Karyotype of Genus Ipomoea

Goichi Nakajima

Biological Laboratory, Faculty of Technology, Gumma University, Kiryu, Japan

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Cytological studies of the family Convolvulaceae have been carried out by Heitz (1926), Yasui (1928), Nagao (1928), Kano (1929) and others. Particularly the study of the chromosomes of the genus Pharbitis and its kindred genus Ipomoea was carried out by Heitz (1926), Yasui (1928), Nagao (1928), Kano (1929), Nakajima (1931, 1936), Wolcott (1937), King and Bamford (1937) and Watanabe (1939).

It seems to me that the above mentioned author's reports are restricted to the number of chromosomes, except the report of Yasui (1928) who investigated the meiosis of pollen mother cells of 11 cultivated strains of Pharbitis Nil; and very rare occurrence of the haploid plant was reported by U (1930) and Katayama (1935).

The findings of these authors concerning Pharbitis and Ipomoea are as shown in Table 1.

As one of a series of genetical and cytological researches on the genus Ipomoea and Pharbitis, the present author tried to determine the karyotype of these plants, and especially of the cultivated strains of Pharbitis Nil the morphological characters of which are very different.

Materials and methods

The species of Pharbitis and Ipomoea used in the present research were as follows: Ph. Nil, Ph. hederacea, Ph. purpurea, I. indica, I. lacunosa and I. rubro-caerulea, and as to Pharbitis Nil 30 cultivated strains were used in the present research. The seeds of these were given by Mr. Nakamura of Japanese morning glory fancier and Dr. Takenaka of Dept. of Cyto-genetics, The National Institute of Genetics of Japan.

The plants were cultivated in pots of 15 to 20 cm in diameter, five or six individuals being taken from each species and strains. In June and July, the root tips, 3~4 cm in length, were collected two or three times from these plants for the observation of chromosomes.

The root tips were treated before fixation with 8-oxyquinoline aqueous solution of 0.002 mol for 2~3 hours at room temperature, and washed in running water about 10 minutes. Then the root tips were dipped in the mixture made of 9 parts of 2% acetic orceine and one part of normal hydro-
Table 1. Chromosome numbers in *Pharbitis* and *Ipomoea*

<table>
<thead>
<tr>
<th>Plants</th>
<th>n</th>
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<th>Authors</th>
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<td>Orthopomoea</td>
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<td><em>Ipomoea leptophyla</em> Torr.</td>
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<tr>
<td>Arborescentes</td>
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<tr>
<td><em>I. arborescens</em> (Humb. et Bonpl.) G. Don.</td>
<td>30</td>
<td></td>
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<td>Pharbitis</td>
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<tr>
<td>Cephalanthae</td>
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<td>30</td>
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<td>King and Bamford (1937)</td>
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<tr>
<td><em>I. pestigridis</em> L.</td>
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<td>Watanabe (1939)</td>
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<tr>
<td>Hederacea</td>
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<tr>
<td><em>I. purpurea</em> (L.) Lam</td>
<td>15</td>
<td>30</td>
<td>Kano (1929), Nakajima (1936), King and Bamford (1937)</td>
</tr>
<tr>
<td>(Ph. hispidia Chois.)</td>
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</tr>
<tr>
<td><em>I. hederacea</em> (L.) Jacq.</td>
<td>15</td>
<td>30</td>
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<tr>
<td>(Ph. hederacea Chois.)</td>
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<td><em>I. nil</em> (L.) Roth.</td>
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<tr>
<td><em>I. leari</em> Paxton</td>
<td>15</td>
<td>30</td>
<td>U (1930), Katayama (1935)</td>
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<td></td>
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<td>(Ph. insularia Chois.)</td>
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<td>Wolcott (1937), King and Bamford (1937), Watanabe (1939)</td>
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<td>30</td>
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<td>Palmatae</td>
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<td>King and Bamford (1937)</td>
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<td><em>I. digitata</em> L.</td>
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<td>30</td>
<td>King and Bamford (1937)</td>
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<td>Jalapae</td>
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<tr>
<td><em>I. paudurata</em> (L.) G. F. W. Mey.</td>
<td>15</td>
<td>30</td>
<td>Wolcott (1937), King and Bamford (1937)</td>
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<td><em>I. ramoni</em> Chois.</td>
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<td><em>I. carolina</em> Pursh</td>
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<td>Wolcott (1937)</td>
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<td><em>I. lacunosa</em> Linn.</td>
<td>15</td>
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<tr>
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<tr>
<td><em>I. violacea</em> L.</td>
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<td>Nakajima (1931), Wolcott (1937), King and Bamford (1937)</td>
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<td>(I. rubrocaerulea Hook)</td>
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chloric acid for 5~6 minutes at 58~60°C for fixation. Subsequently these materials were cooled to the room temperature, and then the root tips cut in suitable length were mounted by means of the aceto-orceine smear method.

