Sorex bedfordiae has the Smallest Diploid Chromosome Number of the XY Group in the Genus *Sorex* (Mammalia, Soricidae)

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Summary Karyological data on the lesser stripe-backed shrew, *Sorex bedfordiae*, were obtained from four specimens collected on Mt. Laojun, Lijiang District, Yunnan Province, China. Three of the four *S. bedfordiae* specimens had karyotypes consisting of $2n=26$, $NFa=44$, with 4 metacentric, 4 submetacentric, 2 subtelocentric, and 2 acrocentric pairs, and 1 acrocentric X and acrocentric Y. This karyotype has the smallest diploid chromosome number in the XY group in the genus *Sorex*. The fourth specimen of *S. bedfordiae* had a different karyotype consisting of an additional pair of medium-sized metacentric chromosomes, *i.e.*, $2n=28$, $NFa=48$. These supernumerary chromosomes appear to constitute a new chromosome group in the genus *Sorex* and might provide new information concerning the taxonomy of soricid species.

Key words China, Karyotype, Shrews, Soricinae, *Sorex bedfordiae*.

In China, the subfamily Soricinae consists of 35 species belonging to eight genera, and there is much confusion over species taxonomy (Wang 2003). The genus *Sorex* is the largest group, and there are 15 species in China. There is a paucity of taxonomic information on *Sorex* from southern and central China. For example, *Sorex bedfordiae*, which occurs from Myanmar to Nepal, is distributed from Yunnan and Sichuan in China (Wang 2003). *Sorex bedfordiae* was once accepted as synonym of *S. cylindricauda*, which it resembles in terms of the point where a black stripe enters the back; this is an external characteristic of these two species. However, Hoffmann (1987) separated *S. bedfordiae* and *S. cylindricauda* based on a simple comparison of morphological characters. Most studies of Chinese soricid species have simply compared their morphology. No karyological studies of *Sorex* have examined specimens from China. The only reported karyotypes of the genus *Sorex* in East Asia are from Russia, Japan, and Mongolia (Takagi and Fujimaki 1966, Ivanitskaya and Malygin 1985, Tsuchiya 1985, Ivanitskaya *et al.* 1986, Tada and Obara 1988, Biltueva *et al.* 2000, Moribe *et al.* 2007). One reason for the lack of studies on soricid species from China is that the habitat of most soricid species is found in mountainous areas, and fresh cells are difficult to sample. This study reports the karyotype of *S. bedfordiae* contributing new information to soricid taxonomy.

Materials and methods

Karyological data for *S. bedfordiae* were obtained for four specimens collected on Mt. Laojun,

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Fig. 1. Collection site on Mt. Laojun, Yunnan, China.

Table 1. External measurements of *Sorex bedfordiae*

No	Species	Sex	BW	TL	LTv	HFcu	HFsu	EL	HBL	TR	Testis (W×L)
JUM081A	<i>Sorex bedfordiae</i>	♂	3.8	104	46	12.0	11.1	7.1	58	79.2	1.16×0.85(—)
JUM081B	<i>Sorex bedfordiae</i>	♂	4.3	105	47	12.6	11.6	7.0	58	81.0	1.37×1.06(—)
JUM085	<i>Sorex bedfordiae</i>	♀	4.2	111	50	12.4	11.4	6.8	61	82.0	—
JUM087	<i>Sorex bedfordiae</i>	♀	3.9	105	47	12.7	11.6	6.9	58	81.0	—

BW: Bodyweight (g), TL: Total Length (mm), LTv: Length of Tail vertebrae (mm), HFcu: Hind Foot cum unguis (mm), HFsu: Hind Foot sie unguis (mm), EL: Ear Length (mm), HBL: Head and Body Length (mm), TR: Tail Ratio (%).

