

planktonic foraminifera, which coincides with the upper part of NP4 of nannoplankton zone and suggested that the volcanism in Krishna–Godavari Basin lasted for about 6.0 m.y. Earlier, the lower basaltic flow was reported during Late Maastrichtian and upper flow was dated as Early Paleocene in age⁴. The present study very precisely suggests that Deccan volcanism initiated⁵ in ca. 67.4 m.y. (base of *Micula murus* zone) and ceased at ca. 63.6 m.y. (top of *Cruciplacolithus tenuis* zone). The volcanism in the Razole area of Krishna–Godavari basin lasted for about 3.8 m.y. and not 6.0 m.y. as visualized by earlier workers³.

Some of the calcareous nannofossils survived after the massive submarine volcanic eruption⁶ or the extra-terrestrial impact⁷, which are the probable causes of the mass extinction at the end of the Cretaceous. *Placozygus sigmoides* and *Thoracosphaera* spp. known as "survivors", show their presence in the basal Danian of the supratrappean sediments in the Razole area. The absence of *Faciculithus* spp. typical of Late Danian age further supports this dating. The blooms of *Thoracosphaera* apparently have a worldwide distribution and it is also considered as a marker for the Cretaceous/Tertiary boundary.

Nannofossil data of the supratrappean and infratrappean sediments suggests that the maximum duration of Deccan Volcanism is 3.8 m.y. in the Razole area of Krishna–Godavari Basin. During the recent years the palaeomagnetic, palaeontological and geochemical data from the Deccan continental flood basalts in India have been used to suggest that volcanic activity may have lasted less than 1 million years⁸. It will, therefore, be of interest if absolute dates of the flows just overlying CC26 zone and underlying NP2 zone of Razole subsurface are obtained for exact duration of volcanic episode.

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Bivalent interlocking and telomere adhesions in crown daisy

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Chrysanthemum coronarium L. (crown daisy), a diploid composite, possesses a versatile meiotic system, exhibiting chromosomal translocations, or bivalent interlocking and telomere adhesions or normal meiosis in different populations in a varying frequency. Whereas in some populations about 40% plants with radiate heads exhibit translocation heterozygosity, in the other populations 47% plants exhibit bivalent interlocking and telomeric adhesions; the remaining plants of these populations are meiotically normal. In about 85% PMCs, the bivalent interlocking is distinct, in the remaining 15% PMCs, it is bizarre due to overlapping and overcrowding of the diplotene/diakinesis bivalents and simulates ring interlocking. This early prophase interlocking and telomere adhesions do not impair the subsequent meiotic course which proceeds normally, resulting in high gametic and seed fertility ($\geq 93\%$).

CROWN daisy, *Chrysanthemum coronarium* L. (Compositae) ($2n = 2X = 18$), a native of Mediterranean

