streams, rivers, as well as alpine, sub-alpine, and valley lakes, which support a rich diversity of aquatic vegetation (Ganie et al., 2014) (Fig. 1).

Survey and collection

For the present study, a range of aquatic habitats throughout the Kashmir Himalaya were extensively explored for collection of *Potamogeton* species during the last decade (2010–2020) and 15 sites were selected for the detailed sampling during the present study (Fig. 1). These habitats varied in water depth, flow, altitude, areal extent, tropic status and type of water body (lakes, marshes, wetlands, water channels, and alike). The survey and collection of plant samples were done throughout the growing season usually from March to December.

Laboratory studies

The collected plant materials were studied in the laboratory for quantitative and qualitative characters, such as shape and size of leaves, stipules, petiole, peduncle, flowers, fruits, and carpel number. The specimens were preserved

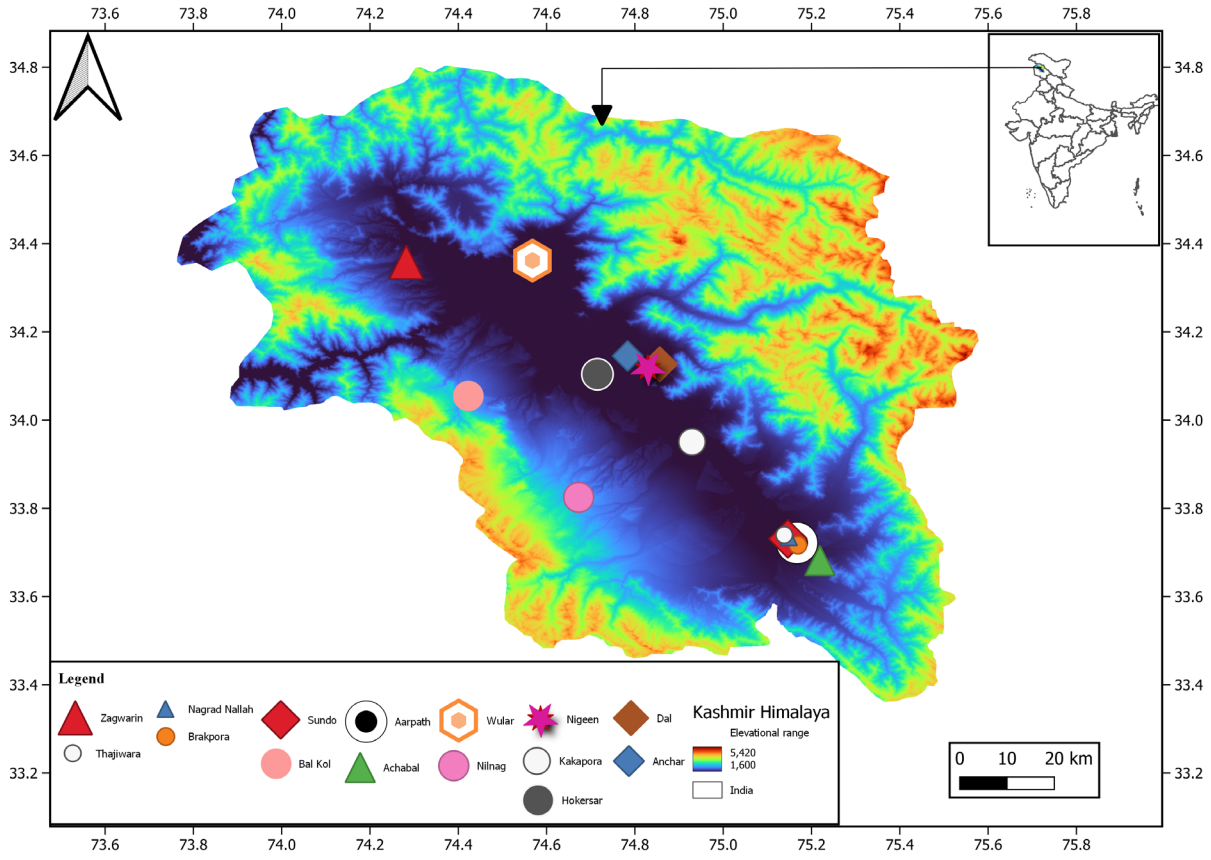

Fig. 1. Map showing different collection sites of *Potamogeton* species in Kashmir Himalaya.

using standard herbarium methods, and voucher specimens were deposited in the University of Kashmir Herbarium (KASH) at the Centre for Biodiversity & Taxonomy, Department of Botany. Some of the specimens have also been deposited at The Herbarium of the Institute of Botany, Czech Republic (PRA). The abbreviations for herbaria follow *Index Herbariorum* (Thiers, 2025 continuously updated). The specimens were identified with the help of relevant literature (Wiegleb & Kaplan, 1998; Kaplan et al., 2009; Zhang et al., 2010; www.efloras.org), as well as comparative herbarium studies, mostly at KASH. For species description and preparation of the identification key, the live plant material of each species collected from different aquatic habitats across the Kashmir Himalaya was used. The illustrations of all the identified species, collected from different locations, were also drawn from fresh plant material. To draw the micro characters, a magnifying glass and a stereo-zoom microscope (Make: Leica S9D, Germany) were used.

Results

In the study area, the genus is one of the most diverse and dominant groups of aquatic plants. The species show widespread distribution, occurring in lakes, ponds, marshes, streams, springs and rice fields; and inhabit almost all the lentic and lotic water-bodies including oligo-, meso-, and eutrophic lakes, rivulets and streams of valley up to sub-alpine elevations (Fig. 1). During the present study, 12 *Potamogeton* species have been reported: three species (*Potamogeton amblyophyllus* C.A.Meyer, *P. berchtoldii* Fieber and *P. trichoides* Cham. & Schltdl.) are the first-time distribution records for Kashmir Himalaya; the latter two species are also new distribution record for India as well. The dichotomous key and detailed taxonomic description, based on the

freshly collected material from the study region, along with illustrations and photographs of all the 12 species, are presented below:

Key to the *Potamogeton* species of Kashmir

1. Leaves oblong-linear to elliptical or orbicular, 1–13 times as long as wide, more than 4 mm wide, (3–) 5–35-veined, sessile and/or petiolate, submerged and/or floating, entire and/or denticulate at margins 2

1. Leaves filiform to linear, 13–250 times as long as wide, 0.2–4 mm wide, (1–) 3(–5)-veined, all sessile, submerged, entire at margins 7

2. Leaves long petiolate, petioles 15–150 mm long; floating leaves often present 3

2. Leaves sessile, subsessile, or shortly petiolate, petioles up to 15 mm long; floating leaves always absent 5

3. Submerged leaves phyllodial, linear; floating leaves with a flexible junction and often a distinct angle at the top of the petiole immediately below the lamina, often different in colour ..... *P. natans*

3. Submerged leaves with oblong lamina; floating leaves (if present) without a flexible discoloured junction and an angle at the top of the petiole 4

4. Submerged leaves mucronate at apex, lamina with ± parallel margins for most of their length, 9–13-veined; floating leaves often absent even in adult plants ..... *P. wrightii*

4. Submerged leaves acute to subobtuse at apex, never mucronate, lamina with convex margins, 11–21-veined; floating leaves almost always present in adult (flowering or fruiting) plants 11

5. Leaves (3–)5(–7)-veined, 4–10 mm wide, leaf margins serrate, with teeth usually easily visible to the naked eye; fruits adnate at base, beak at least half as long as the rest of the fruit ..... *P. crispus*

5. Leaves 9–33-veined, 12–50 mm wide, leaf margins entire or very minutely denticulate, with teeth not or only scarcely visible to the naked eye; fruits free at base, beak much less than half as long as the rest of the fruit 6

6. Leaves sessile, amplexicaul to semi-amplexicaul at base, clasping the stem, 18–60 mm long, rounded to subacute, never mucronate ..... *P. perfoliatus*

6. Leaves subsessile or shortly petiolate, petioles up to 15 mm long, lamina cuneate at base, (30–)50–200 mm long, mucronate at apex ..... *P. lucens*

7. Stipules adnate to leaf base, forming a sheath around the stem above the node, leaf lamina arising at the top of the sheath, 5 mm or more above the node; peduncle lax, not projecting, inflorescence above water surface, flowering inflorescence submerged or floating at water surface 8

7. Stipules free from leaves, leaf lamina arising directly from the node; peduncle stiff, flowering inflorescence submerged or projecting above water surface 9

8. Leaf sheaths connate, tubular toward base at least when young, appearing as a closed ellipse when transversally dissected; leaves obtuse to rounded at apex ..... *P. amblyophyllus*

8. Leaf sheaths convolute, appearing as a short spiral when transversally dissected; leaves mostly acute to acuminate at apex ..... *P. pectinatus*

9. Flowers with 1(–2) carpels; fruits compressed from sides, 2.5–3.3 mm long; leaves relatively rigid, mostly 0.2–1.0 mm wide, leaf midrib occupying 1/4–2/3 of the leaf width near the base, leaves acuminate at apex ..... *P. trichoides*

9. Flowers usually with 4 carpels; fruits convex on sides, 1.8–2.5 mm long; leaves flaccid, mostly 0.5–3.0 mm wide, leaf midrib occupying 1/20–1/4 of the leaf width near the base, leaves mostly acute at apex 10

10. Stipules connate, tubular at least when young, appearing as a closed ellipse when transversally

dissected; turions axillary, brownish-yellow to brownish green; nodal glands absent or inconspicuous; leaves without bands of lacunae bordering midrib or rarely narrow bands present; midrib of at least young leaves distinctly thickened toward leaf base, with strongly convex lower side in cross-section ..... *P. pusillus*

10. Stipules convolute, appearing as an open ellipse or a short spiral when transversally dissected; turions terminal, dark green; nodal glands present at least on some nodes, often well developed; leaves mostly with broad and conspicuous bands of lacunae bordering midrib; midrib not thickened toward leaf base, with only indistinctly convex lower side in cross-section ..... *P. berchtoldii*

11. Carpels 4; fruit obovate to semicircular, 3–4 mm, abaxial keel distinct..... *P. nodosus*

11. Carpels (1 or) 2(or 3); fruit broadly obovoid, 2.9–3.7 mm, abaxial keels 3, with a sharp midrib and ± obtuse lateral keels..... *P. distinctus*

Taxonomic treatment

Potamogeton amblyophyllus C.A.Meyer, Beitr. Pflanzek. Russ. Reiches 6: 10. 1849. ("amblyophyllus"). *Stuckenia amblyphylla* (C.A.Meyer) Holub., Preslia 69: 364. 1997. *Type*: GEORGIA, Prope pagum Kasbek, 900 m, 02.08.1844, Dr. Kolenati 2127 (holo LE; iso BM, C-Baagöe, fragment in LD!). **Figs. 2 & 14a**

Plants herbaceous, growing in freshwaters; rhizome slender, terete, perennial; stem with nodes and internodes, branched, slender, terete, annual to perennial; leaves linear to linear long, 5–13 cm long, 1–3 mm wide, olive green to dark green, 3-veined, lateral veins marginal and inconspicuous, margins entire, sessile, straight at base, obtuse at apex; stipules adnate, connate, 2 –4 cm long fused with leaves for 1–2 cm, persistent; peduncles 3–7 cm long; spikes 1–2 cm long, thicker than stem, cylindrical, monoliform with 8–12 flowers in 3–6 whorls; flowers 2–3 mm in diameter, perianth round - flabelliform, 1.5 mm long, 1–2 mm wide; androecium 1–1.5 mm long and ca.1 mm broad; gynoecium1 mm long, ca. 0.5 mm wide, usually 4 in number.

Flowering & fruiting: June to September & fruits not produced.

Habitat & Ecology: Running waters of streams and rivulets; prefer oligo- to mesotrophic waterbodies.

Distribution: China, Central Asia, Afghanistan, Iran, Türkiye, Caucasus (POWO, 2025), and now Kashmir Himalaya, India.

Specimens examined: INDIA, **Jammu & Kashmir**, Achabal spring, 1610 m asl, 33°41′03″N, 75°13′12″E, 20.07.2006, *Aijaz* 10011; Nambal rivulet, 1605 m asl, 33°43′09″N, 75°11′04″E, 05.07.2007, *Aijaz, Wafai & Reshi* 10012; Nagrad stream, 1605 m asl, 33°42′00″N, 75°11′31″E, 12.07.2007, *Aijaz* 10013; Mehandi Kadal, 1600 m asl, 33°38′00″N, 75°06′01″E, 11.07.2009, *Aijaz* 1001 (KASH). Nambal rivulet, 1605 m asl, 33°43′09″N, 75°11′04″E, 10.07.2006, *Aijaz* 1016 (PRA).

