

Geographical Distribution and Morphological Diversity of Wild Strawberry Germplasm Resource in China

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Abstract

Based on a systematical investigation, 11 species of *Fragaria* spp. have been described as distributed in China. There are eight diploid species including *F. vesca* L., *F. nilgrrensis* Schlecht., *F. pentaphylla* Lozinsk., *F. gracilis* A. Los., *F. nubicola* Lindl., *F. viridis* Duch., *F. daltoniana* J. Gay. and *F. mandschurica* Staudt., three tetraploid species, including *F. orientalis* Losinsk., *F. moupinensis* (Franch.) Card. and *F. corymbosa* A. Los. The wild strawberry species are mainly distributed in northeastern, northwestern and southwestern China. Among the 11 species, *F. orientalis* Losinsk. is distributed widely from Jilin to Hunan. *F. nubicola* Lindl. and *F. daltoniana* J. Gay. were only found in Tibet. *F. viridis* Duch., is originated in Xinjiang region. A pentaploid strawberry genotype was found in Changbai Mountains in northeast China. Morphological analysis of 58 wild strawberry genotypes native to China was done in the field. Among the 33 morphological traits, the fruit shape, petal shape, hair on pedicel and stolon, and calyx state showed great differences. The C.V. of most of morphological traits was between 21% and 47%. But the C.V. of petal length, flower width, and length of hairs on petiole were below 20% and especially of fruit shape, reached 80.03%.

INTRODUCTION

About 20 species of strawberry are recognized in the world. All species are in wild state except the widely cultivated one, *F. ananassa*. In China, Changbai Mountains, Tianshan Mountains, Qinling Mountains, Big and Little Xing'an Mountain Range, Qinghai-Tibet Plateau, and the Yunnan-Guizhou Plateau are natural wild strawberry gene pools, in which many wild strawberry species, variation and types exist. Seven species native to the country are recognized by Yu (1979), which are *F. vesca* L., *F. orientalis* Losinsk., *F. nilgrrensis* Schlecht., *F. moupinensis* (Franch.) Card., *F. pentaphylla* Lozinsk., *F. gracilis* A. Los. and *F. nubicola* Lindl. Duan et al. (1983) reported that there are five species in Tibet including *F. pentaphylla* Lozinsk., *F. gracilis* A. Los. and *F. nubicola* Lindl., *F. moupinensis* (Franch.) Card., and *F. daltoniana* J. Gay. Cao et al. (1988) reported that wild strawberry were rich in Qinling-Ba Mountains, in which four species were found. *F. corymbosa* A. Los. was first found in this area. Yan et al. (2001) reported *F. viridis* Duch. located in mountain slope and grassland from Yili to Tacheng and Wulumuqi. Lei et al. (2001) described *F. viridis* Duch. found in Tianshan Mountains. A natural pentaploid strawberry genotype was found in northeastern China by Lei et al. (2005).

MATERIALS AND METHODS

58 genotypes collected from the country were maintained at the National Peach and Strawberry Germplasm Repository at Nanjing, Jiangsu. The runner plants from each genotype were obtained from field-grown mother plants. Ten plants of each genotype were set into two boxes with 44 cm × 31 cm × 21 cm (length × width × tall) in mixture media with peat, perlite and soil (1:1:1) in October 2006. Each genotype was arranged in completely randomized design in a single common open field. Plants were irrigated, fertilized, and protected from various pests and diseases as needed. 33 morphological traits (Table 2) such as plant posture, plant height, leaf color, petal shape, pedicel hair, runner color, fruit shape, and so on were evaluated by Zhao et al. (2006). All traits were

measured in spring or summer in 2007. 9 traits have their numerical value. 24 traits are assigned value (Table 1). The SPSS 13.0 program was used to conduct analysis of variance.