The figures were drawn by aid of Abbe's camera lucida using Zeiss 1.5 mm apochromatic objective and ×15 compensation ocular and the original magnification was ×3,000.

**Results of observations**

It is known that the 6 species of *Pharbitis* and *Ipomoea* have 30 (15 pairs) somatic chromosomes of very small size, and this was confirmed by the present author for 6 species of the two genera (Table 1).

1) *Pharbitis hispida* Chois. (*Ipomoea purpurea* (L.) Lam.)

This species is indigenous to tropical America and it was introduced into Japan many years ago and has been cultivated in this country. Today it is commonly found everywhere as *Ph. Nil*, Japanese Morning Glory. All somatic chromosomes of this species were of curved stick or rod shaped, the length varying between 1.85~1.33 µ and differing very slightly (Fig. 1 a, b).

Among the 15 pairs both chromosomes of one pair have a satellite or trabant at one end; those of 3 pairs have a fiber attachment at the median (constriction); the other 3 pairs at the submedian (constriction) and the remaining 8 pairs at a terminal end (rod shaped).

The karyotype formula may be represented by

$$K(2n) = 30 = 2A_{m}^{1} + 2A_{s}^{m} + 2A_{r}^{t} + 4B_{s}^{t} + 4B_{m}^{t} + 2B_{st}^{t} + 4B_{st}^{t} + 6C_{0t}^{t} + 4D_{0t}^{t}$$

2) *Pharbitis hederacea* Chois. (*I. hederacea* (L.) Jaq.)

The habitat of this species is tropical America, but it is now cultivated in Japan being called the American Morning Glory. The 15 pairs of somatic chromosomes of this species were also stick or rod shaped like the above mentioned species and the length varying between 1.85~1.33 µ and differing very slightly (Fig. 2 a, b).

Among the 15 pairs both chromosomes of two pairs have a satellite at one end; those of 4 pairs have a fiber attachment at the submedian (constriction); the other 2 pairs have at the median (constriction) and the remaining 7 pairs at a terminal end (rod shaped).

The karyotype formula may be represented by

$$K(2n) = 30 = 2A_{st}^{1} + 2A_{0t}^{t} + 2B_{st}^{t} + 2C_{sm}^{t} + 4C_{st}^{t} + 2C_{m}^{t} + 2D_{st}^{t} + 4D_{m}^{t} + 6D_{0t}^{t} + 4E_{0t}^{t}$$


This species in originally indigenous to Sulphur Island, but in the southern part of Japan it becomes perennial under some protecting material in winter. All somatic chromosomes (15 pairs) of this species were of curved stick or rod shaped the length varying between 2.22~1.35 µ and differing very slightly (Fig. 3 a, b).

Among the 15 pairs both chromosomes of 2 pairs have a satellite or
trabant at one end; those of 2 pairs have a seta at one end; the other 3 pairs have a fiber attachment at the submedian (constriction) and the remain-
ing 8 pairs at a terminal end (rod shaped). Among all the plants and in this present research, chromosomes with a seta, were found only in this species.

The karyotype formula may be represented by

\[ K(2n) = 30 = 2A_0^t + 2A_0^s + 2B_0^t + 6C_0^t + 2C_0^s + 4C_0^e + 2C_1^s + 2C_1^t + 2D_1^s + 6D_1^t + 2E_0^t \]

4) *Ipomoea lacunosa* Linn.

This species is not found widely in Japan today, for the flowers are not very big and beautiful and so people do not cultivate them. All its somatic chromosomes are stick or rod shaped the length varying between 1.40–0.38 μ and differing very slightly (Fig. 4 a, b).

Among the 15 pairs, both chromosomes of 3 pairs have a fiber attachment at the median (constriction); the other 3 pairs at the subterminal and the remaining 9 pairs at a terminal end (rod shaped).

The karyotype formula may be represented by

\[ K(2n) = 30 = 2A_0^t + 4B_0^t + 4B_0^m + 2B_0^s + 2C_0^m + 6C_0^t + 6D_0^t + 2E_0^t + 2F_0^t \]

5) *Ipomoea violacea* L. (*I. rubro-caerulea* Hook.)