Notes: *Potamogeton amblyophyllus* is closely related to *P. pectinatus* in having filiform to linear leaves but differs in having connate leaf sheaths and obtuse to round leaf apex (vs. convolute leaf sheaths and acute to acuminate leaf apex). *Potamogeton amblyophyllus* is an orthographic variant and considered incorrect in formal nomenclature.

Potamogeton berchtoldii Fieb. in Bercht. & Opiz, Oekron – Techn. Fl. Bohm 2(1): 277. 1838. *Lectotype* (designated by Kaplan, 2014); CZECH REPUBLIC, Bohdanec, *P.M. Opiz* 11479 (PRC [PRC454049, sheet 1] digital image!). **Figs. 3 & 14b**

Plants herbaceous, submerged; rhizomes very thin slender and perennial; stem branched with nodes and internodes, slender, terete or nearly so, branches (late in season) often terminate by winter bud; leaves linear to linear- setaceous, acute at apex, 2–6 cm long, 0.2–0.3 cm wide, light green to deep green, translucent and flaccid, entire, sessile, 3-veined, lateral veins often obscure joining the mid rib below the tip;

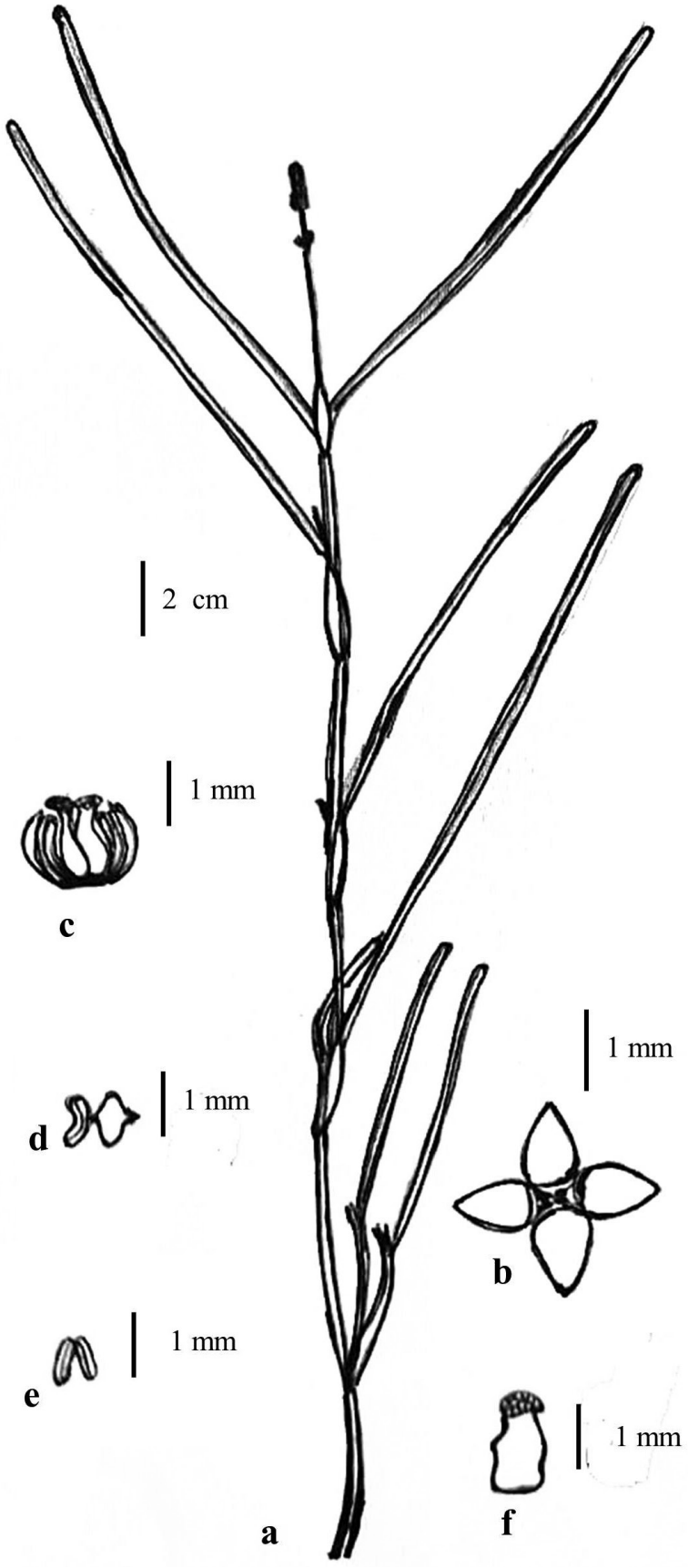

Fig. 2. *Potamogeton amblyophyllus* C.A.Meyer: **a**. Habit; **b**. Flower; **c**. L.S of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium.

stipules hyaline to sub-herbaceous, 0.5–1.5 cm long, usually clasping the stem half the length and free distally; peduncles thin and slender, 1–4 cm long; spikes 0.2–0.5 cm long, sub-globose with 2–4 flowers compactly arranged in 1–3 whorls; flowers ca. 2 mm in diameter; tepals ca. 1 mm long, 1–1.5 mm broad; carpels 4; androecium 4, 1 mm long.

Flowering & fruiting: May to August & fruits not produced.

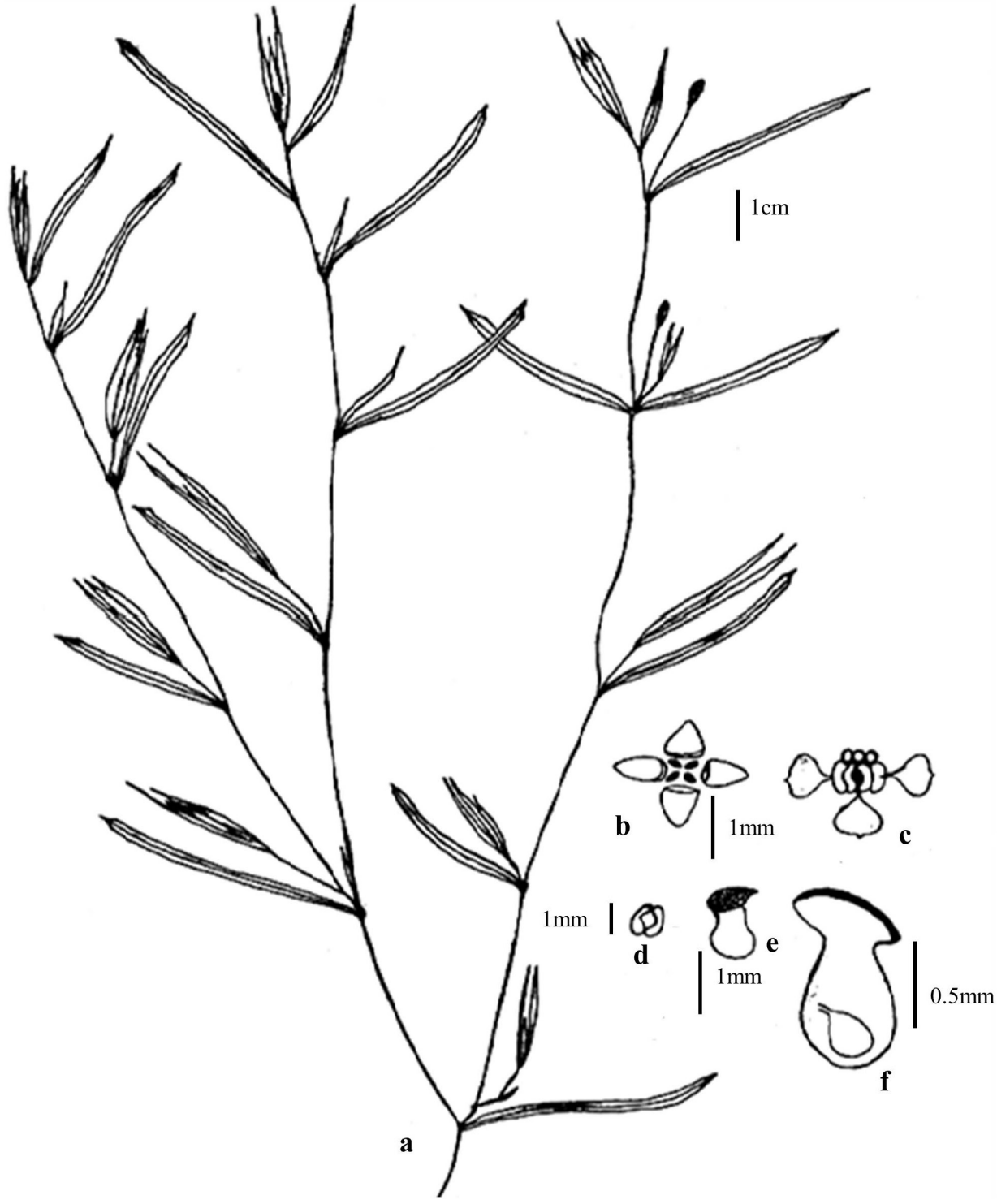

Fig. 3. *Potamogeton berchtoldii* Fieb.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium; **e**. Gynoecium; **f**. L.S of gynoecium showing basal placentation.

Habitat & Ecology: Running waters of springs and streams; prefers oligotrophic waterbodies.

Distribution: Asia, Europe, North America and northern Africa (POWO, 2025), and now Kashmir Himalaya, India.

Specimens examined: INDIA, Jammu & Kashmir, Achabal spring, 1610m asl, 33^{0}41′03″N, 75^{0}13′12″E, 08.05.2006, *Aijaz* 10021; Nagrad stream, 1605 m asl, 33^{0}42′00″N, 75^{0}11′31″E, 18.06.2007, *Aijaz* 10022; Bal Kol, 1950 m asl, 34^{0}03′34″N, 74^{0}25′40″E, 23.06.2008, *Aijaz* 10023; Kul Hama, Spring- near Wular lake, 1595m asl, 34^{0}25′20″N, 74^{0}40′16″E, 25.06.2009, *Aijaz* 10024. Zagwarin-Kupwara, 1620m asl, 34^{0}30′36″N, 74^{0}15′02″E, 02.07.2009, *Aijaz* 10025 (KASH). Nagrad stream, Anantnag, 1605m asl, 33^{0}42′00″N, 75^{0}11′31″E, 17.06.2012, *Aijaz* 10027 (PRA).

Notes: *Potamogeton berchtoldii* is closely related to *P. pusillus* in having stipules free from leaves, leaf lamina arising directly from the node but differs in having terminal dark green turions; nodal glands present, often well developed, leaves mostly with broad and conspicuous bands of lacunae bordering midrib (vs. turions axillary, brownish-yellow to brownish green; nodal glands absent or inconspicuous; leaves without bands of lacunae bordering midrib or rarely narrow bands present).

Potamogeton crispus L., Sp. Pl. 126. 1753. Type: EUROPE, Linnaeus 175.6 (holo LINN !). **Figs. 4 & 14c**

Plants herbaceous, submerged; rhizome slender, compressed, annual to biennial; stem with nodes and internodes, branched, laterally compressed and somewhat angled, glabrous, annual or partly winter green; stiff axillary turions develop on the stem; leaves linear-oblong to linear- oblanceolate, sessile, 3–12 cm long, 0.4–0.9 cm wide, bright green to dark green, translucent, margins finely serrate and strongly undulate, the apex broadly rounded, the base semi-clasping, 3–7 nerved, with narrow to broad rows of lacunae bordering the mid rib; stipules 0.5–1.5 cm long, slightly adnate to base, translucent, decaying early; peduncles 3–10 cm long, thick at base; spikes 1.3–2.5 cm long, cylindrical with 8–11 flowers loosely arranged in 3–5 whorls; flowers 3 mm in diameter; perianth blade orbicular, 2 mm long, 2–3 mm wide; androecium 1.5–1.7 mm long, 1.5 mm broad; carpel 1.7–2 mm long, 0.5 mm broad; carpels 4, shortly connate at base; fruit obovate, 2–4 mm long (excluding beak), 1.5–2.8 mm broad, rounded on back, keels obtuse but prominent, the dorsal one strongly developed below and with small tooth near the base, dark olive to brownish in colour; beak prominent, incurved, longer than fruit; winter buds (turions) bur-like, hard and spiny, greenish-brown pine cone-like.

Flowering & fruiting: April to May & May to June.

Habitat & Ecology: Both running and standing waters and almost all types of water bodies with oligo- to eutrophic conditions.

