Chromosome numbers of Japanese Scutellaria （Lamiaceae）

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Takashi Sawanomukai[1,2], Yoshikane Iwatsubo[1] and Naohiro Naruhashi[1] : **Chromosome numbers of Japanese *Scutellaria* (Lamiaceae)**

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Abstract

Chromosome counts of 16 species and two varieties of *Scutellaria* (Lamiaceae) collected from 45 localities in Japan were reported. First counts were the following 11 taxa : *S. amabilis* (2n=26), *S. brachyspica* (2n=26), *S. indica* var. *parvifolia* (2n=26), *S. iyoensis* (2n=26), *S. kiusiana* (2n=26), *S. laeteviolacea* var. *laeteviolacea* (2n=26), *S. laeteviolacea* var. *maekawae* (2n=26), *S. muramatsui* (2n=26), *S. pekinensis* var. *transitra* (2n=28), *S. shikokiana* (2n=28) and *S. tsusimensis* (2n=26). New counts were reported in *S. dependens* (2n=28), *S. strigillosa* (2n=30) and *S. yezoensis* (2n=30). Chromosome counts for *S. barbata* (2n=26), *S. guilielmii* (2n=28), *S. indica* var. *indica* (2n=26) and *S. rubropunctata* var. *rubropunctata* (2n=26) were confirmed.

Key words : chromosome number, Japan, Lamiaceae, *Scutellaria*.

The genus *Scutellaria* L. (Lamiaceae), a large one containing about 360 species, is almost worldwide in distribution (Paton 1990). In Japan, 19 species including one naturalized species, and 6 varieties occur (Yamazaki 1993 ; Sato et al. 2001).

In the classification of *Scutellaria* in Japan, Yamazaki (1993) places *S. guilielmii* in the Subgen. *Scutellariopsis*, while the others, except for *S. barbata*, in the Subgen. *Scutellaria*. *Scutellaria barbata* is not included in Yamazaki's system, because this naturalized species was first found in Kumamoto Prefecture by Sato et al. (2001), after Yamazaki's classification system was proposed. According to the classification, Subgen. *Scutellaria* of Japan has three sections : Sect. *Minores* having *S. dependens*, Sect. *Galericularia* involving *S. stigillosa* and *S. yezoensis*, and Sect. *Stachymacris* constituted of *S. amabilis*, *S. brachyspica*, *S. indica*, *S. iyoensis*, *S. kikai-insularis*, *S. kiusiana*, *S. kuromidakensis*, *S. laeteviolacea*, *S. longituba*, *S. muramatsui*, *S. pekinensis*, *S. rubropunctata*, *S. shikokiana* and *S. tsusimensis*. The 14 species of Sect. *Stachymacris* is divided into five series : Ser. *Pekinenses* composed of *S. pekinensis*, Ser. *Shikokianae* having *S. shikokiana*, Ser. *Longitubae* having *S. longituba*, Ser. *Prostratae* constituted of *S. kikai-insularis*, and Ser. *Indicae* composed of *S. amabilis*, *S. brachyspica*, *S. indica*, *S. iyoensis*, *S. kiusiana*, *S. kuromidakensis*, *S. laeteviolacea*, *S. muramatsui*, *S. rubropunctata* and *S. tsusimensis*.

In the 19 species of *Scutellaria* occurring in Japan, chromosome number has been reported as follows : 2n=16 in *S. yezoensis* (Probatova et al. 1989), 2n=26 in *S. barbata* (Hsieh and Huang 1995), *S. indica* var. *indica* (Xu et al. 1992 ; Hsieh and Huang 1995 ; Denda 2002), *S. longituba* (Ono 1977), *S. rubropunctata* var. *minima* (Denda 2002), *S. rubropunctata* var. *naseana* (Denda 2002) and *S. rubropunctata* var. *rubropunctata* (Denda 2002), 2n=28 in *S. guilielmii* (Shiuchi and Kanemoto 1999), 2n=32 in *S. dependens* (Scheel 1931, in Fedorov 1969), *S. pekinensis* var. *ussuriensis* (Probatova et al. 1991) and *S. strigillosa* (Nishikawa 1985 ; Sokolovskaya et al. 1986 ; Probatova and Sokolovskaya 1990). These counts show that *Scutellaria* of Japan has dysploid changes in chromosome number. Chromosome information often throws light on the taxonomic relationships

