

Batrachospermum hongdongense (sect. *Batrachospermum*, *Batrachospermaceae*), a new species from Shanxi, China

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ABSTRACT. *Batrachospermum hongdongense* (Batrachospermaceae, Batrachospermales, Rhodophyta), a new species from Shanxi province, China, is described and illustrated. This species is assigned to sect. *Batrachospermum* in that carpogonial branches are long, straight, and do not differ from the primary fascicle cells. This new species is similar to *B. carpoinvolucrum* Sheath et Vis in having involucrel filaments terminated with carpogonia, and to *B. debile* Entwisle et Foard and *B. kraftii* Entwisle et Foard in the length of carpogonia. It differs from *B. carpoinvolucrum* in having long-scimitar trichogyne (vs. clavate trichogyne), and from *B. debile* and *B. kraftii* in having involucrel filaments bearing carpogonia (vs. involucrel filaments without).

Keywords: *Batrachospermum hongdongense*; Batrachospermaceae; China; Rhodophyta.

INTRODUCTION

Members of the red algae are widely distributed in oceans around the world. More than 200 taxa of red algae are found in freshwater habitats. They are reported to appear in moving water and attached to rocks and other substrata (Kumano, 2002). The Batrachospermales is the most important group of freshwater red algae, and the *Batrachospermum* is the largest genus among them.

The genus *Batrachospermum* Roth (1797) was established over 200 years ago. To date, more than one hundred species have been reported, and they are distributed worldwide. The *Batrachospermum* is distinguished from other Rhodophyte genus based on a heterotrichous life history phase, lack of tetraspore production, and carposporophytes that have a definite shape. Most taxa are classified into seven sections based on the shape of their trichogyne and carpogonial branch, but some taxa have remained difficult to place (Entwisle and Foard, 1997; Kumano, 2002). Twenty-six species have been previously recorded in China (Hua and Shi, 1996; Jao, 1940, 1941; Shi et al., 1993, 2006; Xie et al., 1999, 2003; Xie and Shi, 2003, 2004, 2005).

In 2006, we discovered a *Batrachospermum* in the Shanxi province of China which did not match any species description. Therefore, we describe it as a new species based on the combination of *B. carpoinvolucrum* Sheath et Vis-like involucrel filaments with apical carpogonia and *B.*

debile Entwisle et Foard and *B. kraftii* Entwisle et Foard-like long carpogonia (Vis and Sheath, 1996; Entwisle and Foard, 1997; Kumano, 2002).

Batrachospermum hongdongense S. L. Xie et J. Feng, sp. nov.—TYPE: CHINA. Shanxi Province, Hongdong County, Guangsheng Temple (111°47'49.86" N, 36°14'23.18" E), on stones and rocks in a stream, 3 Apr 2006, SAS06009 (holotype, SXU). Figures 1, 2

Frons diocea, caespitosa, mucosa, purpurea, 2.5-3.5 cm alta, irregularibus ramosissima. Verticilli globosi, remoti, fere 350-380 µm crassi, ramuli primarii dichotome vel trichotome ramose, 10-12-cellulares, cellulis longi-abovatis, 6-12 µm longis, 4-6 µm latis; secundarii nulli, pili pauci. Cellulae axiales 100-120 µm longae; 30-40 µm latae. Filia corticalia cylindrical, 45-55 µm longis, 4-6 µm in latis.

Spermatangia globosa, singulata vel binata, terminalia vel lateralialia in ramulis primariis, 5-7.5 µm diametro. Ramuli carpogoniferi recti, e cellulis basalibus vel terminalia filis bracteatis. Carpogonium 45-52 µm longum, 5-6 µm in latum, trichogyne longi-scimitaria, haud pedicellato. Carposporophyta 1-3, globosi, sparsa in et out verticillis, 65-100 µm diametro, carposporangia ovoidea, 5-7.5 µm lata, 8.5-15 µm longa.

