Jin MURATA* & Miyoko IIJIMA**: **New or noteworthy chromosome records in *Arisaema****

邑田 仁*・飯嶌美代子**: テンナンショウ属の染色体数に関する新知見

The genus *Arisaema* is a large group of Araceae comprising about 150 species (Airy Shaw 1973) and has been recently revised by Hara (1971) and Ohashi & J. Murata (1980). Cytologically nearly 60 species have been examined by Bowen (1940, 1945), Ito (1942), Malik (1961), Sharma & Mukhopadhyay (1965), Kurosawa (1966, 1971, 1977), Larsen (1969), Hotta (1971) and others, but there are not a few problems in identification of materials and in identification of the chromosome numbers. Of the currently recognized 13 or 14 sections the following three have not been cytologically examined, i.e. sections Franchetiana, Attenuata and Dochafa. The former two are considered to be more primitive groups in the genus (Hara 1971, Li 1980) and the last is specialized and monotypic. Therefore, much more cytological information is necessary for a thorough taxonomic study of the genus.

In the present study chromosome numbers of 15 species of 10 sections are reported; those of *A. inclusum*, *A. rhizomatum*, *A. franchetianum*, *A. flavum* and *A. yunnanense* are determined for the first time. The results obtained are compared with those of previous reports on chromosome numbers in each of the sections.

Meterials and methods All the plants examined except *A. flavum* were collected from their natural habitat. The origin of the material of *A. flavum* is unknown but it was received from Biologisch Institute der Universität Stuttgart. Living materials have been cultivated in the Botanical Gardens, Faculty of Science, University of Tokyo. Root tips from the cultivated material were, after pretreatment with 0.05% colchicine for 4-5 hours at room temperature, fixed by a 3:1 mixture of absolute alcohol and glacial acetic acid. Then they were macerated with 1N HCl, stained with Schiff's solution and squashed. Voucher specimens without indication are kept in the Herbarium, Botanical Gardens,

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Observations

1) Sect. Fimbriata Engler

Arisaema inclusum N.E. Brown. 2n=24 (Fig. 1A). Voucher specimen: J. Murata 12320, Indonesia, Java, Cibodas (cult. in Bot. Gard.), 5 Oct. 1982.

