Session I: Systematics and Phylogeny

Poster presentation

The *Triticeae* in China

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Abstract: By posting draft treatments to the Web prior to publication, the editors of the Flora of China make it possible for English speakers to examine the taxonomic diversity and distribution of genera within the country. The treatment of the *Triticeae* shows China as having 18.9 species of *Triticeae* per 1000 km^2; comparable figures for the former Soviet Union and the United States are 6.4 and 4, respectively. All the genera have their greatest concentration in western China, most in Xinjiang province. Maps for each genus are provided, based on information in the draft treatment. It must be emphasized that the posted treatment is a *draft* treatment. As might be expected, we found a few substantive errors of the kind that are normally caught once a manuscript undergoes the final, intensive editing. Our inclusion of comments on such points in this paper demonstrates the value of making early editions of a treatment available for scrutiny by others.

Keywords: *Triticeae*; China; phytogeography; taxonomy

For the past few years, Chinese taxonomists, in conjunction with colleagues from other countries, have been working on an English-language, illustrated Flora of China (FoC). The volumes have, as their starting point, the 80 volumes of the Chinese language *Flora Reipublicae Popularis Sinicae* (FRPS). The English-language flora is a condensed and revised version of the FRPS, one that reflects the taxonomic and floristic research conducted since publication of its predecessor. The illustrations are presented in separate volumes that are published after the corresponding text volume. The resulting volumes will provide, for many taxonomists, their first opportunity to appreciate the tremendous diversity of China's flora. They are being published jointly by the Missouri Botanical Garden Press and the Chinese Academy of Science. So far, 11 text and 10 illustration volumes have been published. The complete *Flora* will comprise 25 text volumes and an equal number of illustration volumes.

At the start of the project, organizers of the FoC project decided to make its resources available on the Web (see http://flora.huh.harvard.edu/china/). These resources include distribution maps for individual species. The maps are, however, rather limited as they are based only on specimens in the Missouri Botanical Garden herbarium or from

information about type specimens. Treatments are posted as soon as they have received preliminary editing, often two or more years before publication of the corresponding print volume.

This paper is based on the treatment of the *Triticeae* that was posted early in 2005. It would not be possible without the efforts of the taxonomists who developed the treatments. We thank them and the editors, Dr. S.-L. Chen, Institute of Botany, Jiangsu Province and Chinese Academy of Sciences, Najing, China, and Dr. Guanghua Zhu, Missouri Botanical Garden, St. Louis, Missouri, U.S.A. The purpose of this paper is to provide an overview of the diversity of the *Triticeae* in China, compare it to that in three other large regions for which floras are, or will shortly be available (the former Soviet Union, Tsvelev 1976; Europe, Tutin *et al.* 1980; North America, Barkworth *et al.* in prep.), and discuss some of the taxonomic differences in generic treatment among them.

MATERIALS AND METHODS

Our starting point for this paper was the draft treatment of the *Triticeae* for the Flora of China, edited by Chen and Zhu (2005) and posted to the Web in March 2005. We recorded the distribution of individual species, as reported in the treatment, at the level of provinces. There were 13 species, all rather widespread, for which the provincial distributions were not provided. Consequently, they are not included in the following summaries and discussion.

Topographic, temperature, precipitation, and provincial boundary data came from the China Data Center website (University of Michigan 2005). ArcView (ESRI 1998) was used to prepare the maps. All data were converted to a WGS 1984 Albers projection for preparation of the maps.

We summarized the distributional information by genus, following the taxonomic treatment in FoC, both in the treatment of the Chinese *Triticeae* and, to some extent, in summarizing the *Triticeae* of other areas. For instance, FoC recognizes the genus *Hystrix*; the *Flora of North America* does not but the summary tables presented here recognizes the two North America species that Hitchcock (1951) included in *Hystrix* as members of the genus. Such differences in interpretation are discussed in the section on taxonomy. We confined our discussion to the distribution of the perennial, or mostly perennial, genera because most of the annual species are weedy.

RESULTS

China is the fourth largest country in the world, with 9.3 million km^2, approximately the same land area as the United States (9.2 million km^2). Within this area, it has both the lowest land in the world, Turpan Pendi at –154 m, and the highest point, Mt. Everest at 8850 m. The most extreme topographic variation is in western China, as are the most extreme temperatures (Figures 1a–c).

