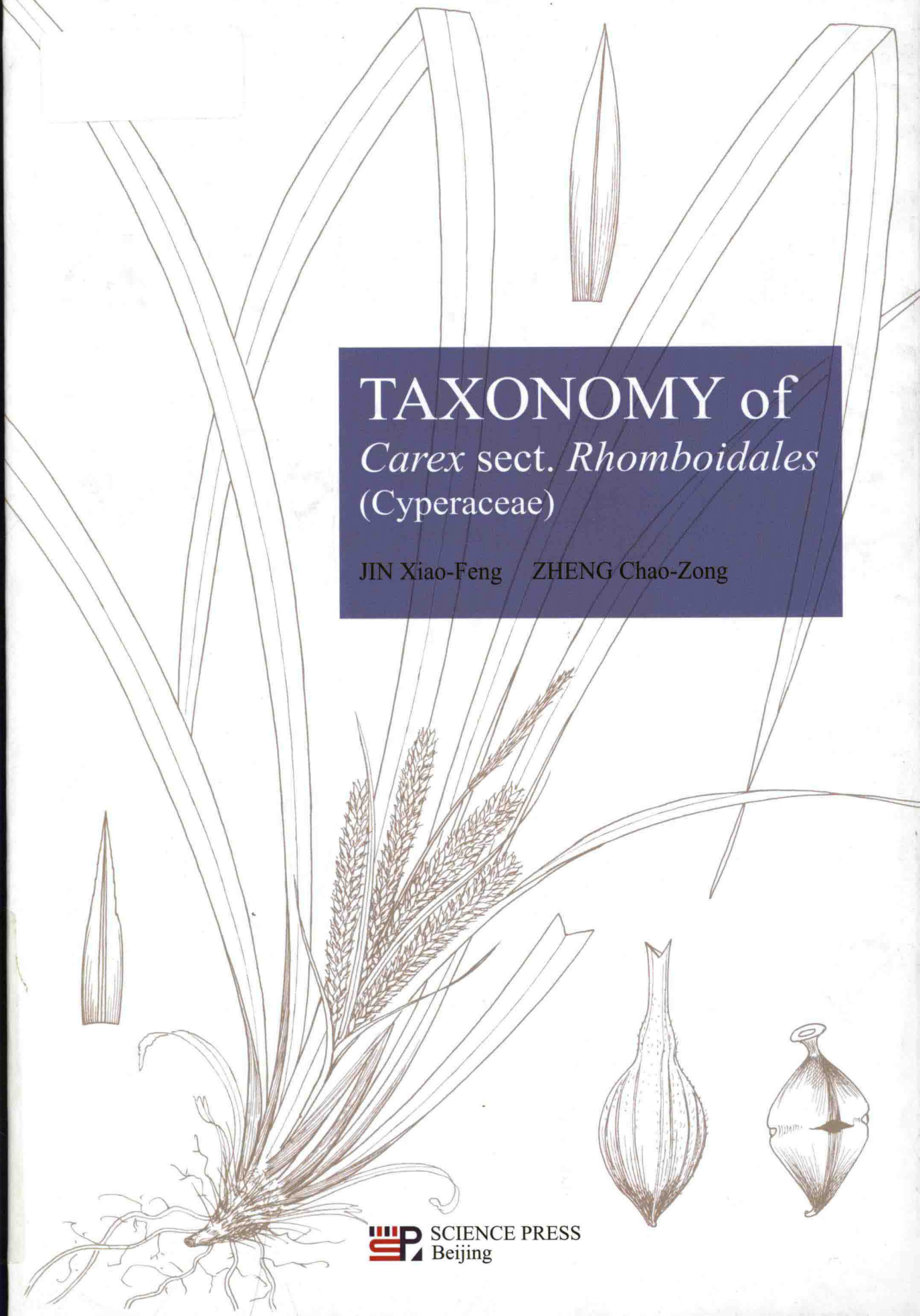
TAXONOMY of *Carex* sect. *Rhomboidales* (Cyperaceae)

JIN Xiao-Feng ZHENG Chao-Zong



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Synopsis

Based on literature survey, specimen examination and field work, together with the observations of achene micromorphology, perigynium micromorphology and leaf anatomy, this monograph presents the delimitation and revision of *Carex* sect. *Rhomboidales* (Cyperaceae).

