# Comparative Morphology of Some Japanese Chrysanthemums (Preliminary Report)

By

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NIWA (1936) has carried out detailed morphological studies on the numerous cultivated and several wild species of Japanese *Chrysanthemum*. Taxonomically KITAMURA (1940) has investigated all the species of the genus in this country. The present author is engaged in the study of polyploidy in chrysanthemums, using some species of eastern Japan. Little work has been done up to now dealing with the relation between the external characters and polyploidy in the genus. This paper is a preliminary report on comparative morphology of Japanese chrysanthemums in relation to polyploidy.

The author expresses his sincerest thanks for many kind advices to Dr. Y. TAKENAKA of the National Institute of Genetics and Dr. M. KITAGAWA of the Yokohama National University. Thanks are also due to Dr. F. A. LILIENFELD of the National Institute of Genetics for reading the manuscript.

## I. Material

Materials investigated are shown in Tab. 1. The plants used are classified by KITAMURA (1940) as follows:

*Chrysanthemum* L.
- Section *Pyrethrum*
  - Subsection 1. *Nipponicae*
    - *Ch. nipponicum* MATSUM.
  - Subsection 2. *Leucanthemum*
    - *Ch. arcticum* L. subsp. *Maekawanum* KITAMURA
  - Subsection 3. *Dendranthema*
    - *Ch. Makinoi* MATSUM. et NAKAI
    - *Ch. boreale* MAKINO
    - *Ch. rupestre* MATSUM. et KOIDZUMI
    - *Ch. Shiwogiku* KITAMURA var. *kinokuniense* SHIMOTOMAI et KITAMURA
    - *Ch. pacificum* NAKAI

Among the seven, the following two species are dealed with by NIWA (1936): *Ch. nipponicum* and *Ch. Makinoi*, though the latter is treated as *Ch. japonicum*. As to the cytological data on the seven species, details can be

found in the following papers: TAHARA (1914–'15, 1921), SHIMOTOMAI (1933), and NAGAMI (1957). Concerning their geographical distribution, readers are referred to MAEKAWA (1921), SHIMOTOMAI (1933), and NAGAMI (1954, '56). Materials used are sampled from small populations showing the typical phenotypes. The localities, from which the seven samples were obtained, are listed in Tab. 1.

Tab. 1. Wild chrysanthemums in eastern Japan.

| species | chromosome number (2n) | habitat | locality |
|---|---|---|---|
| *Chrysanthemum nipponicum* MATSUM. | 18 | coast | Shiwogama (Miyagi Prefecture) |
| *Ch. Makinoi* MATSUM. et NAKAI | 18 | inland & mountain | Mishima (Shizuoka Pref.) |
| *Ch. boreale* MAKINO | 18 | inland | Takao (Tokyo) |
| *Ch. rupestre* MATSUM. et KOIDZUMI | 18 | mountain | Mt. Tanigawa (Gumma Pref.) |
| *Ch. Shiwogiku* KITAMURA var. *kinokuniense* SHIMOTOMAI et KITAMURA | 72 | coast | Shirahama (Wakayama Pref.) |
| *Ch. pacificum* NAKAI | 90 | coast | Misaki (Kanagawa Pref.) |
| *Ch. arcticum* L. subsp. *Maekawanum* KITAMURA | 90 | coast | Shiwogama (Miyagi Pref.) |

## II. Results

Some results obtained by the author's observations on the external characters of the seven chrysanthemums are summarized in Tab. 2 and Fig. 1. For convenience, each species is designated respectively by the letters as follows: *Ch. nipponicum*—N, *Ch. Makinoi*—M, *Ch. boreale*—B, *Ch. rupestre*—R, *Ch. Shiwogiku* var. *kinokuniense*—S, *Ch. pacificum*—P, and *Ch. arcticum* subsp. *Maekawanum*—A.