The Flora of China recognizes 13 genera and 175 species of *Triticeae* within China. This translates into a species density of 18.9 species/1000 km^2. This compares with 4 species/1000 km^2 for the United States and 6.4 species/1000 km^2 for the former Soviet Union. Within all three regions, the tribe's density is unevenly concentrated, but this is particularly marked in China where the tribe is essentially restricted to the northern and western parts of the country (Figures 2–9).

Genera with monohaplomic species

There are three perennial genera in China that are frequently treated as being monohaplomic

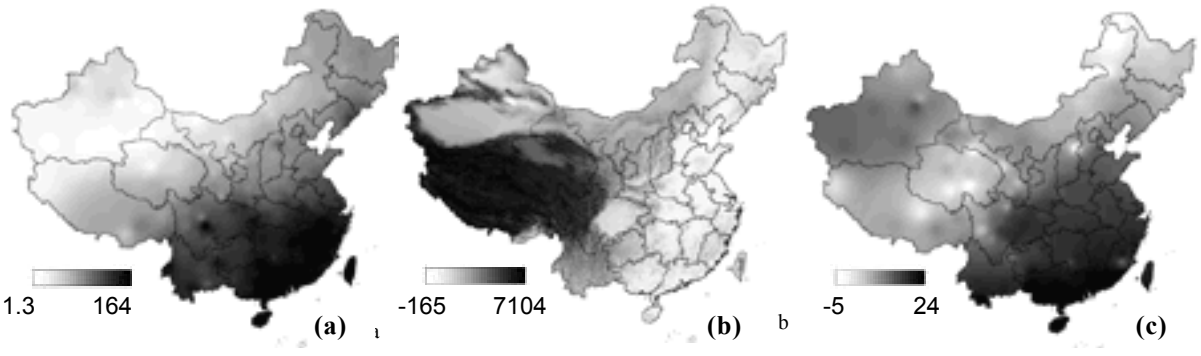

Figure 1. Variation in (a) precipitation in cm, (b) elevation in m, and (c) annual temperature across China