Distribution: Native to Asia, Europe, Africa; introduced into North America and South America (POWO, 2025)

Specimens examined: INDIA, Jammu & Kashmir, Dal lake, 1600m, 17.07.1968, *GNJ* 1081; Gadigarh- Jammu, 400m, 09.01.1969, *B.M.Sharma* 29; Dal lake, 1600m, 04.07.1974, *A.R. Naqshi* 4070; Dal lake, 1600m, 11.05.1975, *A.M Kak* 8090; Hygham,1600m, 06.06.1975, *A.M. Kak* 2028; Kujar,1625m,19.11.1981, *G. H. Dar* 3312; Saidiwarie,1800m, 04.05.2001, *G. H. Khanday* 870; Bod-dal,1800m, 05.05.2001, *G. H. Khanday* 865; Prangam,1800m, 08.05.2001, *G. H. Khanday* 868.; Mandipura,1800m, 05.05.2001, *G. H. Khanday* 837; Anchar lake,1595m asl, 34°10′55″N, 74°48′10″E, 07.05.2005, *Aijaz* 10031; Dal lake,1595m asl, 34°08′48″N, 74°52′51″E, 13.05.2006, *Aijaz* 10032; Nilnag lake, 2180m asl, 33°51′25″N, 74°41'45″E, 19.05.2006, *Aijaz* 10033; Nambal rivulet,1605m asl, 33°43′09″N, 75°11′04″E, 05.07.2007, *Aijaz, Wafai and Reshi* 10034; Aarpath rivulet,1600m asl, 33°43′09″N,

75°11′04″E, 25.07.2008, *Aijaz* 10035; Manasbal lake, 1590m asl, 34°15′26″N, 74°41′26″E, 27.06.2008, *Aijaz* 10036 (KASH).

Notes: *P. crispus* is related to *P. perfoliatus* in having sessile, subsessile and floating leaves always absent but differs in having linear-oblong to linear-

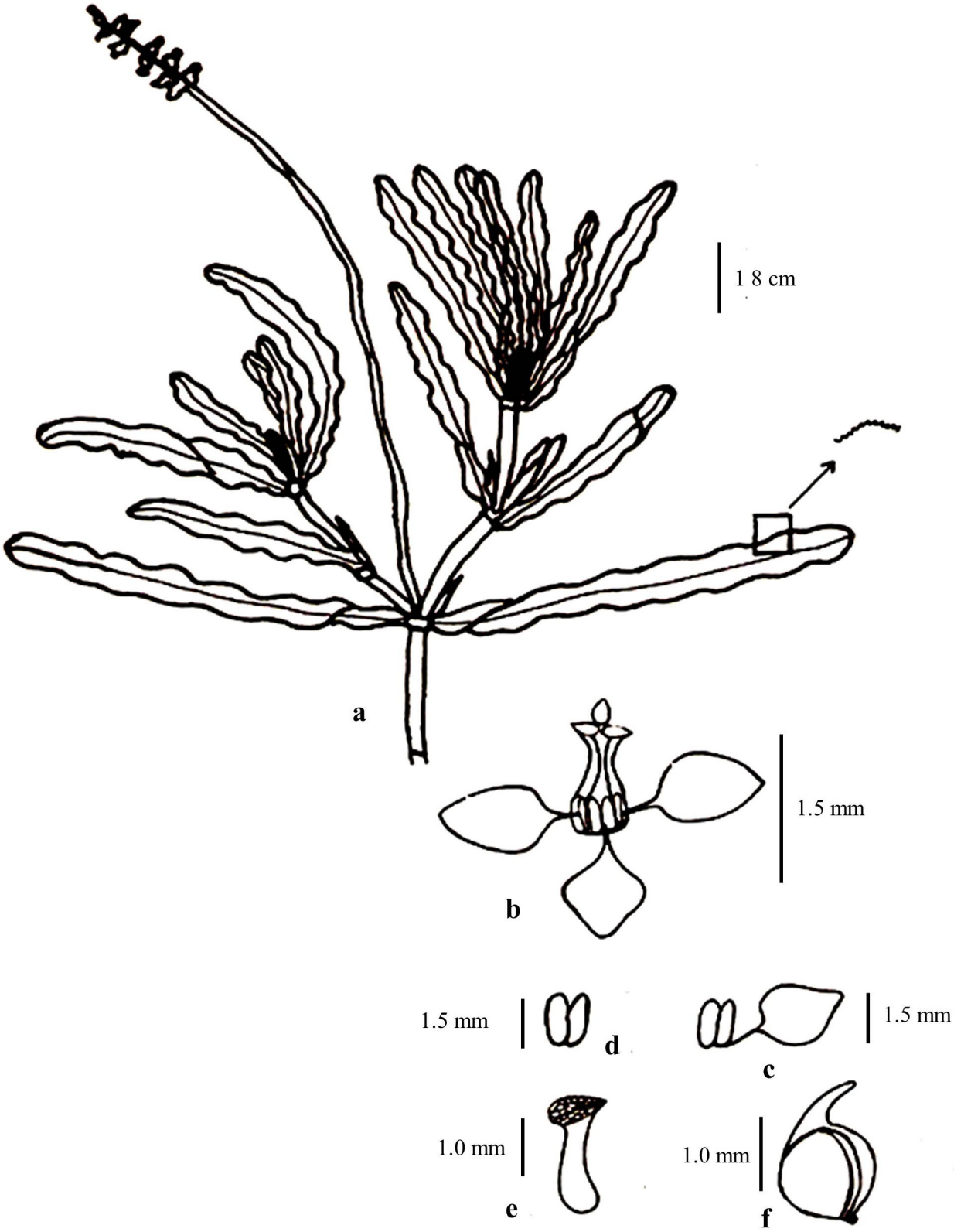

Fig. 4. *Potamogeton crispus* L.: **a**. Habit; **b**. L.S of flower; **c**. Androecium adnate to tepal; **d**. Androecium; **e**. Gynoecium; **f**. Fruit.

oblanceolate leaves and beak at least half as long as the rest of the fruit (vs. sub-orbicular to oblong ovate leaves and beak short).

Potamogeton distinctus A.Bennett, J. Bot. 42: 72. 1904. *Lectotype* (designated by Kaplan, 2009): JAPAN, Amori, July 1902, Dr. Litwinow 2424 (BM!; *Isolecto* BM [herb. BM000630538, sheet 1]). **Figs. 5 & 14d**

Plant herbaceous, leaves floating; rhizome whitish in colour, terete, perennial with apical winter buds; stem unbranched or sparingly branched terete, annual; submerged leaves present; petiolate, petioles 5–20 cm long; lamina narrowly lanceolate to lanceolate, herbaceous, often decaying early, 9–17-veined, sometimes reduced to phyllodes; floating leaves petiolate, blade 4 –12 cm, 1–4 cm wide, opaque broadly elliptical or ovate lanceolate, leathery, 11–19-veined, base obtuse or sometimes cuneate, apex acute or obtuse; stipules axillary, convolute, 2–8 cm, membranous, translucent, amplexicaul, often persistent; spikes cylindric, 3–8.3 cm, densely flowered, contiguous; peduncles thicker than stem, 3–10 cm; carpels (1 or)2(or 3); fruit broadly obovoid, 2.9–3.7 mm, abaxial keels 3, with a sharp midrib and ± obtuse lateral keels.

Flowering & fruiting: June to August & fruiting July to September.

Habitat & Ecology: Both running and standing waters of lakes, ponds, streams.

Distribution: South Asia (Himalaya), South-East Asia and East Asia (China, Mongolia, Japan) (POWO, 2025)

Specimens examined: INDIA, Jammu & Kashmir, Nilnag lake, 2180m asl, 33°51′25″N, 74°41′45″E, 05.09.2013, *Aijaz* 8221; Kandizal, Pulwama, 1622m asl, 33°58′01″N, 74°52′10″E, 5.9.2013, *Aijaz* 8721 (KASH).

Notes: *Potamogeton distinctus* is closely related to *P. nodosus* in having submerged leaves with acute to subobtuse apex, never mucronate, lamina with convex margins, 11–21-veined but distinguished in having 1-2 carpels per flower and obovate to semicircular fruit (vs. carpels 4 per flower, fruit broadly obovoid)

Potamogeton lucens L., Sp. Pl. 1 : 126.1753. *Type*: EUROPE, Linnaeus 73.20 (holo LINN!). **Figs. 6 & 14e**

Plants herbaceous, submerged; rhizome robust, terete, biennial to perennial; stem branched, slender with nodes and internodes, terete, annual; leaves narrowly oblong to broadly elliptical with short often obsolescent petiole; leaf lamina, 3–20 cm long, 2.5–3.5 cm broad, yellowish green lustrous, translucent margins with minute denticles and undulate, apex mucronate, base broadly to narrowly cuneate, 9–11 veined, without rows and lacunae bordering the mid rib; stipules axillary, convolute 2–10 cm long, translucent, mostly persistent peduncles, 4–15 cm long, thickened upwards; spikes 4–6 cm long, cylindrical with 30–39 flowers densely arranged in 8–12 whorls; flowers 3 mm in diameter; perianth lobe orbicular 1 mm long, 1–1.5 mm broad; androecium 0.5–1.5 mm long., 1–1.5 broad; carpels 4, 0.75 mm long, 0.5 mm broad; fruit sub-globose with distinct dorsal keel, 3–4.5 mm long, green to brownish in colour; beak very stout, central.

Flowering & fruiting: April to July & May to August.

Habitat & Ecology: Standing waters of lakes and ponds only with oligo- to eutrophic conditions.

Distribution: Asia, Europe and northern Africa (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Dal lake, 1600 m, 12.06.1968, GNJ 996; Shaltang, 1600m, 12.06.1968, JNJ 996; Dal lake, 1600 m, 14.09.1972, A.R. Naqshi 305; Hygham,1600m, 05.05.1975, A.M. Kak 3689; Anchar lake, 1595 m asl, 34°10′55″N, 74°48′10″E, 07.05.2005, *Aijaz* 10041; Dal lake, 1595 m asl, 34°08′48″N, 74°52′51″E, 13.05.2006, *Aijaz* 10042; Nilnag lake, 2180 m asl, 33°51′25″N, 74°41′45″E, 19.05.2006, *Aijaz* 10043; Manasbal lake, 1590 m asl, 34°15′26″N, 74°41′26″E, 27.06.2008, *Aijaz* 10044; Wular lake, 1595 m asl, 34°20N, 74°44E, 08.07.2008, *Aijaz* 10045 (KASH).

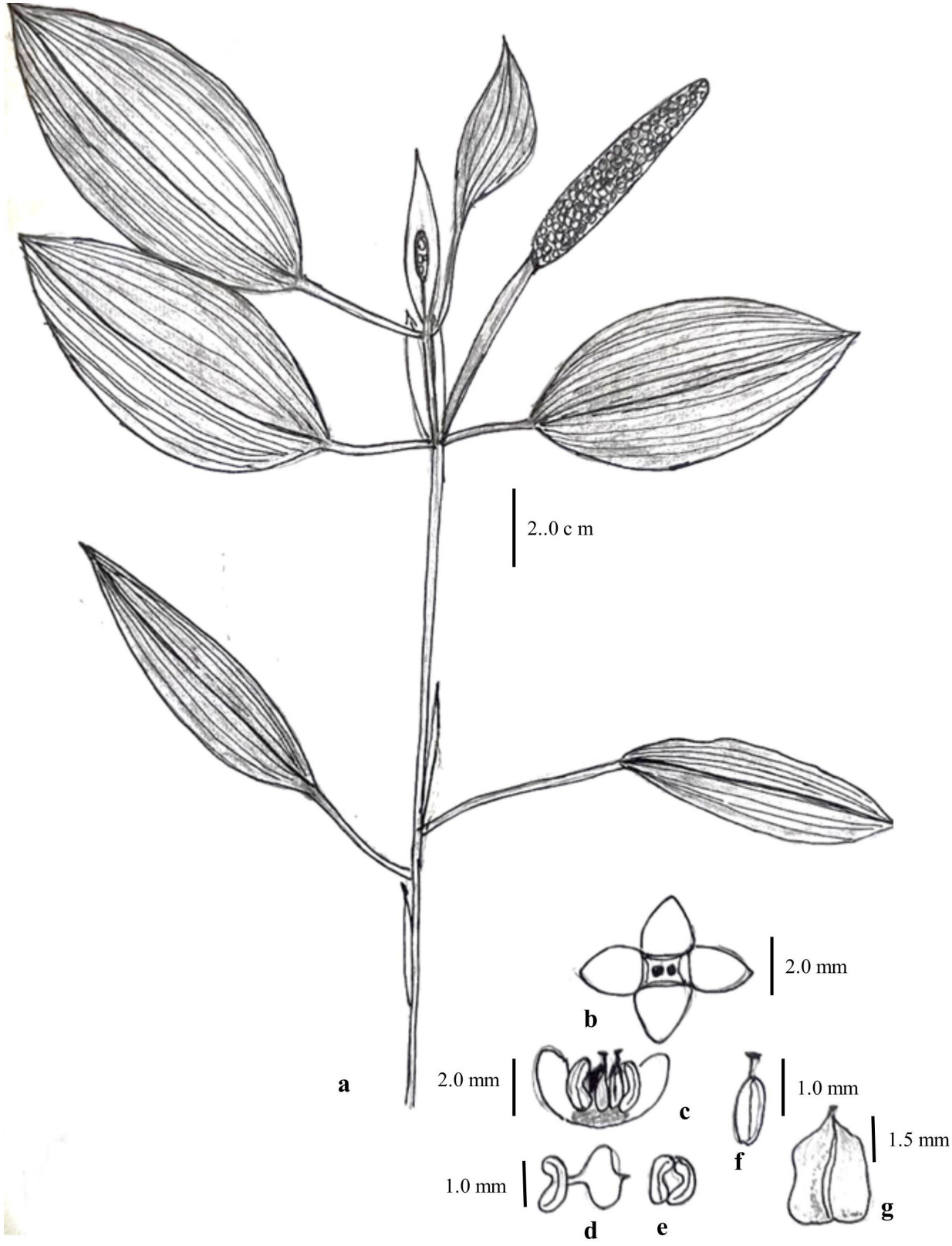

Fig. 5. *Potamogeton distinctus* Bennet: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium; **g**. Fruit.

