

Ceratophyllum platyacanthum subsp. *oryztorum* (Kom.) Les (Ceratophyllaceae): an addition to the flora of India from Kashmir Himalaya

Aijaz Hassan Ganie^{1*}, Bilal A Tali¹, Anzar A. Khuroo², Zafar A. Reshi¹ and Donald H. Les³

1 Department of Botany, University of Kashmir, Srinagar-190 006, Jammu and Kashmir, India

2 Centre for Biodiversity and Taxonomy, University of Kashmir, Srinagar-190 006, Jammu and Kashmir, India

3 Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269-3043 USA

* Corresponding author. E-mail: aijazku@gmail.com

Abstract: *Ceratophyllum platyacanthum* Cham. subsp. *oryztorum* (Kom.) Les (Ceratophyllaceae) is recorded for the first time from Kashmir Himalaya and India. The species differs from its closely related taxon, *Ceratophyllum demersum*, in having smaller leaves and the fruit with a facial spine. A comparison between *Ceratophyllum demersum* and *C. platyacanthum* subsp. *oryztorum*, and the taxonomic description, photographs and distribution map are provided to facilitate its field identification in the region.

Keywords: aquatic angiosperm, biodiversity, taxonomy, *Ceratophyllum demersum*

The family Ceratophyllaceae is monotypic and comprises the single genus *Ceratophyllum* L. Globally, the genus includes six species: *C. demersum* L., *C. echinatum* A. Gray, *C. muricatum* Cham., *C. platyacanthum* Cham., *C. submersum* L., and *C. tanaiticum* Sapj. (Les 1986, 1988a, 1988b). Species delimitation in the genus is quite difficult using vegetative or floral characters, with the fruit providing the most practical morphological characters for distinguishing taxa (Sapjegin 1902; Soó 1966; Les 1986, 1989).

The earliest record of *Ceratophyllum* from the Indian subcontinent was established by Hooker (1885), who reported a single species: *C. demersum* L. Cook (1996) later recorded two species from India: *C. demersum* (which occurs throughout India), and *C. muricatum* (which is known only from the south and central Indian states of Kerala, Madhya Pradesh, Odisha, Rajasthan, and Tamil Nadu). Until now, only *C. demersum* has been recorded from freshwater ecosystems in the Kashmir Himalaya region, which is located along the north-western boundary of India (Kaul and Zutshi 1967; Stewart, 1972; Kak and Durani 1985; Kak, 1990).

While carrying out botanical surveys to document the aquatic flora of the Kashmir Himalaya, specimens of a typical *Ceratophyllum* species were collected from Manasbal Lake (1,590 m above sea level [a.s.l.]; 34°15'26" N, 074°41'26" E) and the Hokersar wetland area (1,600 m a.s.l.; 34°06'29" N, 074°43'39" E). A critical examination of morphological features, in particular the mature fruit characters (Les 1988b), readily identified these specimens as *C. platyacanthum* subsp. *oryztorum* (V. Komarov) Les, a taxon not reported previously from the region in the previously published taxonomic literature (Hooker 1885; Kaul and Zutshi 1967; Stewart 1972; Kak 1990; Cook 1996). However, in an unpublished account, Les (1986) earlier had confirmed the presence of *C. platyacanthum* subsp. *oryztorum* in Kashmir based on a specimen from Dal Lake that was collected in 1917. Our eventual search of herbarium material at Missouri Botanical Garden (MO), Philadelphia Herbarium (PHIL), and University of Kashmir Herbarium (KASH) turned up additional records, which were unknown previously because of their misidentification as *C. demersum*. Therefore, the current report is to document the occurrence and clarify the distribution of *C. platyacanthum* subsp. *oryztorum* in the Kashmir Himalaya, India.

The Kashmir Himalaya is situated in the northern fringe of the India between 33°22' and 34°50' N and 073°55' and 073°33' E (Figure 1), covering an area of ca. 16,000 km². Standard herbarium methods (Bridson and Forman 1992) were used during collection, processing and preparation of the herbarium specimens. New voucher specimens have been deposited at the University of Kashmir Herbarium (KASH); previously collected specimens were located at MO and PHIL. The micro-characters were analyzed and photographed using a trinocular stereo zoom microscope (Model: Carl Zeiss Discovery V8).