Lijiang District, Yunnan Province, China (Fig. 1). The collection site was at an elevation of 3900 m above sea level at 26°37'94"N latitude and 99°43'52"E longitude. The identification of species was based on reports of external and skull morphology by Hoffmann (1987). Details on the collection and some external measurements of the specimens are listed in Table 1. The specimens were sacrificed, and bone marrow cells were cultured for chromosome preparation in the field. After a 40-min treatment with colchicines in RPMI1640 with 15% calf serum, the cells were incubated in 0.075 M KCl at 37°C for 18 min. Cells were collected with a hand-operated centrifuge and spread on glass slides and air-dried under moist conditions after being fixed with Carnoy's fixative (methanol:acetic acid=3:1). Conventional Giemsa staining was applied in the laboratory. The conventional chromosome pairs were categorized as metacentric (M), submetacentric (SM), subtelocentric (ST), or acrocentric (A), according to Zima and Kral (1984). All specimens (JUM081A, 081B, 085, 087) are stored in the Chinese Academy of Sciences, Kunming Institute of Zoology.

Results and discussion

Three of the four specimens of *S. bedfordiae* had a karyotype of $2n=26$, $NFa=44$, consisting of 1 large and 3 medium metacentric pairs, 4 large submetacentric pairs, 2 large subtelocentric pairs, and 1 large and one small acrocentric pair, and a medium-sized acrocentric X and small acro-

Fig. 2. The karyotype of *Sorex bedfordiae* ♀. $2n=26$, $NFa=44$.

Fig. 3. The karyotype of *Sorex bedfordiae* ♂. $2n=28$, $NFa=48$.

Fig. 4. The diploid number of the genus *Sorex* in XY group (Zima *et al.* 1998) and added the number of *S. bedfordiae*.

centric Y (Fig. 2).

Soricinae is separated into two groups according to the sex-determination system: one is XX(♀)/XY(♂), and the other is XX(♀)/XY₁Y₂(♂). The former is a common system in mammals, while the latter has been confirmed in very few species (Obara, 1988). The reported karyotypes of members of the XY group of Soricinae are mostly $2n=36-42$ for Asian Soricinae and $2n=52-66$ for European and American Soricinae (Zima *et al.* 1998). The chromosome number for *S. bedfordiae* ($2n=26$) was much smaller than reported values for this group.

Either the diploid number of *S. bedfordiae* is the smallest number in the Asian *Sorex* XY group (Fig. 4) or the number $2n=26$ constitutes a new group. In addition, one of the four *S. bedfordiae* specimens had a diploid number of 28 (Fig. 3). This resulted from one additional pair of mid-sized metacentric chromosomes. The karyotypes $2n=26$ and 28 might not reflect typical intra-specific chromosome polymorphisms, because one metacentric pair involves at least three very complicated rearrangements. This increase by one metacentric pair without any rearrangements involving the other chromosome pairs is explained as follows. Initially, 2 acrocentric pairs formed from 1 metacentric pair *via* Robertsonian fission. Then, independent pericentric inversions occurred in these acrocentric pairs, producing 2 new metacentric pairs. Such chromosome changes probably constitute reproductive barriers when they cause problems during meiosis in heterozygotes, leading to reduced fertility (White 1978, King 1993). Therefore, it is difficult to consider such a change as

variation within *S. bedfordiae*.

One possible explanation of the two karyotypes in *Sorex bedfordiae* is that one specimen ($2n=28$) is actually another species that closely resembles *S. bedfordiae*. *Sorex bedfordiae* is similar to *Sorex cylindricauda*, which is distributed in Sichuan, China, and was once treated as a synonym of *S. cylindricauda*. Hoffmann (1987) reported that these two species have different skull lengths. In this study, we identified the specimen with the $2n=28$ karyotype as *S. bedfordiae* based on external and skull measurements. Alternatively, the additional metacentric pair might be a B chromosome composed of C-heterochromatin, which stains positively using the C-band method (Trifonov *et al.* 2002). We have not yet examined this possibility. B chromosomes have been described in more than 50 species of mammals, including *Apodemus peninsulae* (Rodentia) and *Nyctereutes procyonoides* (Carnivora) (Trifonov *et al.* 2002), although a B chromosome has never been reported in a soricid species.

Further study is needed because of the small number of metaphases and individuals analyzed. The karyotype of *S. bedfordiae* and other *Sorex* in Southeastern Asia might constitute a new chromosome number group, which should prove important when considering the chromosome variation and evolution in soricid species.

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