



Carex concava (*Carex* sect. *Rhomboidales*, Cyperaceae), a new species from Hainan, China

HU-BIAO YANG^{1a}, XIAO-XIA LI^{2a}, CHANG-JUN BAI¹, WEN-QIANG WANG¹ & GUO-DAO LIU^{1*}

¹Tropical Crops Genetic Resources Institute, Chinese Academy of Tropical Agricultural Sciences, Danzhou Hainan 571737, China. E-Mail: liuguodao2008@163.com (author for correspondence).

²Environment and Plant Protection Institute, Chinese Academy of Tropical Agricultural Sciences, Hainan 571737, China.

^aThese authors contributed equally to this work.

Abstract

A new species of *Carex* sect. *Rhomboidales*, *Carex concava*, is described and illustrated from Hainan, China. The new species is similar to *C. paracheniana* but differs in having wider blades and longer sheaths of bracts; inflorescence with 3 spikes; terminal spike 2–6 cm long and with a 4–14 cm long peduncle; lateral spikes 3–6 cm long, loosely flowered and with 8–15 cm long peduncles; staminate glume ovate, 1-veined costa excurrent into a shortly awn ca. 0.3 mm; pistillate glume ovate, ca. 4 mm long, 1-veined costa excurrent into a awn ca. 1 mm; perigynia fusiform and green; nutlets inclined-oval, brownish black, with 3 angles deeply constricted at the middle and the side toward of spike-stalk deeply concave at base.

Key words: New species, taxonomy

Introduction

The genus *Carex* L. (1753:972) is one of the largest genera of vascular plants, comprising about 2,000 species distributed almost worldwide in various habitats (Ohwi 1936, Nelmes 1951, Ball & Reznicek 2003, Dai *et al.* 2000, Frodin 2004, Global *Carex* Group 2016). 527 species in three subgenera and 69 sections were recorded in recently published Flora of China (Dai *et al.* 2010). Recently, additional 19 species have been reported (Jin *et al.* 2004, 2010, 2011, 2012a, 2012b, 2013; Shimizu 2008; Zhao *et al.* 2011; Yu *et al.* 2012; Wang *et al.* 2012; Deng 2014; Yang *et al.* 2014, 2015a, 2015b).

The genus *Carex* is clearly distinguished from other genera of the Cyperaceae in having consistently unisexual flowers and a perigynium, the latter a sac-like structure of prophyllar origin that surrounds the naked gynoeceum (Blaser 1944, Jiménez-Mejías *et al.* 2016). *Carex* has been variously divided in subgenera and sections based on the following characters among others: number of stigmas, inflorescence structure, and distribution of staminate and pistillate flowers within the spikes. The most influential classification was that of Kükenthal (1909) who recognized four subgenera which, according to Egorova (1999) nomenclatural update, are subg. *Carex*, subg. *Vigneastra* (Tuckerman 1843:10), subg. *Vigneia* (B. Beauvois in T. Lestiboudois 1819:22) and subg. *Psyllophora* (Degland 1828:285). This classification was widely followed by most authors (Koyama 1962; Reznicek 1990; Dai 2000, 2010; Waterway *et al.* 2007, 2009).

Carex sect. *Rhomboidales* (Kükenthal 1909:622) belongs to *C.* subg. *Carex* and is characterized by long-sheathing bracts with short blades, trigonous, rhombic to ovoid perigynia with columniform bidentate beaks at the apex, and obovoid or ovoid, trigonous nutlets that are constricted in the middle part and mitrate or hastate at the apex (Ohwi 1936, Kükenthal 1909). The section consists of 52 taxa (42 species, six subspecies and four varieties), mainly distributed in eastern Asia, with 36 species native to China and five species in Hainan Island (Oda *et al.* 2003; Dai 2010; Jin & Zheng 2013; Yang 2015a, 2015b). Hainan Island is located at the southern part of China, at the northern edge of tropical Asia, has about 4100 vascular plant species (Liao *et al.* 2001). To date, 28 species of *Carex* have been reported from Hainan (Deng 2014; Wang 2012; Yang 2014, 2015a, 2015b; Liu & Bai 2012).