Forty species with six subspecies and four varieties are recognized in this monograph, including a new species *Carex pengii* X. F. Jin & C. Z. Zheng. Four subspecies and one variety are combined: *Carex harlandii* subsp. *khoi* (T. V. Egorova & Aver.) X. F. Jin, *C. canina* subsp. *collifera* (Ohwi) X. F. Jin, *C. wahuensis* subsp. *sakonis* (T. Koyama) X. F. Jin, *C. longirostrata* subsp. *tsinlingensis* (K. T. Fu) X. F. Jin, and *C. rhynchophora* var. *chorda* (H. Lév. & Vaniot) X. F. Jin. Lectotypes are designated for *C. basiflora* C. B. Clarke, *C. brevicuspis* C. B. Clarke, *C. boottiana* Hook. & Arn., *C. hancei* C. B. Clarke, *C. harlandii* Boott, *C. simulans* C. B. Clarke, *C. wilfordii* C. B. Clarke and *C. wahuensis* C. A. Mey. subsp. *robusta* (Franch. & Sav.) T. Koyama. Twenty-eight names of taxa are reduced as synonyms. All recognized species, subspecies and varieties are described with illustrations and specimen cited.

Foreword

Carex L. , with more than 2000 species, is the largest genus in the family Cyperaceae. It is cosmopolitan and easily distinguished from the other genera of Cyperaceae. Sedges provide numerous economic and esthetic benefits. Some species, like *C. lingii*, *C. scaposa*, *C. siderosticta* and *C. muskingumensis*, are used as ornamentals. Rhizomes and achenes of some species, e. g. *C. baccans* and *C. phacota*, have medicinal usage. Some sedges, such as *C. dickinsii*, *C. olivacea* and *C. thunbergii*, are dominant species in freshwater wetlands, while others, e. g. *C. kobomugi*, *C. pumila*, *C. scabrifolia* and *C. arenaria*, grow readily in sand and play an important role in water and soil conservation.

Carex sect. *Rhomboidales*, which belongs to the core *Carex* clade, is mainly distributed in East Asia, although a few species extend to southern Asia and the Far East of Russia. Taxonomic revisions of the section have been made by several authors, but sectional delimitation is still problematic, and thus a further taxonomic revision of the section is needed.

This monograph, *Taxonomy of Carex sect. Rhomboidales* (*Cyperaceae*), comprises six parts: (i) a brief taxonomic history of sect. *Rhomboidales*; (ii) achene morphology and micromorphology; (iii) perigynium morphology and micromorphology; (iv) leaf anatomy; (v) morphological characters and their variations; and (vi) taxonomic treatment of all species in the section.

The reader may notice that the taxonomic revision of *Carex* sect. *Rhomboidales* by the present authors is different from previous ones in the following aspects: (i) the extent of field works and population sampling; (ii) examination of almost all the type specimens in sect. *Rhomboidales*; and (iii) critical examination of all available herbarium specimens. Achenes and perigynia have been demonstrated to be the most important characters for delimitation of species and sections. Based on morphological observations and analysis of achene micromorphology, perigynium micromorphology and leaf anatomy, the section has been recircumscribed and emended. In this monograph, 40 species with six subspecies and four varieties of sect. *Rhomboidales* worldwide are recognized, including one species new to science. In addition, new combinations of four subspecies and one variety are made, and 28 names are reduced to synonyms.

This monograph provides detailed morphological characterization of *Carex* sect.

Rhomboidales, as well as rational circumscription of all species. It is certainly valuable for the taxonomy of the whole genus. The monograph also raises three new taxonomic questions, previously not noticed: (i) whether the emended sect. *Rhomboidales* is mono phyletic or paraphyletic; (ii) whether the section *Rhomboidales* can be divided into infra-sectional groups; and (iii) the origin, dispersal and distribution pattern of sect. *Rhomboidales*.

China is incredibly rich in flora. However, due to the short history of taxonomy in China and other reasons, plant taxonomy and botanical inventory still have a long way to go. Therefore, monographic works like this should be particularly encouraged.

Hong Deyuan

Chairman of Botanical Society of China
Academician of Chinese Academy of Sciences
15 April 2013

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JIN Xiao-Feng and ZHENG Chao-Zong

18 April 2013

Contents

1

Brief Taxonomic History of *Carex* Sect. *Rhomboidales*

This chapter gives a brief taxonomic history of *Carex* sect. *Rhomboidales*.

1.1 Introduction

Cyperaceae, a monocot family in the order Poales, contains 106 genera and ca. 5400 species worldwide, with closest relatives, Juncaceae and Thurniaceae (Dai & al., 2010). With more than 2000 species (Reznicek, 1990), *Carex* L. is the largest genus in the family Cyperaceae. The genus has traditionally been divided into four subgenera: subg. *Vigneastra* (Tuck.) Kük., subg. *Vignea* (B. Beauv. ex Lestib.) Peterm., subg. *Psyllophora* (Degl.) Peterm., and subg. *Carex* (Govaerts & al., 2007; Dai & al., 2010). More recently, these subgenera are known to be largely polyphyletic or paraphyletic, with the notable exception of subg. *Vignea* (Waterway & Starr, 2007). The genus *Carex* itself, however, is cosmopolitan and easily distinguished from the other genera of Cyperaceae based on the combination of unisexual flowers and achenes enveloped in perigynia (Nelmes, 1951).