## III. Summary and Discussion

1. The materials morphologically compared are as follows: *Chrysanthemum nipponicum* (N), *Ch. Makinoi* (M), *Ch. boreale* (B), *Ch. rupestre* (R), *Ch. Shiwogiku* var. *kinokuniense* (S), *Ch. pacificum* (P), and *Ch. arcticum* subsp. *Maekawanum* (A). According to KITAMURA (1940), they are classified as follows:

*Chrysanthemum* L.
- Section *Pyrethrum*
  - Subsection 1. *Nipponicae*—N
  - Subsection 2. *Leucanthemum*—A
  - Subsection 3. *Dendranthema*—M, B, R, S, P

Tab. 2. Morphological characters of seven wild chrysanthemums of eastern Japan. N, *Ch. nipponicum*; M, *Ch. Makinoi*; B, *Ch. boreale*; R, *Ch. rupestre*; S, *Ch. Shiwogiku* var. *kitakamiense*; P, *Ch. pacificum*; A, *Ch. arcticum* subsp. *Maekawanum*

| species | inflo-rescence | diameter of head | florets | | | | involucral bracts | | | | flower-ing season | height | growth habit | lamina | petiole | stipule | hair |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ligulate | | tubular | | outer | | inner | | | | | | | | |
| | | | form | colour | form | colour | form | margin | form | margin | | | | | | | |
| N | terminal | 43 mm | 4-nerved. narrowly oblong. broadly linear. 2-denticulate, obtuse or rounded at apex. t. l (total length), 23 mm. co (corolla), 5×21 mm. ov (ovary), 2 mm. | white | tubular. t. l, 6.6 mm. co, 4.6 mm. ov, 1 mm. | yellow | triangular ovate. acute at apex. 6×10 mm. | lacerate. narrowly scarious. | rhombic oblong. rounded at apex. wholly scarious. 4×12 mm. | irregularly crenulate. | Sept.–Oct. | 50–100 cm | perennial (suffrutescent). erectous. branched. no creeper found. | broadly oblanceolate. obtuse at apex. cuneate at base. crenate-serrate at margin. 3×9 cm. | sessil | | |
| M | corymbose | 30 mm | 4-nerved. oblong. 3-denticulate at apex. t. l, 11 mm. co, 3×10 mm. ov, 0.7 mm. | white | funnel-shaped. t. l, 5 mm. co, 4 mm. ov, 1 mm. | yellow | narrow ovate. convex at keel. pubescent outside. 2×5 mm. | entire | obovate. wholly scarious. 3×7 mm. | undulate at upper part. | Oct.–Nov. | 40–60 cm | perennial (herbaceous). erectous. branched at upper part. some creepers found. | deltoid-ovate. tri-fid. acute at apex. rounded at base. obtusely mucronate-dentate at margin. 3×3.5 cm. | short. 0.5 cm. | | +++ forked |
| B | corymbose | 13 mm | 4-nerved. oblong. 3-denticulate at apex. t. l, 7 mm. co, 1.7×6 mm. ov, 0.7 mm. | yellow | somewhat funnel-shaped. t. l, 4.5 mm. co, 4 mm. ov, 1 mm. | yellow | linear-subulate. pubescent outside. 0.5×3 mm. | entire | narrow elliptic. wholly scarious. 2.5×6 mm. | obsoletely denticulate. | Oct.–Nov. | 60–120 cm | perennial (herbaceous). erectous. fasciculate. branched at upper part. abundant creepers found. | broadly ovate. 2-jugo-pinnatiparted. acumate at apex. cordate at base. obtusely mucronate-dentate at margin. 8×8 cm. | short. 2 cm. | | ++ forked |
| R | corymbose | 3.5 mm | | | tubular. t. l, 5 mm. co, 3.2 mm. ov, 1.8 mm. | yellow | subulate. foliaceous. 0.5×1.7 mm. | minutely lacerate. | oblong–elliptic. scarious. 1.5×3 mm. | minutely lacerate. | Aug.–Sept. | 13–20 cm | perennial (herbaceous). erectous. branched at upper part. many creepers found. | ovate. pinnately parted. lobes linear entire. acuminate at apex. cuneate at base. 2×2.5 cm. | winged. 1.5 cm. | paired. minute. | +++++ forked |
| S | corymbose | 7 mm | | | funnel-shaped. t. l, 5 mm. co, 3.2 mm. ov, 1.8 mm. | yellow | subulate. slightly lacerate at apex. 1×6 mm. | minutely lacerate. | elliptic–ovate slightly lacerate at apex. scarious. 3×5 mm. | entire | Nov.–Dec. | 30–60 cm | perennial (herbaceous). erectous or oblique. branched at upper part. many creepers found. | spathulate. obtusate at apex. cuneate at base. coarsely few dentate at upper part. 1.5×6 cm. | sessil | paired. minute. | +++++ forked |
| P | corymbose | 5 mm | | | tubular. t. l, 5 mm. co, 3.1 mm. ov, 1.9 mm. | yellow | lanceolate-subulate. pubescent. 1×4 mm. | minutely lacerate. | ovate. wholly scarious. 3×5 mm. | entire | Oct.–Dec. | 30–60 cm | perennial (herbaceous). erectous or oblique. branched at upper part. many creepers found. | oblong. obtuse at apex. long-cuneate at base. coarsely few dentate at upper part. 2×6 cm. | almost sessil. | paired. minute. | ++++ forked |
| A | corymbose | 45 mm | 4-nerved. linear-oblong. 3-denticulate, teeth rounded at apex. t. l, 22 mm. co, 6×20.2 mm. ov, 1.8 mm. | white | tubular. t. l, 6.4 mm. co, 4.4 mm. ov, 2 mm. | yellow | lanceolate-subulate. pubescent. 2×7 mm. | minutely lacerate. | spathulate. wholly scarious. 3.5×9 mm. | lacerate at upper part. | Sept.–Dec. | 15–40 cm | perennial (herbaceous). erectous. few branched at upper part. many creepers found. | broadly ovate-cuneate. rounded at apex. truncate-cuneate at base. irregularly incised and acuminate-dentate at margin. 6×6 cm. | long. winged. 6 cm. | | + spine-shaped |