Description. Thalli dioecious, gelatinous, caespitose, violet-red, approx. 2.5-3.5 cm high, irregularly branched (Figure 1A, B). Whorls globose, 350-380 µm in diameter, slightly separated, internodes approx. 150-300 µm (Figure 1C). Fascicles 2-3 dichotomously branched, 10-12 cells long; cells long ovoid, 6-12 µm long, 4-6 µm in diameter.

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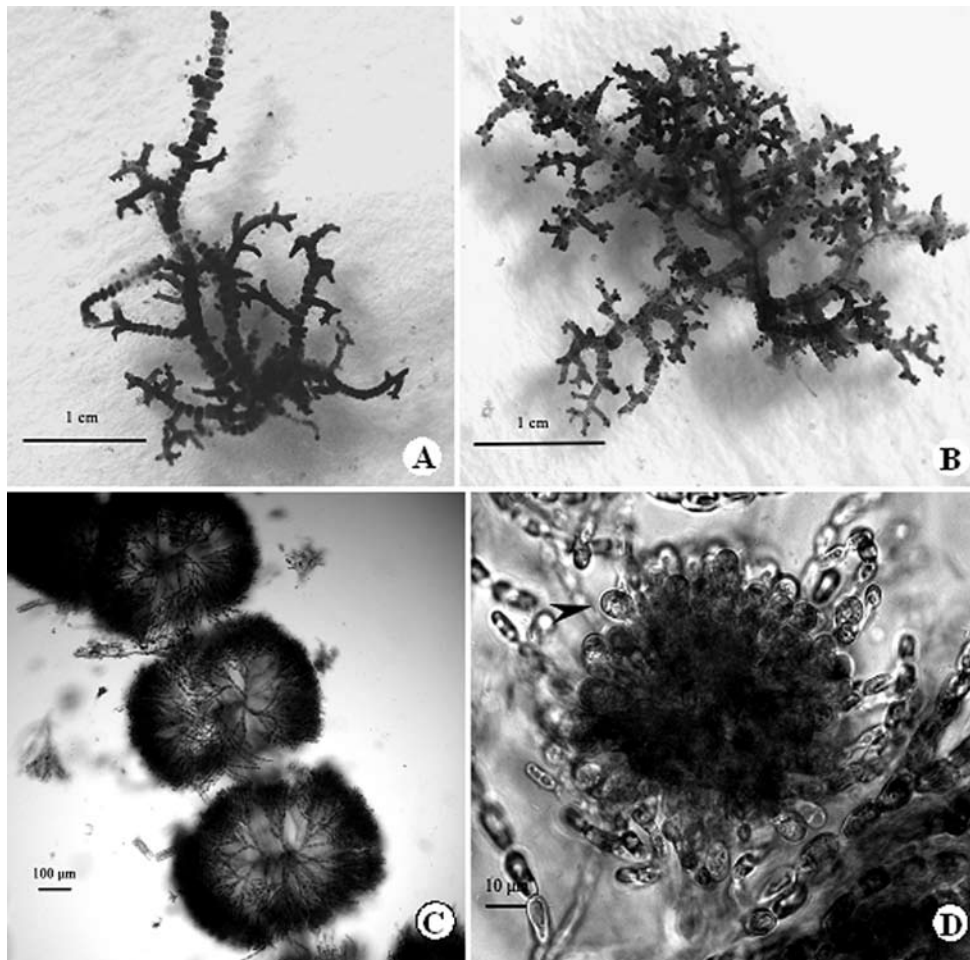


Figure 1. A, B, Habit of frond; C, Part of a frond, showing shape of whorls; D, Carposporophyte and carposporangium (arrow).

Secondary fascicles absent. Terminal hairs rare. Axial cells 100-120 μm long, 30-40 μm in diameter, and main axis with cortication consisting of cylindrical cells only, 45-55 μm long, 4-6 μm in diameter.

