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The cytotaxonomy of naturalized British *Mimulus*

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ABSTRACT

Naturalized British *Mimulus guttatus* Fischer ex DC. is diploid, $n = 14$. *M. moschatus* Dougl. ex Lindl. is also diploid, $n = 16$. Five hybrid clones derived from *M. guttatus* and species of the *M. luteus* L. complex (*M. luteus*, *M. cupreus* Dombrain and *M. tigrinus* hort.) had $2n = 45$ and were sterile.

Three *Mimulus* species of American origin are naturalized in Britain. The North American *M. guttatus* Fischer ex DC. and *M. moschatus* Dougl. ex Lindl. and the South American *M. luteus* L. are part of the present-day British flora (Perring & Walters 1962, Warburg 1962, Roberts 1964). In addition, putative sterile hybrids of *M. guttatus* × *M. luteus* and *M. cupreus* × *M. guttatus* have been widely observed in Britain as escapes (Roberts 1964, 1968). *M. cupreus* Dombrain is a South American species which belongs to the *M. luteus* complex (Vickery 1969). It has been introduced to Britain as a garden plant but is doubtfully naturalized (Roberts 1968).

This note reports chromosome numbers and pairing of some naturalized British *Mimulus* populations. All chromosome observations were made on meiotic preparations of (1) fresh pollen-mother-cells (PMCs) stained in acetic orcein, or (2) PMCs which had been fixed in 1:3 acetic alcohol, stored in 70% alcohol and squashed in aceto-carmine. Vouchers for each population studied have been deposited in the University of Utah (**UT**) herbarium.

In North America, *M. guttatus* ranges from the Aleutian Islands to the Mexican state of Chihuahua and from the Pacific Coast inland to the Rocky Mountains. Over most of its range it is diploid ($n = 14$) but scattered tetraploid ($n = 28$) populations have evolved at the northwestern and southeastern limits of its range (McArthur *et alii* 1972). All six British populations reported here are diploid with $n = 14$ (Table 1).

The single population of *M. moschatus* examined has $n = 16$ (Table 1) as does western North American material (Mukherjee & Vickery 1961, Vickery & Tai 1970).

M. luteus occurs naturally along the flanks of the Andean Cordillera in Chile and Argentina. Although reported as widely distributed in Britain (Perring & Walters 1962), it is in fact quite rare. Many records of it are really records of hybrids between *M. luteus* and *M. guttatus* (Roberts 1964). *M. luteus* has aneuploid chromosome races of $n = 30$, 31 and 32 (Vickery 1969). Nineteenth-century European horticulturalists were active in developing showy garden plants using *M. luteus* and *M. cupreus* as stock (Grant 1924). Many races of these