RESULTS

Wild strawberry species were rich in China due to its diverse ecological environment. Based on document data home and abroad, with the addition of some results of on-the-spot observation, 11 species of *Fragaria* spp. are distributed in China (Fig. 1): 8 diploid species including (1) *F. vesca* L.; (2) *F. nilgriensis* Schlecht.; (3) *F. pentaphylla* Lozinsk.; (4) *F. gracilis* A. Los.; (5) *F. nubicola* Lindl.; (6) *F. viridis* Duch.; (7) *F. daltoniana* J. Gay.; (8) *F. mandshurica* Staudt; 3 tetraploid species including (1) *F. orientalis* Losinsk.; (2) *F. moupinensis* (Franch.) Card.; (3) *F. corymbosa* A. Los. The wild strawberries are mainly distributed in northeastern, northwestern and southwestern China. Of all the species, *F. orientalis* Losinsk. distributed very widely. This species were found in forest margins or open field, and sparse bush with grass on overcast slope at elevation of 1000 metres, from Jilin to Heilongjiang, Inner Mongolia, Hebei, Shanxi, Shanxi, Qinhai, Gansu, Sichun, Shandong and Hunan. *F. vesca* L. spread across 13 provinces. The distribution area of *F. nubicola* Lindl., *F. daltoniana* J. Gay. and *F. viridis* was narrow: *F. nubicola* Lindl. and *F. daltoniana* J. Gay. were found in Tibet. *F. nubicola* Lindl. located in the ditch edge of the forest, forest margins and slope mountain at elevation of 2500-3900 metres. *F. viridis* Duch. was found in slope mountain or grassland along the river at elevation of 450-1900 metres in Xinjiang region. *F. nilgriensis* Schlecht and *F. moupinensis* (Franch.) Card. are distributed in southwestern China. *F. corymbosa* A. Los. is concentrated in Jilin, Shanxi, Shanxi, Gansu, and Hebei. A pentaploid strawberry genotype was found in Changbai Mountains in northeast China.

The results showed that different traits among different genotypes had much diversity. Among the 33 morphological traits, the fruit shape, petal shape, hairs on pedicel and stolon, and calyx state showed great difference, which the coefficient of variation reaching above 50% averagely, especially of fruit shape, reaching 80.03%. The C.V. of the plant height, position of inflorescence relative to foliage, petiole length and petiole hair was 46.46%, 44.00%, 42.41% and 41.01% respectively. The C.V. of most morphological traits was between 21% and 47%. The C.V. of petal length, flower width, and length of hairs on petiole were below 20% (Table 2).

DISCUSSION

According to published description and some results of our on-the-spot investigation, 11 strawberry species exist in China. While two species including *F. daltoniana* J. Gay. and *F. nubicola* Lindl are located in a narrow region at high elevation and difficult to be found, up to now there is no report that a live plant sample of these two species has been collected by Chinese researchers. The description of Chinese wild strawberry distribution should be studied further. Our result showed the diversity of different traits in Chinese wild strawberry. The fruit shape, petal shape, hairs on pedicel and stolon, calyx state showed great difference. These traits can be used as main traits to distinguish the species. In our study, some wild genotypes did not flower in the experiment site, for which the reason may be that the environment is much different from that in which the genotype once grew.

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Tables

Table 1. Morphological characters and their given value.

Morphological traits	Value
Plant posture	erect=1, intermediate=2, prostrate=3
Leaf shape	round=1, ellipse=2, long ellipse=3, rhombus=4, oval=5, upside-down oval=6
Leaf color	yellow green=1, green=2, dark green=3
Leaf face state	spoon=1, edging up=2, level=3, level with top down=4, edging down=5
Petiole color	green=1, light red=2, red=3
Petiole hair	outspreading=1, intermediate=2, appressed=3
Petiole hair length	short=1, intermediate=2, long=3
Petiole hair density	few=1, intermediate=2, dense=3
Position of inflorescence relative to foliage	beneath=1, slightly beneath=2, same level=3, slightly above=4, above=5
Petal shape	oblate=1, round=2, sector=3, oval=4, upside-down oval=5, ellipse=6
Position of stamen	low=1, intermediate=2, high=3
Pedicel hair	outspreading=1, outspreading up=2, outspreading down=3, appressed=4
Pedicel hair length	short=1, intermediate=2, long=3
Pedicel hair density	few=1, intermediate=2, dense=3
Stolon color	light red=1, pale red=2, red=3, dark red=4
Stolon hair	outspreading=1, intermediate=2, appressed=3
Stolon hair length	short=1, intermediate=2, long=3
Stolon hair density	few=1, intermediate=2, dense=3
Branching habit of stolon	neither plantlet nor stolon on the odd knot=1, no plantlet but stolon on the odd knot=2, plantlet on the odd knot except the first knot=3
Fruit shape	oblate=1, round=2, conic=3, short conic=4, long conic=5, wedge=6, spindle=7, cylindrical=8, oval=9, neck=10
Fruit color	white=1, orange=2, red=3, dark-red=4, purplish red=5
Achene position	sunken=1, slightly sunken=2, level=3, slightly raised=4, raised=5
Achene color	yellow=1, yellow-green=2, yellow and red=3, red=4
Calyx growing state	flat-close=1, flat-away=2, main calyx flat-away=3, auxiliary calyx rollback=4, rollback=5

Table 2. Mean, standard deviation, range, and variance for 33 traits of *Fragaria* spp. distributed in China.