During an investigation of the flora of Wuzhi Shan Nature Reserve in 2014, a novel species of *Carex* was collected and is here recognized as a new species in section *Rhomboidales*: *Carex concava*. Morphologically, this new species has affinities with *Carex paracheniana* X. F. Jin, D. A. Simpson & C. Z. Zheng and *C. brevicuspis* (Jin *et al.* 2012).

Materials and Methods

Material of this new species was collected from Wuzhi Shan Nature Reserve (Fig 4). Morphological description of the new species was based on examination of five fresh and pressed specimens. Details of the terminal staminate spikes, lateral pistillate spikes, pistillate glumes, perigynia and nutlets were examined and photographed under a stereomicroscope (Olympus SZX16-6156). The perigynia and nutlets shape of *Carex concava* were observed using a Philips XL-30E scanning electron microscope (SEM). The studied specimens are kept in the Herbarium of the South China Botanical Garden of the Chinese Academy of Sciences (IBSC), and the Tropical Crops Genetic Resources Institute of the Chinese Academy of Tropical Agricultural Sciences (TCGRI).

Results

The new species is most similar to *C. paracheniana* based on the shape of the involucre bracts, the perigynia and the nutlets with 3 angles deeply constricted at middle and the side concave, but differs by the adaxial side of nutlets deeply concave below the constrictions (Figs 1–3). The new species is also similar to *C. brevicuspis* in the perigynia and the nutlets with 3 angles deeply constricted at middle and the side concave, but differs by the lateral spikes with loosely flowered, base of nutlets not stipitate and the adaxial side of nutlet deeply concave below the constrictions. Differences between the three taxa are listed in Table 1.

TABLE 1. Morphological comparison between *Carex concava*, *C. paracheniana* and *C. brevicuspis*.

Character	<i>C. concava</i>	<i>C. paracheniana</i>	<i>C. brevicuspis</i>
Blades	5–10 mm wide	3–5 mm wide	4.5–13.5 mm wide
Bract sheaths	Ca. 5 cm long	0.5–1.5 cm long	2.5–4 cm long
Inflorescence	Spikes 3	Spikes 3–4	Spikes 4–5
Spikes	Terminal spike 2–6 cm long, with a 4–14 cm long peduncle; lateral spikes 3–6 cm long, entirely female, loosely flowered and with 8–15 cm long peduncles	Terminal spike 2–3 cm long, with a ca. 4 cm long peduncle; lateral spikes bearing a few staminate flowers at apex, 1–3 cm long, densely flowered and with 1.5–3 cm long peduncles	Terminal spike 2–5 cm long, with a ca. 2.5 cm long peduncle; lateral spikes 3–8 cm long, bearing a few staminate flowers at apex, densely flowered
Glumes	Staminate glumes ca. 4 mm long, ovate, yellowish white, green 1-veined costa excurrent into a shortly awn ca. 0.3 mm; pistillate glumes ovate, ca. 4 mm long, white	Staminate glumes ca. 5 mm long, ovate-oblong, pale brown, green 3-veined costa on dorsal surface; pistillate glumes ovate-elliptic, ca. 6.5 mm long, glaucous	Staminate glumes ca. 11 mm long, lanceolate, yellowish brown, brown 1-veined costa on dorsal surface; pistillate glumes lanceolate, ca. 5 mm long, pale yellow
Perigynia	Fusiform, green, ca. 7 mm long	Broadly ovoid, brownish green, 7–7.5 mm long	Ovoid or broadly ovoid, brownish green, 6–7 mm long
Nutlets	Rhombic-oval, ca. 4 mm long, brownish black, with the three angles deeply constricted at the middle, the adaxial side deeply concave below the constrictions, base not stipitate.	Rhombic-ovoid, ca. 5 mm long, castaneous, with the three angles constricted at the middle, sides concave above and below the constrictions, base stipitate.	Rhombic-ovoid, ca. 4 mm long, castaneous, with the three angles constricted at the middle, sides concave above and below the constrictions, curved stipitate at base.

