

ORIGIN, NATURE AND LIMIT OF POLYPLOIDY IN MARIGOLDS

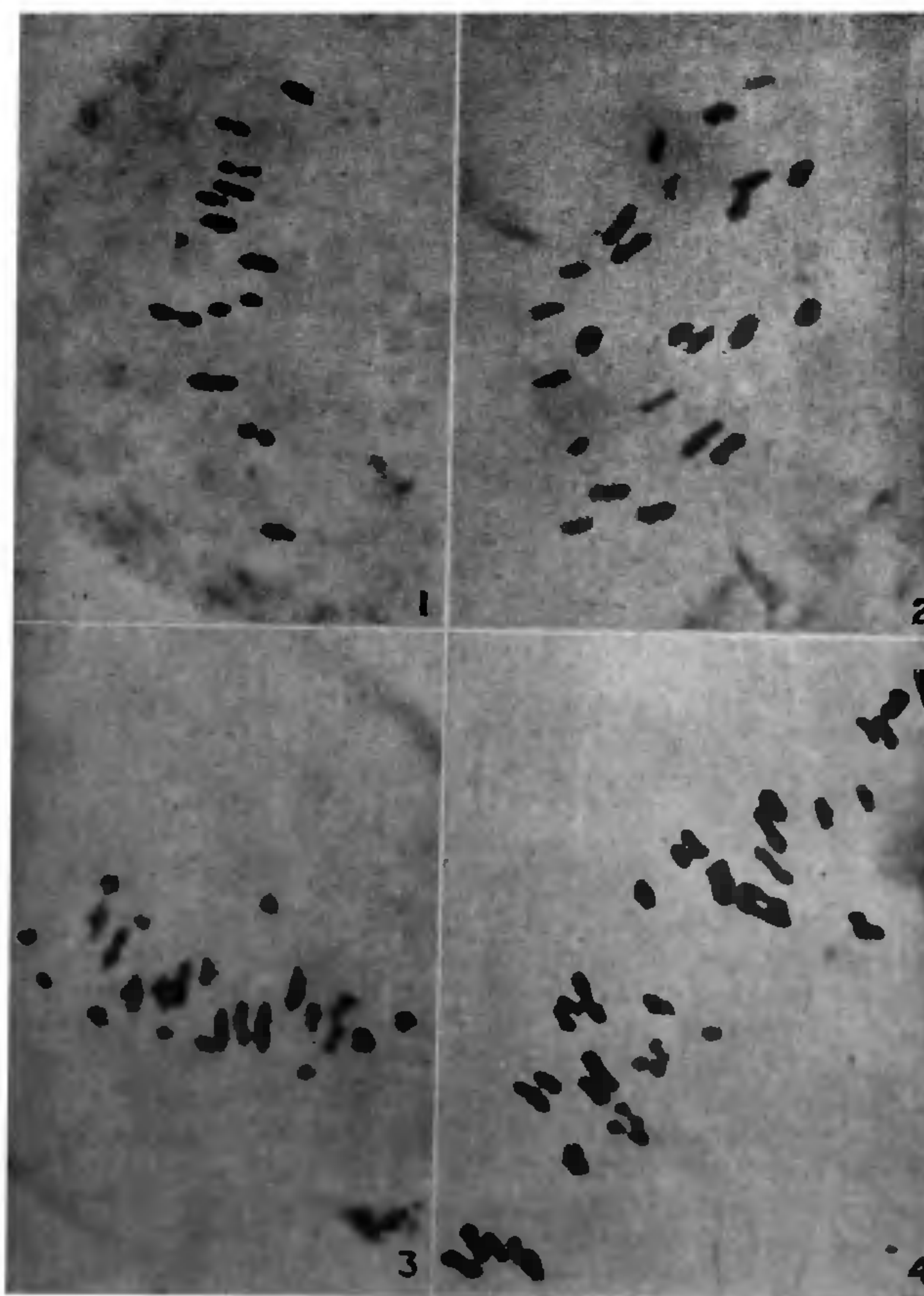
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THE two marigolds, the African (*Tagetes erecta* Linn.) and the French (*T. patula* Linn.), are actually natives of Mexican region and their popular names are misleading inasmuch as these have been acquired during their roundabout entry in Europe. In India these were introduced by Portuguese⁷ and spread quickly because of the ease in cultivation, adaptability to varying soil and climatic conditions, longer blooming period and beautiful flowers that have excellent keeping quality. At present, marigolds constitute one of the five most commonly cultivated