Notes: *Potamogeton lucens* is related to *P. perfoliatus* in having 9–33-veined leaves and entire or very minutely denticulate leaf margins but differs in having subsessile or shortly petiolate leaves, lamina cuneate at base and mucronate at apex (vs. leaves sessile, amplexicaul to semi-amplexicaul at base, clasping the stem, rounded to subacute, never mucronate)

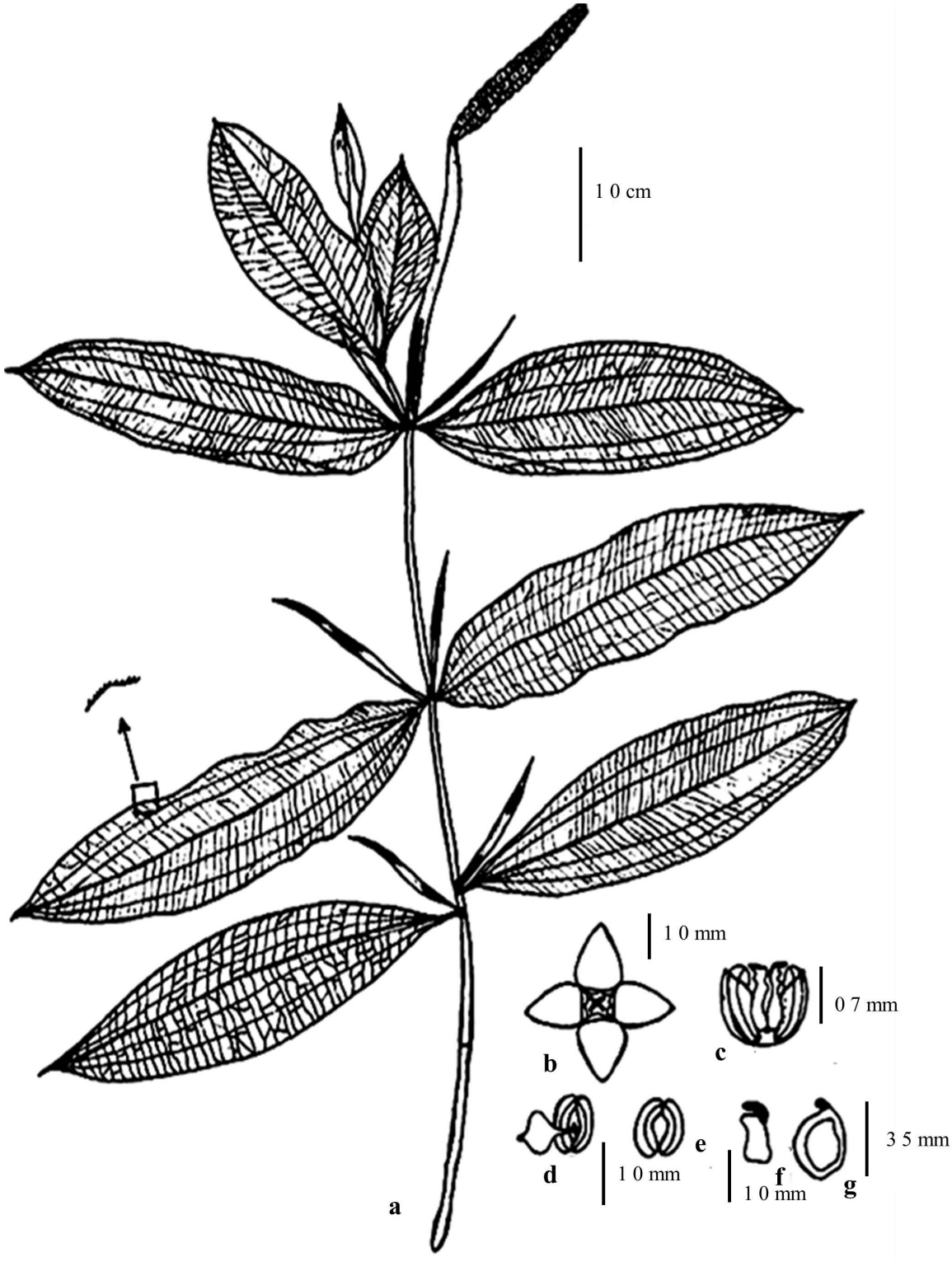

Fig. 6. *Potamogeton lucens* L.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium; **g**. Fruit.

Potamogeton natans L., Sp. Pl. 126. 1753. *Lectotype* (designated by Dandy, 1971): EUROPE, *Linnaeus* 175.1 (LINN digital image!). **Figs. 7 & 14f**

Plants herbaceous, floating; rhizomes robust, glabrous, terete, perennial, over-wintering by phylloid shoots; stems with nodes and internodes, branched, terete, annual to perennial; winter buds axillary, short leaf shoots; submerged leaves linear, 10–30 cm long, 1 –3 mm broad with no differentiation of blade and petiole, dark green, obscurely 1–3 veined, entire at margins, straight at base, narrow obtuse to accumulate at tip; floating leaves coriaceous, petiolate, petiole 5–20 cm long; petiole always with a dis-coloured section at the junction with the leaf lamina, leaf lamina broadly elliptical to ovate, 4–11 cm long, 2–4.5 cm wide, opaque, brown green or yellow green to olive green or dark green, margins entire, 15–30 veined, cordate to round at base, acute to obtuse at apex, stipules of submerged leaves clasping, whitish, persistent, hooked at apex when young, soon splitting and spiraling, 4–10 cm long, with 2 strong keels; stipules of floating leaves larger, 5–12 mm broad at base, translucent, persistent; peduncles 5–17 cm long, thicker than stem, gradually tapering upward; spikes 3.5–6 cm long, cylindrical with 30–60 flowers in 8–15 whorls, flowers 4–5 mm in diameter; perianth blade ca. 2 mm long, ca. 3 mm broad; carpels 4; androecium 2–2.5 mm long, 1.75–2 mm broad; gynoecium 2 mm long, 1 mm broad; fruit obovoid, slightly compressed laterally, dorsal margins strongly rounded and keeled when dry; beak stout, sub-terminal, reddish brown- reddish green in colour.

Flowering & fruiting: May to July & June to August.

Habitat & Ecology: Standing waters of lakes and ponds with oligo- to eutrophic conditions

Distribution: Native to Asia, Europe and northern Africa; and introduced into North America (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Dal lake,1600m, 18.08.1986, *GNJ* 1132; Anchar lake,1600m, 27.09.1981, G. H. Dar 3236; Anantnag, 1660m, 1983, *A. Ahmad* 409; Negeen lake,1600m, 08.08.1995, *Bilques* 3811; Dal lake,1600m, 15.08.1995, *Bilques* 32; Anchar lake,1595m asl, 34°10′55″N, 74°48′10E, 17.06.2005, *Aijaz* 10051; Dal lake,1595m asl, 34°08′48″N, 74°52′51″E, 23.06.2006, *Aijaz* 10052; Nilnag lake, 2180m asl, 33°51′25″N, 74°41′45″E, 29.06.2006, *Aijaz* 10053; Manasbal lake,1590m asl, 34°15′26″N, 74°41′26″E, 01.07.2008 *Aijaz*, 10054; Wular lake,1595m asl, 34°25′20″N, 74°4016″E, 08.07.2008, *Aijaz*, 10055 (KASH). Manasbal lake,1590m asl, 34°15′26″N, 74°41′26″E, 01.07.2008, *Aijaz* 10054 (PRA).

Note: *Potamogeton natans* is closely related to *P. nodosus* in having long petiolate floating and submerged leaves but differs in having floating leaves with a flexible junction and often a distinct angle at the top of the petiole immediately below the lamina, often different in colour and cordate to round leaf base (*vs.* floating leaves without a flexible junction and narrowly cuneate leaf base).

Potamogeton nodosus Poiret in Lamarck, Encycl. Meth. Bot., Suppl. 4: 535. 1816 ('nodosum'). *Type*: SPAIN, *Pierre André Pourret s.n.* (P [P00539311] digital image!). **Figs. 8 & 14g**

Plants herbaceous, floating; rhizome white with rusty red spots, terete, perennial with apical winter buds; stem unbranched or sparingly branched terete, annual; submerged leaves present (absent in landforms); petiolate, petioles 2–13 cm long; lamina oblong to oblanceolate, sometimes reduced to phyllodes, 1–3 cm wide tapering to petiole, 5–25 cm long, tip acute, 7–15 nerved, with narrow to broad rows of lacunae bordering the mid rib, minutely denticulate at margins; floating leaves coriaceous, petiolate, 3–15 cm long, lamina oblong to broadly elliptical or ovate lanceolate, 4–13 cm long, 2–5 cm wide, opaque, bright green to olive green narrowly cuneate at base, obtuse to broadly acute at apex, 15–25 veined; stipules of submerged leaves brownish, delicate and decaying early, linear, acute to obtuse, 3–10 cm long; those of the floating leaves