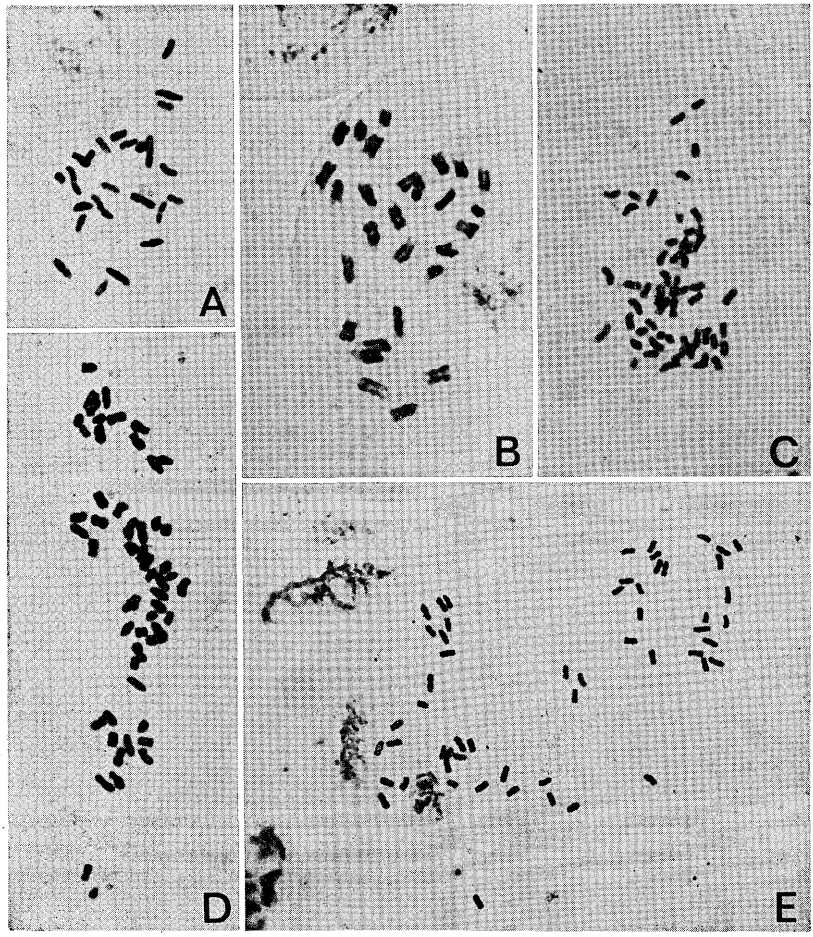

Fig. 1. Somatic chromosomes of *Arisaema* (×1100). A. *A. inclusum* (J. Murata 12320, 2n=24). B. *A. rhizomatum* (J. Murata 11646, 2n=28). C. *A. consanguineum* (J. Murata 12307, 2n=56). D. *A. flavum* (J. Murata 12305, 2n=56). E. *A. franchetianum* (J. Murata 12301, 2n=56).

This section is distributed mostly in tropical and subtropical regions; Formosa, south-eastern China, Indo-China and the Malaysian Islands. There is no satisfactory taxonomic treatment for the section, and species are still uncertain. Cytological investigations have been made for only two species from Thailand. Hotta (1971) reported 2n=28 in *A. album* and Larsen (1969) reported 2n=24 in *A. roxburghii* (as *A. cuspidatum*). The number 2n=24 is so far known only in this section. A Javan species, *A. inclusum*, is found to have the same chromosome number as *A. roxburghii*. Morphologically these two species are very similar and distinguished only by the colouration of the spathe. These facts suggest that they are closely related and may be taxonomically identical.

2) Sect. Decipientia Engler

Arisaema rhizomatum C.E.C. Fischer. 2n=28 (Fig. 1B). Voucher specimen: J. Murata 11646, China, Si-Chuang-Sheng, Mt. E-Mei, alt. 1600 m, 18 Oct. 1981.

This section consists of only two species, *A. rhizomatum* and *A. decipiens*, and is characterized by having a creeping rhizome. It is considered to be a primitive group by Hara (1971) and Li (1980). The only cytological report is by Sharma & Sarkar (1967-68) in which the chromosome number of *A. decipiens* is reported to be 2n=28. The chromosome number of *A. rhizomatum* is also 2n=28. Therefore, this section seems to be characterized by having diploid chromosomes of the basic number X=14.

3) Sect. Sinarisaema Hara

Arisaema consanguineum Schott. 2n=56 (Fig. 1C). Voucher specimen: J. Murata 12307, China, Yunnan, Kunming (cult. in Bot. Gard.), 25 May 1982.

This section is a characteristic group with radiately foliolated leaves. In all seven species of the section hitherto examined, the chromosome numbers are 2n=28 (*A. consanguineum* by Sharma & Mukhopadhyay 1965 as *A. sanguineum*, Mehra & Sachdeva 1971 and Kurosawa 1971; *A. concinnum* by Sharma & Sarkar 1971, Mehra & Sachdeva 1976; *A. echinatum* by Hotta 1971; *A. erubescens* by Larsen 1969, Hotta 1971, Sharma & Sarkar 1971 and Mehra & Sachdeva 1976; *A. formosanum* and *A. kelung-insularis* by Hotta 1971; *A. polyphyllum* by Pancho 1971 as *A. podophyllum*), but 2n=56 (*A. concinnum* by Bowden 1940, 1945 and Malik 1961) and 2n=48 (*A. consanguineum* by Sarker et al. 1978) have also been reported. 2n=56 is reported here for the first time for *A. consanguineum*.

4) Sect. Franchetiana

Arisaema franchetianum Engler. 2n=56 (Fig. 1E). Voucher specimen: J.