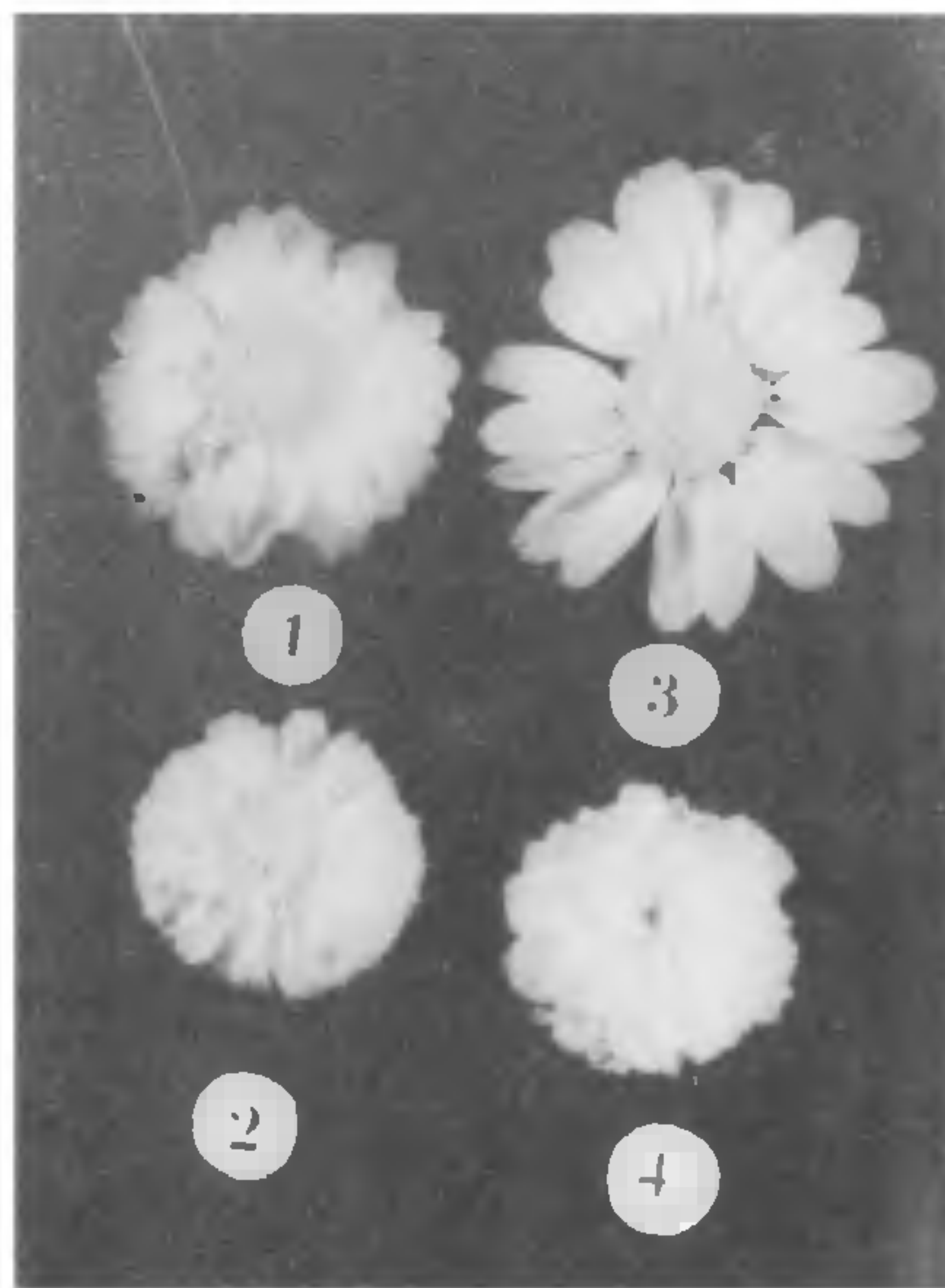