Taxonomic treatment

Carex concava H.B. Yang, X.X. Li & G.D. Liu sp. nov. (Figs 1–3)

Diagnosis:—The new species is similar to *C. paracheniana*, but differs in having more wider blades and longer sheaths of bracts, inflorescence with 3 spikes; terminal spike 2–6 cm long and with a 4–14 cm long peduncle, lateral spikes 3–6 cm long, loosely flowered and with 8–15 cm long peduncles; staminate glume ovate, 1-veined costa excurrent into a shortly awn ca. 0.3 mm; Pistillate glume ovate, ca. 4 mm long, 1-veined costa excurrent into a awn ca. 1 mm; Perigynia fusiform and green; nutlets inclined-oval, brownish black, with 3 angles deeply constricted at the middle and the adaxial side deeply concave below the constriction.

Type:—CHINA. Hainan: Wuzhi Shan County, Wuzhi Shan Nature Reserve, under forest, alt. 1200–1500 m, 10 April 2014, Yang Hubiao 20140410002 (holotype, IBSC; isotype, TCGRI).

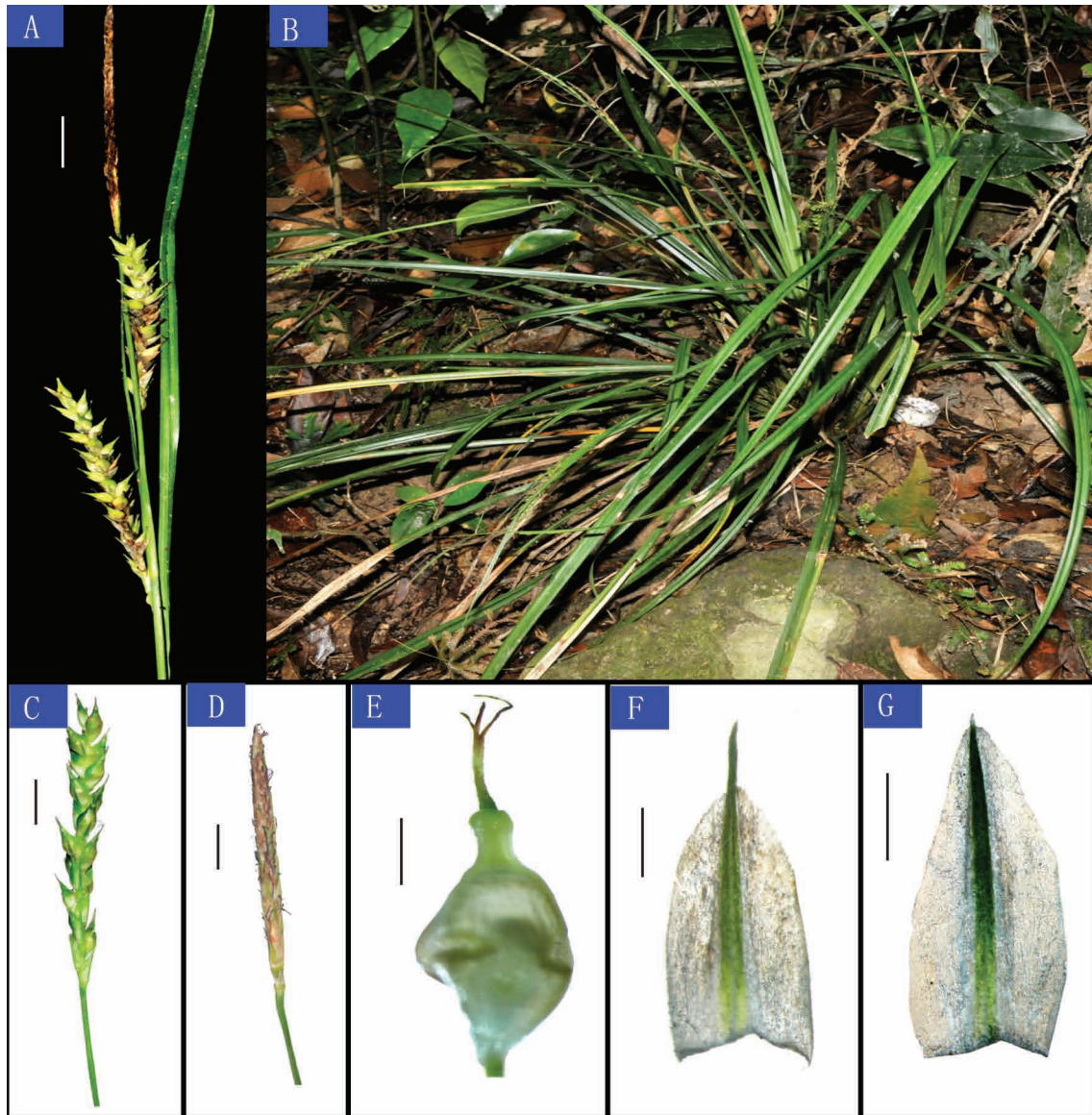


FIGURE 1. *Carex concava*. **A.** Inflorescence. **B.** Habit. **C.** Lateral pistillate spike. **D.** Terminal staminate spike. **E.** Perigynium with stigmas. **F.** Pistillate glume. **G.** Staminate glume. Scale A, B, D bars=1 cm; E, F, G bars=1 mm. Photographs by Hu-Biao YANG (Apr. 15th, 2014).