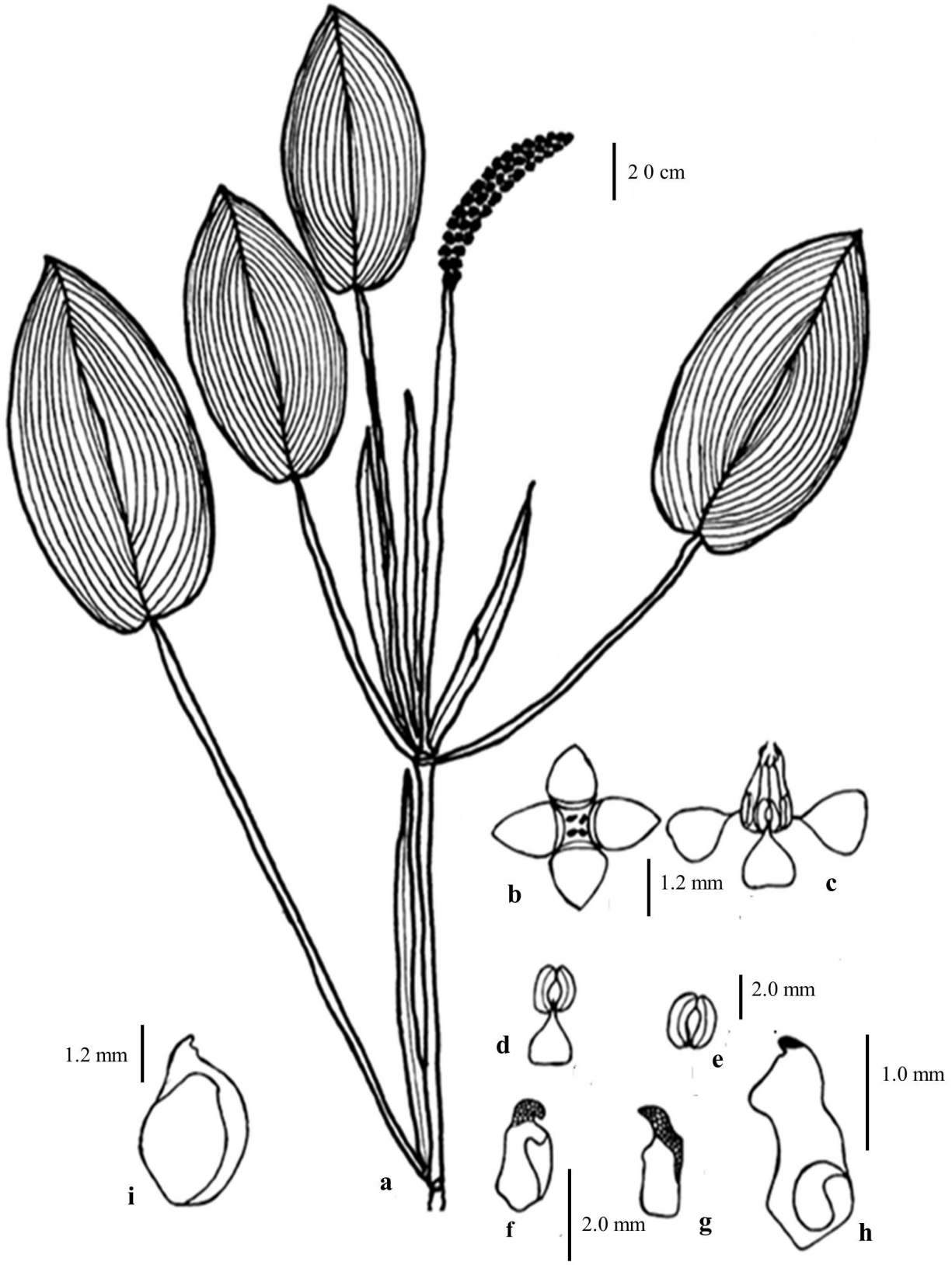

Fig. 7. *Potamogeton natans* L.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium–back side; **g**. Gynoecium–front side; **h**. L.S of gynoecium showing basal placentation; **i**. Fruit.

similar but usually broader at base and more or less 2 keeled; peduncles thicker than stem, 3–12 cm long; spikes 4–7 cm long, cylindrical, 3–3.5 cm in diameter; perianth lobe orbicular, 1.5–2 mm long, 2 mm broad; androecium 1–2 mm long, 1–15 mm broad; carpels 4, 1.5–2 mm long, 1 mm broad; fruit obovate to semicircular, three keeled, dorsal one strongly developed, 3–4 mm long, brownish to reddish in colour; beak stout, apical, slightly recurved.

Fig. 8. *Potamogeton nodosus* Pioret: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium; **g**. Fruit.

Flowering & fruiting: June to August & July to September.

Habitat & Ecology: Both running and standing waters of lakes, ponds, streams, irrigation channels, rice fields, and ditches with oligo- to eutrophic conditions.

Distribution: Asia, Europe, North America,Africa and northern South America (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Sum-Jammu, 450m, 14.03.1970, *B. M. Sharma* 394; Dal lake, 1600m, 08.08.1974, *A. R. Naqshi*; Kujar, 1625m, 12.07.1981, *G. H. Dar* 2446; Beehama, 1650m, 24.08.1981, *G. H. Dar* 3029; Kangan, 1850m, 04.07.1983, *G. H. Dar* 6400; Preng,1800m, 12.07.1983, *G. H. Dar* 6631; Panzath,1600m, 1983, *A. Ahmad* 4206; Langate,1800m, 17.05.1984, *M. A. Hakeem*; Anchar lake, 1595m asl, 34°10′55″N, 74°4810″E, 09.07.2005, *Aijaz* 10061; Dal lake,1595m asl, 34°08′48″N, 74°5251″E, 12.07.2006, *Aijaz* 10062; Nilnag lake, 2180m asl, 33°51′25″N, 74°41′45″E, 16.07.2007, *Aijaz* 10063; Manasbal lake, 1590m asl, 34°15′26″N, 74°4126″E, 19.07.2008, *Aijaz* 10064; Nambal rivulet,1605m asl, 33°43′09″N, 75°11′04″E, 25.07.2008, *Aijaz*, 10065; Irrigation channel–Sundoo,1605m asl, 33°42′00″N, 75°11′3″E, 25.07.2008, *Aijaz* 10066; Kakapora pond, Pulwama,1590m asl, 33°59′01″N, 74°56′0″E, 10.08.2007, *Aijaz* 10067; Kakapora pond, Pulwama,1590m asl, 33°59′01″N, 74°56′01″E, 15.07.2008, *Aijaz* 100671; Kakapora pond, Pulwama,1590m asl, 33°59′01″N, 74°56′01″E, 07.07.2012, *Aijaz* 100672; Wular lake in one of its springs at Ajas, Bandipora, 1645m asl, 34°19′55″N, 74°40′47”E, 16.08.2012, *Aijaz* 10069 (KASH).

Potamogeton pectinatus L., Sp. Pl. 127. 1753. *Stuckenia pectinata* (L.) Börner, Fl. Deutsche Volk 713. 1912. *Lectotype* (designated by Dandy, 1971): EUROPE, J. Burser 124 (UPS!). **Figs. 9 & 14h**

Plants herbaceous, submerged; rhizome robust, terete, perennial with apical tubers at the end of growing season; stem sparingly to richly branched, slender, terete, annual to perennial, sometimes axillary leaf shoots and axillary tubers (on shoots) produced as winter buds; leaves filiform to narrowly linear, entire, sessile, 3–20 cm long, 0.1–0.4 cm broad, bright green to olive green, 3–5 veined, lateral veins inconspicuous, margins entire, straight at base, acuminate to acute at apex; stipule prominent, 2–5 cm long, the base adnate to leaf to form a sheath wider than stem, greenish to whitish in colour, the free portion less than length of sheath; peduncles 2–15 cm long; spikes 2–6 cm long with 5–12 flowers arranged in 3–5 whorls; spikes contiguous at first, later become monoliform; flower 2 mm in diameter, perianth lobes orbicular, 1 mm long, 1.5–2 mm broad; androecium 1 mm long, 1–1.5 mm broad; carpel 1 mm long, 0.5 mm broad; fruit obliquely obovate, narrow at base, rounded on the dorsal side, dorsal keel absent, lateral keels obscure, ca. 0.3–0.5 mm long, reddish yellow or pale olive green in colour; beak usually curved, very short.

Flowering & fruiting: May to August & June to September.

Habitat & Ecology: Both running and standing waters of lakes, ponds, streams, and ditches with oligo- to eutrophic conditions.

Distribution: Asia, Europe, Africa, North America and South America (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Dal lake,1600m,03-08-1968, *GNJ* 1870; Parooh-Jammu 400m, 10.01.1970, *B. M. Sharma* 332; Manasbal,1600m, 28.09.1974, *A. M. Kak* 930; Shey-Leh, 3300m, 08.07.1976, *Herbier et al.* 6856; Nubra, 3400m, 28.07.1980, *A. R. Naqshi* 7456; Anchar,1600m, 27.09.1981, *GNJ* 3261; Dal lake,1600m, 16.06.1995, *Bilques* 20; Anchar lake,1595m asl, 34°10¢55²N, 74°48¢10²E, 10.06.2005, *Aijaz* 10071; Dal lake,1595m asl, 34°08¢48 ²N, 74°52¢51²E, 21.06.2006, *Aijaz* 10072; Manasbal lake,1590m asl, 34°15¢26²N, 74°41¢26²E, 23.06.2007, *Aijaz* 10073; Wular lake,1595m asl, 34°25¢20²N, 74°40¢16 ²E,

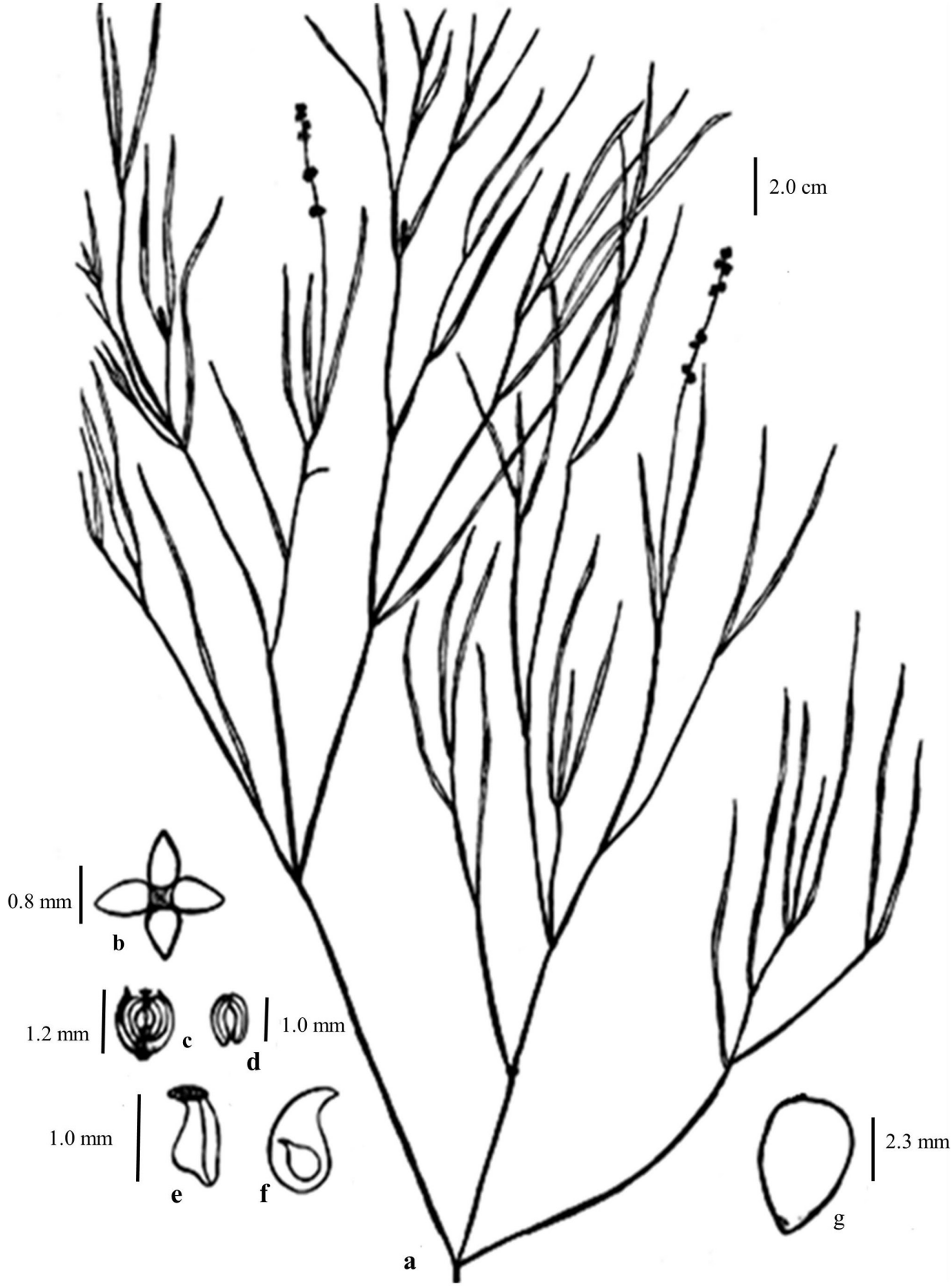

Fig. 9. *Potamogeton pectinatus* L.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium; **e**. Gynoecium; **f**. L.S of gynoecium showing basal placentation; **g**. Fruit.