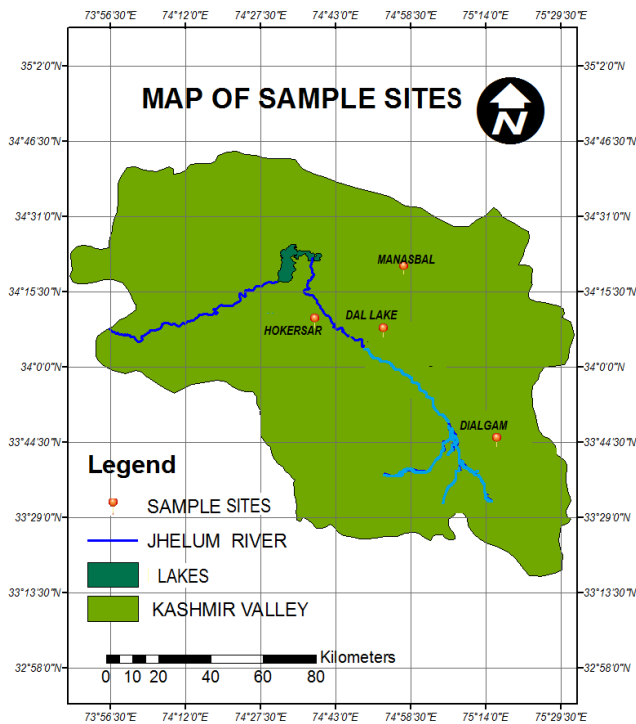


Figure 1. Distribution of *Ceratophyllum platyacanthum* subsp. *oryzetorum* in the Kashmir Himalaya, India.

Hooker (1885) recorded only *C. demersum* L. from India and Ceylon (now Sri Lanka), and was unable to distinguish any potentially different species due to the absence of live material. Nearly a century later, Les (1986) discovered a specimen of *C. platyacanthum* subsp. *oryzetorum* that was collected from Dal Lake, Kashmir in 1917 (Stewart, s.n.; MO). Although that record (and another from the same locality: Stewart 7163; PHIL) represent the earliest known collections of *C. platyacanthum* subsp. *oryzetorum* from India, those reports were never published. An additional unpublished record from Dal Lake (collected in 1972) also was discovered by the authors among several misidentified *Ceratophyllum* specimens at KASH. Subsequently, a new locality for this taxon was found at Dialgam from a specimen collected in 1975 (A.M. Kak, 3429), which again was correctly determined among the misidentified material at KASH. No other records of this taxon materialized until 2013, when several collections were made by the authors at Manasbal Lake (Figure 1).

In addition to *C. platyacanthum*, Les (1986) also reported the occurrence of *C. muricatum* in India, a record that had remained unpublished until the species was included in a contemporary aquatic flora of the country (Cook 1996). Yet, that flora lacked any mention of *C. platyacanthum*, which is first documented by the present account. Therefore, based on the present study, the flora of the India currently includes three taxa: *C. demersum*, *C. muricatum*, and *C. platyacanthum* subsp. *oryzetorum*. Only *C. demersum* and *C. platyacanthum* subsp. *oryzetorum* are known to occur in the Kashmir Himalaya,

and several comparisons are provided to facilitate their taxonomic identification (Figure 2; Table 1).

Ceratophyllum platyacanthum* Chamisso subsp. *oryzetorum (V. Komarov) Les, Syst. Bot. 13: 517. 1988.

Type: U.S.S.R., Nikolisk – Ussuriiskii, in valle fl Suifun ad canali irrigatorio orryzetorum prope p. Denisovka, 21 Aug 1930. Komarov s.n. (syntype: LE)

Synonyms: *Ceratophyllum oryzetorum* Kom.; *Ceratophyllum demersum* var. *pentacorne* Kitag.; *Ceratophyllum demersum* var. *quadrispinum* Makino; *Ceratophyllum demersum* f. *quadrispinum* (Makino) Kitag.

English name: Facially-spined Hornwort

Vernacular name (Kashmiri): Kind-e-Hill

Stems up to 1.0–1.5 m long, green with prominent nodes and internodes, terrete, length of internodes varies from 0.5–1.0 cm. Leaves deep green, in whorls of 6–10 at stem nodes, whorls 2.0–4.0 cm in diameter; blades divided dichotomously from 0.4–0.6 cm above the leaf base; leaf segments linear, 1.0–2.3 cm long with marginal thorn-like denticles. Flowers not seen. Achene brown or dark green, 4–5 × 2–3 mm, the surface smooth, the margins wingless and spineless, facial spines 2, 0.5–9.5 mm, not decurrent; basal spines 2, 1.5–12.5 mm, straight or curved; terminal (stylar) spine 2–12.5 mm.

Global distribution: China, Japan, Korean Peninsula, Russia (Far East) and now reported from the India (Kashmir Himalaya)

Local distribution: This plant has now been recorded from three districts in the Kashmir Himalaya including Srinagar (Dal lake, Hokersar wetland), Ganderbal (Manasbal), and Anantnag (Dialgam) (Figure 1).