TABLE 1. CHROMOSOME-PAIRING DATA FOR NATURALIZED BRITISH *MIMULUS*

Taxon	Locality and collection number	No. of cells studied	Chromosome-pairing	
			Range	Mean
M. guttatus	McArthur 37 Along banks and in sandpits of River Nidd, one mile west of Birstwith, Mid-W. Yorks., v.c. 64	37	14_{II}	14_{II}
M. guttatus	McArthur 38 Along banks of River Skell at Fountains Abbey, Mid-W. Yorks., v.c. 64	21	14_{II}	14_{II}
M. guttatus	McArthur 39 Along banks and around supports of stone bridge over the River Dee, Chester, Cheshire, v.c. 58	14	14_{II}	14_{II}
M. guttatus	McArthur 44 In a small stream which crosses the A5 road about one mile east of Maerdy, Denbigh, v.c. 50	28	14_{II}	14_{II}
M. guttatus	R. H. Roberts[1] Bridge of Earn, Mid Perth, v.c. 88	4	14_{II}	14_{II}
M. guttatus	McArthur 49 Along banks of Jed Water, Jedburgh Abbey, Roxburgh, v.c. 80	11	14_{II}	14_{II}
M. guttatus × *M. luteus* (*guttatus*-like)	McArthur 35 In marshy area near Meanwood Beck, off Parkside Road and Ring Road, Meanwood, Leeds, Mid-W. Yorks., v.c. 64	59	$0–3_{III}+7–15_{II}+15–31_{I}$	$0{\cdot}29_{III}+10{\cdot}61_{II}+22{\cdot}92_{I}$
M. guttatus × *M. luteus* (*luteus*-like)	McArthur 40[2] Small stream at Nant y Garth, near Port Dinorwic, Caernarvon, v.c. 49	16	$0–1_{III}+6–14_{II}+14–33_{I}$	$0{\cdot}12_{III}+12{\cdot}44_{II}+19{\cdot}76_{I}$
M. guttatus × *M. tigrinus* (*tigrinus*-like)	McArthur 42[2] In a small stream at Gerlan, Bethesda, Caernarvon, v.c. 49	5	$0–1_{III}+11–14_{II}+17–21_{I}$	$0{\cdot}40_{III}+12{\cdot}40_{II}+19{\cdot}00_{I}$
M. guttatus × *M. tigrinus* (*tigrinus*-like)	McArthur 43[2] In stream at Llanllechid, Caernarvon, v.c. 49	1	$14_{II}+17_{I}$	$14_{II}+17_{I}$
M. guttatus × *M. cupreus* (*cupreus*-like)	R. C. Palmer and W. Scott,[3] 1962 Near Scalloway, Mainland, Zetland, v.c. 112		Only second division cells were observed. $n = 45/2$	
M. moschatus	McArthur 36 In marshy area near Meanwood Beck, off Parkside and Ring Roads, Meanwood, Leeds, Mid-W. Yorks., v.c. 64	43	16_{II}	16_{II}

[1] Provided by R. H. Roberts.
[2] Collected 1971, with R. H. Roberts. Studied by Roberts (1964).
[3] Provided by R. H. Roberts. Studied by Roberts (1968).

two species are readily interfertile and produce fertile progeny (Roberts 1968, Vickery 1969). Some horticultural selections were developed with large, showy, yellow corollas blotched with red anthocyanin spots of various sizes and variously distributed; these were called *M. tigrinoides* hort. or *M. tigrinus* hort. (Grant 1924, Miller & Bailey 1929). These selections also have $n = 31 \pm 1$ (Mukherjee & Vickery 1959, 1960; Mia *et alii* 1964) or $2n = c\ 64$ (Brožek 1931, 1932) and are fertile. In Britain, however, selection has apparently been taken a step further. The horticultural selections, either by natural pollination or human design, were hybridized with *M. guttatus* producing sterile hybrids. I examined scores of garden plants from private and public gardens in Yorkshire, Lancashire, Cheshire, Durham, and Northumberland. Morphologically most of the plants

resembled the showy *M. tigrinus*, but some were more like *M. luteus*, *M. cupreus* or *M. guttatus*. None of these garden plants produced seed. Possibly the hybrids are so widely used because they do not seed themselves around the garden. It may also be, as suggested by Roberts (1964), that the hybrids are more winter-hardy than *M. luteus*. In any case, sterile hybrids of several morphological types are widely grown in Britain. They have spread and occur as naturalized clones along water-courses and in other wet places. The chromosome constitution of five of these clones was analyzed (Table 1). They all have $2n = 45$. Analysis of 81 cells from four clones indicates a mean pairing association of $0{\cdot}26_{III} + 11{\cdot}12_{II} + 21{\cdot}98_{I}$ with a range of $0\text{-}3_{III} + 6\text{-}15_{II} + 14\text{-}33_{I}$. These pairing results are essentially similar to those obtained by Mukherjee & Vickery (1962) and Mia & Vickery (1968) with greenhouse synthesized hybrids of *M. guttatus* × *M. luteus*. Most of the chromosome pairing in these hybrids has been attributed to the presence of a basic, 14 chromosome genome throughout most of section *Simiolus* Greene (Vickery 1966). Both *M. guttatus* and the *M. luteus* complex belong to this section.

