A new species of *Ephedra* L. (Ephedraceae) from Sichuan, China with a note on its systematic significance

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Abstract. A new species, *Ephedra dawuensis* Y. Yang, is described and illustrated. This species is similar to *E. equisetina* Bunge in having thin branchlets 0.8-1 mm in diam. and brown scale-like leaves, and to *E. saxatilis* Royle ex Florin in having oblong-ellipsoid seeds and a short micropylar tube ca. 0.5 mm long. It differs from *E. equisetina* in having female cones bearing 2 or 3 pairs of bracts (vs. 4 or 3 pairs of bracts), purplish black, oblong-ellipsoid seeds (vs. ovoid seeds), and a shorter micropylar tube (vs. 1.5-2 mm long), and from *E. saxatilis* in having thinner branchlets and brown scale-like leaves (vs. yellowish, narrow triangular, leaves). This new species is assigned to *E. sect. Ephedra* in that the bracts of female cones become fleshy at maturity. Intermediate character states of this new species provide evidence for the hypothesized affinity between *E. equisetina* and *E. saxatilis*.

Keywords: China; Ephedra dawuensis; Ephedraceae; Himalayas; Taxonomy.

Introduction

In 1999, I noticed a new form of *Ephedra* from Sichuan of China (W.K. Hu 13049) that I realized was a new species because of the unique combination of E. equisetina Bunge-like vegetative characters and E. saxatilis Royle ex Florin-like reproductive characters. I had only one specimen at my disposal at that time and needed more specimens to confirm my viewpoint. Fortunately, in the summer of 2002, Dr. M. Mikage of the Faculty of Pharmaceutical Sciences, Kanazawa University and his colleagues collected some specimens of Ephedra from Sichuan of China including one specimen (M. Mikage, A. Takahashi, T. Okutsu, Q. S. Li 0101075) identical to W. K. Hu 13049. This corroborated my former assumption that this entity is a new species. Further investigation on testa sculptures of over 40 Ephedra species (Yang, unpubl. res.) indicated that the testa sculpture of this new species (Figure 2A) differs from that of E. saxatilis (Figure 2C) in having a clear cellular profile and an impressed intercellular furrow, and from that of E. equisetina (Figure 2B) by the absence of a warty testa sculpture.

Ephedra dawuensis Y. Yang, sp. nova—TYPE: China. Sichuan, Garzê Xian (31°36' N, 99°54' E), on slopes, woody, ca. 0.5 m tall, fruit red, common, 7 Sep 1951, *W. K. Hu* 13049 (holotype, PE). (Figure 1)

Haec species nova affinis Ephedrae saxatili Royle ex Florin et E. equisetinae Bunge, a illa differt ramulis gracilioribus, foliis brunneis squamiformibus, a hac differt seminibus oblongis ellipsoideis. *Diagnosis*. This new species is similar to *E. saxatilis* and *E. equisetina*, but differs from the former by its thinner green branchlets and brown scale-like leaves, and from the latter by the female cones bearing 2 or 3 pairs of bracts, the purplish black, and oblong-ellipsoid seeds, and a shorter micropylar tube.

Description. Plants woody, to 0.5 m tall. Stems woody, to 21.6 cm × 6 mm on specimen; bark grayish black, smooth to rough, longitudinally split. Branchlets densely clustered at nodes of woody stems, yellowish green, 3-9 cm long; internodes 1.7-3 cm long, 0.8-1 mm in diam., densely and finely warty. Leaves 2 at nodes, brown and scale-like, triangular, 2-4 mm long, basal 1/2 fused to completely split, apex slightly recurved, acute to obtuse. Male cones unknown. Female cones paired or solitary at nodes, pedunculate; peduncles ca. 4 mm long. Bracts in 2 or 3 pairs, fused for ca. 2/3 their length, fleshy at maturity. Seeds 1 or 2 in each cone, included in bracts, purplish black, oblong-ellipsoid, 6.1-6.8 × 3.1-3.4 mm, apex acute when ventral surface plane and dorsal surface convex, or apex slightly beaked when both ventral and dorsal convex. Micropylar tube straight, short, ca. 0.5 mm long.

Etymology. The specific epithet is derived from the county name of the type locality, Dawu Xian, Sichuan Province, China.

Relationships. Ephedra dawuensis Y. Yang clearly belongs to *E.* sect. *Ephedra* because it has red, fleshy bracts when the mature female cones are mature. This species is similar to *E. saxatilis* in the strong, erect, woody stems, and the reproductive characters, e.g., the purplish black seed color, the oblong-ellipsoid seed shape, the short micropylar tube (ca. 0.5 mm long), the bracts in 2 or 3 pairs, and the degree of fusion of uppermost pair of bracts of

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Figure 1. *Ephedra dawuensis* Y. Yang (from holotype, drawn by Ying-bao Sun). A, Habit. Bar: 1 cm; B, Female cone. Bar: 3 mm; C, Seed, dorsal view. Bar: 3 mm; D-E, Variation of seed shape; D, Seed, ventrally plane, lateral view. Bar: 3 mm; E, Seed, ventrally convex, lateral view. Bar: 3 mm.