and used flowers in urban and rural India. Furthermore, the rapid diffusion of marigolds both in India and Southern Europe by the Portuguese and Spanish indicates that, during the pre-Columbian domestication, these species had become sufficiently attractive ornamentals in the region of their origin and there is ethno-botanical evidence for their long selection history in relation to religious ceremonies which led to morphological diversification in them³.

T. erecta, a diploid ($n = 12$; Fig. 1), is generally tall (about 90 cm) with large double flowers.



FIGS. 1-4. Metaphase I in pme in *T. erecta* (12 II, Fig. 1), *T. patula* (24 II, Fig. 2), F_1 *T. erecta patula* (12 II + 12 I, Fig. 3) and amphiploid *T. erecta-patula* (2 IV + 32 II, Fig. 4), $\times 1,500$.

Heterosis has been exploited in this species with remarkable success and F_1 hybrids are medium tall with often very large (15.2 cm across) uniform flowers. Even types with odourless foliage have been evolved. *T. patula*, on the other hand, is a dwarf (15–45 cm) tetraploid ($n=24$; Fig. 2) species with relatively small flowers (2.5–5.1 cm). While former has orange to very light lemon coloured flowers, in the latter the colour varies from golden yellow to rusty red and all combinations in between.

The tall habit and smell of the leaves of *T. erecta* have been generally regarded as undesirable characters. For this reason, triploid interspecific hybrids (*T. erecta* \times *patula*) have been marketed in the USA and have been preferred because they combine the characters like relatively large double flowers (5.1–7.6 cm) with medium tall to dwarf habit, and diversity in colour and prolificity of flowering. On an average the triploids show 0.1 III + 12.35 II + 11.0 I (Table I) at metaphase I in male meiosis. The most common association being 12 II + 12 I (Fig. 3). Meiosis is highly irregular leading to sterility which confers the character of continued blooming.

there is morphological diversity and also variation in fertility. There is, however, no correlation between chromosome number, morphology and fertility of C_1 segregates.