Murata 12301, China, Yunnan, Kunming (cult. in Bot. Gard.), 25 May 1982.

The Chinese section Franchetiana with 7 species (Li 1979) has not been cytologically examined. Morphologically it is very similar to the sect. Trisecta Schott which is distributed in the Himalayas, Tibet and adjacent Chinese regions. The chromosome numbers in section Trisecta have so far been determined to be 2n=20 (*A. costatum* by Kurosawa 1977), 2n=26 (*A. Wallichianum* and *A. sikkimense* by Sharma & Sarkar 1971) and 2n=28 (*A. griffithii* by Sharma & Sarkar 1967-68; *A. intermedium* by Malik 1961, Mehra & Sachdeva 1979 as n=14, and 1976; *A. ostiolatum* by Kurosawa 1971; *A. speciosum* by Kurosawa 1966, Sharma & Sarkar 1971; *A. utile* by Sharma & Sarkar 1971). Consequently the species of section Trisecta have diploid chromosomes of basic number X=10, 13 and 14. While in the present study, the chromosome number of *A. franchetianum* was determined to be 2n=56, which is considered to be a tetraploid of basic number X=14.

5) Sect. Dochafa (Schott) Hara

Arisaema flavum (Forsk.) Schott. 2n=56 (Fig. 1D). Voucher specimen: J. Murata 12305, Seed from Biologish Institut der Universität Stuttgart (cult. in Bot. Gard.), 10 Aug. 1982.

The chromosome number of *A. flavum* is determined for the first time.

6) Sect. Attenuata Engler

Arisaema yunnanense Buchet. 2n=48 (Fig. 2A). Voucher specimen: J. Murata 12302, China, Yunnan, Kunming (cult. in Bot. Gard.), 25 May 1982.

In the present study a chromosome number is reported for the first time for this section.

7) Sect. Tortuosa Engler

Arisaema dracontium (L.) Schott. 2n=56. Voucher specimen: J. Murata 12389, U.S.A., Maryland, Montgomery Country, Potomac River, Plummer's Island (cult. in Bot. Gard.), 6 May 1982.

A. heterophyllum Blume. 2n=28 (Fig. 2D). Voucher specimen: J. Murata 12306A & 12306B, China, Si-Chuang-Sheng, Mt. E-Mei (cult. in Bot. Gard.), 1 May 1982. 2n=168 (Fig. 2C). Voucher specimen: J. Murata 12313, Japan, Kagoshima Pref., Kirishima Mts., Koike (cult. in Bot. Gard.), 22 May 1982.

A. tortuosum (Wall.) Schott. 2n=28 (Fig. 2B). Voucher specimen: J. Murata 12303, Eastern Nepal, Mangmaya Gaon to Hurure, alt. 1960 m (cult. in Bot. Gard.), 25 Jun. 1982; J. Murata 12304, Eastern Nepal, Hurure to Mure, alt.