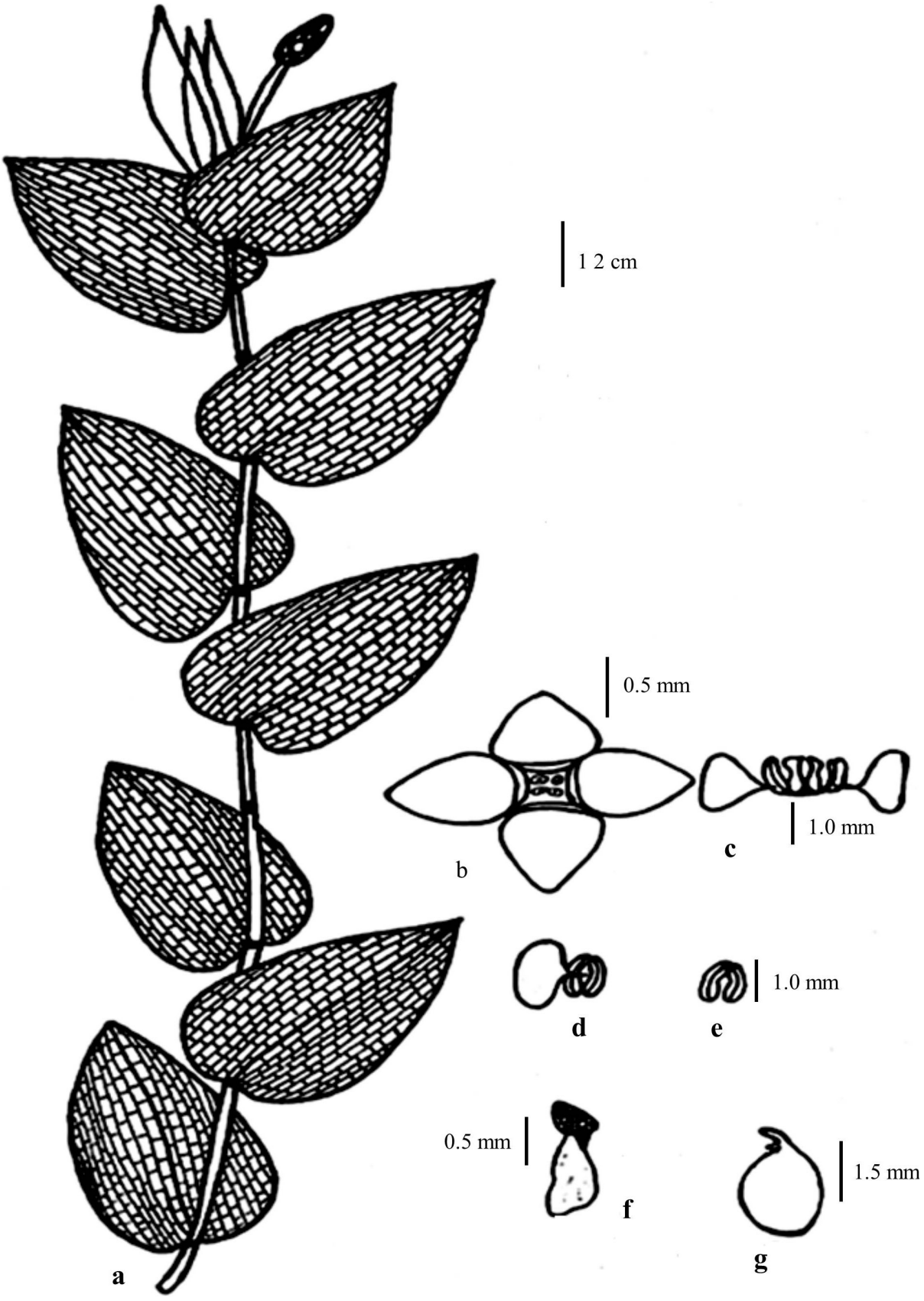

Fig. 10. *Potamogeton perfoliatus* L.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium; **g**. Fruit.

08.07.2008, *Aijaz*, 10074; Nambal rivulet,1605m asl, 33°43¢09 ²N, 75°11¢04 ²E, 03.07.2007, *Aijaz, Wafai and Reshi* 10075; Aarpath rivulet,1600m asl, 33°43¢09 ²N, 75°11¢04²E, 25.07.2008, *Aijaz* 10076 (KASH). Manasbal Lake, 1590 m asl, 34°15¢26 ²N, 74°41¢26 ²E, 10.07.2012, *Aijaz* 10079 (PRA).

Potamogeton perfoliatus L., Sp. Pl. 126. 1753. *Type*: CANADA, *Linnaeus* 207 (Holo GH!). **Figs. 10 & 14i**

Plants herbaceous, submerged; rhizome terete, perennial with apical winter buds; stem with nodes and internodes, unbranched to richly branched, slender, terete, annual; leaves sub-orbicular to oblong ovate, sessile, 2–6 cm long, 1–3.5 cm wide, bright green to dark green, margins with obscure denticulations, obtuse to acute at apex, amplexicaul at base, 10–20 veined with narrow rows of lacunae bordering the midrib; stipules axillary, convolute, 0.5–2 cm long, translucent, decaying early; peduncles 2–8 cm long, as thick as or slightly thicker than stem; spikes 1–1.5 cm long cylindrical with 6–12 flowers in 2–5 whorls; flowers 2 mm in diameter; perianth blade orbicular ca.1 mm long, 1.5 mm broad; androecium 0.5–1 mm long and 1 mm broad; carpel 1 mm long, 0.25 mm broad; fruit obliquely obovate, dorsal keel indistinct, green to brownish in colour, 2–3 mm long; beak short and lateral.

Flowering & fruiting: May to July & June to August.

Habitat & Ecology: Both running and standing water of springs and spring streams with oligotrophic waters.

Distribution: Asia, Europe, Africa, North America and Australia (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Batahchoe-Simbal, 900m, 13.02.1971, B. M. Sharma 782; Panikhar, 3400m, 08.08.1975; Meender-Poonch, 900m, 06.02.1988, G. H. Dar 9518; Manasbal lake-Outlet,1590m asl, 34°15′26″N, 74°41′26″E, 12.07.2006, *Aijaz* 10081; Nagrad stream, 1605m asl, 33°42′00″N, 75°1131″E, 08.07.2006, *Aijaz* 10082; Spring stream Thajiwaea, 1605m asl, 33°42′18″N, 75°12′15″E, 08.07.2006, *Aijaz* 10083 (KASH).

Potamogeton pusillus L., Sp. Pl. 127. 1753. *Type*: EUROPE, *Linnaeus* 175.15 (holo LINN !). **Figs. 11 & 15a**

Plants herbaceous, submerged; rhizome absent or develop late in growing season, filiform, terete, annual to biennial; stem usually much branched, slender terete or slightly compressed, annual or perennial; leaves sessile, linear 2–10 cm long, 0.2–0.3 cm wide, bright green to olive green to dark green, entire at margins, narrowly cuneate at base, acuminate or acute to sub-obtuse at apex, 3–5 veined, the lateral nerves obscure in narrow extremes; stipules 6–15 mm long, clasping the stem and with margins united as base to above the middle, translucent, persistent to decaying; peduncles 3–10 cm long, axillary, filiform, as thick as stem; spikes 0.3–1 cm long, cylindrical with 2–5 flowers in 2 – 3 whorls; flowers 1.5–2 mm in diameter; perianth rounded- flabiliform with slender claw, 0.5–10 mm long, 0.5–1.0 mm wide; androecium 0.5–0.8 mm long, 0.5–1 mm broad; carpel 0.5–1 mm long, ca.0.5 mm broad; fruit obliquely obovoid, dorsal keel obscure, lateral keels absent, dark to olive green in colour, 2–3 mm long; beak facial, prominent, erect.

Flowering & fruiting: May to July & June to August.

Habitat & Ecology: Standing waters of lakes with meso- to eutrophic waters.

Distribution: Asia, Europe, Africa, North America and South America (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Anchar lake, 1595 m asl, 34°10′55″N, 74°48′10″E, 10.06.2005, *Aijaz* 10091; Dal lake, 1595 m asl, 34°08′48″N, 74°52′51″E, 21.06.2006, *Aijaz* 10092; Manasbal lake, 1590 m asl, 34°15′26″N, 74°41′26″E, 23.06.2007, *Aijaz* 10093; Nilnag lake, 2180 m asl, 33°51'25″N, 74°41'45″E, 16.07.2007, *Aijaz* 10094 (KASH).

Note: *Potamogeton pusillus* is closely related to *P. trichoides* in having stipules free from leaves, leaf lamina arising directly from the node and stiff peduncle but differs in having 4 carpels per flower, fruit obliquely obovoid, dorsal keel obscure (vs.

1–2 carpels per flower, fruit sub-globose, dorsal keel distinct)

Potamogeton trichoides Cham. & Schltdl., Linnaea 2(2): 175, t.4, f.6. 1827. *Type*: EUROPE, April 1827, *Chamisso & Schlechtendal* 175 (holo HAL!). **Figs. 12 & 15b**

Plants herbaceous, submerged; rhizome absent or present during late stages, filiform, terete; stem sparingly to richly branched, filiform, terete to slightly compressed, annual to perennial; leaves sessile, linear 2–13 cm long, 0.1–0.2 cm broad, bright green to dark green, often with brownish

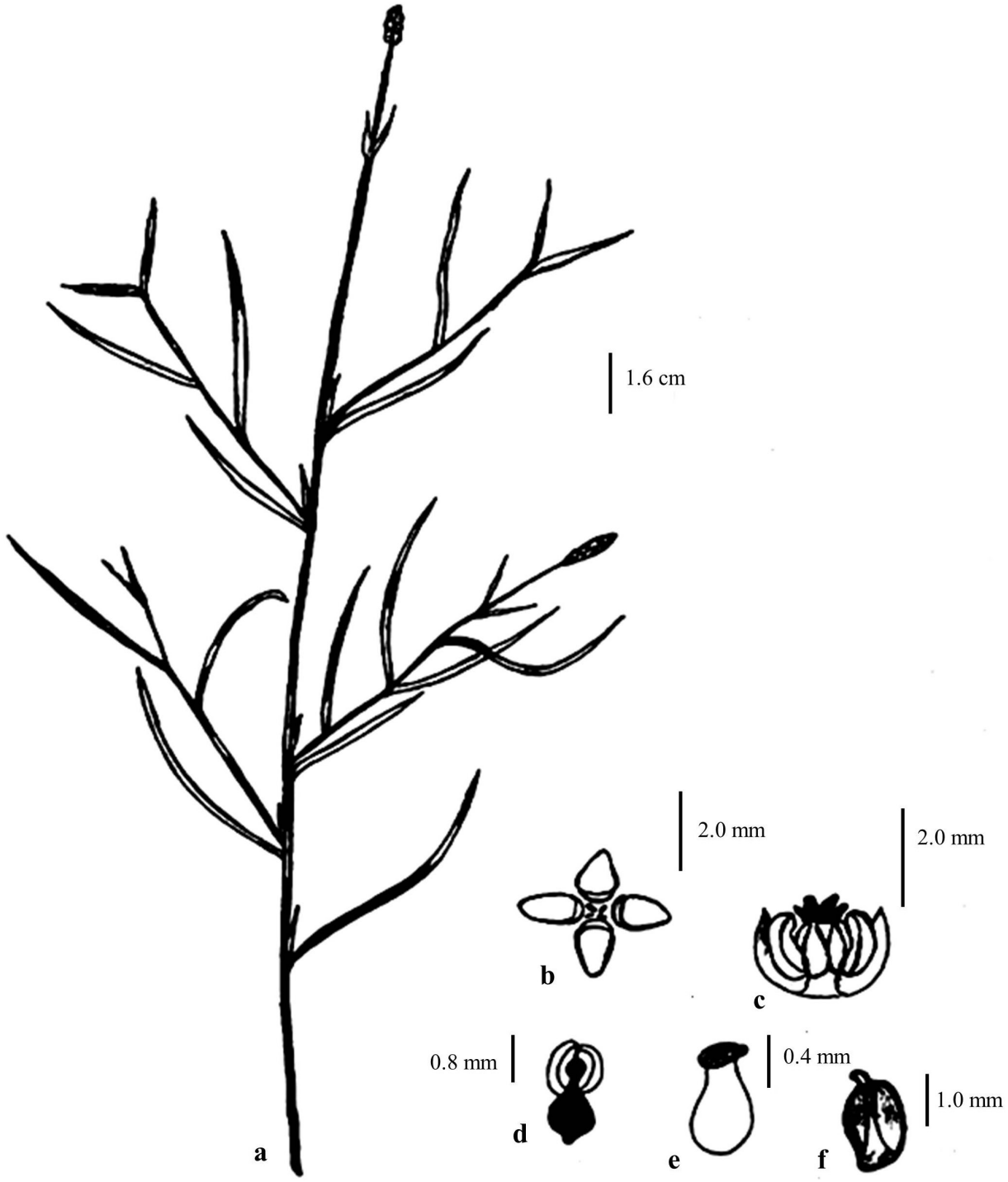

Fig. 11. *Potamogeton pusillus* L.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Gynoecium; **f**. Fruit.