Carex sect. *Rhomboidales* Kük. was established by Kükenthal in his famous worldwide monograph of *Carex*, but he didn't designate the type (Kükenthal, 1909). Section *Rhomboidales* was validly published by designating *C. thibetica* Franch. as the type (Wang, 1962). The achenes of species in sect. *Rhomboidales* as traditionally circumscribed are obovoid, ovoid or rhombic-ovoid, trigonous, and frequently constricted in the middle of angles, with apices mitrate or hastate (Kükenthal 1909; Dai & al., 2000; Dai & al., 2010). Section *Rhomboidales sensu* Kükenthal is mainly distributed in eastern and southeastern Asia, with a few species extending to Europe (Kükenthal, 1909).

Hereafter in this chapter and the following ones, " *Rhomboidales* s. l. " refers to sections *Rhomboidales* and *Careyanae* as circumscribed in the *Flora of China*. While "*Rhomboidales* s. s. " refers to sect. *Rhomboidales* as circumscribed in the *Flora of China* treatment (Dai & al., 2010).

1.2 Brief taxonomic history of *Carex* sect. *Rhomboidales* before Kükenthal (1909)

Although *Carex chinensis* is treated as a member of sect. *Mitratae* Kük. in this monograph, it was the first species of sect. *Rhomboidales* s. l., and described from eastern China by Retzius (1783).

Meyer (1831) described many species of *Carex*, including *C. longirostrata* and *C. wahuensis*, in the monograph *Cyperaceae Novae* (*Descriptionibus et Inconibus Illustratae*). Although no specimens were designated as type of *C. longirostrata* and *C. wahuensis*, these two species were validly published with illustrations.

Boott (1846) described some new species of *Carex*, including *C. bongardii* and *C. jackiana*. *Carex jackiana* was placed in sect. *Careyanae* Tucker (Dai & al., 2010). In Boott's *Illustraions of the genus Carex* (Part II) (Boott, 1860), *C. harlandii* and *C. tenebrosa* were published as new species, and two collections (*C. Wilford 313* and *C. Wilford 513*) were designated as type of *C. harlandii*. In Bentham's *Flora Hongkongensis* (Bentham, 1861), *C. manca* Boott was described, with the type collected from Hongkong.

Böeckeler (1884) described 57 new species of Cyperaceae, including *Carex wichurae* and *C. chlorocystis* in sect. *Rhomboidales*. *Carex wichurae* was spelled as '*Carex wichurai*' in the protologue.

In the monograph *Enumeratio Plantarum in Japan Sponte Crescentium* (vol. 2), Franchet and Savatier (1878) published *Carex bongardii* var. *robusta* and *C. filipes* as new taxa. *C. boottiana* was reduced to the synonymy of *C. bongardii* var. *robusta*. Later, Franchet (1895) described many new speices of *Carex* from eastern Asia, including *C. longkiensis*, *C. dichroa*, *C. matsumurae*, *C. rhynchophora*, *C. rouyana*, *C. grandisquama* and *C. fauriei* (replaced by *C. insaniae*) of sect. *Rhomboidales* s. l. *Carex thibetica* was published as a new species in *Plantae Davidianae* (vol. 2) by Franchet (1888). Franchet (1898) published a taxonomic revision of *Carex* from eastern Asia, and described *C. manciformis*, *C. oxyphylla*, *C. sparsinux* and *C. laticeps* of sect. *Rhomboidales* s. l. as new species.

In the *Flora Manchuriae*, Komarov (1901) described *Carex xiphium* as a new species.

Clarke's (1903) work should be mentioned. He carried out a detailed identification and recognized 150 species of *Carex* from China, Korea and Luchu Archipelago. He described many new species in this monograph, including *C. simulans*, *C. hancei*, *C. brevicuspis* and *C. basiflora* of sect. *Rhomboidales*.

Léveillé (1903, 1905) described *Carex heudesii* and *C. cavaleriei* as new species respectively, and the latter was reduced to a synonym of *C. laticeps*. After identifing of

the specimens collected by P. Cavalerie and J. Esquirol from Guizhou, Léveillé (1906) described seven new species of *Carex*, including *C. blinii*, *C. chorda* and *C. hangtongensis* of sect. *Rhomboidales* s. l. Later, he described six new species of *Carex* from Korea, with *C. macrandrolepsis* belonging to sect. *Rhomboidales* s. l.