Character	Ephedra equisetina	Ephedra dawuensis	Ephedra saxatilis
Bract numbers (pairs)	3 or 4	2 or 3	2 or 3
Bract fusion degree	1/2	2/3 or more	3/4-7/8
Seed shape	Ovoid, convex on both sides	Oblong-ellipsoid, adaxial plane and abaxial convex, or ovoid convex on both sides	Oblong-ellipsoid, adaxial plane and abaxial convex
Seed color	Gray to grayish brown	Purplish black	Purplish black
Micropylar tube length (mm)	1.5-2	0.5	0.5-1
Micropylar tube shape	Straight to curved	Straight	Straight
Leaf shape	Scale-like and apex obtuse	Scale-like and apex obtuse	Acute to acuminate
Leaf color	Brown	Brown	Whitish green
Branchlet diameter (mm)	0.8-1	0.8-1	1.5-2.5

 Table 1. A comparison of morphological characters among *Ephedra saxatilis* Royle ex Florin, *E. equisetina* Bunge, and *E. dawuensis*

 Y. Yang.

the female cones (Table 1). *Ephedra dawuensis* is also similar to *E. equisetina* in the thin branchlets (ca. 0.8-1 mm in diam.), the brown scale-like leaves, the woody habit, the seeds sometimes beaked and ventrally swollen (Figure 1E; Table 1). This assemblage of characters suggests that the new species is closely related to both *E. saxatilis* and *E. equisetina* and that the three species may form a clade.

Pachomova (1971) assumed that *E. saxatilis* is closely related to *E. equisetina* based on a study of female cone characters of the genus. Mussayev (1978) further considered that *E. saxatilis* may be derived from *E. equisetina*. However, no immediate characters have been reported. The present author believes that the two species are closely related because of their shared overall similarity in the frequent uniovulate cones bearing large seeds, fewer pairs of bracts, and the strong, woody habit. The discovery of *E. dawuensis* provides further evidence for the close relationship between *E. saxatilis* and *E. equisetina* because *E. dawuensis* has some intermediate characters between the two species (Table 1).

Ephedra dawuensis differs from E. equisetina in having female cones bearing 2 or 3 pairs of bracts, purplish black, oblong-ellipsoid seeds, and a shorter micropylar tube, and from E. saxatilis in having thinner branchlets and brown scale-like leaves. Seed surface sculptural characters are important to systematics of *Ephedra* (Yang, unpubl. res.), those of E. dawuensis, E. equisetina, and *E. saxatilis*, were studied by using SEM (Figure 2A-2C). The results indicate that the three species have clearly distinguishable seed surface sculptural characters. Ephedra equisetina has warty seed surface ornamentations (Figure 2B) that are fundamentally different from the smooth pattern of E. dawuensis with clear profile of epidermal cells (Figure 2A) and the irregular seed surface of E. saxatilis (Figure 2C). In short, E. dawuensis shows close affinity with E. saxatilis in its reproductive organs but with *E. equisetina* in its vegetative organs. In addition, both E. dawuensis and E. saxatilis are endemic to Himalayas while E. equisetina is widespread through Mid-Asia, from the Canary Islands eastward to Shandong of



Figure 2. Seed sculpture of three *Ephedra* species. A, *Ephedra dawuensis* showing the impressed intercellular furrows. Bar: 50 μm; B, *Ephedra equisetina* showing warty sculpture. Bar: 100 μm; C, *Ephedra saxatilis* showing irregular seed ornamentation. Bar: 50 μm.

China. This combination of evidence suggests that *E. dawuensis* and *E. saxatilis* might be derived from a common ancestor close to *E. equisetina* with the Himalayan uplift.

In conclusion, *E. dawuensis* and *E. saxatilis* are closely related to each other. They may share a common ancestor with *E. equisetina*. Further studies are encouraged to illuminate the relationships among these species in detail.

Additional specimens examined. China, Sichuan, Garzê Zangzu Zizhouzhou, Dawu Xian, Xianshui Town (30°59.261' N, 101°07.215' E), alt. 3,100 m, 30 Jul 2001 (fr.), *M. Mikage, A. Takahashi, T. Okutsu, Q. S. Li 0101075* (paratype, PE).

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中國四川麻黃屬一新種及其系統學意義

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報導了麻黃屬一新種:道浮麻黃。該種在小枝纖細、葉褐色鱗片狀方面與木賊麻黃相似,在種子長 圓狀橢球形、珠孔管短等方面與藏麻黃相似。它與木賊麻黃的區別在於雌球花具 2-3 對苞片,長圓狀橢 球形種子紫黑色,珠孔管較短,與藏麻黃的區別在於小枝纖細,葉褐色鱗片狀。由於該種雌毬果苞片成熟 時肉質,因此應歸入麻黃屬肉苞組。前人提出木賊麻黃與藏麻黃關係密切,道浮麻黃在形態上介於二者之 間,為前人提出的假說提供了證據。

關鍵詞:中國;道孚麻黃;麻黃科;喜馬拉雅山;分類。