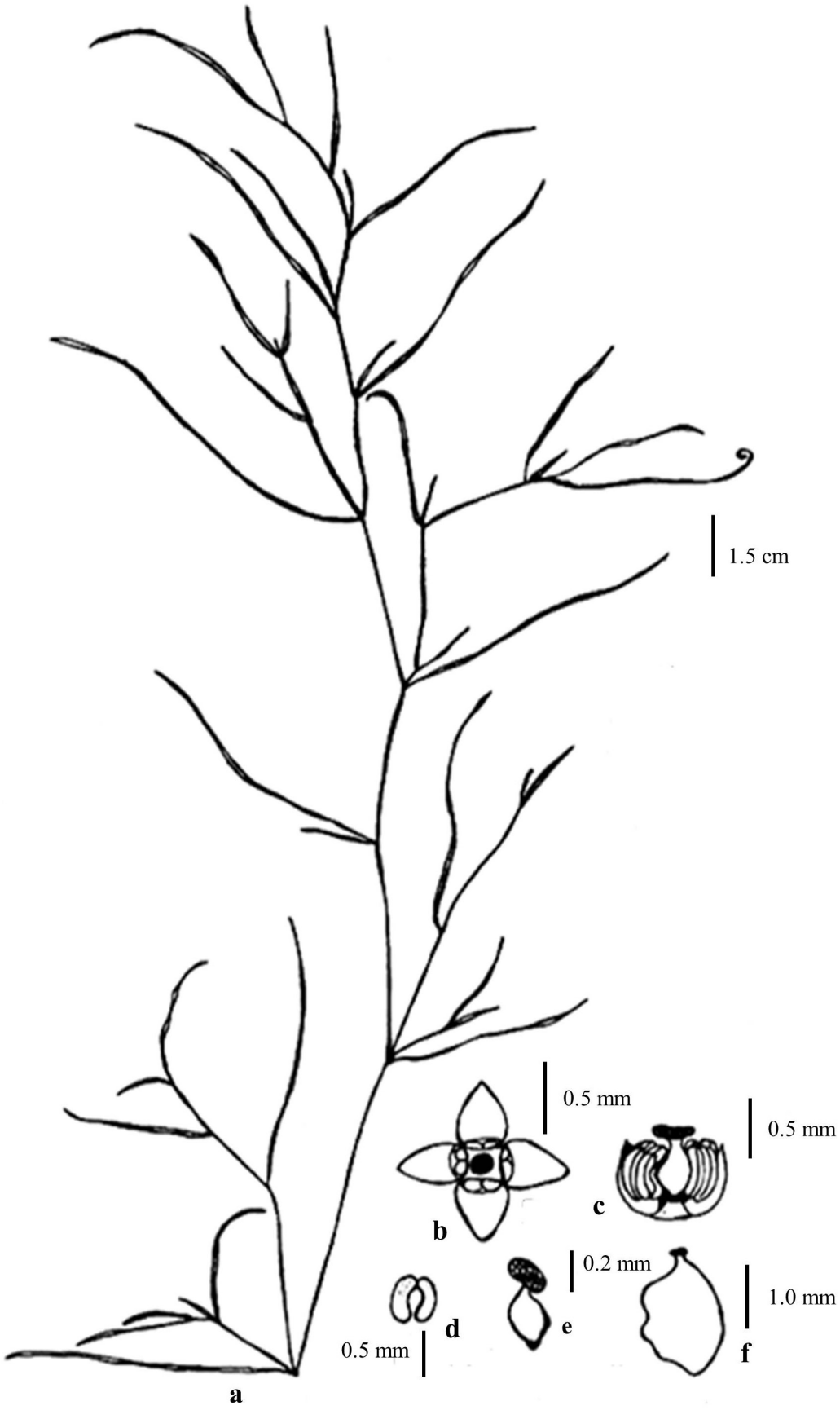

Fig. 12. *Potamogeton trichoides* Cham. & Schltdl.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium; **e**. Gynoecium; **f**. Fruit.

tinge, entire at margins, narrowly cuneate at base, acuminate at apex, 1-veined (rarely 3 nerved), without transverse connections; stipules axillary, convolute 0.5–3 cm long, translucent often with green tinge, persistent; peduncles 2–11 cm long, slender of uniform thickness throughout; spikes 0.3–0.5 cm long, oblong- ovoid with 2–4 flowers in 2 whorls; flowers with 1 (rarely 2) carpel, 1.5 mm in diameter; perianth rounded- flabiliform, with slender claw, 0.5 mm long and 0.7 mm broad; carpel 0.5–0.8 mm long, 0.5 mm broad; fruit sub-globose, dorsal keel distinct, dark green in colour, 2–3 mm long; beak short and straight.

Flowering & fruiting: May to July & June to August.

Habitat & Ecology: Standing waters of lakes with meso- to eutrophic waters.

Distribution: Asia, Europe and Africa(POWO, 2025); and now Kashmir Himalaya, India.

Specimens examined: INDIA, Jammu & Kashmir, Manasbal lake, 1590 m asl, 34°15′26″N, 74°41′26″E, 23.06.2007, *Aijaz* 10010; Wular lake-Kulhama side, 1595 m asl, 34°25′20″N, 74°40′16″E, 08.07.2008, *Aijaz* 100101; Hokarsar Wetland, 1600 m asl, 34°06′29″N, 74°43′39″E, 02.08.2012, *Aijaz* 100102 (KASH). Hokarsar Wetland, 1600 m asl, 34⁰06′29″N, 74⁰⁴3′39″E, 02.08 2012, *Aijaz* 100102 (PRA).

Potamogeton wrightii Morong, Bull. Torrey Bot. Club 13: 158, t. 59. 1886. ("Wrightii"). *Type*: JAPAN, *Wright* 320 (holo K [K000203604] digital image!). **Figs. 13 & 15c**

Plants herbaceous, floating to submerged; rhizomes slender, terete, perennial, with apical winter buds; stems unbranched or sparingly branched, slender, terete, annual; submerged leaves petiolate, 1.5–8.2 cm long; lamina lanceolate or mostly oblong to narrowly oblong, 5–17 cm long, 1.4–4 cm broad, bright green to yellow green, margins minutely denticulate, narrowly cuneate at base, mucronate at apex, sometimes undulate; lowest leaves sometimes reduced to phylloides, 8–25 cm long, 9–15 veined, with narrow rows of lacunae bordering the mid rib; intermediate leaves sometimes present; floating leaves usually absent or sometimes present, petiolate, lamina oblong to elliptical, 7.5–17 cm long, 2–4.2 broad, opaque, coriaceous, bright green, sometimes with reddish tinge, narrowly cuneate at base, mucronate at apex; petiole 2.6–15 cm long; stipules axillary, convolute, 3–10 cm long, translucent, persistent; peduncles 5.4–9 cm long, slightly thicker than the stem; spikes 2.7–5.7 cm long, cylindrical with 39–50 flowers in 10–16 whorls; flowers 2.5–3 mm in diameter; perianth lobe orbicular, 1.5 cm long and 1.5–2 mm wide; androecium 1–1.5 mm long, 1.5 mm wide; carpel 1–1.5 mm long, 0.5 mm wide; fruit 0.2–0.3 cm long, with a ventral protrusion leading to characteristic rhomboid shape, dorsal keel more or less distinct, dark brown in colour.

Flowering & fruiting: June to August & July to September.

Habitat & Ecology: Both running and standing waters of lakes and streams, with oligo- to eutrophic conditions

Distribution: Asia (POWO, 2025).

Specimens examined: INDIA, Jammu & Kashmir, Dal lake, 1595 m asl, 34°08′48″N, 74°52′51″E, 12.07.2006, *Aijaz* 100110; Manasbal lake, 1590 m asl, 34°15′26″N, 74°41′26″E, 19.07.2008, *Aijaz* 100112; Nambal rivulet, 1605 m asl, 33°43′09″N, 75°1104″E, 25.7.2008, *Aijaz* 100113; Aarpath rivulet, 1600 m asl, 3343′09″N, 75°1104″E, 25.07.2008, *Aijaz* 100114 (KASH).

Note: *Potamogeton wrightii* is closely related to *P. nodosus* in long peiolated leaves but differs in having submerged leaves mucronate at apex, floating leaves often absent even in adult plants (vs. submerged leaves acute at apex, floating leaves usually present).

Discussion

During the present study, 12 distinct species of *Potamogeton* have been recorded from different aquatic habitats of Kashmir Himalaya. Of these, *P.*

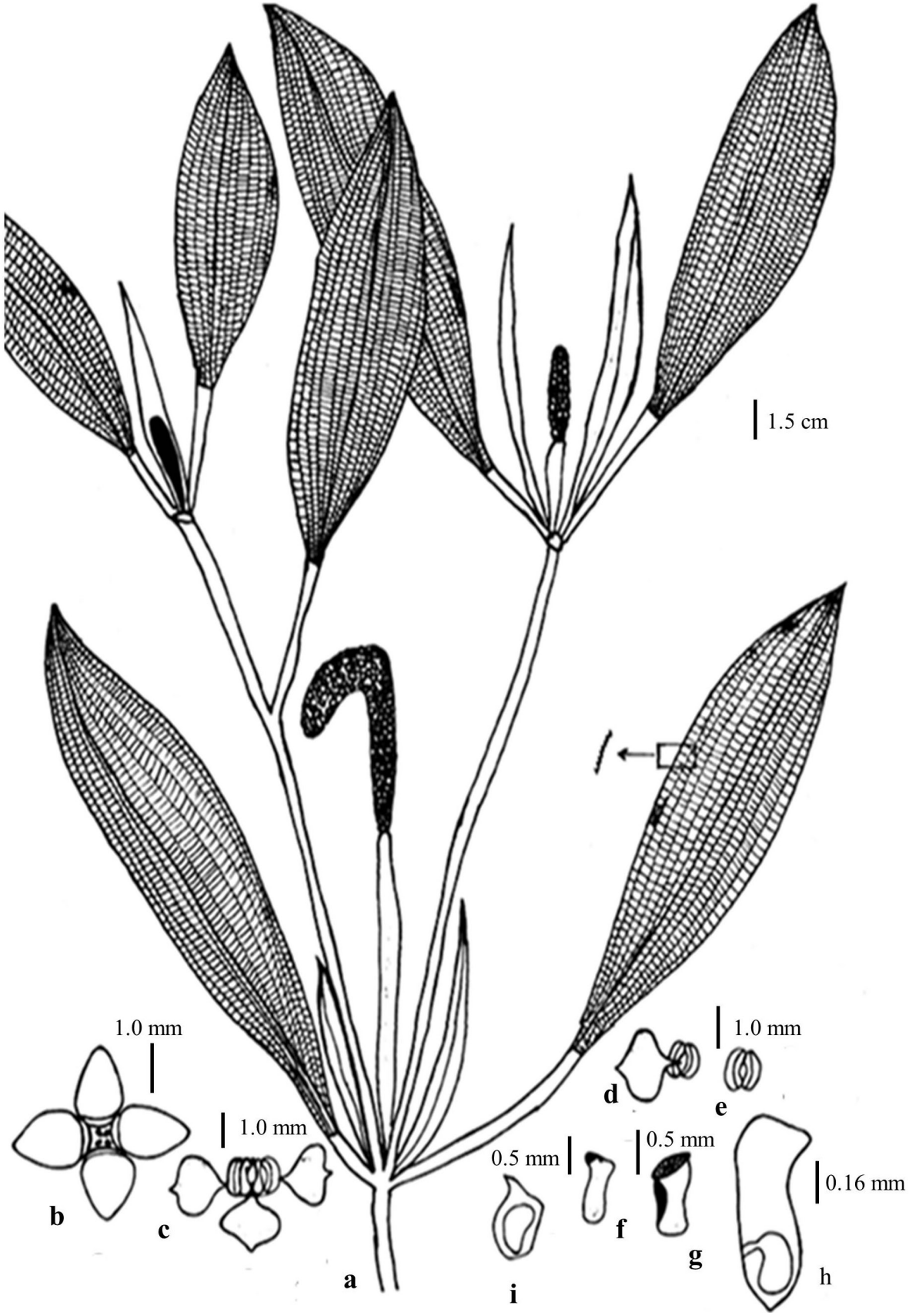

Fig. 13. *Potamogeton wrightii* Morong.: **a**. Habit; **b**. Flower; **c**. L.S. of flower; **d**. Androecium adnate to tepal; **e**. Androecium; **f**. Gynoecium–front side;

amblyophyllus, *P. berchtoldii*, and *P. trichoides* have been reported for the first time from Kashmir valley, and *P. berchtoldii* and *P. trichoides* are new distribution records for India.