Table 1. Collection locality or source of studied taxa of *Scutellaria* in Japan

Taxon	Collection site（One plant from each locality）
S. *amabilis* H. Hara	Hakusan-jinja, Aono, Asahi-cho, Nyu-gun, Fukui-ken
	Oyamadani-cho, Fukui-shi, Fukui-ken
	Hinomiya-jinja, Gejo, Kosugi-machi, Imizu-gun, Toyama-ken
	Jo-yama, Toyama-shi, Toyama-ken
	Sotowano, Fuchu-machi, Nei-gun, Toyama-ken
S. *barbata* D. Don	Ezu-ko, Ezu, Kumamoto-shi, Kumamoto-ken
S. *brachyspica* Nakai et H. Hara	Kasuga-jinja, Maeba-cho, Fukui-shi, Fukui-ken
	Shizuhara, Miyama-cho, Kitakuwada-gun, Kyoto-fu
	Ohya, Yachiyo-cho, Taka-gun, Hyogo-ken
S. *dependens* Maxim.	Hamakurosaki, Toyama-shi, Toyama-ken
	Shirodani, Tokuyama-shi, Yamaguchi-ken
S. *guilielmii* A. Gray	Searashi, Nakajima-machi, Kashima-gun, Ishikawa-ken
	Komaki, Nakajima-machi, Kashima-gun, Ishikawa-ken
S. *indica* L. var. *indica*	Engo-ji, Kochi-shi, Kochi-ken
	Higuchi, Kumage-cho, Kumage-gun, Yamaguchi-ken
S. *indica* L. var. *parvifolia*（Makino）Makino	Uramura-cho, Toba-shi, Mie-ken
	Kusube-cho, Ise-shi, Mie-ken
	Otonashi-yama, Futami-cho, Watarai-gun, Mie-ken
S. *iyoensis* Nakai	Nakazukita, Tokuyama-shi, Yamaguchi-ken
S. *kiusiana* H. Hara	Misumi-yama, Hagi-shi, Yamaguchi-ken
S. *laeteviolacea* Koidz. var. *laeteviolacea*	Heisen-ji, Katsuyama-shi, Fukui-ken
	Takayashiro-yama, Tajimi-shi, Gifu-ken
	Nojiri, Ohkuwa-mura, Kiso-gun, Nagano-ken
S. *laeteviolacea* Koidz. var. *maekawae*（H. Hara）H. Hara	Iwagomori-yama, Ichihashi, Tsuruga-shi, Fukui-ken
	Jododani, Nagaokakyo-shi, Kyoto-fu
S. *muramatsui* H. Hara	Matsukura, Uozu-shi, Toyama-ken
	Kumano, Unazuki-machi, Shimoniikawa-gun, Toyama-ken
	Iou-zen, Fukumitsu-machi, Nishitonami-gun, Toyama-ken
	Ohsawa, Ohmi-machi, Nishikubiki-gun, Niigata-ken
S. *pekinensis* Maxim. var. *transitra*（Makino）H. Hara	Ichijyodani, Fukui-shi, Fukui-ken
	Konpira-san, Kuniyama-machi, Fukui-shi, Fukui-ken
	Zukawa, Takaoka-shi, Toyama-ken
	Ushigamase, Ohsawano-machi, Kaminiikawa-gun, Toyama-ken
	Nabetani, Mitsu-cho, Mitsu-gun, Okayama-ken
	Tomakomai-shi, Hokkaido
S. *rubropunctata* Hayata var. *rubropunctata*	Ohura, Nago-shi, Okinawa-ken
S. *shikokiana* Makino	Akatani, Ohto-mura, Yoshino-gun, Nara-ken
	Kasagata-yama, Yachiyo-machi, Taka-gun, Hyogo-ken
	Shioiri, Chunan-cho, Nakatado-gun, Kagawa-ken
S. *strigillosa* Hemsl.	Ohwada, Teradomari-machi, Santo-gun, Niigata-ken
	Kakizaki, Kakizaki-machi, Nakakubiki-gun, Niigata-ken
	Yufutsu, Tomakomai-shi, Hokkaido
	Togashiohama, Oga-shi, Akita-ken
S. *tsusimensis* H. Hara	Izumi, Kamitsushima-cho, Kamiagata-gun, Nagasaki-ken
S. *yezoensis* Kudo	Kirigamine, Suwa-shi, Nagano-ken（cult.）