Specimens examined (numbers in brackets refer to Figure 1): India. Jammu and Kashmir. Anantnag District (4): Dialgam, 1,700 m a.s.l., 21-VII-1975, A.M. Kak, 3429 (KASH). Ganderbal District (1): Manasbal Lake, 08-VIII-2013, Aijaz, Khuroo & Bilal 77771(KASH); 05-IX-2013, Aijaz, Khuroo & Bilal 77772 (KASH); 10-VIII-2014, Aijaz, Khuroo & Bilal 77773 (KASH). Srinagar District (2): Dal Lake, 1,676 m a.s.l., 21-VII-1917, Stewart, s.n. (MO); n.d., Stewart 7163 (PHIL); 1,600 m a.s.l., 05-III-1972, G. N. Dar, 1828 (KASH).

Table 1: A taxonomic comparison between *Ceratophyllum demersum* and *C. platyacanthum* subsp. *oryzetorum*

Character	Taxon	
	<i>C. demersum</i> L.	<i>C. platyacanthum</i> subsp. <i>oryzetorum</i> (Kom.) Les
Leaf		
Colour	Bright green	Deep green
Diameter of leaf whorl	1.5–6.0 cm	2.0–4.0 cm
Length of leaf segment	1.5–2.0 cm	1.0–2.0 cm
Achene		
Colour	Dark green to reddish brown	Brown or dark green
Size	3.0–6.0 × 2.0–4.0 mm	4.0–5.0 × 2.0–3.0 mm
Facial spines	Absent	Present