Spermatangia globose, single or in pairs, terminal or lateral on fascicles, 5-7.5 μm in diameter (Figure 2A). Carpogonial branches straight, arising from the base of fascicles or terminating in involucrel filaments, 5-12 cells long; carpogonia 45-52 μm long, 5-6 μm in diameter; trichogyne narrowly long-scimitar, without a stalk (Figure 1B-F). Carposporophytes definitely shaped, spherical, 1-3 per whorl, scattered in inner or outer parts of the whorl, 65-100 μm in diameter; carposporangia ovoid, 8.5-15 μm long, 5-7.5 μm in diameter (Figure 1D).

Ecology. This species grows on rocks and stones in a stream in Guangsheng Temple, Hongdong County, Shanxi, China. The stream is about 10 m wide, 30 cm in depth, and the water is clear, temperature is 11.5°C, pH 6.5.

Distribution. Hongdong County, Shanxi, China (Figure 3); known only from the type locality.

Etymology. The specific epithet is derived from the county name of the type locality.

Relationship to other species. *Batrachospermum hongdongense* clearly belongs to sect. *Batrachospermum* given its carpogonial branches are long, straight, and not distinct from the primary fascicles cells (Vis and Sheath, 1996; Vis et al., 1995).

This species is similar to *B. carpoinvolucrum* in being dioecious, and in the carpogonial branch having some involucrel filaments terminated by carpogonia. *Batrachospermum hongdongense* differs from *B. carpoinvolucrum* in having narrowly long-scimitar trichogyne, 5-6 μm in diameter, carpogonia 45-52 μm long, and long carpogonial branch, about 5-12 cells long while the latter's trichogyne is clavate, 7-8.5 μm in diameter, only 15-26 μm long, carpogonial branch 6-7 cells long. This taxon is also similar to *B. debile* and *B. kraftii* in the length of carpogonia, about 40-60 μm . *Batrachospermum hongdongense* differs from *B. debile* and *B. kraftii* in having carpogonia terminate some involucrel filaments. In addition *B. debile* trichogynes are narrow club-liner, 3-5 μm in diameter, and the carpogonial branch is typically only 5-7 cells long. *B. kraftii* trichogynes are oblique-ellipsoidal to scimitar, and 6-11 μm in diameter (Table 1).

In conclusion, because *B. hongdongense* has whorls

developed normally, carpogonium-bearing branches not spirally twisted, and carposporophyte consisting of gonimoblast filaments and carposporangia distributed in whorls, it was considered to belong to the section

Batrachospermum. So far eleven species have been reported in this section from China (Hua and Shi, 1996; Jao, 1940, 1941; Shi et al., 1993; Xie et al., 1999; Xie and Shi, 2003, 2004) (Table 2).