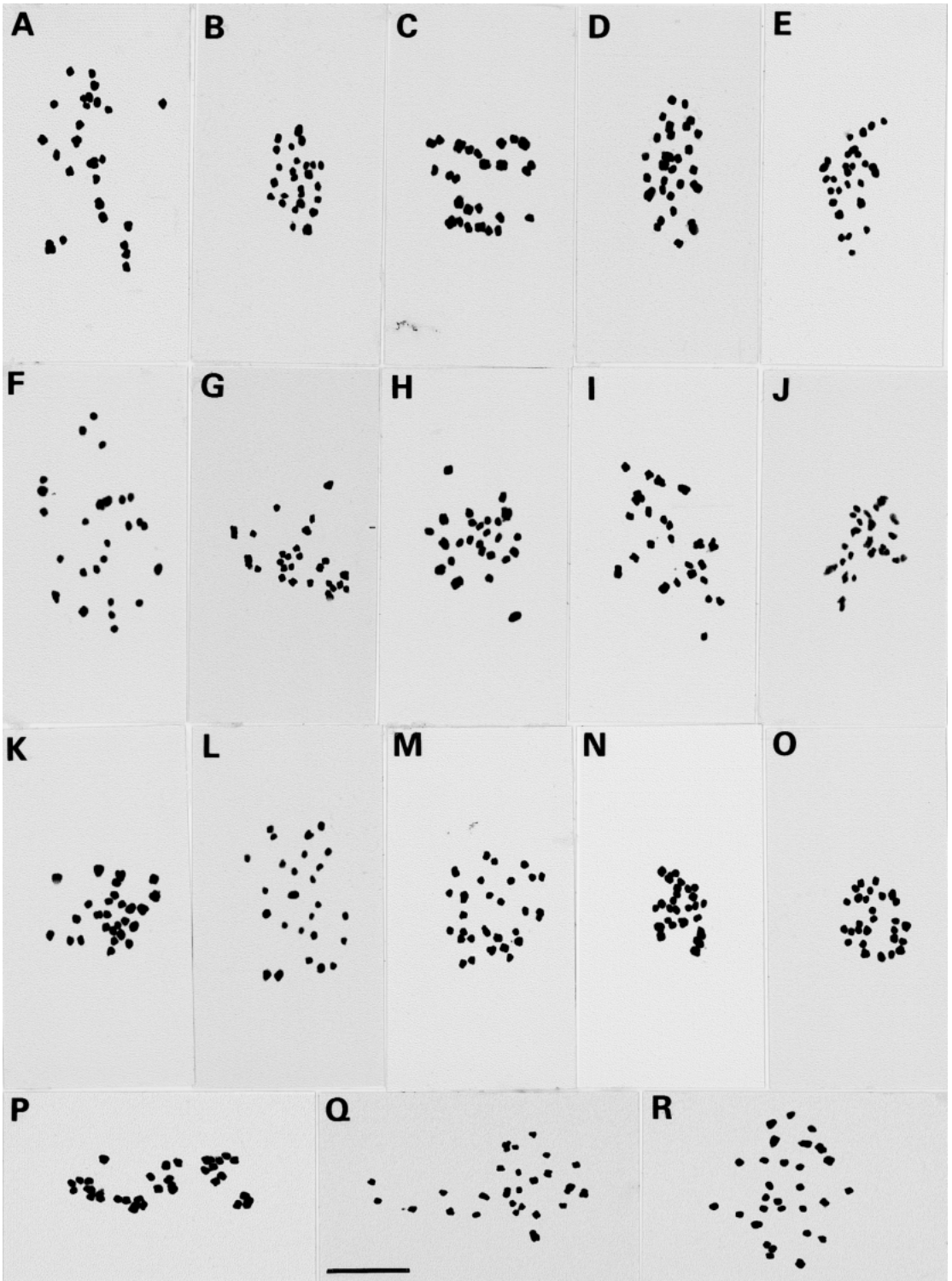

Fig. 1. Somatic metaphase chromosomes of 16 species and two varieties of Japanese *Scutellaria*. A, *S*. *amabilis* (2n=26) ; B, *S*. *barbata* (2n=26) ; C, *S*. *brachyspica* (2n=26) ; D, *S*. *dependens* (2n=28) ; E, *S*. *guilielmii* (2n=28) ; F, *S*. *indica* var. *indica* (2n=26) ; G, *S*. *indica* var. *parvifolia* (2n=26) ; H, *S*. *iyoensis* (2n=26) ; I, *S*. *kiusiana* (2n=26) ; J, *S*. *laeteviolacea* var. *laeteviolacea* (2n=26) ; K, *S*. *laeteviolacea* var. *maekawae* (2n =26) ; L, *S*. *muramatsui* (2n=26) ; M, *S*. *pekinensis* var. *transitra* (2n=28) ; N, *S*. *rubropunctata* var. *rubropunctata* (2n=26) ; O, *S*. *shikokiana* (2n=28) ; P, *S*. *strigillosa* (2n=30) ; Q, *S*. *tsusimensis* (2n=26) ; R, *S*. *yezoensis* (2n=30). Bar=10 μm.

among taxa. The aim of this paper is to ascertain the chromosome numbers of *Scutellaria* in Japan.