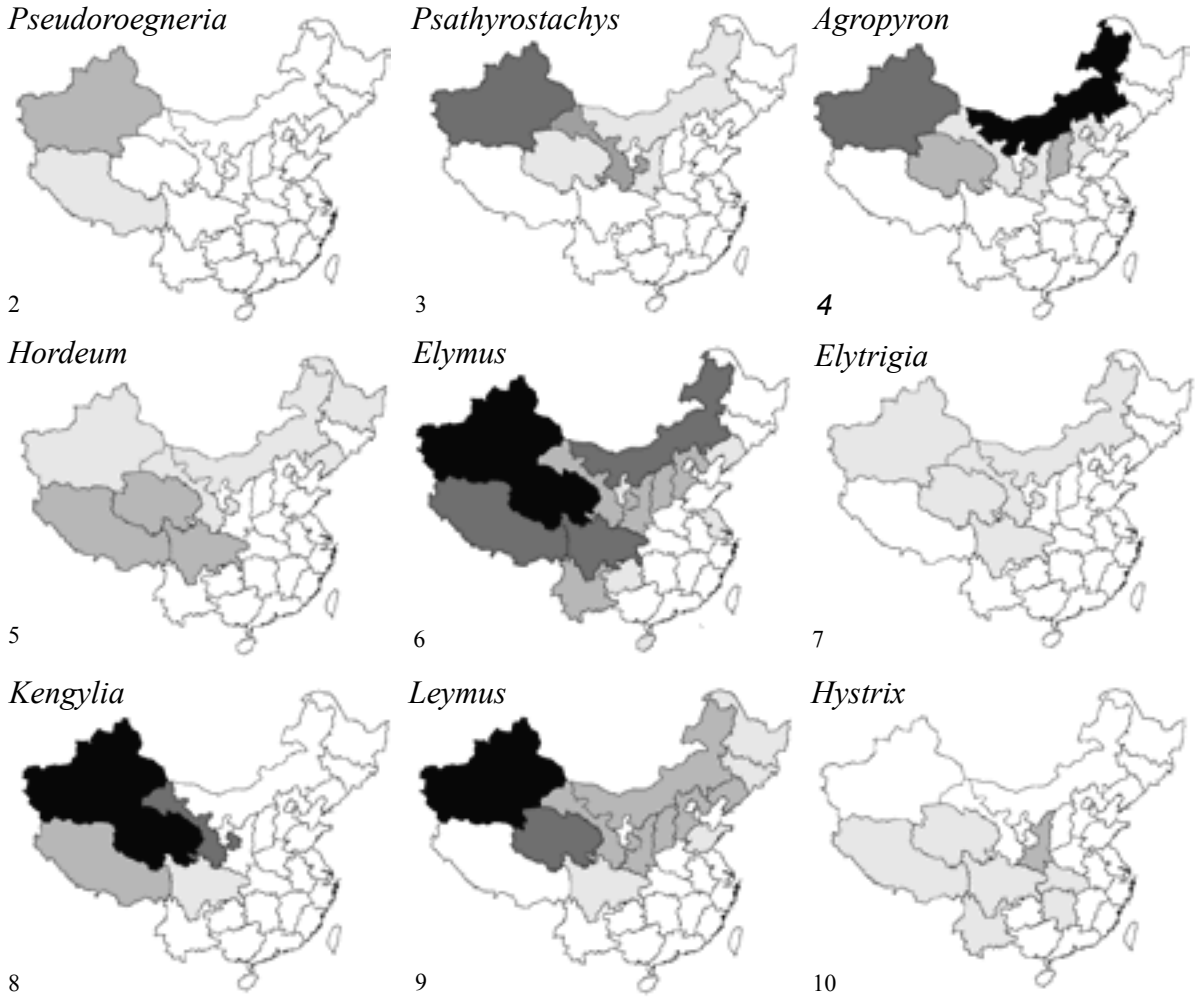

Figure 2–10. Distribution of species of *Triticeae* in China. In all figures, darker shading indicates more species. Figures in parentheses are total number of species, number of species represented by each different shade on the map, from lowest to highest. For clarity, the number of different shades was restricted to 4.

2. *Pseudoroegneria* (4, see comments in text; 1, 3). 3. *Psathyrostachys* (5; 1, 2, 3). 4. *Agropyron* (5; 1, 2, 3–4, 5). 5. Native and established *Hordeum* (4; 1, 3). 6. *Elymus* (87; see comments in text under *Pseudoroegneria*; 1, 2–10, 11–17, 18–28). 7. *Elytrigia* (1; 1). 8. *Kengyilia* (35; 1, 2-5, 6–8, 9–11). 9. *Leymus* (25; 1, 2–4, 5–8, 9–11). 10. *Hystrix* (2; 1, 2).

(e.g., Dewey 1984; Löve 1984; Yen *et al*. 2005), that is, being based on a single haplome: *Pseudoroegneria*, *Psathyrostachys,* and *Agropyron.* The authors of the treatment do not state that they are using haplomic constitution as a guide to generic delimitation as was recommended in the three papers cited. Nevertheless, the key indicates that they regard each of these three genera as monohaplomic, *Pseudoroegneria* being characterized by the **St** haplome, *Psathyrostachys* by the **Ns** haplome, and *Agropyron* by the **P** haplome (haplome designations from http://www.herbarium.usu.edu/triticeae/genmsymb.htm). According to this interpretation, all three genera contain diploid and tetraploid, but not hexaploid, species.

The only species of *Pseudoroegneria* recognized in the draft treatment, *P. cognata*, is restricted to Xinjiang Province in China, extending from there through Central Asia to Afghanistan. Two other species that the draft treatment places in *Elytrigia*, *Elytrigia aegilipoides* (Drobow) N.R. Cui and *E. ferganensis* (Drobow) Nevski, both of which are often included in *Pseudoroegneria*, are also confined, so far as China is concerned, to Xinjiang Province. One other species, endemic to Xizang province (Tibet) and treated as *Elymus elytrigioides* in the draft, should, based on the citation and its haplomic constitution (Lu 1996; Ding *et al*. 2004), also be included in *Pseudoroegneria*, as should the two species of *Elytrigia.* The map (Figure 4) reflects such

a revision. Alternatively, the haplome designations in the key to genera should be revised.

Psathyrostachys is more widely distributed in China than *Pseudoroegneria*, even with the expanded interpretation suggested, extending across six non-coastal northern provinces. Nevertheless, only one province, Xinjiang, is home to three species (Figure 5), the same province that has the most species of *Pseudoroegneria*.

Agropyron has a distribution in China that is generally similar to that of *Psathyrostachys*, except that its greatest concentration is in Nei Mongol rather than Xinjiang. Its second highest species concentration is, however, Xinjiang.