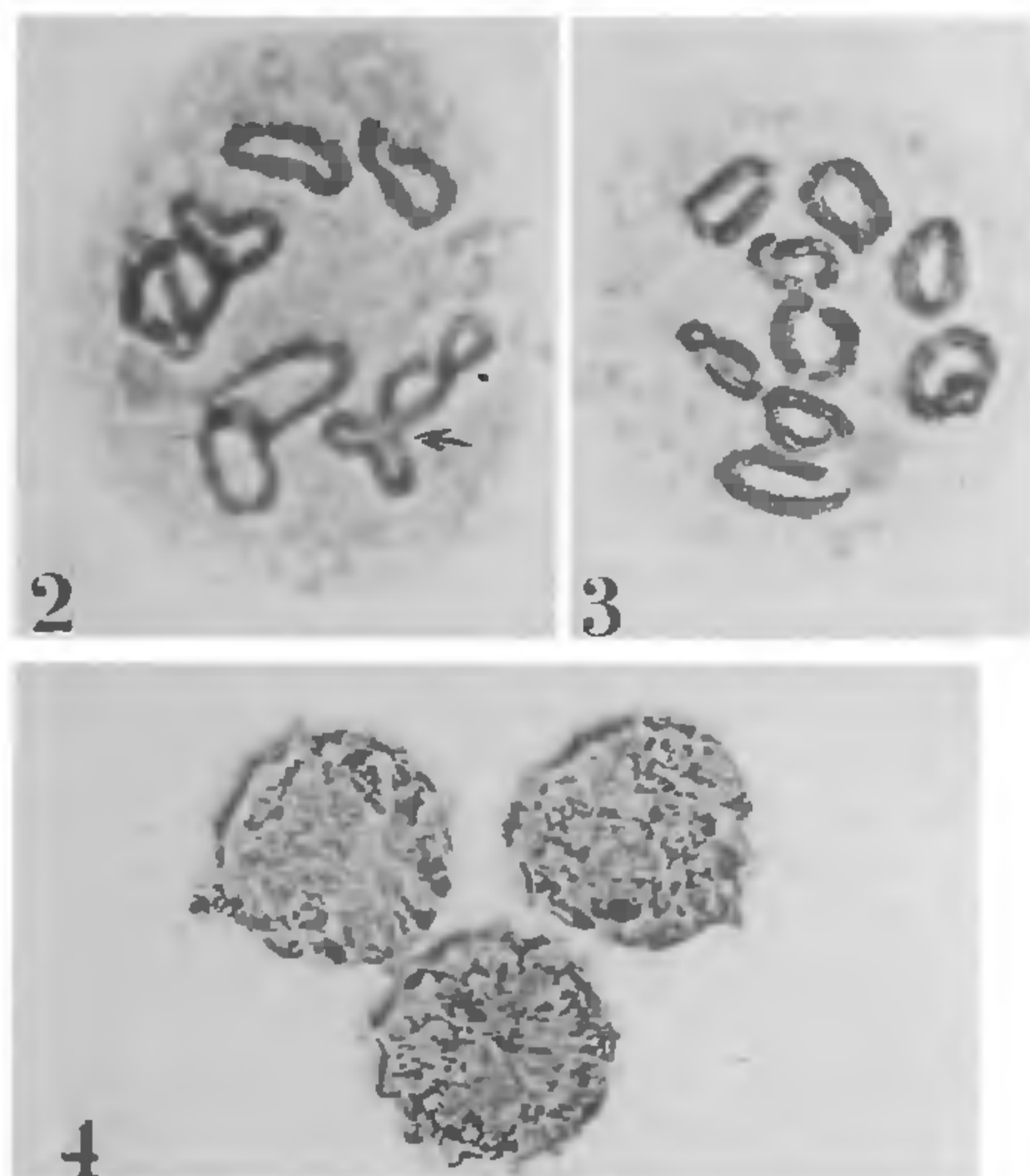