Herbs perennial. Rhizome short, ligenous, covered with dark brown fibrous remains of old leaf sheaths. Culms central, 20–45 × ca. 0.2 cm, trigonous. Leaves basal, longer than culms, with ca. 5 cm long sheaths at base; blades green, 5–75 × 0.5–1 cm, glabrous on both surfaces, acuminate at apex. Involucral bracts shortly, leafy, 15–23 × ca. 0.3 cm, sheathed; sheaths ca. 5 cm long. Inflorescence paniculate, with 3 spikes; terminal spike staminate, linear-cylindrical, 2–6 × ca. 0.2 cm, with a peduncle 4–14 cm long; lateral spikes pistillate, linear-cylindrical, 3–6 × ca. 0.5 cm, loosely flowered, pedunculate; peduncles exerted from sheaths, 8–15 cm long. Staminate glumes ovate, ca. 4 × 2 mm, membranous, glabrous, obtuse at apex, with a green 1-veined costa excurrent into a shortly awn ca. 0.3 mm. Pistillate glumes ovate, yellowish white, ca. 4 × ca. 2 mm, membranous, obtuse at apex, with a green 1-veined costa excurrent into a awn ca. 1 mm. Perigynia fusiform, ca. 7 mm long, slightly longer than pistillate glume, obtusely trigonous, sparsely pubescent on

upper veins, distinctly veined, apex gradually contracted into shortly beak, beak sparsely pubescent on veins. Nutlets tightly enveloped, rhombic-oval, trigonous, ca. 4 × ca. 2 mm, brownish black, with 3 angles deeply constricted at the middle, the adaxial side deeply concave below the constriction, apex abruptly contracted into a cylindrical, slightly curved short beak, expanding into an annulate orifice; style-base persistent, thickened.