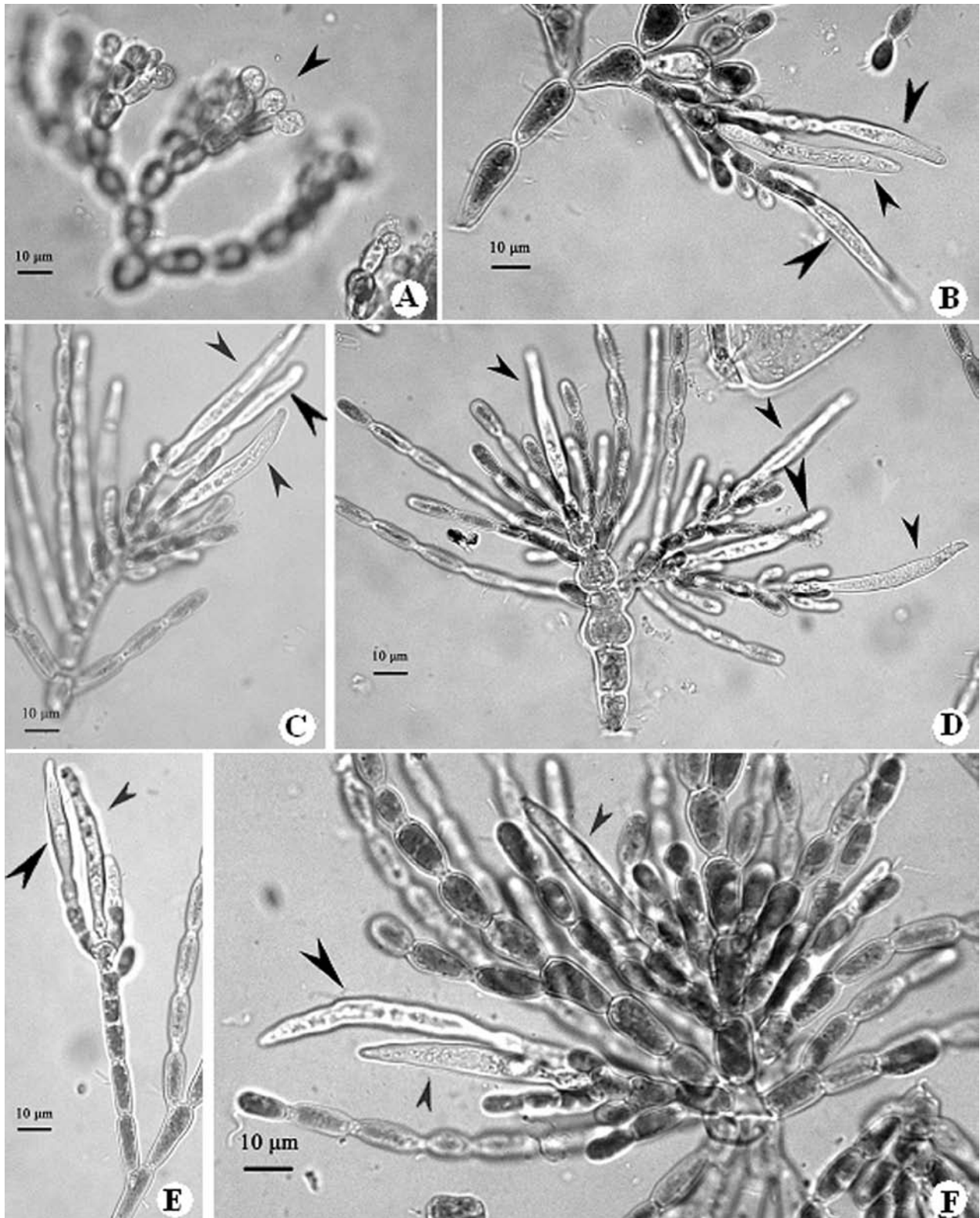


Figure 2. A. Primary fascicle, showing spermatangium (arrow); B, C, D, E, F. Carpogonial branch and carpogonium (arrow) with long involucral filaments terminated with carpogonia (large arrows).

Table 1. Comparison of *Batrachospermum hongdongense* S. L. Xie et J. Feng, *B. carpoinvolucrum* Sheath et Vis, *B. debile* Entwisle et Foard and *B. kraftii* Entwisle et Foard.

Character	<i>B. hongdongense</i>	<i>B. carpoinvolucrum</i>	<i>B. debile</i>	<i>B. kraftii</i>
Thallus (cm)	2.5-3.5		2-3	1-10
Whorl shape	Spherical	Barrel-spherical	Barrel-spherical	Barrel-spherical
Whorl diameter (μm)	350-380	489-853	300-550	420-1,300
Internode (μm)	150-300		110-180	200-530
Primary fascicle (cell number)	10-12	8-10	6-12	11-20
Carpogonial branch (cell number)	5-12	6-7	5-7	5-14
Carpogonia diameter (μm)	2-3	3-4	3-4	3-5
Carpogonia long (μm)	45-52	15-26	32-60	20-40
Trichogyne shape	Scimitar-linear	Clavate	Club-linear	Oblique-ellipsoidal to scimitar
Trichogyne diameter (μm)	5-6	7-8.5	3-5	6-11
Involucral filament	With carpogonia	With carpogonia	Without carpogonia	Without carpogonia
Spermtangium shape	Spherical	Spherical	Spherical	Spherical
Spermtangium diameter (μm)	5-7.5	8-10	5-6	5-8
Carposporophytes shape	Spherical	Spherical	Hemispherical	Spherical
Carposporophytes number per whorl	1-3	1-3	1	1-2(-3)
Carposporophytes site	Inner or outer whorls	Beyond whorls	Inner or outer whorls	Inner whorls rarely outer
Carposporoangia diameter (μm)	5-7.5	7-11	7-9	7-14
Carposporangia long (μm)	8.5-15	10-14	10-16	18-26

