

## Short Note

### Karyological Study of the Gray Shrew *Crocidura attenuata* (Mammalia: Insectivora) from Taiwan

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**Masaharu Motokawa, Masashi Harada, Liang-Kong Lin, Kazuhiro Koyasu and Shōsaku Hattori (1997)**  
Karyological study of the gray shrew *Crocidura attenuata* (Mammalia: Insectivora) from Taiwan. *Zoological Studies* 36(1): 70-73. The conventional, G-band, and C-band karyotypes of the gray shrew *Crocidura attenuata* from Taiwan were investigated. The autosomes consist of 3 meta- or submetacentric, 4 subtelocentric and 12 acrocentric pairs. The X and Y chromosomes are submetacentric and acrocentric, respectively. The diploid chromosome number and fundamental number were determined to be 40 and 56, respectively. This karyotype is different from that of a Thai specimen previously recorded as *C. attenuata*.

**Key words:** *Crocidura attenuata*, Chromosomal evolution, Taxonomy, Soricidae.

Shrews of the genus *Crocidura* are small insectivore mammals known from Palaeartic, Oriental, and Afrotropical regions (Hutterer 1993). This genus is comprised of at least 151 species (Hutterer 1993) and is separated by the results of electrophoretic analysis into 2 monophyletic groups, the Palaeartic and Oriental clade and the African clade (Maddalena 1990). Within this genus, about 50 species have previously been karyotyped (e.g., Maddalena and Ruedi 1994, Ruedi and Vogel 1995). Maddalena and Ruedi (1994) proposed a hypothesis of chromosomal evolution in *Crocidura* by assuming an ancestral karyotype of  $2n = 38$  and  $FN = 54$  ( $2n$ : diploid chromosome number;  $FN$ : fundamental number of chromosome arms including 2 female sex chromosomes) which consists of 4 metacentric, 3 subtelocentric, and 11 acrocentric pairs, and metacentric X and acrocentric Y chromosomes. According to this hypothesis, species from the Palaeartic and Oriental clade generally show stable ( $2n = 38$  or  $40$ ) or decreasing chromosome numbers from the ancestral karyotype, while most species from the African clade have increasing numbers from the ancestral condition (Maddalena and Ruedi 1994). One exception to this trend is the karyotype of the gray shrew, *C. attenuata*, an Oriental species recorded from Southeast Asia and Taiwan (for details on distribution, see Corbet and Hill 1992, Hutterer 1993) with an increasing chromosome number ( $2n = 50$ ) (Tsuchiya et al. 1979, Maddalena and Ruedi 1994). Karyotypic relationships of some Palaeartic and Oriental species have been studied (e.g., Ruedi et al. 1990, Maddalena

and Ruedi 1994, Ruedi and Vogel 1995), but those of *C. attenuata* have not been clarified because the banding karyotype of this exceptional species has not been obtained. In this paper, we investigate the G- and C-band karyotypes of *C. attenuata* from Taiwan and discuss the karyotypic relationships between *C. attenuata* and several other Oriental and Palaeartic species.

**Materials and Methods**—We examined 10 shrews collected from Taiwan (1 male and 1 female from Neipu Hsian, Pingtung Co.; 1 female from Kaohsiung City; 1 male and 1 female from Taichung City; and 1 male and 4 females from Alishan, Chiayi Co.). These specimens were identified on the basis of morphological characters following Corbet and Hill (1992), Jameson and Jones (1977), and Heaney and Timm (1983). Cytological preparations were made from tail tissue culture cells by the routine method of Yosida (1980). The G- and C-band techniques of Seabright (1971) and Sumner (1972) were applied for differential staining. Nomenclature of chromosomes follows Maddalena and Ruedi (1994).

**Results**—In 10 specimens, a total of 396 metaphases were counted (Table 1). The diploid chromosome number and fundamental number were determined to be 40 and 56, respectively, in all specimens examined. The conventional, G-band, and C-band karyotypes are shown in Fig. 1. The autosomes consisted of 3 meta- or submetacentric (nos. 1-3), 4 subtelocentric