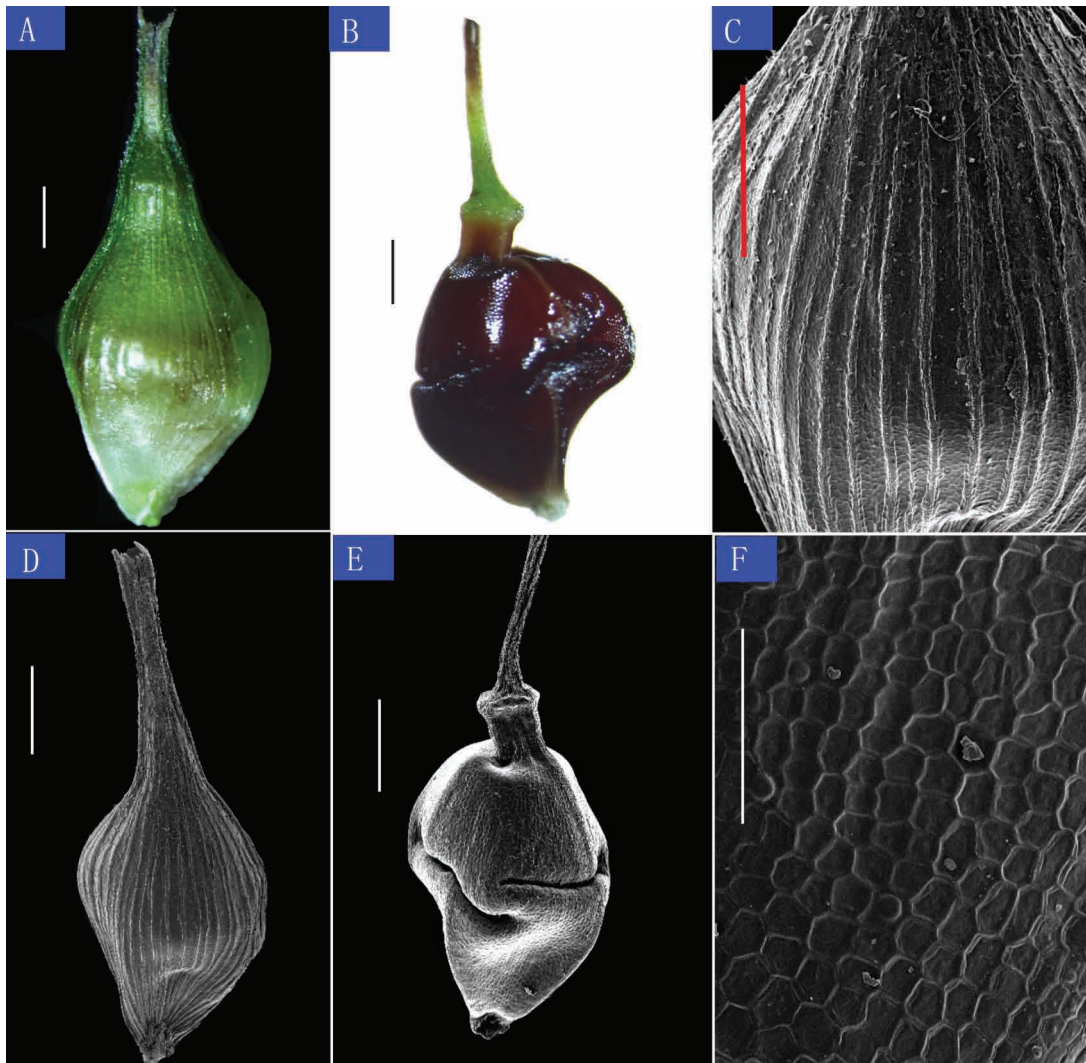


FIGURE 2. *Carex concava*, **A.** Perigynium. **B.** Nutlet. **C.** Perigynium, distinctly veined (SEM). **D.** Perigynium (SEM). **E.** Nutlet (SEM). **F.** Epidermal cells (SEM). (Scale bars A, B, D, E=1 mm; C=500 μ m; F=200 μ m). Photographs by Hu-Biao YANG (Apr. 15th, 2014 and Oct. 10th, 2014).