Traits	Mean	Maximum	Minimum	SD	Range	C.V.(%)
Fruit shape	2.9	8	1	2.33	7	80.03
Petal shape	2.0	5	1	1.17	4	57.50
Pedicel hair	2.0	4	1	1.12	3	56.95
Calyx state	1.9	4	1	0.94	3	50.49
Stolon hair	1.3	3	1	0.66	2	50.10
Plant height (cm)	11.8	23.0	3.0	5.48	20.0	46.46
Position of inflorescence relative to foliage	3.5	5	1	1.54	4	44.00
Petiole length (cm)	7.49	13.81	3.05	3.17	10.76	42.41
Petiole hair	1.3	3	1	0.55	2	41.01
Petiole color	1.8	3	1	0.70	2	39.54
Leaf shape	2.5	5	1	0.98	4	38.92
Stolon color	2.9	4	1	1.10	3	37.79
Stolon hair density	1.9	3	1	0.72	2	36.93
Leaf color	2.0	3	1	0.70	2	35.65
Fruit color	2.8	4	1	0.97	3	35.08
Stolon thickness (mm)	1.1	2.31	0.41	0.39	1.90	33.86
Achene position	4.0	5	1	1.36	4	33.58
Petiole hair density	2.3	3	1	0.70	2	30.92
Plant posture	2.2	3	1	0.68	2.0	30.27
Stolon hair length	2.1	3	1	0.62	2	29.75
Position of stamen	2.4	3	1	0.71	2	29.22
Pedicel hair density	1.9	3	1	0.52	2	26.94
Branching habit of stolon	2.3	3	1	0.62	2	26.76
Stolon knot length (cm)	17.3	28.99	8.07	4.61	20.92	26.57
Pedicel hair length	2.2	3	1	0.56	2	25.50
Achene color	2.9	4	1	0.71	3	23.92
Leaf length (cm)	4.87	7.18	2.04	1.14	5.14	23.46
Leaf width (cm)	3.70	5.36	1.66	0.84	3.70	22.56
Petal width (cm)	0.93	1.27	0.59	0.20	0.68	21.32
Leaf face state	3.0	4	2	0.57	2	19.25
Petal length (cm)	0.97	1.31	0.61	0.18	0.70	18.80
Flower size (cm)	2.12	2.93	1.33	0.37	1.60	17.69
Petiole hair length	2.8	3	1	0.38	2	13.34

Figures

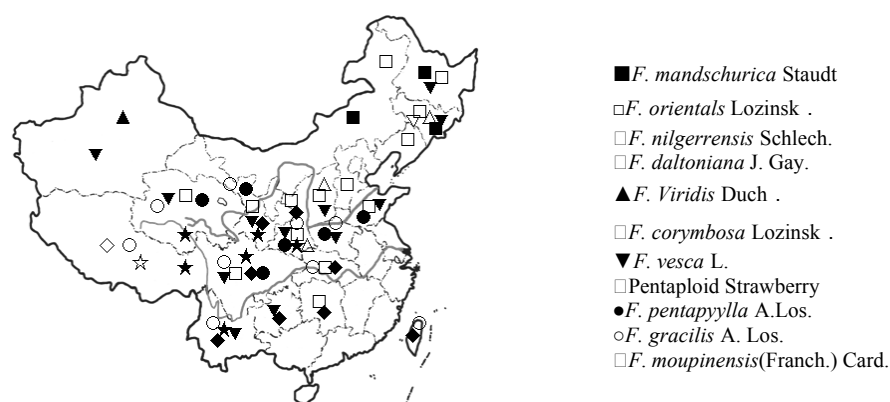


Fig. 1. Distribution of *Fragaria* species in China.