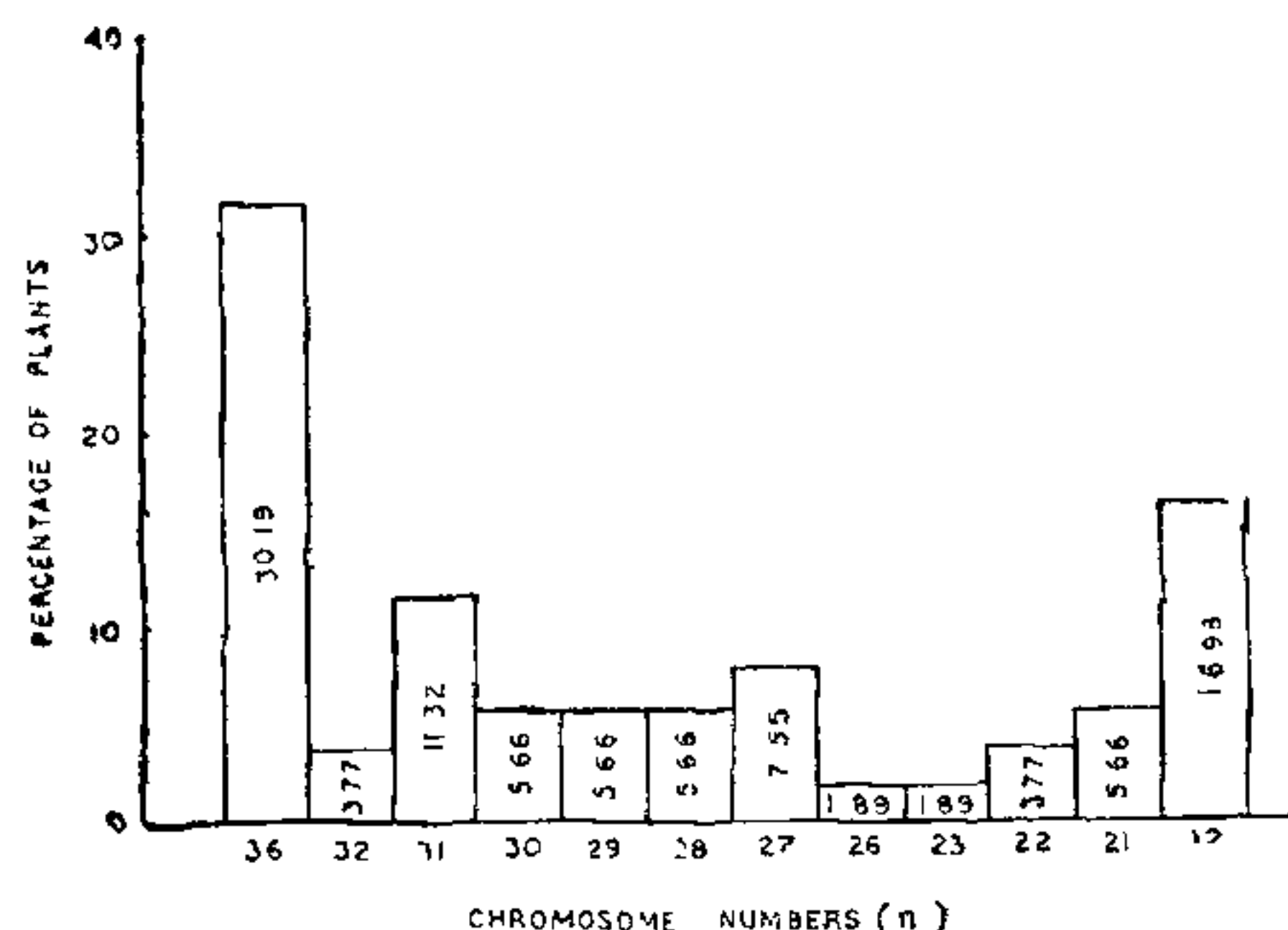


FIG. 5. Chromosomal variation in C_1 progeny of amphiploid *T. erecta-patula*.

Based on the morphological and cytogenetical evidence, Towner⁶ and Bolz¹ have concluded that *T. patula* ($2n=48$ ApAp BpBp) is probably of amphidiploid origin between *T. erecta* (A_1A_1) and

TABLE I

Chromosome associations, chiasma frequency and fertility in species and hybrids of marigold
(Range is given within brackets)

Taxon	2n	Associations at metaphase				Xa frequency	Fertility (%)	
		IV	III	II	I		Pollen	Seed
<i>T. erecta</i>	24	11.9 ± 0.02 (11–12)	0.2 ± 0.04 (0–2)	20.25 ± 0.59 (17–22)	76.46	91
<i>T. patula</i>	48	24	..	42.65 ± 0.605 (38–46)	92.14	94
<i>T. erecta</i> \times <i>patula</i>	36	..	0.1 ± 0.02 (0–1)	12.35 ± 0.007 (9–16)	11.0 ± 0 (4–18)	23.4 ± 1.08 (15–30)	0–33	0
<i>T. erecta-patula</i>	72	0.75 ± 0.012 (0–2)	..	33.95 ± 0.04 (30–36)	1.1 ± 0.09 (0–6)	59.65 ± 1.70 (45–69)	57.28	42

Colchi-hexaploids (Fig. 4) from the triploid hybrid showed generally 36 II but on an average there are 0.75 IV + 33.95 II + 1.1 I with reasonable male and female fertility (Table I). The C_1 progeny of the amphiploid *T. erecta-patula* was morphologically and cytologically very heterogeneous (Fig. 5). Out of the 80 plants raised, 68 were analysed in detail, and, of these, only 30.18% had the parental 6x number, while in the remaining 69.82% the number varied from $2n=64$ ($6x-8$) to 24 ($2x$). The plants with diploid number constituted nearly 17% being next highest to the 6x level. Parallel to cytological heterogeneity,