Distribution and habitat:—*Carex concava* was collected from Wuzhi Shan Nature Reserve, Hainan, China. It grows under the tropical mountain rain forest at altitudes of 1200–1500 m. Associates include *Podocarpus imbricatus* Blume, *Dacrydium pierrei* Hickel, *Altingia obovata* Merr. & Chun, *Xanthophyllum hainanense* Hu, *Daphniphyllum paxianum* K.Rosenthal, *Daemonorops margaritae* (Hance) Becc., *Calamus tetradactylus* Hance, *Licuala fordiana* Becc., *Millettia pachyloba* Drake, *Manglietia hainanensis* Dandy, *Carex tsoi* Merrill et Chun, *C. planiscapa* Chun et F.C.How. and *C. breviscapa* C.B. Clarke.

Phenology:—Flowering occurs from March and usually nutlets mature from April to June.

Etymology:—The epithet “*concava*” refers to the nutlets, which are deeply constricted at the middle and the side toward of spike-stalk deeply concave at base.

Relationships:—The new species belongs to *Carex* sect. *Rhomboidales*. In Hainan Island, five species, *C. harlandii* Boott (Boott 1860), *C. saxicola* Tang & F.T. Wang (Tang & Wang 1977), *C. longipetiolata* Q.L. Wang, H.B. Yang & Y.F. Deng (Wang *et al.* 2012), *C. procumbens* H.B. Yang, X.X. Li & G.D. Liu (Yang *et al.* 2015a), and *C. jianfengensis* H.B. Yang, X.X. Li & G.D. Liu (Yang *et al.* 2015b) have been reported. Besides, five new taxa from other regions have recently been described in sect. *Rhomboidales*: *C. jubozanensis* J. Oda & A. Tanaka (Oda *et al.* 2003), *C. austrozhejiangensis* C.Z. Zheng & X.F. Jin (Jin *et al.* 2004), *C. kagoshimensis* Tak. Shimizu (Shimizu 2008),

C. yandangshanica C.Z. Zheng & X.F. Jin (Jin *et al.* 2010) and *C. paracheniana* X.F. Jin, D.A. Simpson & C.Z. Zheng (Jin *et al.* 2012b). However, *C. concava* can be easily distinguished from all the species mentioned above by its nutlets with 3 angles deeply constricted at the middle, the side toward of spike-stalk deeply concave at base. It is similar to *C. paracheniana* based on the shape of nutlets and perigynia, but differences are clear as mentioned in Table 1. Furthermore, based on SEM observations, this new species has no protruding central silica bodies in epidermal cells (Fig 2). *Carex paracheniana* displays protruding, irregularly 5-6-gonal, central silica bodies in epidermal cells (Jin & Zheng 2013).



FIGURE 3. *Carex concava*. A. Habit. B. Terminal staminate spike. C. Lateral pistillate spike. D. Staminate glume. E. Pistillate glume. F. Perigynium. G. Nutlet. Drawn by Yu-xi Zhu.

Additional specimens examined (Paratypes):—CHINA. Hainan: Wuzhi Shan County, Wuzhi Shan Nature Reserve, under forest, alt. 1200 m, 17 April 2014, Yang Hubiao 20140417008 (four paratypes, TCGRI).