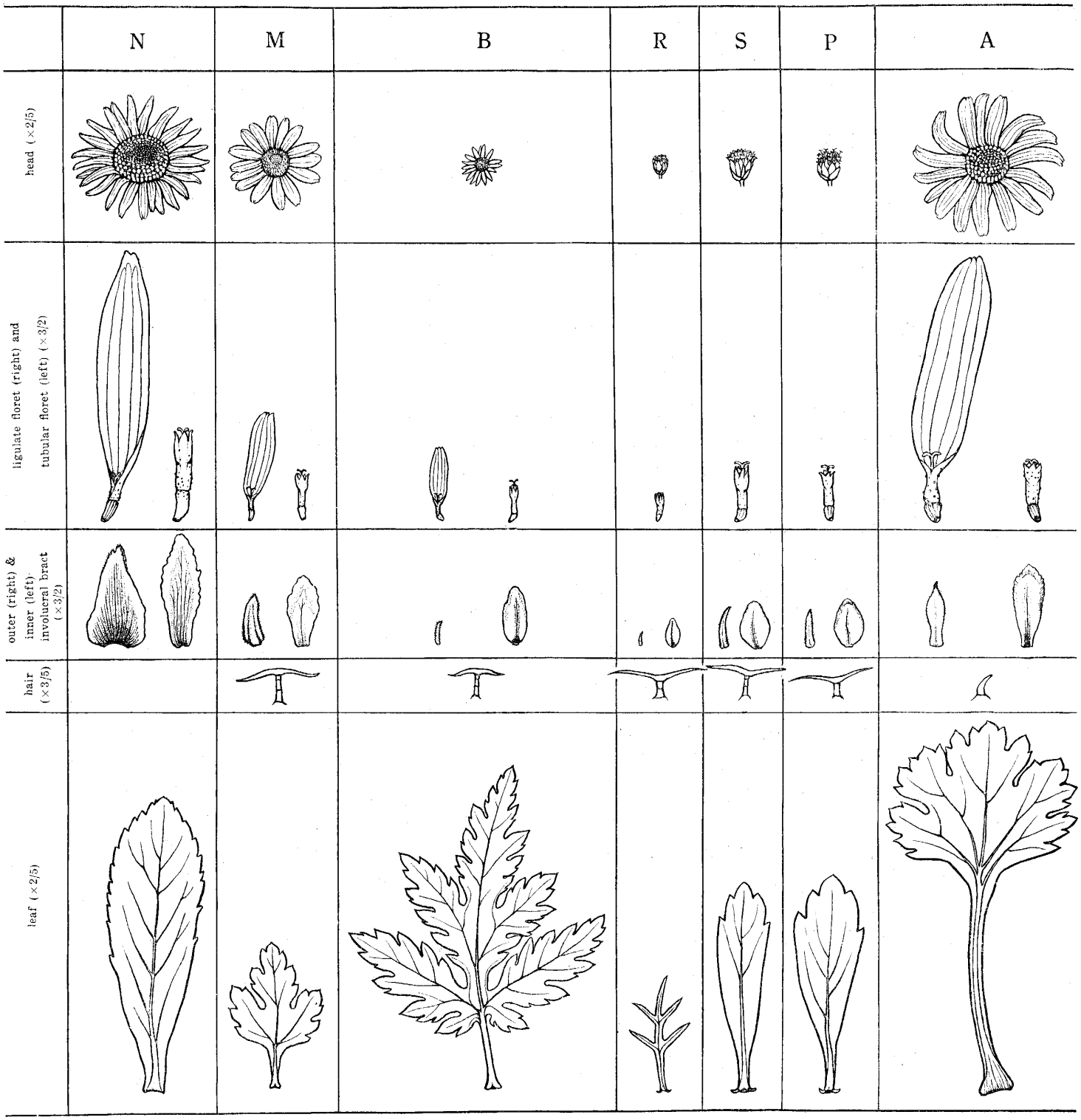


Fig. 1. Flowers and leaves of seven chrysanthemums of eastern Japan.
N, *Ch. nipponicum*; M, *Ch. Makinoi*; B, *Ch. boreale*; R, *Ch. rupestre*; S, *Ch. Shiwogiku* var. *kinokuniense*; P, *Ch. pacificum*; A, *Ch. arcticum* subsp. *Maekawanum*.

Among them, four, N, M, B and R, are diploid, and three, S (octoploid), P (decaploid) and A (decaploid), are polyploid.

2. It may be concluded that the results obtained by the author generally support the view of KITAMURA (1940) on the classification of the seven chrysanthemums. But it must be pointed out that in Subsection *Dendranthema* no clear description is given with respect to the differences between the species group with ligulate floret (M and B) and that without them (R, S and P).

The differences between the two groups are summarized as follows: (a) the former has ligulate florets, and the latter has none, (b) the former has entire involucral bracts, and the latter minutely lacerate ones, (c) the former has no stipules, and the latter has paired and minute ones, and (d) the former has few hairs on the lower-surface of leaf, and the latter has numerous haires which cause the whitish appearance for the lower-surface of it.