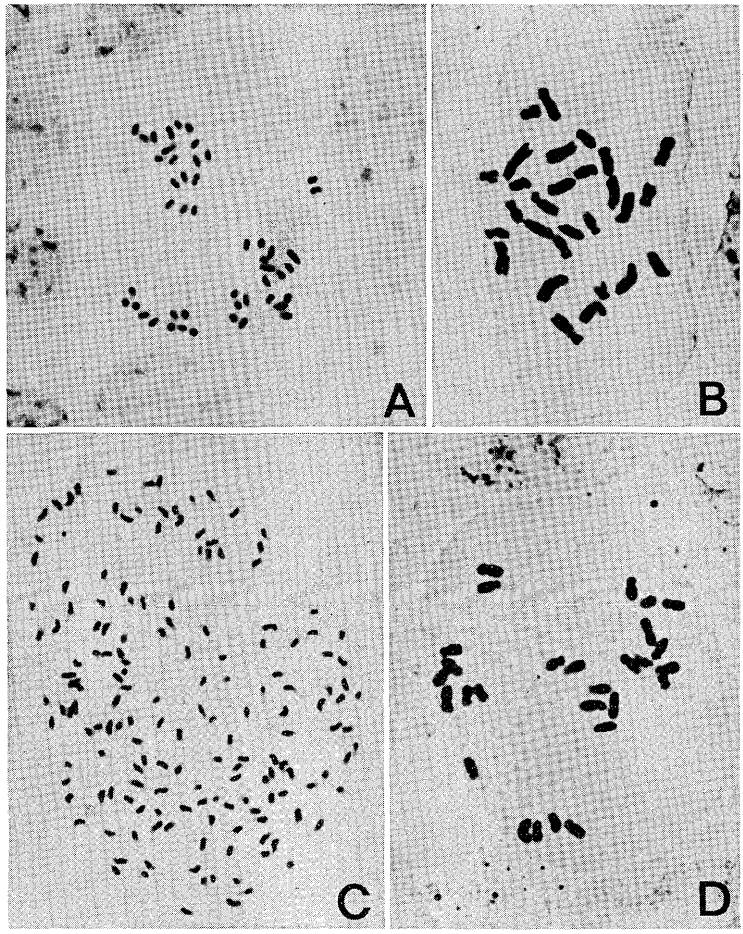

Fig. 2. Somatic chromosomes of *Arisaema*. A. *A. yunnanense* (J. Murata 12302, 2n=48). B. *A. tortuosum* (J. Murata 12303, 2n=28). C. *A. heterophyllum* (J. Murata 12313, 2n=168). D. *A. heterophyllum* (J. Murata 12306A, 2n=28). A, C (×1200). B, D (×1600).

1950 m (cult. in Bot. Gard.), 5 Jul. 1982; Y. Tateishi 7805, Eastern Nepal, Mangshing Kharka to above Mangshing Gaon, alt. 2300 m, 3 Oct. 1981 (in TUS). 2n=56. Voucher specimen: Y. Tateishi 8028, Eastern Nepal, Phedi to Hedanna, alt. 1060 m, 11 Oct. 1981 (in TUS).

Three representative species of this section have so far been examined and in each species poliploidy is known to occur. In *A. dracontium* 2n=28 and 56

have been reported (Bowden 1940, Huttleston in Darlington 1955). The chromosome number of *A. heterophyllum* have been examined only once by Ito (1949) probably using Japanese material, and was reported to be 2n=ca 140. This species has formerly been known to have a monoecious spadix with male and female flowers only. Such a spadix is found in all the specimens from Japan, Korea and Formosa, including the Japanese plants with 2n=168 chromosomes examined in the present study. Recently Li (1979) described *A. heterophyllum* with abortive flowers like slender protuberances arranged among or above the fertile flowers. The plant obtained from Mt. E-Mei, China, for which the chromosome number was determined to be 2n=28, has such a spadix as described by Li. Accordingly the Japanese plants of *A. heterophyllum* are different not only morphologically but also cytologically from the Chinese plants described by Li (1979). The chromosome number, 2n=168, found in the Japanese plants is considered to be dodecaploid of basic number X=14.

Here it should be noted that the Indian plant, whose chromosome number is reported to be 2n=28 by Bowden (1945) under the name of *A. ambiguum*, is not true *A. ambiguum* Engler. *A. ambiguum* is a Chinese plant not distributed in India. The terminal leaflet of *A. ambiguum* is smaller than its adjacent lateral leaflets (Engler 1920, in key of the sect. Tortuosa) but in the voucher specimen of his report (Bowden 119220) it is not smaller than its adjacent ones. Therefore, the material examined by Bowden does not seem to be *A. ambiguum* but *A. tortuosum*, which is very similar to *A. ambiguum* and grows abundantly in India.