Figure 1. Four head types of *Chrysanthemum coronarium*.



Figures 2-4. 2, Diplotene showing two separate bivalents + three interlocked + two interlocked + two terminally adhered (\leftarrow) bivalents; 3, Diakinesis showing nine ring bivalents having two terminal chiasmata/bivalent, except one which has only one; 4, Mature pollen grains.

region, naturalized very well in temperate regions, is planted for its cut flowers in North India in winter and blooms from January to May, but profusely in spring. Due to self-incompatibility, it is cross-pollinated¹. It is a prolific seed producer and propagates only by seeds. It produces variable-sized capitula which are radiate or ligulate with either yellow or creamish white florets (Figure 1). The radiate types represent the single heads and the ligulate types the double heads. About 3-11% of plants with radiate heads produce more than two ligulate florets. Existence of translocation heterozygosity in crown daisy in 40% radiate heads is known¹⁻³. The present investigation of over 500 plants reveals the absence of translocation heterozygosity in radiate heads of another population grown here. In this, in 47% plants, bivalent interlockings and telomeric adhesions are rampant (Figure 2), but in the remaining 53% plants, these are absent and the bivalents are normal (Figure 3). Of the normally formed 9 bivalents, 8 are ring type with one interstitial chiasma in one bivalent and the ninth bivalent is rod type due to the precocious chiasma terminalization at diakinesis. The mean chiasma frequency and its standard deviation per PMC and per bivalent are 17.89 ± 2.14 and 1.99 ± 0.22 , respectively. The bivalent interlocking is maximum at diplotene, gets

reduced at diakinesis and disappears at MI. Further, the meiotic course is normal and the mean pollen fertility is about $96 \pm 2.7\%$ (Figure 4). Since the chromosomal anomalies, especially the high frequency of translocation heterozygosity as reported earlier¹⁻³, are absent in the presently investigated populations, the meiotic impediments, arrests or abnormalities associated with these anomalies are neither expected nor were observed in this material.