This species is also indigenous to tropical America and is well known by the name of Heavenly Blue. In recent times it gradually became popularized in Japan as a summer flower.

All somatic chromosomes of this species are comparatively large and curved stick or rod shaped the length varying between 3.10–1.55 μ and differing very slightly (Fig. 5 a, b).

Among the 15 pairs, chromosomes of the longest 4 pairs have a fiber attachment at the submedian (primary constriction) and they have a secondary constriction on the longer arm; in the other 4 pairs each chromosome has a satellite at one end and half of them (2 pairs) have a constriction at the median; in the remaining 7 pairs, those of 6 have a fiber attachment at the median, and those of the one last pair has a fiber attachment at a terminal end (rod shaped).

The karyotype formula may be represented by

\[ K(2n) = 30 = 6cA_0^e + 2cB_0^e + 4C_0^m + 2C_0^s + 2C_1^s + 4D_0^m + 6E_0^m + 2E_0^s + 2F_0^s \]

6) *Pharbitis Nil* Chois. (*I. nil* (L.) Roth.)

This species is indigenous to the Tropics of Old World and was introduced into Japan ca. 1,200 years ago. Today it is popular as a summer flower (Asagao) and numerous strains are cultivated. They are well known in the world as Japanese Morning Glory.

Twenty cultivated strains were used in this research.

All somatic chromosomes of the strains used were the curved stick or the rod shaped, the length of which differs very slightly. And they were somewhat larger than those of the 5 species mentioned above. The length of the somatic chromosomes of the most popular strain of this species which we may call prototypic was found to lie between 3.50–1.45 μ.
Among 15 pairs, 4 pairs have a satellite on one end of the homologous chromosomes, and the other 10 pairs do not have it. But in 10 pairs a fiber attachment at one end (rod shaped), and in one pair a constriction at the median were observed.

The 20 strains of Ph. Nil used, may be divided into 2 groups by their morphological characteristics and their karyotype formulas may be represented as follows:

\[
\text{Figs. 16-25. Somatic plates in root tip cells of cultivated strains of Pharbitis Nil. ca. } x 3,000. \\
16, \text{ Rangiku. 17, Murasaki-fubuki. 18, Uzu-yanagi. 19, Uzu-kuruma-maru. 20, Uzu-kikyoyae. 21, Maru-kuruma. 22, Gudai-momo. 23, Shishi-A. 24, Itoba-itzaki-botan. 25, Haribaitozaki-botan.}
\]

A. Common strains

Prototype: Fig. 6 a, b.

\[
K(2n)=30=2A_{st}^n+2B_{st}^m+2B_{st}^n+2C_{st}^m+2C_{st}^n+4D_{st}^m+6E_{st}^m+2F_{st}^n+4F_{st}^n+4F_{st}^n
\]

Matsushima (yellow-mutable): Fig. 2 a, b.

\[
K(2n)=30=2A_{st}^n+2A_{st}^m+2A_{st}^m+2B_{st}^n+2B_{st}^m+2B_{st}^n+8C_{st}^m+6D_{st}^m+4E_{st}^n
\]

Shirotae (yellow, retracted, dragonfly): Fig. 8 a, b.
K(2n) = 30 = 2A_b + 2A_c + 2B + 2C + 2D_1 + 6D_2 + 4E_2 + 4F_3 + 2F_4

Juro-ba (retracted + dragonfly + side reduced): Fig. 9 a, b.

K(2n) = 30 = 2A_c + 2A_c + 2B + 4B_2 + 4C_c + 2D_1 + 10D_2 + 4E_3

Tenshin (variagated retracted-dragonfly): Fig. 10 a, b.

K(2n) = 30 = 2A_c + 2B_c + 4B_2 + 6C_1 + 2C_1 + 2C_2 + 2C_3 + 4C_4 + 2D_2 + 4D_2 + 2E_3

Figs. 1b—12b

Chijimi-ariake (crepe): Fig. 11 a, b.

K(2n) = 30 = 2A_c + 2B_c + 6B_c + 6C_1 + 2D_2 + 2D_2 + 2E_3 + 2F_4 + 2F_4 + 4F_4

Chijimi-saki (wrinkled): Fig. 12 a, b.