Materials and methods

Plants of 16 species and two varieties of *Scutellaria* collected from 45 localities in Japan were used in the study. In each collection locality one plant was collected. The taxa studied and their collection localities are listed in Table 1. These plants were grown at the experimental garden of Toyama University. Chromosome numbers were established from root tip cells of the potted plants. The actively growing root tips were pretreated in a 2.1 mM 8–hydroxyquinoline aqueous solution for 1 hr at 25℃ and subsequently kept for 15 hr at 6℃. They were fixed in a mixture of glacial acetic acid and absolute ethyl alcohol (1 : 3) for 1 hr, and then soaked in 1 N HCl for a few hours. After being macerated in 1 N HCl at 60℃ for about 10 min, they were immersed in tap water. The meristems of root tips were stained in a drop of 1.5% lacto-propionic orcein on the slide glass and ordinary squash technique was applied in preparation. Voucher specimens of *Scutellaria* used in the study will be deposited in the herbarium of the Botanic Gardens of Toyama (TYM).

Results and discussion

Scutellaria taxa studied had small chromosomes ranging from 0.4 μm to 1.6 μm in length and their centromere constrictions were often obscure (Fig. 1). Chromosome counts of the 16 species and two varieties in *Scutellaria* studied were as follows: 2n=26 in *S. amabilis*, *S. barbata*, *S. brachyspica*, *S. indica* var. *indica*, *S. indica* var. *parvifolia*, *S. iyoensis*, *S. kiusiana*, *S. laeteviolacea* var. *laeteviolacea*, *S. laeteviolacea* var. *maekawae*, *S. muramatsui*, *S. rubropunctata* var. *rubropunctata* and *S. tsusimensis*, 2n=28 in *S. dependens*, *S. guilielmii*, *S. pekinensis* var. *transitra* and *S. shikokiana*, 2n=30 in *S. strigillosa* and *S. yezoensis* (Fig. 1, Table 2). As shown in Table 2, chromosome counts are reported for the first

Table 2. Chromosome numbers of examined taxa in *Scutellaria* of Japan

Taxon	Present count (2n)	Previous count (2n)	References
S. amabilis	26	—	
S. barbata	26	26	Hsieh and Huang (1995)
S. brachyspica	26	—	
S. dependens	28	32	Scheel (1931, in Fedorov 1969)
S. guilielmii	28	28	Shiuchi and Kanemoto (1999)
S. indica var. *indica*	26	26	Xu et al. (1992), Hsieh and Huang (1995), Denda (2002)
S. indica var. *parvifolia*	26	—	
S. iyoensis	26	—	
S. kiusiana	26	—	
S. laeteviolacea var. *laeteviolacea*	26	—	
S. laeteviolacea var. *maekawae*	26	—	
S. muramatsui	26	—	
S. pekinensis var. *transitra*	28	—	
S. rubropunctata var. *rubropunctata*	26	26	Denda (2002)
S. shikokiana	28	—	
S. strigillosa	30	32	Nishikawa (1985), Sokolovskaya et al. (1986), Probatova and Sokolovskaya (1990)
S. tsusimensis	26	—	
S. yezoensis	30	16	Probatova et al. (1989)

time for the following 11 taxa: *S. amabilis*, *S. brachyspica*, *S. indica* var. *parvifolia*, *S. iyoensis*, *S. kiusiana*, *S. laeteviolacea* var. *laeteviolacea*, *S. laeteviolacea* var. *maekawae*, *S. muramatsui*, *S. pekinensis* var. *transitra*, *S. shikokiana* and *S. tsusimensis*. The chromosome count of 2n=26 in *S. barbata* agrees with the count reported by Hsieh and Huang (1995); 2n =26 in *S. indica* var. *indica* is consistent with the count by Xu et al. (1992), Hsieh and Huang (1995) and Denda (2002); 2n=26 in *S. rubropunctata* var. *rubropunctata* agrees with the count by Denda (2002); 2n=28 in *S. guilielmii* coincides with the count by Shiuchi and Kanemoto (1999).