**Figure 3.** Distribution of *Batrachospermum hongdongense* in Shanxi Province, China.

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Table 2. Distribution of *Batrachospermum* section *Batrachospermum* in China.

Species	Distribution in China	Ecology	Reference
<i>B. anatinum</i>	Shanxi (Taiyuan), Anhui (Chuzhou), Henan (Linxian), Chongqing	Water temperature 9-15°C, pH 6-7, on rocks, sands and stone wall in streams	Jao, 1941
<i>B. arcuatum</i>	Shanxi (Lucheng), Hunan (Jishou)	Water temperature 16°C, pH 7.5, on rocks in streams	Xie et al., 1999
<i>B. boryanum</i>	Shandong (Ji'nan)	Water clear, water temperature 17°C, pH 6, on rocks in streams	Xie and Shi, 2003
<i>B. gelatinosum</i>	Shanxi (Pingding), Heilongjiang (Shangzhi), Jiangsu (Nanjing), Henan (Xinyang), Hubei (Luotian), Hunan (Hengshan), Chongqing	Water temperature 10-22.5°C, pH 6.5-7.8, on rocks and stone wall in streams and mountain streams	Jao, 1940, 1941
<i>B. heteromorphum</i>	Hubei (Luotian)	On rocks in a mountain stream	Shi et al., 1993
<i>B. hongdongense</i>	Shanxi (Hongdong)	Water clear, water temperature 11.5°C, pH 6.5, on rocks and stone in a stream	
<i>B. involutum</i>	Heilongjiang (Ning'an)	Water temperature 18°C, pH 7.4, on rocks in waterfall	Xie and Shi, 2003
<i>B. lochmodes</i>	Hubei (Changyang)	Water temperature 16.5°C, pH 6.5, on rocks in a mountain stream	Xie and Shi, 2003
<i>B. longipedicellatum</i>	Jiangsu (Xuzhou)	Water temperature 16-17°C, pH 7.5, on calcareous land in a spring stream	Hua and Shi, 1996
<i>B. pengzhouense</i>	Sichuan (Pengzhou)	Water clear, water temperature 17.8°C, on land in a spring stream	Xie and Shi, 2004
<i>B. szechwanense</i>	Chongqing (Beibei)	On cement wall in a rush stream	Jao, 1941

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中國串珠藻屬一新種：洪洞串珠藻

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本文報道了串珠藻屬一新種：洪洞串珠藻 *Batrachospermum hongdongense*。該種採自山西省洪洞縣廣勝寺。此種雌雄異株，在果胞體的苞片上長有果胞，與 *Batrachospermum carpoinvolucrum* Sheath et Vis 相似，受精絲形狀與 *B. debilis* Entwisle et Foard 和 *B. kraftii* Entwisle et Foard 相似。它與 *B. carpoinvolucrum* 的區別在於受精絲為曲劍形，末端尖細，直徑 5-6 μm ，果胞長 45-52 μm ，而 *B. carpoinvolucrum* 為杵形，直徑 7-8.5 μm ，果胞長僅 15-26 μm ；與 *B. debilis* 和 *B. kraftii* 的區別在於後兩者雌雄同株，苞片上不長有果胞，並且 *B. debilis* 的受精絲為細的杆狀，直徑 3-5 μm ，*B. kraftii* 的受精絲為斜橢圓形，直徑 6-11 μm 。

關鍵詞：洪洞串珠藻；串珠藻屬；中國；紅藻門。