A. tortuosum is a polymorphic species with a wide distribution from India through the Himalayas to Tibet and its phenetic races are sometimes regarded as distinct species under such names as *A. curvatum* and *A. hellebolifolium*. Here, however, we are comparing the chromosome numbers in *A. tortuosum* under a broad sense of species. Consequently the chromosome numbers of *A. tortuosum* have so far been determined to be 2n=24, 26, 28 and 56 (Tab. 1). Of these, 2n=24 is doubtful and should be rejected because it appears that 28 chromosomes can be counted in the plate shown in Sharma & Mukhopadhyay (1965). Taking geographical data into consideration, it is suggested that cytological differentiation is occuring in *A. tortuosum* in the Himalayan region. Plants with 2n=28 or 56 chromosomes, in which the basic number is considered to be X=14, are found commonly in the Eastern and Western Himalayas. While

Tab. 1. Geographical difference in chromosome numbers of *Arisaema tortuosum*

	Basic number	
	X=13	X=14
W. Himalaya	2n=26 Bowden 1945 (as *A. ambiguum*) Malik 1961 (as *A. curvatum*) Malik 1961 (as *A. hellebolifolium*) n=26 Mehra & Sachdeva 1975	2n=28 Mehra & Sachdeva 1971, 1976 Mehra & Sachdeva 1971 (as *A. hellebolifolium*) Mehra & Sachdeva 1971, 1976 (as *A. curvatum*)
E. Himalaya		n=14 Mehra & Sachdeva 1979 Sachdeva 1977 2n=28 Murata & Iijima (present study) 2n=24 (but seems to be 2n=28) Sharma & Mukhopadhyay 1965 2n=56 Hotta 1971 Murata & Iijima (present study)

plants with 2n=26 or 52 (n=26) chromosomes, in which the basic number is considered to be X=13, are so far known only from the Western Himalayas.

8) Sect. Pistillata Engler

Arisaema ringens Schott. 2n=28. Voucher specimen: J. Murata 12320, Japan, Nagasaki Pref., Mt. Iwayasan (cult. in Bot. Gard.), 31 Mar. 1980.

9) Sect. Clavata Engler

Arisaema negishii Makino. 2n=28. Voucher specimen: J. Murata 4993-a, Japan, Tokyo Pref., Hachijo Is., NW slope of Mt. Miharayama, alt. 400–500 m, 5 Apr. 1973.

A. heterocephalum Koidz. var. *majus* Serizawa. 2n=28. Voucher specimen: J. Murata 12030, Japan, Kagoshima Pref., Ooshima-gun, (Tokunoshima Is.), Izen-machi, Koshima (cult. in Bot. Gard.,), 20 Jan. 1982.

10) Sect. Arisaema

Arisaema monophyllum Nakai. 2n=28. Voucher specimen: J. Murata 9718, Japan, Honshu, Fukushima Pref., Iwaki-shi, Sedoyamagaroo (cult. in Bot. Gard.),

10 May 1980.

A. sikokianum Fr. et Sav. 2n=28. Voucher specimen: J. Murata 12031, Japan, Kochi Pref., Nangoku-shi, Saitani (cult. in Bot. Gard.), 30 Apr. 1980.

A. sazensoo (Blume) Makino. 2n=28. Voucher specimen: J. Murata 12302, Japan, Kagoshima Pref., Mt. Takakumayama (cult. in Bot. Gard.), 22 May 1982.

The section Arisaema is a large group showing remarkable diversity in morphology and has many taxonomic problems. Cytologically, however, it is uniform and most of the species are known to have 2n=28 chromosomes (Hotta 1971, etc). Only in *A. serratum*, *A. amurense* and *A. undulatifolium* (For the synonymic treatment see Ohashi & J. Murata 1980.) have aneuploid numbers been known.

A. serratum is a polymorphic species with a wide distribution covering all over Japan as well as Korea and its vicinity. The chromosome number of the species is reported mostly to be 2n=28, but 2n=26 is reported several times (Nakajima 1933, Lee 1970, Iijima 1982). It is notable that all the plants on Hachijo Is. seem to have 2n=26 chromosomes (Iijima 1982), which suggests that the population of *A. serratum* on the island may be cytologically differentiated as a result of geographical isolation.