The only previous chromosome count of naturalized British *Mimulus* was by Maude (1940). She reported a root-tip count of $2n = 48$ for *M. langsdorfii* Donn (= *M. guttatus*), a chromosome number otherwise unrecorded for *M. guttatus*. This suggests that her specimen may have been a *M. guttatus*-like hybrid or a tetraploid *M. guttatus*. *Mimulus* chromosomes are small (0·5–3·0 μm) and often difficult to distinguish.

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REFERENCES

BROŽEK, A. (1931). Further investigations on the genetics of flower colours in *Mimulus cardinalis* Hort. *Preslia*, **10**: 42–46.

BROŽEK, A. (1932). Mendelian analysis of the 'red-orange-yellow' group of flower-colours in *Mimulus cardinalis* Hort. *Preslia*, **11**: 1–11.

GRANT, A. L. (1924). A monograph of the genus *Mimulus*. *Ann. Mo. bot. Gdn*, **11**: 99–389.

MAUDE, P. F. (1940). Chromosome numbers in some British plants. *New Phytol.*, **39**: 17–32.

MCARTHUR, E. D., ALAM, M. T., ELDREDGE, F. A., TAI, W. & VICKERY, R. K. (1972). Chromosome counts in section *Simiolus* of the genus *Mimulus* (Scrophulariaceae), IX. Polyploid and aneuploid patterns of evolution. *Madroño*, **21**: 417–420.

MIA, M. M., MUKHERJEE, B. B., & VICKERY, R. K. (1964). Chromosome counts in section *Simiolus* of the genus *Mimulus* (Scrophulariaceae), VI. New numbers in *M. guttatus*, *M. tigrinus*, and *M. glabratus*. *Madroño*, **17**: 156–160.

MIA, M. M. & VICKERY, R. K. (1968). Chromosome counts in section *Simiolus* of the genus *Mimulus* (Scrophulariaceae), VIII. Chromosomal homologies of *M. glabratus* and its allied species and varieties. *Madroño*, **19**: 250–256.

MILLER, W. & BAILEY, L. H. (1929). *Mimulus*, in BAILEY, L. H. *The standard cyclopedia of horticulture*, **2**: 2054–2055. New York.

MUKHERJEE, B. B. & VICKERY, R. K. (1959). Chromosome counts in the section *Simiolus* of the genus *Mimulus* (Scrophulariaceae), III. *Madroño*, **15**: 57–62.

MUKHERJEE, B. B. & VICKERY, R. K. (1960). Chromosome counts in the section *Simiolus* of the genus *Mimulus* (Scrophulariaceae), IV. *Madroño*, **15**: 239–245.

MUKHERJEE, B. B. & VICKERY, R. K. (1961). Chromosome counts in the genus *Mimulus* (Scrophulariaceae). *Madroño*, **16**: 104–105.

MUKHERJEE, B. B. & VICKERY R. K. (1962). Chromosome counts in the section *Simiolus* of the genus *Mimulus* (Scrophulariaceae), V. The chromosomal homologies of *M. guttatus* and its allied species and varieties. *Madroño*, **16**: 141–155.

PERRING, F. H. & WALTERS, S. M., eds. (1962). *Atlas of the British flora*. London.

ROBERTS, R. H. (1964). *Mimulus* hybrids in Britain. *Watsonia*, **6**: 70–75.

ROBERTS, R. H. (1968). The hybrids of *Mimulus cupreus*. *Watsonia*, **6**: 371–376.

VICKERY, R. K. (1966). Speciation and isolation in section *Simiolus* of the genus *Mimulus*. *Taxon*, **15**: 55–63.

VICKERY, R. K. (1969). Crossing barriers in *Mimulus*. *Jap. J. Genet.*, **44**, Suppl. **1**: 325–336.

VICKERY, R. K. & TAI, W. (1970). In LÖVE, A. IOPB chromosome number reports, XXVII. *Taxon*, **19**: 437–442.

WARBURG, E. F. (1962). *Mimulus*, in CLAPHAM, A. R., TUTIN, T. G. & WARBURG, E. F. *Flora of the British Isles*, 2nd ed., pp. 684–685. Cambridge.

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