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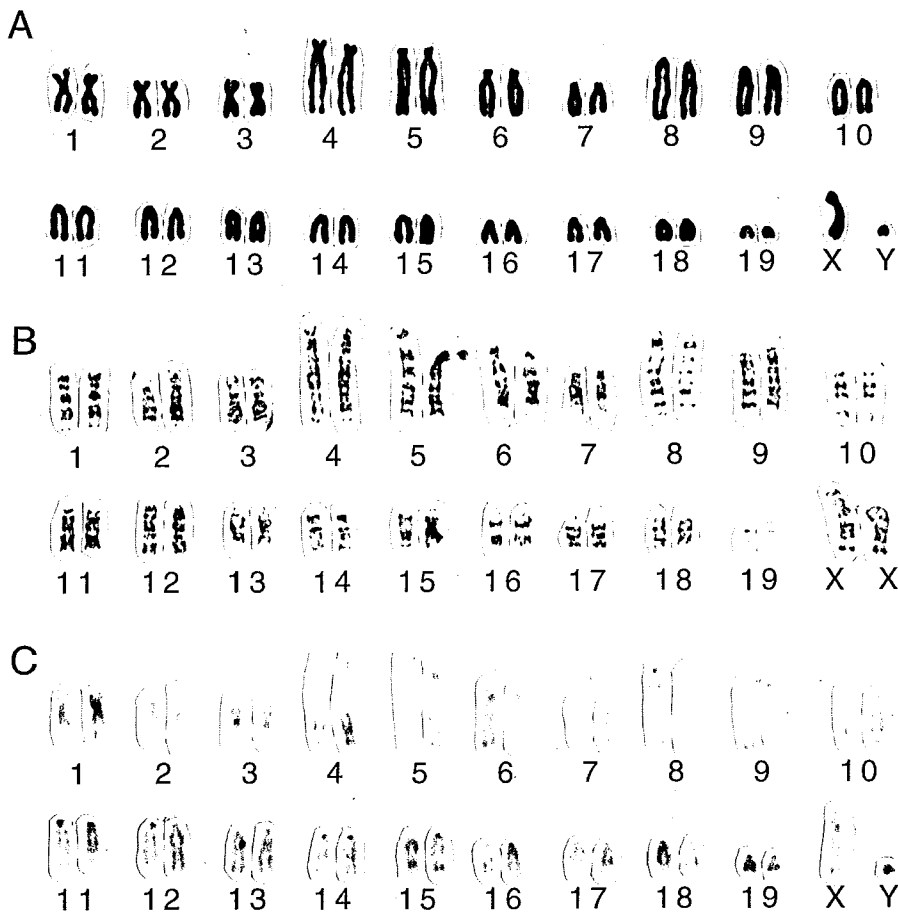
(nos. 4-7), and 12 acrocentric (nos. 8-19) pairs. The X and Y chromosomes were submetacentric and the smallest acrocentric, respectively. The G-band chromosomes were arranged according to Harada et al. (1985) (Fig. 1B). A small C-band was observed in the centromeric part of the 12 acrocentric pairs (nos. 8-19), but other C-bands in the autosomes were too small to be detected (Fig. 1C). The X chromosome showed C-bands at the distal part of the long arms and centromeric

region, and the Y chromosome was entirely stained.

**Discussion**—Tsuchiya et al. (1979) reported the karyotype of *C. attenuata* from Thailand as  $2n = 50$  and  $FN = 66$ , based on lung tissue culture cells of a single female specimen identified following Lekagul and McNeely (1977). The karyotype of *C. attenuata* from Taiwan greatly differs from that from Thailand (Tsuchiya et al. 1979). This discrepancy is probably due to

**Table 1.** Chromosome counts in *Crocidura attenuata* from Taiwan

Locality	Sex	No. of specimens examined	No. of cells observed	Chromosome counts ( $2n$ )			
				38	39	40	41
Neipu Hsian	male	1	35	0	2	33	0
	female	1	42	0	3	39	0
Kaohsiung City	female	1	32	0	1	31	0
	male	1	34	1	2	32	0
Taichung City	female	1	39	0	3	36	0
	male	1	62	0	2	60	0
Alishan	female	4	152	1	4	147	0
	male	1	39	0	3	36	0
Total		10	396	2	17	378	0



**Fig. 1.** Conventional (A), G-band (B), and C-band (C) karyotypes of *Crocidura attenuata* from Neipu Hsian, Taiwan. The bar represents 10  $\mu$ m.

a misidentification of the specimen from Thailand, because Heaney and Timm (1983) pointed out the misdescription of *C. attenuata* by Lekagul and McNeely (1977): i.e., the cranium of a *Crociodura* from Thailand figured by Lekagul and McNeely (1977) and identified as *C. fuliginosa* is actually *C. attenuata*, whereas the skull and measurements Lekagul and McNeely (1977) attribute to *C. attenuata* are those of *C. fuliginosa*. Similar confusion between *C. attenuata* and *C. fuliginosa* has been pointed out by other authors (Jenkins 1976 1982, Davison 1984, Ruedi et al. 1990).