K(2n) = 30 = 2A_m + 2B_m + 2C_1 + 2C_1 + 2D_2 + 2D_2 + 2D_2 + 2D_2 + 2E_2 + 6E_3

+ 2F_4 + 2F_4 + 4F_4

Shidare (weeping): Fig. 13 a, b.
K\( (2n) = 30 \) = \( 2^t A_1^{st} + 2A_2^{st} + 2B_1^{st} + 2B_2^{st} + 8B_3^{st} + 2C_1^{st} + 2C_2^{st} + 6C_3^{st} + 4E^{st} \)

Kodachi (dwarf): Fig. 14 a, b.

K\( (2n) = 30 \) = \( 2^t A_1^{sm} + 2A_2^{sm} + 2A_3^{sm} + 2B_1^{sm} + 2B_2^{sm} + 2^t C_1^{sm} + 2C_2^{sm} + 12C_3^{sm} + 2D_1^{st} + 2D_2^{st} \)

Tatsuta (maple): Fig. 15 a, b.

K\( (2n) = 30 \) = \( 4A_1^{st} + 2A_2^{st} + 4B_1^{st} + 2B_2^{st} + 4^t C_1^{st} + 2C_2^{st} + 4C_3^{st} + 4C_4^{st} + 2D_1^{st} + 2D_2^{st} \)

Rangiku (polymorphic): Fig. 16 a, b.

K\( (2n) = 30 \) = \( 4c_1 A_1^{sm} + 2A_2^{sm} + 2B_1^{sm} + 2B_2^{sm} + 2C_1^{st} + 2C_2^{st} + 8C_3^{st} + 2D_1^{st} + 4D_2^{st} + 2E^{st} \)

B. Uncommon strains

Murasaki-fubuki (purple, brizzard): Fig. 17 a, b.
K(2n) = 30 = 2A_{m} + 4'B_{t} + 2B_{n} + 10C_{t} + 2C_{m} + 2'D_{t} + 6D_{t} + 2E_{t}

Uzu-yanagi (contracted, willow): Fig. 18 a, b.

K(2n) = 30 = 2A_{t} + 2'B_{t} + 4B_{t} + 2B_{t} + 2'B_{t} + 2'C_{t} + 2'C_{t} + 2C_{t} + 2C_{t} + 2'D_{t} + 6D_{t} + 2E_{t} + 4D_{t} + 2E_{t}

Uzu-kuruma-maru (contracted): Fig. 19 a, b.

K(2n) = 30 = 2A_{t} + 2'B_{t} + 4B_{t} + 4'B_{t} + 2'B_{t} + 2'B_{t} + 2'C_{t} + 6D_{t} + 6D_{t} + 6E_{t}

Uzu-kikyo-yae (contracted, star, petaloid): Fig. 20 a, b.

K(2n) = 30 = 4A_{m} + 2B_{t} + 4B_{t} + 4'B_{t} + 2'B_{t} + 2'C_{t} + 6D_{t} + 6D_{t} + 6E_{t}

Maru-kuruma (reversed, duplicated): Fig. 21 a, b.

K(2n) = 30 = 4A_{t} + 4'B_{t} + 6B_{t} + 8C_{t} + 2'D_{t} + 2D_{t} + 4E_{t}

Gudai-momo (crepe, pink reversed petaloid): Fig. 22 a, b.

K(2n) = 30 = 2A_{m} + 2B_{m} + 6C_{t} + 2C_{m} + 4'C_{t} + 6D_{m} + 2'E_{t} + 2'E_{t} + 2F_{t}

Shishi-A (ferthered): Fig. 23 a, b.

K(2n) = 30 = 2A_{t} + 4'B_{t} + 2B_{t} + 4B_{t} + 2'B_{t} + 2'B_{t} + 2'C_{t} + 4C_{t} + 2D_{t} + 4D_{t} + 4E_{t}

Itoba-itozaki-botan (willow, delicate, duplicated): Fig. 24 a, b.

K(2n) = 30 = 2A_{t} + 2A_{m} + 2'B_{t} + 2'C_{t} + 4C_{m} + 4C_{m} + 2'D_{t} + 10D_{t} + 2E_{t}

Hariba-itozaki-botan (acuminate, delicate, duplicated): Fig. 25 a, b.

K(2n) = 30 = 2A_{t} + 4A_{m} + 2A_{m} + 2'B_{t} + 4'B_{t} + 4B_{m} + 4'C_{t} + 6C_{m} + 2C_{m} + 2D_{t}

The karyotype of some strains among them has not been definitely determined, and it may be said that even in each group the karyotype may be different among strains. Accordingly, at present it seems difficult to discuss the kinship among the strains it will well be done when the karyotype of more strains is definitely determined.

Literature cited