As shown in Table 2, the chromosome count presented in the study for *S. strigillosa* (2n=30) is different from the count of 2n=32 given by Nishikawa (1985), Sokolovskaya et al. (1986), and Probatova and Sokolovskaya (1990). In our study, *S. strigillosa* collected from four localities, one locality each in Akita Prefecture and Hokkaido, and two localities in Niigata Prefecture, showed 2n=30 chromosomes, then we could not find any plant with 2n=32 chromosomes as reported by Nishikawa (1985) as plant collected at Zenibako in Otaru City, Hokkaido in Japan. In *S. dependens*, 2n=32 chromosomes was given by Scheel (1931, in Fedorov 1969), however, the plant used in our study had 2n=28 chromosomes. In *S. yezoensis*, 2n=16 chromosomes was given for plant from the Kuril Islands by Probatova et al. (1989), whereas 2n=30 chromosomes was found in the present study. In these taxa, further cytological study should be made to elucidate the diversity of chromosomes.

The original basic chromosome number of *Scutellaria* is not clear yet. Darlington and Wylie (1955) suggested the basic chromosome number of *Scutellaria* was x=8, however, the dysploid changes of 2n=26, 28 and 30 chromosomes found in the present study indicate that the basic chromosome numbers of these *Scutellaria* taxa are x=13, 14, and 15.

According to Yamazaki's classification system, the taxa having 2n=28 chromosomes are found in Subgen. *Scutellariopsis* and *Scutellaria* both. In Subgen. *Scutellaria*, the two species with 2n= 30 chromosomes of *S. strigillosa* and *S. yezoensis* are both placed in the Sect. *Galericularia*, while the three taxa with 2n=28 chromosomes of *S. dependens*, *S. pekinensis* var. *transitra* and *S. shikokiana* are divided into two sections: *S. dependens* is placed in Sect. *Minores*, *S. pekinensis* var. *transitra* and *S. shikokiana* are both in Sect. *Stachymacris*. All the taxa belonging to the Ser. *Indicae* have consistently 2n=26 chromosomes indicating that the numerical variation of chromosome number is not occurred in speciation in the Ser. *Indicae* of Subgen. *Scutellaria* of Japan.

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沢之向　隆[1,2]・岩坪美兼[1]・鳴橋直弘[1]：日本産タツナミソウ属（シソ科）の染色体数

日本には，18 種 2 変種のタツナミソウ属が知られている（Yamazaki　1993）。今回，16 種 2 変種について，合計 45 カ所から採集した植物を用いて染色体数を調べた。染色体数は以下のとおりであった。

Scutellaria amabilis（ヤマジノタツナミソウ），*S. barbata*（セイタカナミキソウ），*S. brachyspica*（オカタツナミソウ），*S. indica* var. *indica*（タツナミソウ），*S. indica* var. *parvifolia*（コバノタツナミ），*S. iyoensis*（ハナタツナミソウ），*S. kiusiana*（ツクシタツナミソウ），*S. laeteviolacea* var. *laeteviolacea*（シソバタツナミ），*S. laeteviolacea* var. *maekawae*（ホナガタツナミソウ），*S. muramatsui*（デワノタツナミソウ），*S. rubropunctata* var. *rubropunctata*（アカボシタツナミソウ），*S. tsusimensis*（アツバタツナミソウ）は 2n=26，*S. dependens*（ヒメナミキ），*S. guilielmii*（コナミキ），*S. pekinensis* var. *transitra*（ヤマタツナミソウ），*S. shikokiana*（ミヤマナミキ）は 2n=28，そして *S. strigillosa*（ナミキソウ），*S. yezoensis*（エゾナミキ）は 2n=30 であった。これらの染色体基本数は x=13，14，15 と考えられる。なお，アツバタツナミソウ，オカタツナミソウ，コバノタツナミ，シソバタツナミ，ツクシタツナミソウ，デワノタツナミソウ，ハナタツナミソウ，ヒメナミキ，ホナガタツナミソウ，ミヤマナミキ，ヤマジノタツナミソウ，およびヤマタツナミソウの染色体数は初めての報告である。ところでヒメナミキは，今回の観察では 2n=28 であったが国外においては 2n=32 が報告されている。エゾナミキは，今回の観察では 2n=30 であったが国外では 2n=16 の報告もある。ナミキソウについては，ロシアおよび北海道小樽市の植物より 2n=32 が報告されているが，今回の観察では 2n=30 であった。これらについては，今後さらに調査を行う必要がある。

Yamazaki（1993）の *Scutellaria* 亜属の分類に従うと，今回の染色体数の観察結果は，*Galericularia* 節の 2 種がともに 2n=30，*Stachymacris* 節 *Indica* 列では 2n=26（9 種 2 変種），*Pekinenses* 列では 2n=28（1 種），そして *Shikokiana* 列では 2n=28（1 種）である。*Scutellaria* 亜属では，染色体数が 2n=26，28，30 と多様であるが，*Indicae* 列の 9 種 2 変種は全て 2n=26 であることから，この列における種分化には，染色体数の多様化は関与していないことを示唆している。

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