Ito (1942) examined 4 specimens of *A. amurense* subsp. *robustum* (as *A. robustum*) and reported 2n=56 for all of them. But this count is doubtful, as the plates given in his report show nearly 52 or 104 chromosomes (the latter number is determined for the cell plate with doubled chromosomes). Other authors have reported the chromosome number of Japanese plants of *A. amurense* subsp. *robustum* to be 2n=52 (Hotta 1966, 1971 as *A. robustum* and *A. ovale*, Serizawa 1981 as *A. amurense* var. *robustum*, *A. amurense* var. *ovale* and *A. amurense* var. *inaense*), 2n=26 (Serizawa 1981 as *A. amurense* var. *robustum*) or rarely 2n=39 (Serizawa 1981 as *A. amurense* var. *robustum*). Therefore, it may be concluded that the basic chromosome number of the species in Japan is X=13. Although Lee (1970) reported 2n=56 for Korean plants under the name of *A. robustum*, the identification of these plants is problematical. In Korea both *A. amurense* subsp. *robustum* and *A. amurense* subsp. *amurense* are known but a reliable distinction has not been found between them. So they have frequently been recognized as subspecies or varieties. The chromosome number of *A. amurense* subsp. *amurense* has been reported only once to be 2n=56-59 and 66-68 by Соколовская (1966) under the name of *A. amurense*.

Ito (1942) examined the chromosome number of *A. undulatifolium* and reported 2n=32 for two specimens as well as 2n=28 for other three specimens. Subsequently, however, such an aneuploid number as 2n=32 has not been reported for the species or its allies; only 2n=28 has been reported (Hotta 1971, Serizawa 1980).

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日本，中国，ネパール，ジャワおよび北アメリカ産のテンナンショウ属植物15種についてその染色体数を報告する。これらのうち，以下の5種 *A. inclusum* 2n=24, *A. rhizomatum* 2n=28, *A. franchetianum* 2n=56, *A. flavum* 2n=56, *A. yunnanense* 2n=48 については初めての報告である。ここに得られた結果と従来発表されている染色体数を各節毎に比較したところ，以下のことが明らかとなった。1) ジャワ産の *A. inclusum* とインドシナ産の *A. roxburghii* は外部形態的にきわめてよく似ており，仏炎苞の色以外には明らかな区別点が知られていない。これら2種の染色体数は共に 2n=24 であり，現在まで知られている他のどの種類とも異なる。従ってこれらはきわめて近縁であると考えられ，同一種である可能性がある。2) 横にはう根茎を持つことにより原始的とみなされている Decipientia 節では，この節に属する全2種がともに 2n=28 の染色体を備えている。3) *A. consanguineum* では従来 2n=28 とのみ報告されていたが，中国（雲南省）産の資料では 2n=56 であり，種内倍数性が示された。4) Franchetiana 節の染色体数が初めて調べられ，*A. franchetiana* では 2n=56 であることがわかった。Franchetiana 節は形態的に Trisecta 節によく似ており，分布も重なっている。しかし Trisecta 節の染色体は調べられた限りすべて2倍体（2n=20, 26, 28）であり，4倍体は知られていない。5) Attenuata 節の染色体数が初めて調べられ，*A. yannanense* では 2n=48 であることがわかった。6) Tortuosa 節の代表的な3種類ではいずれも種内倍数性を示すことが明らかとなった。*A. dracontium* ではすでに 2n=28 と 56 が報告されており，本研究で調べた資料は 2n=56 であった。*A. heterophyllum* では従来 2n=ca 140 と報告されていたが，本研究では日本産 2n=168，中国（四川省）産 2n=28 という結果が得られた。日本産の 2n=168 は基本数 x=14 の12倍体であると思われる。また *A. tortuosum* では，東部ヒマラヤ産の資料で 2n=28, 56 という結果が得られた。従来の報告と合わせて検討したところ，染色体数が 2n=28, 56 で基本数 x=14 と考えられるものはヒマラヤ地域の東部にも西部にも分布しているが，2n=26, 52 (n=26) で基本数 x=13 と考えられるものは現在のところ西部ヒマラヤでしか発見されていないことがわかった（Tab. 1）。