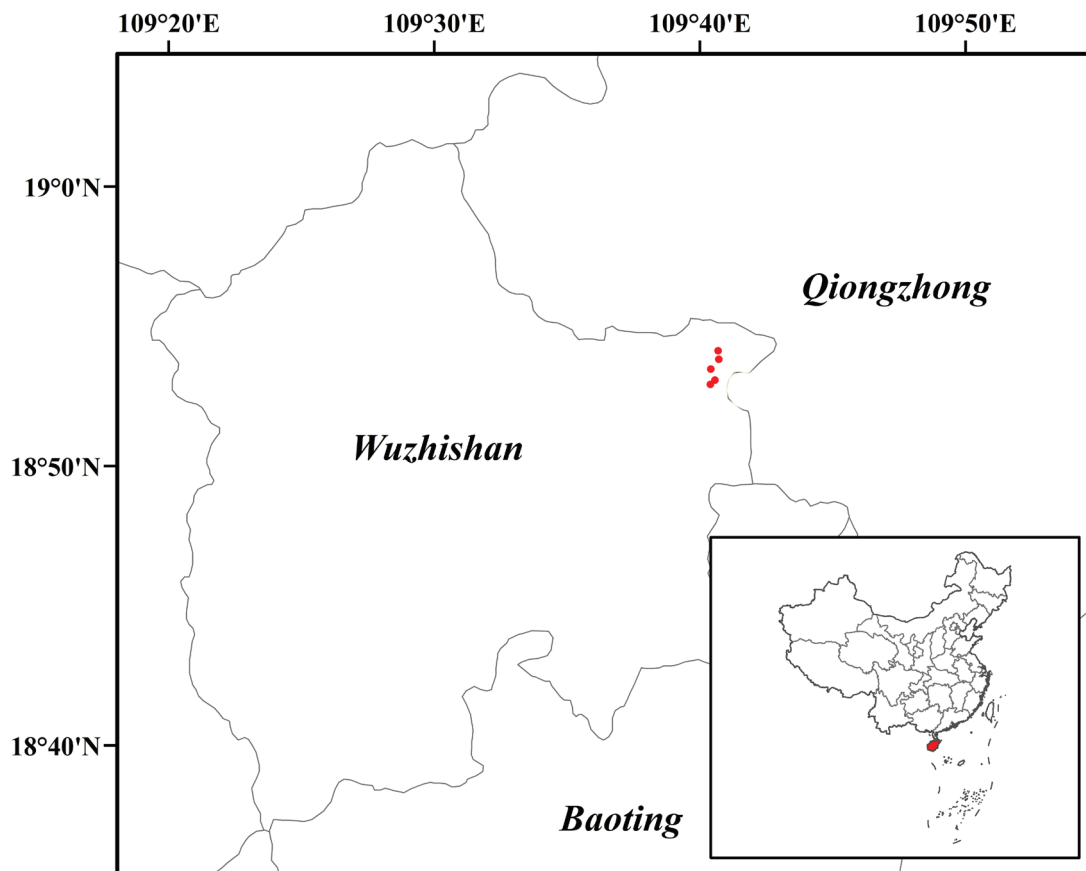


FIGURE 4. Distribution of *Carex concava* in Hainan, China.

Key for the *C. Sect. Rhomboidales* species occurring in Hainan.

Carex concava can be distinguishing from related species of section *Rhomboidales* in Hainan Island by the following key.

- 1. Lateral spikes androgynous (2)
- Lateral spikes pistillate (3)
- 2. Leaves 10–22 mm wide; perigynia 9–10 mm long, glabrous; nutlets, ca. 7 mm long apex abruptly contracted into a slender and erect beak, base curved-stipitate..... *C. harlandii*
- Leaves 8–10 mm wide; perigynia 7–8 mm long, sparsely pubescent; nutlets ca. 4 mm, apex abruptly contracted into a narrowly cylindrical curved beak, base not stipitate..... *C. saxicola*
- 3. Lateral spikes with long peduncles more than 5–8 cm; the adaxial side below the constriction deeply concave *C. concava*
- Lateral spikes sessile or with short peduncles not more than 3 cm; the adaxial side below the constriction flattish (4)
- 4. Leaves 10–15 mm wide; culms erect; perigynia ovate-lanceolate, 7–8 mm long, sparsely pubescent; nutlets ca. 5.5 mm long, base not stipitate, apex with a long erect beak *C. longipetiolata*
- Leaves ca. 5 mm wide; culms prostrate on the ground; perigynia fusiform, 7–10 mm long, glabrous; nutlets ca. 7 mm long, base shortly stipitate, apex with a short curved beak *C. procumbens*

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