Hordeum, unlike *Pseudoroegneria*, *Psathyrostachys*, and *Agropyron* includes hexaploids as well as diploids and tetraploids. It also differs in having four different haplomes (Bothmer *et al*. 1995), two of which are found among the species that grow in China. The **I** genome is confined, so far as the Chinese flora is concerned, to cultivated taxa and their derivatives that are not included in the maps. The remaining four species contain only the **H** haplome. These species differ in their distribution from that of the other monogenomic genera being most abundant in three more southern and western provinces than Xinjiang: Qinghai, Tibet (Xizang), and Sichuan (Figure 6). They also extend through the northern provinces that are also occupied by *Psathyrostachys*. The only species present in the two coastal provinces of Heilongjiang and Liaoning is *H. jubatum* L., which is probably introduced from North America. The diploid species, to the extent that these are identified, are confined to the more western provinces.

Polyhaplomic genera

As treated in the Flora of China, China is home to five polyhaplomic genera: *Elymus*, *Kengyilia*, *Leymus*, *Hystrix* and *Elytrigia* (excluding the two **St** species discussed under *Pseudoroegneria*). *Elymus* is interpreted as including both **StH** and **StY** genera, and 88 native species are recognized. This makes it the largest genus of *Triticeae* in China. Some Chinese taxonomists (e.g., Yen *et al.* 2005) treat the **StY** species as members of *Roegneria.* Because the haplomic constitution is not known for all the Chinese taxa, it has not been possible to distinguish between the distribution of *Elymus sensu stricto* (that is, just the **StH** species) and *Roegneria.*

Elymus sensu FoC has its greatest diversity in western China (Figure 7), with Xinjiang and Qinghai provinces having the most species. It extends beyond the range of the **St** (*Pseudoroegneria*) and **H** (*Hordeum*) species, but only one record, that of *E. hybridus* in Jiangsu province, is disjunct from the distribution of the two known progenitors. Because no **Y** diploids are known, it is impossible to compare the distribution of *Elymus sensu* FoC to that of **Y** diploids.

Elytrigia repens is a widespread, weedy species in some parts of the world that is sometimes included in *Elymus*. Its genomic constitution is generally given as **StStH**, but Mason-Gamer (2004) has shown that it is more complex than such a formula suggests.

Species of *Kengyilia* are hexaploids that combine all three haplomes found in *Elymus sensu* FoC: **ST**, **Y**, and **P.** The distribution of *Kengyilia* resembles that of *Elymus* except that it is absent from the northeast provinces (Figure 8), even those in which both haplome progenitors are present.

Leymus consists of polyploids, all of which, so far as they have been studied, appear to combine two forms of the **Ns** haplome that characterizes *Psathyrostachys.* The distribution of the genus in China (Figure 9) is also similar to that of *Psathyrostachys*, but extending somewhat further south and east of that genus. Once again, the genus is most abundant in Xinjiang.

The distribution of the two species of *Hystrix* (Figure 10) give the genus a rather different distribution from that of all the other perennial genera of the *Triticeae* in China. One species, *H. komarovii* (Roshev.) Ohwi is found throughout northeastern China and in Hebei and Shaanxi provinces; the other species, *Hystrix duthiei* (Stapf *ex* Hook. f.) Bor grows in the southern and western provinces of Hunan, Sichuan, Xizang and Yunnan plus Hubei and Shaanxi of central China. The haplomic constitution of the two species is not known. Of the two North American species sometimes included in *Hystrix*, one has a haplomic constitution of **StH**, the other appears to be an octoploid based on the **Ns** haplome.

CONCLUSIONS

Posting the draft treatment of the *Triticeae* for the Flora of China to the Web made possible development of an overview of the tribe and its distribution within China in advance of the treatment's

publication. It also risks dissemination of errors that would be caught in final editing. Whether the risk is worth the price must be decided by a project's leaders. Some funding agencies consider it almost essential. On the other hand, some authors might well object to public display of their work at this stage.

The generic treatment adopted in the Flora of China is somewhat different from that found in the Tsvelev's (1976) treatment of the tribe for the Soviet Union and that proposed by Barkworth *et al*. (in preparation) for the Flora of North America treatment. The primary difference lies in the treatment of perennial species that used to be included in *Agropyron* and acceptance of *Hystrix*. Some of the differences reflect lack of knowledge about most Chinese species among most non-Chinese students of the tribe. Publication of an English language Flora of China should help correct this. Other differences reflect the major differences in taxonomic philosophy among those working on the tribe that is a problem for all those working with the tribe, even within a country.

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