Kükenthal (in Diels, 1905) prepared the Cariceae of Flora of Tsinlingshan (Mt. Qinling), *Carex thibetica* var. *minor* and *C. giraldiana* were described as new.

Dunn and Tutcher (1905) described a new species, *Carex phoenicis* which collected from north-eastern Guangdong. Dunn carried out a botanical expedition in Fujian of China, and described six new species of *Carex* (Dunn, 1908). Among them, *C. radiciflora* and *C. rivulorum* belonged to sect. *Rhomboidales*.

1.3 Brief taxonomic history of *Carex* sect. *Rhomboidales* since Kükenthal (1909)

In the worldwide monograph of *Carex*, Kükenthal (1909) established sect. *Rhomboidales*, and 31 species were recognized. *Carex chinensis* var. *longkiensis* (Franch.) Kük., *C. manca* var. *wichurae* (Böeckeler) Kük., *C. brevicuspis* var. *basiflora* (C. B. Clarke) Kük., *C. wahuensis* var. *boottiana* (Hook. & Arn.) Kük., *C. filipes* var. *sparsinux* (C. B. Clarke) Kük., and *C. filipes* var. *rouyana* (Franch.) Kük. were proposed and combined as variety rank. Later, Kükenthal (1929) described five new species from Jiangsu and Zhejiang provinces of China, and *C. hastata* of sect. *Rhomboidales* was included.

Camus (1909) described two new species of *Carex*, and *C. techenkeouensis* from Sichuan was belonged to sect. *Rhomboidales* and was later reduced to synonym of *C. thibetica*.

Dunn (1910) described some new species as the supplement of *Flora of Hongkong*, including *Carex canina* of sect. *Rhomboidales*.

Hayata studied the *Carex* in Taiwan, as well as carried out a taxonomic study on the seed plants in Taiwan. He described *C. reflexistyla*, *C. tatsutakensis*, *C. taihokuensis* and *C. hoozanensis* of sect. *Rhomboidales* s. l. as new species (Hayata, 1911, 1916, 1921).

Koidzumi (1918) described a common island species of *Carex* : *C. boninensis*. In the *Florae Symbolae Orietali-Asiaticae*, Koidzumi (1930) proposed the name *C. insaniae* to replace *C. fauriei*.

Nakai (1922) described a new species of *Carex*, *C. tenuistachya*. Kitagawa (1934) published a new variety of *C. tenuistachya*, and named var. *pallida*.

Honda (1929, 1930) described many new species and varieties from Japan, and *Carex sekimotoi* of sect. *Careyanae* and *C. nankaiensis* of sect. *Rhomboidales* were published.

My deep impression of Ohwi's work is not only the description of many new taxa of *Carex*, but also his taxonomic system. Ohwi (1930) described *C. mayebarana*, *C. papillaticulmis* and *C. subdita* as new species, which were placed in sect. *Rhomboidales*. *Carex mayebarana* was later placed in sect. *Mitratae* (Ohwi, 1936; Akiyama, 1955; Katsuyama, 2005). Later, Ohwi (1931, 1933) described *C. fuscofibrosa* and *C. collifera* respectively. Ohwi's famous taxonomic study was a monograph of *Carex* from Japan and adajecent area (Ohwi, 1936). He divided the genus *Carex* into two subgenera: subg. *Vignea* and subg. *Eucarex* (ille. nom.), and also proposed some new sections, e. g. sect. *Molliculae*, sect. *Rhizopodae* and sect. *Dispermae* etc. In this monograph, Ohwi recognized sect. *Rhomboidales* s. l. into sect. *Rhomboidales* and sect. *Paniceae*, and *C. papillaticulmis* and *C. subdita* were recognized as the varieties of *C. insaniae*. Ohwi (1969) described a new species of sect. *Rhomboidales* (*C. rhombifructus*) from Nepal, which is placed in sect. *Hymenochlaenae* Drejer by the present authors.

Nelmes (1939) described four new species of *Carex*, including *C. diplodon* from Gansu of China.

Akiyama's taxonomic work on *Carex* from far eastern region of Asia should be mentioned (Akiyama, 1955). He totally recognized 60 sections in this region and sect. *Rhomboidales* s. l. was divided into two sections: sect. *Rhomboidales* and sect. *Macroglossae* Akiyama. In the protologue, a new species *C. takasagoana* was described. He also described *C. kiyozumiensis* of sect. *Rhomboidales* (Akiyama, 1931), which was reduced to a synonym of *C. insaniae* var. *subdita* (Ohwi, 1936).