Previously, different workers reported variable number of species from India and erstwhile state of Jammu and Kashmir (Hooker, 1884; Kaul & Zutshi 1967; Stewart, 1972; Kak, 1990; Cook 1996; Kothari, 2001; Chowdery et al. 2015; Indian Flora online- https://indiaflora-ces.iisc.ac.in). Despite exploring all the possible aquatic habitats in the study area, the species such as *P. alpinus* Balb., *P. filiformis* Pers., *P. octandrus* Poiret, *P. polygonifolius* Pourr., *P. tepperi* A. Benn. and *P. zizii* Mert. & W. D. J. Koch. reported by earlier workers from Kashmir (Stewart, 1972; Kak, 1990) and India (Kothari, 2001) have not been collected during the present study. Most likely, these species have been wrongly identified or disappeared because of changes in trophic status of water bodies of Kashmir Himalaya due to anthropogenic factors. The species like *P. fluitans*, *P. polygonifolius* and *P. tepperi* reported earlier from Kashmir and India by different authors (Stewart, 1972; Kak, 1990; Kothari, 2001), belong to *P. nodosus* group and were correctly identified as *P. distinctus* (Weigleb 1990a). Likewise *P. indicus* earlier reported from India by Hooker (1894) was recognized as misidentification of *P. nodosus* (Wiegleb, 1990a). The present study established the presence of *P. natans* in Kashmir Himalaya, as some authors were uncertain with respect to the occurrence of this species in the region (Wiegleb, 1990a). Previously reported species of *P. malaianus* and *P. mucronatus* from India (Hooker, 1884; Cook, 1996) have been correctly identified as *P. wrightii* (Wiegleb, 1990b). Most of illustrations provided in Kothari (2001) completely differ from the given descriptions of plant species; therefore, the report of species needs further investigations. Similarly, previously misreported *P. filiformis* Pers. (=*Stuckenia filiformis* Börner) from Kashmir valley (Kak, 1990) actually grows in Ladakh (Klimes & Dickore 2005) and its occurrence in rest of India is highly doubtful.

Naqshi and Javid (1973) reported two varieties each of *P. lucens* viz., *P. lucens* var. *lucens* and *P. lucens* var. *acuminatus* Schum.) Fries. and two varieties of *P. crispus*, namely *P. crispus* var. *crispus* and *P. crispus* var. *serrulatus* (Schrad.) Reichb from Kashmir, which has been again reported by Kothari (2001). The authors have delimited *P. lucens* var. *acuminatus* from *P. lucens* var. *lucens* in having long aristate tipped leaves and curved spikes, and *P. crispus* var. *serrulatus* from *P. crispus* var. *crispus* in having non-crisped leaves and persistent stipules. During the present investigation, however, it was observed that this morphological variation is merely due to phenotypic plasticity because a single genet having different ramets possesses both the types of leaves, i.e., broad elliptical as well as narrow acuminate leaves or phyllodes. The plants when grown under similar environmental conditions did not retain these characters (Ganie et al., 2014). Therefore, the recognition of these varieties by Naqshi and Javid (1973) was not supported by the results generated during the present study. It was observed that broad elliptical leaved ramets also produced curved spikes. Similarly, even *P. crispus* var. *serrulatus* is a phenotypic variant rather than a taxonomic variety because a genet with ramets possessing both types of leaves was observed. However, another form of *P. crispus* bearing small leaves with more serrated margins collected from Nilnag lake (subalpine lake) differ from plants collected from the valley lakes; cytologically, the two forms were similar with respect to chromosome number (2n = 12x = 84) (Ganie et al., 2016). The plants collected from Nilnag lake retained their characters even when cultivated under common garden experiment, therefore needs further investigations. Phenotypic plasticity in aquatic plants is a well described phenomenon (Bradshaw, 1965; Schmid, 1992), but its prevalence is very high in *Potamogeton* (Kaplan, 2002; Ganie et al., 2014). Two cytotypes of *P. natans* were collected during the present study- one tetraploid (2n = 4x = 52) and another octoploid (2n = 8x = 104) (Ganie *et al.*, 2016).

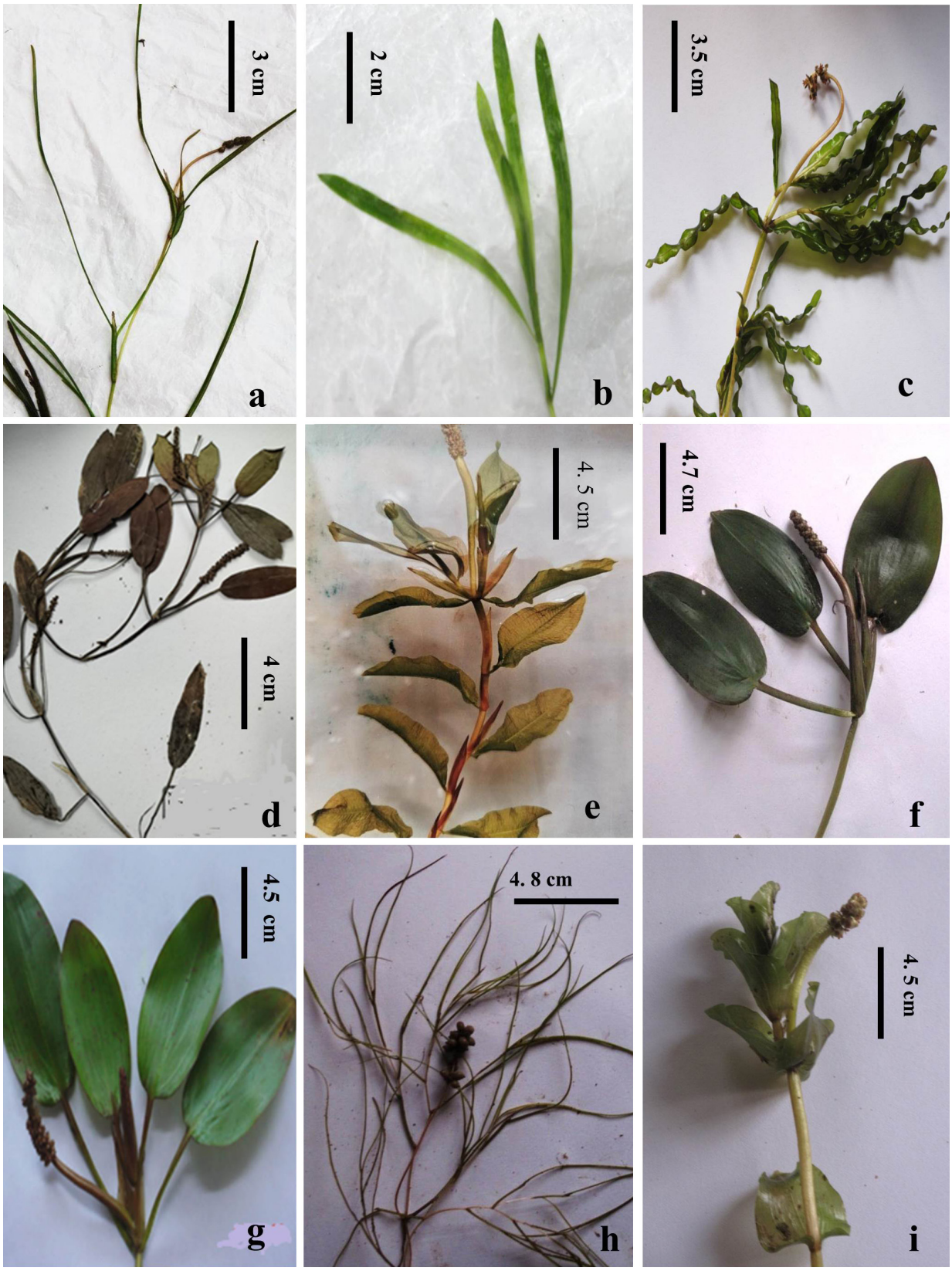

Fig. 14. Species of *Potamogeton* collected from Kashmir Himalaya: **a**. *P. amblyophyllus* C.A.Meyer; **b**. *P. berchtoldii* Fieb.; **c**. *P. crispus* L.; **d**. *P. distinctus* Bennet; **e**. *P. lucens* L.; **f**. *P. natans* L.; **g**. *P. nodosus* Pioret ; **h**. *P. pectinatus* L.; **i**. *P. perfoliatus* L.

Amongst the collected species, *P. lucens, P. natans, P. pusillus* and *P. trichoides* grow in standing waterbodies, whereas *P. amblyophyllus, P. berchtoldii* are exclusively associated with running waterbodies. *Potamogeton crispus, P. distinctus, P. nodosus, P. pectinatus, P. perfoliatus* and *P. wrightii* inhabit both standing and running waters. The species exclusively occurring in running water habitats do not produce the fruits, which may be due to unsuccessful pollination (Ganie et al., 2016); however, the species which inhabit standing waterbodies produce the fruits.

During the present study, some unidentified taxa were also collected which seem to be interspecific hybrids - as the phenomenon of hybridization is prevalent in the genus (Zhanag et al., 2010; Kaplan et al., 2009; Kaplan, 2010; Kaplan et al., 2013), therefore these taxa need further detailed studies including molecular investigation to ascertain their nature.

Recently the filiform to narrow-leaved species were put in genus *Stuckenia* - the genus has recently been recognized (Haynes and Hellquist 2000; Ceska 2001; Haynes and Holm-Nielsen 2003 Kaplan, 2008, Kaplan et al., 2013), therefore some species cited here bear corresponding names under *Potamogeton,* not *Stuckenia.* These species include: *P. pectinatus* L. (= *S. pectinata* (L.) Börner) and *P. amblyophyllus* C.A. Meyer (*S. amblyophyllus* (C.A. Meyer) Holub.

The present study will prove helpful in the correct taxonomic identification of different *Potamogeton* species in Kashmir Himalaya and other parts of India. It is a well-known fact that the correct taxonomic identification is the first and foremost requirement for effective management of aquatic ecosystems. Therefore for the sustainable utilization of these prized ecosystems, it is important that the constituent species of these ecosystems are correctly identified, as aquatic plants are difficult to identify properly due to their inconspicuous floral characters, convergent vegetative morphology, and prevalent hybridization. Thus our study may prove pivotal in scientific, systematic, and sustainable management of aquatic ecosystems in the Himalayan region as well as in other parts of the country as well.

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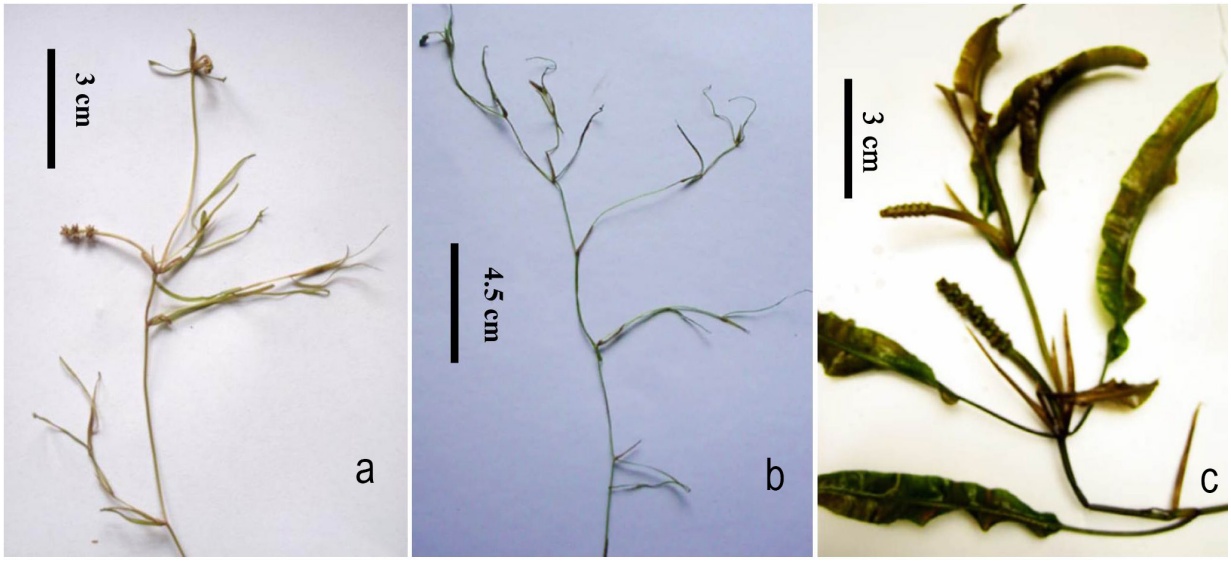

Fig. 15. Species of *Potamogeton* collected from Kashmir Himalaya: **a**. *P. pusillus* L.; **b**. *P. trichoides* Cham. & Schltdl.; **c**. *P. wrightii* Morong.

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