3. Close similarities are found between the two species of S and P. This fact is indicated in Tab. 2 and Fig. 1. It is rather difficult to discern all the phenotypical differences between the two, without the aid of cytological and ecological data which are: (a) S is 2n=72 (octoploid) and P 2n=90 (decaploid), (b) S is found along the Pacific coast of Japan from Osasu (Mie Prefecture) to Hinomisaki (Wakayama Pref.), and P on the same coast from Choshi (Chiba Pref.) to Omaezaki (Shizuoka Pref.).

4. The author's interest is concentrated on the origin of decaploid chrysanthemum, P. As indicated in Tab. 2 and Fig. 1, S is the most related to P, and N is the most different from P. The other species are intermediate between S and N, and can be represented as follows: (S>R)>(M>B)>(A)>(N).

5. MÜNTZING (1936), STEBBINS (1938), FAGERLIND (1944), GUSTAFSSON (1947, '48) and other researchers have pointed out the following facts: (a) polyploidy is found more frequently in perennial herbs than in annuals, and (b) the development of perenniality is a factor determining the origin of polyploidy. As pointed out by TAHARA (1914–'15, 1921), and SHIMOTOMAI (1933), polyploidy is observed among the Japanese chrysanthemums, which are all perennial. It is a remarkable fact that among the seven perennials found in eastern Japan four (N, M, B and R) are diploid and three (S, P and A) are polyploid.

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