Whereas the interlocking between the bivalents is clear in about 85% PMCs, it is not so in about 15% PMCs due to bivalent overlapping and overcrowding. These unclear ones are designated by us as the 'ring interlockings' because they simulate chromosomal rings. Both bivalent and ring interlockings are of four different types and are designated as $A_1, A_2, A_3, A_4; B_1, B_2, B_3, B_4$. They are represented in Figure 5 where

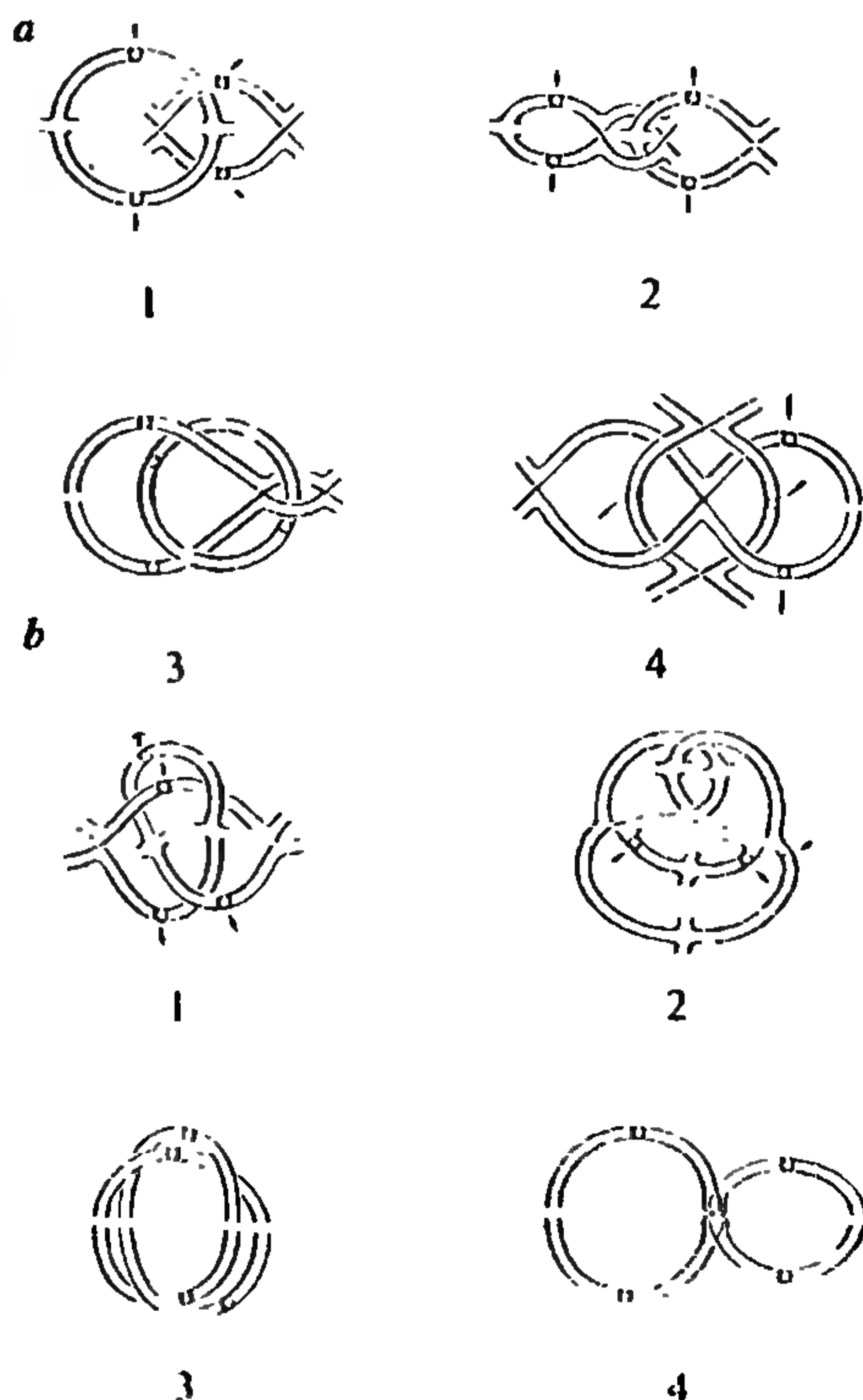


Figure 5 a and b. a, Various modes of interlocking between bivalents at diplotene/diakinesis; b, Various interlocking types within a ring of four chromosomes at diplotene/diakinesis.

Table 1. Comparison of samples A and B and the interlocking types in *Chrysanthemum coronarium* L.

Interlocking type [†]	Sample A (N = 170)			Sample B (N = 205)			SED	Observed difference*
	Mean	SD	SE	Mean	SD	SE		
Bivalent interlocking								
A ₁	55.11	8.58	0.66	57.98	9.12	0.63	0.90	S
A ₂	7.95	2.10	0.16	7.14	2.17	0.15	0.20	S
A ₃	5.11	1.38	0.10	5.88	2.23	0.15	0.17	S
A ₄	14.77	2.04	0.15	14.70	2.20	0.15	0.20	IS
Ring interlocking								
B ₁	6.25	1.27	0.09	5.88	1.35	0.09	0.12	S
B ₂	2.84	0.73	0.05	1.68	0.38	0.02	0.05	S
B ₃	2.27	0.38	0.03	2.94	0.30	0.02	0.03	S
B ₄	4.54	0.88	0.06	3.78	0.97	0.06	0.08	S

[†]For interlocking type configurations (A₁–A₄, B₁–B₄) refer Figure 5. Significance of mean difference determined at 5 P level

SD, standard deviation; SE, standard error; SED, standard error of mean, S, significant, IS, insignificant.

the A portion (upper part) represents the types (85%) in which bivalency is clear but the bivalents interlock with or among one another (termed as bivalent interlocking). In portion B of Figure 5, at the lower part, interlocking appears within a ring of four chromosomes. This is termed as ring interlocking. Of the four bivalent interlocking types, type A₁ is most predominant and type A₃, the least in both the samples (Table 1). On the other hand, in the ring interlockings, type B₁ is the most predominant.

The occurrence of reciprocal translocations in some populations of crown daisy as reported earlier¹⁻³ is ruled out in the population studied presently. Moreover, the expected reductions in pollen fertility or in seed yield/capitulum caused by translocations were not obtained in the present material. Further, none of the chromosomal configurations expected in a translocation heterozygote were observed in this material. Do bivalent and/or ring interlockings and telomere adhesions simulate translocation heterozygosity in crown daisy or do translocations involving interchange segments too minute to detect microscopically exist in the crown daisy, is an open question. Is bivalent interlocking a genetic feature or not, needs to be investigated by intercrossing the plants having bivalent interlocking with those lacking it, and analysing cytologically the F₁ and F₂ progeny plants. Likewise, the genetic significance and biochemical basis

of the telomere adhesion of prophase I chromosomes remains to be determined. Do the telomeres of adhesive chromosomes have GC-rich DNA and does mutation in their DNA primer make them to mass replicate GC base pair sequences^{4,5} or are they modified into sticky ends, needs to be determined by comparing the telomeric ends of *C. coronarium* plants having the sticky telomeres with those lacking such telomeres. Thus crown daisy is an interesting material for biochemical, cytochemical and cytogenetical investigations as it has translocation heterozygosity, bivalent interlocking, telomere adhesions and normal meiosis.

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