T. tenuifolia (B_1B_1) (both $2n=24$), or of taxa closely related to them. The two species show a strong reproductive barrier leading to very few good seeds in F_1 hybrid, seedling mortality, hybrid weakness and sterility. There are on an average hardly 4.4 II (range 0–11 II). On the other hand, the colchicine amphidiploids correspond morphologically with *T. patula* and, like it, are fertile with 24 II as a result of perfect preferential pairing. The extent and nature of homology between A genomes of *T. erecta* and *T. patula* can be assessed from the meiotic behaviour and fertility of the hybrid *T. erecta* \times *patula* and its amphiploid *T. erecta-*

patula. The *Diosera* scheme (12 II + 12 I) and total sterility in the former, is not consistent with 36 II and reasonable fertility in the latter. Thus A genomes in *T. erecta* and *T. patula* do not appear to correspond exactly as is also clear from the total sterility in F_1 triploid hybrid. Obviously, the genomic formulae, are only approximations and do not indicate homology/non-homology in absolute terms⁴. It cannot be said with certainty if the divergence in the prototype *T. patula* took place subsequent to its origin or that some closely related species to *T. erecta* has been the source of its A genome. Thus, out of the three genomes of hexaploid (A_1A_1 ApAp BpBp), two, though related, are, however, not able to work harmoniously, and this amphiploid is a typical segmental allohexaploid in character⁵ in that it possesses, apart from bivalents, a low multivalent frequency, partial fertility (Table I) and segregates genetically for parental characters due to inter-genomal pairing. Obviously, such a condition is not stable and must segregate in the direction of auto- or allo- or stable segmental allopolyploidy. Thus, it must undergo a period of rigorous selection for fertility and stability of desired morphological attributes. This is possible only when heterogenetic associations get restricted due to loss of large duplicated loci. The recovery of about 17%

diploids from the progeny of amphiploid *T. erecta-patula* is not an indication of the phenomenon of depolyploidy² as it is not a case of enbloc segregation of A_1 or Ap genomes, because the diploid progeny does not resemble diploid parental species in morphology or fertility.

The present results tend to indicate that hexaploidy may not be successful in marigolds. The highest level of ploidy reported in about 50% of the species⁶ of the genus *Tagetes* is tetraploidy. Furthermore, the long course of domestication has not been able to establish hexaploidy in *T. erecta* and *T. patula* complex, although there must have been ample opportunities for the same during the course of domestication extending for over 400 years.

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SEROLOGICAL GROUPING OF THE INDIAN BACTERIOPHAGES OF *XANTHOMONAS ORYZAE* (UYEDA AND ISHIYAMA) DOWSON

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THE importance of serological relationships in characterization and classification of bacteriophages including those affecting *Xanthomonas oryzae* has been emphasized by earlier workers¹⁻⁵. In India, Rao⁶ isolated phages for seventy-two isolates of *X. oryzae* collected from various parts of the country and grouped them into fourteen distinct strains based only on their physical properties and host range. The present work, therefore, was undertaken to study the serological behaviour of these phages.

MATERIALS

Two phages, viz., XOP₁₁⁶, polyphagous bacteriophage of Indian origin and OP₂, a well-studied

phage established by Japanese workers were used. Both these phages were grown on S₄ strain of *X. oryzae* (Cultures of the bacterium and phages were obtained from Dr. Y. P. Rao, I.A.R.I., New Delhi).

PREPARATION OF HIGH TITRED XOP₁₁ AND OP₂ PHAGE STOCKS

X. oryzae strain 4 was allowed to grow in P.G.S. broth having Peptone (10 g), Glutamic acid (0.5 g) and Sucrose (10 g) under aerobic conditions in a water bath (27°-30° C) provided with reciprocal shaker arrangements. When the population reached 5×10^7 cells/ml, approximately 500 phage particles each of XOP₁₁ and OP₂ were added separately to each ml of the bacterial culture. The number of