Recently it has become clear that *C. malayana* is a valid species, which has been regarded as a synonym of *C. fuliginosa* by many authors including Jenkins (1976 1982) and Lekagul and McNeely (1977), based on morphological, cytological, and biochemical evidence (Ruedi et al. 1990, Maddalena and Ruedi 1994, Ruedi 1995, Ruedi and Vogel 1995). These 2 species are differentiated in their karyotypes (*C. fuliginosa*:  $2n = 40$ ,  $FN = 54-58$ ; *C. malayana*:  $2n = 38-40$ ,  $FN = 62-68$ ) (Ruedi et al. 1990, Maddalena and Ruedi 1994, Ruedi and Vogel 1995). The karyotype of the Thai specimen of Tsuchiya et al. (1979) differs from both *C. fuliginosa* and *C. malayana*, and also from *C. horsfieldii* ( $2n = 38$ ,  $FN = 48$ ; Krishna Rao and Aswathanarayana 1978), a species known from Thailand, as well as *C. watasei* ( $2n = 26$ ,  $FN = 52$ ; Yosida et al. 1968, Harada et al. 1985) which is distributed in the Ryukyu archipelago and often treated as *C. horsfieldii* (Jameson and Jones 1977, Corbet and Hill 1992, Hutterer 1993). According to Hutterer (1993) and Davison (1984), the other species occurring in Thailand are *C. pullata* and *C. monticola*, but they have not been karyotyped. It is likely that the Thai specimen with  $2n = 50$  chromosomes may belong to one of these species or represents another cryptic species previously included in the *C. fuliginosa* complex. Morphological re-examination of the Thai specimen with  $2n = 50$  chromosomes should be made.

The diploid number of *C. attenuata* from Taiwan ( $2n = 40$ ) is close to the hypothesized ancestral condition of *Crociodura*, as recorded in many other Palaearctic and Oriental species (Maddalena and Ruedi 1994). The karyotype of *C. attenuata* resembles those of *C. dsinezumi* (Harada et al. 1985) and most specimens of *C. fuliginosa* (Ruedi et al. 1990, Ruedi and Vogel 1995), which consist of 3 meta- or submetacentric, 4 subtelocentric, and 12 acrocentric pairs. Furthermore, *C. attenuata* does not differ from *C. dsinezumi* in G-band karyotype (Fig. 1B and Harada et al. 1985). On the other hand, the karyotype of *C. attenuata* is different from those of many other species distributed in East and Southeast Asia (insular species in southeast Asia:  $2n = 30-38$ ,  $FN = 50-62$ , Ruedi and Vogel 1995; *C. malayana*:  $2n = 38-40$ ,  $FN = 62-68$ , Ruedi et al. 1990, Maddalena and Ruedi 1994, Ruedi and Vogel 1995; *C. horsfieldii*:  $2n = 38$ ,  $FN = 48$ , Krishna Rao and Aswathanarayana 1978; *C. watasei*:  $2n = 26$ ,  $FN = 52$ , Yosida et al. 1968, Harada et al. 1985; *C. suaveolens*:  $2n = 39-40$ ,  $FN = 50$ , Tsuchiya 1987). These facts suggest close karyotypic relationships among *C. attenuata*, *C. fuliginosa*, and *C. dsinezumi*. For detailed comparisons among these 3 species, future studies on the G-band karyotype of *C. fuliginosa* are desirable.

The heterochromatic C-band on the distal part of the long arms of the X chromosome and the entirely heterochromatic Y chromosome observed in *C. attenuata* are common characteristics of many Palaearctic, Oriental, and African species (e.g., Maddalena and Ruedi 1994). Thus, these should be regarded as conservative characters in *Crociodura* until further information on phylogenetic relationships are obtained.

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## 臺灣灰鼯鼠之核型研究

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本研究乃檢視臺灣地區灰鼯鼠(*Crocidura attenuata*)核型之傳統染色式，G-帶及C-帶式。體染色體內包含3個中位中節染色體或近中位中節染色體，4個近末端位中節染色體和12個頂位中節染色體。XY性染色體分別為近中位染色體與頂位中節染色體。二倍體細胞染色體數與染色體臂數分別為40及56。本種核型與文獻記載中泰國的灰鼯鼠並不相同。

關鍵詞：灰鼯鼠，染色體進化，分類，尖鼠科。

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