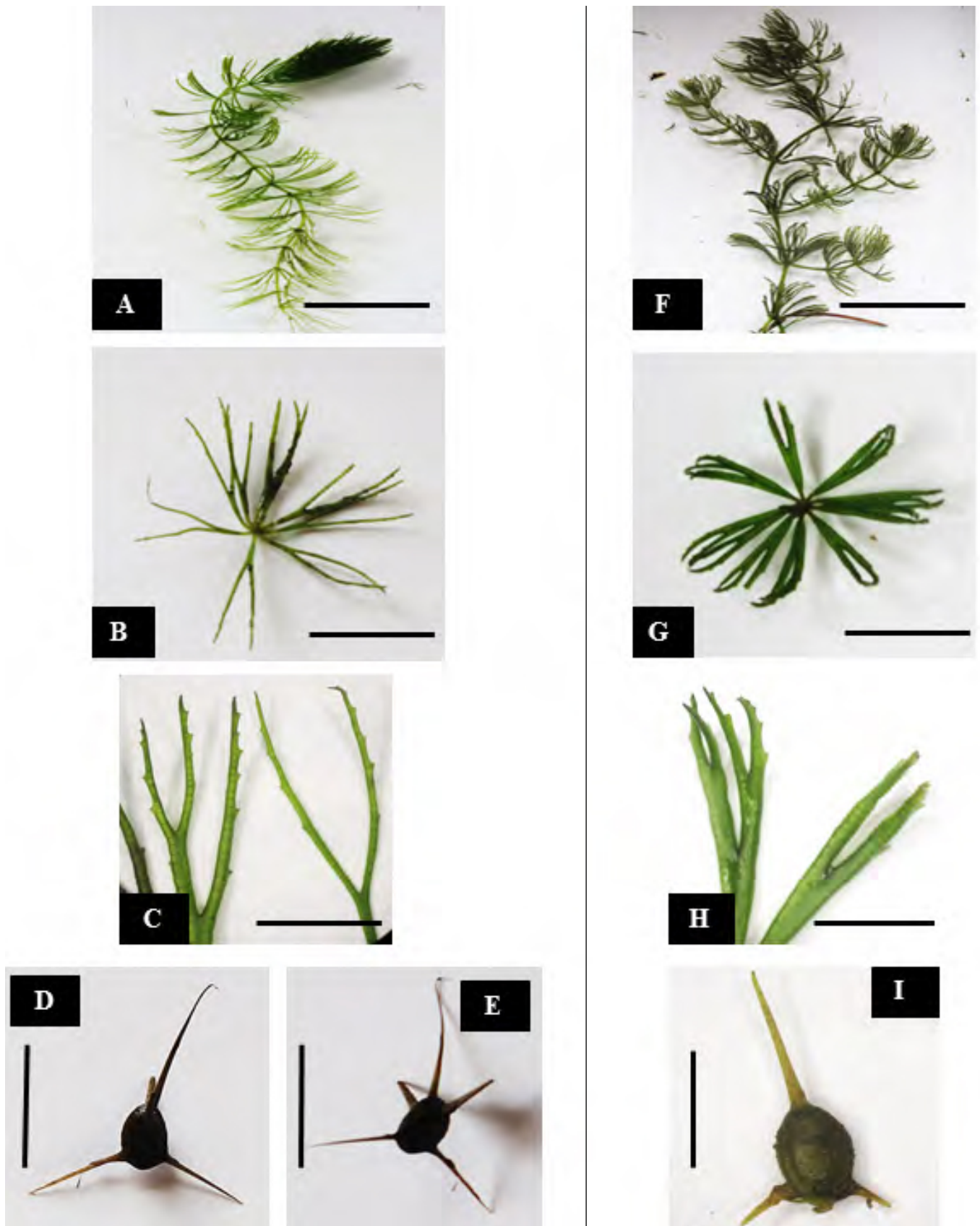


Figure 2. Vegetative and reproductive parts of *Ceratophyllum platyacanthum* subsp. *oryzetorum* and *C. demersum*. **A–E:** *C. platyacanthum* subsp. *oryzetorum*, **(A)** habit (scale = 0.3 cm), **(B)** leaf whorl (scale = 1.6 cm), **(C)** leaf segment (scale = 2.5 cm), **(D and E)** fruit (scale = 4cm). **F–I:** *C. demersum*, **(F)** habit (scale = 0.33 cm), **(G)** leaf whorl (scale = 2.5 cm), **(H)** leaf segment (scale = 2.5 cm), **(I)** fruit (scale = 4cm).

ACKNOWLEDGEMENTS

We thank the Head, Department of Botany, University of Kashmir, Srinagar, for providing necessary facilities, and to Jon Ricketson (MO), for providing us with specimen information.

LITERATURE CITED

- Bridson, D. and L. Foreman (eds.). 1992. The herbarium handbook. Revised edition. Kew: Royal Botanic Garden. xii + 303 pp.
- Cook, C.D.K. 1996. Aquatic and wetland plants of India. Delhi: Oxford University Press. 385 pp.
- Hooker, J.D. 1885. The flora of British India. Vol. 5. Chenopodiaceae to Orchideae. London: L. Reeve and Co. 910 pp. <http://biodiversitylibrary.org/page/18706957>
- Kak, A.M. 1990. Aquatic and wetland vegetation of the Kashmir Himalaya. Journal of Economic and Taxonomic Botany 14(1): 1–14.
- Kak, A.M. and S. Durani. 1985. Family Ceratophyllaceae in the Kashmir Himalayas. Journal of Bombay Nature History Society 82(2): 435–436.
- Kaul, V. and D.P. Zutshi, 1967. A study of aquatic and marshland vegetation of Srinagar. Proceedings of the Natural Institute of Science, India, B 33(3–4): 111–127.
- Les, D.H. 1986. Systematics and evolution of *Ceratophyllum* L. (*Ceratophyllaceae*). A monograph [Ph.D. dissertation]. Columbus, OH: The Ohio State University. 267 pp.
- Les, D.H. 1988a. The evolution of achene morphology in *Ceratophyllum* (*Ceratophyllaceae*). II. Fruit variation and systematics of the “spiny-margined” group. Systematic Botany 13: 73–86.
- Les, D.H. 1988b. The evolution of achene morphology in *Ceratophyllum* (*Ceratophyllaceae*). III. Relationships of the “facially-spined” group. Systematic Botany 13: 509–518
- Les, D.H. 1989. The evolution of achene morphology in *Ceratophyllum* (*Ceratophyllaceae*). IV. Summary of proposed relationships and evolutionary trends. Systematic Botany 14: 254–262.
- Sapjegin, A.A. 1902. Ksystematike roda *Ceratophyllum* [On the systematics of the *Ceratophyllum* genus]. Trudy Obshchestva Ispytatelei Prirody Imperatorskom Khar’kovskom Universitete 37: 309–318. [In Russian].
- Soó, R. 1966. A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve, II. [Manual for taxonomy and phytogeography, flora and vegetation of Hungary]. Budapest: Akadémia Kiadó. 655 pp. [In Hungarian].
- Stewart, R.R. 1972. An annotated catalogue of the vascular plants of West Pakistan and Kashmir. Karachi: Fakhri Printing Press. 257 pp.

Authors’ contribution statement: AHG, BAT and AAK has collected the plant material, the analysis of data were carried out in the laboratory by AHG, AAK, and ZAR. The Herbarium studies were carried out by AHG, AAK, BAT and DHL. AHG, DHL, AAK and ZAR wrote the manuscript.

Received: March 2015

Accepted: April 2015

Academic editor: Nik Fadzly