Koyama (1957) described *Carex sakonis* as a new species, which was similar to *C. boottiana*. Later, he recognized sect. *Rhomboidales* s. l. as a subsection of sect. *Praecoces* Christ (Koyama, 1962). In the *Flora of Taiwan*, Koyama (1978) proposed and combined two new names of *Carex*, namely. *C. wahuensis* subsp. *rubosta* (Franch. & Sav.) T. Koyama and *C. manca* subsp. *takasagoana* (Akiyama) T. Koyama.

When preparing the regional flora of China, some new species of *Carex* sect. *Rhomboidales* were published, including *C. taipaishanica* and *C. longirostrata* var. *tsinlingensis* (Fu in *Flora Tsinlingensis*, 1976), *C. pseudolongirostrata* (Chang and Yang in *Flora Plantarum Herbacearum Chinae Boreali-Orientalis*, 1976), *C. saxicola* (Tang & Wang in *Flora Hainanica*, 1977), *C. lianchengensis* and *C. hexiensis* (Huang & Ling in *Flora Fujianica*, 1995). *Carex pseudolongirostrata* was a superfluous name of *C. nodaeana* (Baranov & Skvortsov, 1965).

During preparing *Flora of Anhui*, Su (1985) described a new variety of *Carex harlandii*, as *C. harlandii* var. *xiuningensis*. Su (1990) described *C. jiuhuaensis* as a new species. Later, he described other three new species and a new variety, namely *C. guniuensis*, *C. koresiformis*, *C. langyaensis* and *C. rhynchophora* var. *margineorostris* (Su,

2009a, 2009b). Liu (1986) described new taxa from Anhui, and *C. harlandii* var. *liuguensis* was published, which was a superfluous name of *C. harlandii* var. *xiuningensis* (Su, 1986).

Wang & al. (1986) described four new species of *Carex*, including *C. zunyiensis*, *C. shangchengensis* and *C. calcicola* of sect. *Rhomboidales*.

Li and Fan (1993) described a new species of *Carex*, namely *C. qingdaoensis*, from Shandong of China.

Liang's taxonomic work on sect. *Rhomboidales* should be mentioned here (Liang, 1994, 1995, 1998, 2000). Liang (1994) described *Carex longqishanensis* as a new species from Mt. Longqi, Fujian of China. Later, Liang (1995) described five new species of sect. *Rhomboidales* s. l., and the species *Carex wushanensis* was later placed in sect. *Careyanae* (Liang, 1995; Dai & al., 2010). Liang (1998) described six new species and a new variety from China. In this protologue, *C. wichurae* and *C. jiuhuaensis* were recognized as the subspecies of *C. manca*. In FRPS (*Flora Republicae Popularis Sinica*), Liang described a variety of *C. thibetica*, namely *C. thibetica* var. *pauciflora* (Dai & al., 2000).

Egorova and Averyanov described a new species of *Carex khoii* from northern Vietnam (Khôi, 2002).

Oda & al. (2003) described *Carex jubozanensis* as a new species, which was regarded similar to *C. longirostrata*. Shimizu (2008) described a new species, *C. kagoshimensis*, which was similar to *C. laticeps*.

Jin & al. described six species of sect. *Rhomboidales* s. l., and five species were from Zhejiang and one species from Guangxi respectively (Jin & al., 2004, 2005, 2011, 2012; Jin & Zheng, 2010).

Recently, Wang & al. (2012) described *Carex longipetiolata*, which was collected from Hainan of China. *Carex paracheniana* was described as a new species from Guangxi and Guizhou provinces of China (Jin & al., 2012).

1.4 Commentary on the taxonomic systems of *Carex* sect. *Rhomboidales*

Ohwi's (1936) and Akiyama's (1955) circumscription of sect. *Rhomboidales* mostly follows Kükenthal, but they ascribed species with non-beaked achenes to sect. *Paniceae* Tuckerm. and sect. *Macroglossae* respectively. Hoshino and Masaki (2011) followed Ohwi's treatment, while Egorova (1999) used sect. *Depauperatae* Meinsh., in which she placed *C. xiphium*, *C. longirostrata*, *C. depauperata* etc. in, and sect. *Rhomboidales* was distinguished from sect. *Depauperatae* in having ring-shaped and thicken style, perigynia many-veined, with bidentate beaks. Katsuyama (2005) also included *C. filipes*, *C. papulosa* and *C. macroglossa* etc. of sect. *Rhomboidales sensu* Kükenthal in sect. *Depauperatae*, which also included the species of sect. *Careyanae*