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## Time and duration of Deccan volcanism in Razole area, Krishna-Godavari Basin, India

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Nannoplankton data throws light on the time and duration of the Deccan trap occurring in the subsurface section of Krishna-Godavari Basin, India. The results are more refined than the planktonic foraminifera data published in the last three years. Calcareous nannoplankton discovered from the infratrappean sediments are assigned to *Micula murus* zone of the Late Maastrichtian age, which fixes the lower age limit of the trap. The supratrappean sediments mark the upper age limit of the trap and are assigned to upper part of NP2 : *Cruciplacolithus tenuis* zone of upper part of Early Danian age. The duration of Deccan volcanism in this region is estimated to be about 3.8 m.y. and not 6.0 m.y. as suggested by earlier workers in the Krishna-Godavari Basin.

This note deals with the study of calcareous nannofossils in the infratrappean and supratrappean subsurface sediments of the Razole Area, Krishna-Godavari Basin, India. The upper and lower limit of the traps and duration of Deccan Volcanism in this region are discussed.

The Sediments between depth interval 3660–3665 m (infratrappean) occurring below the 300 m thick trap and those immediately overlying the trap between depth interval 3360–3365 m (supratrappean) of Razole-A well are examined for calcareous nannofossils (Figure 1). These sediments yielded rare, but reasonably well-preserved calcareous nannofossils whose distribution is shown in Table 1. The nannofossils are documented under Leitz Orthoplan polarizing microscope using oil immersion objective (Figures 2–26).

The subsurface sediments between the depth interval 3660–65 m below the trap yielded the following nannoplankton species : *Micula murus*, *M. decussata*, *Cyclagelosphaera reinhardtii*, *Prediscosphaera spinosa*, *P. cretacea*, *Stradneria crenulata* and *Arkhangelskiella* sp.

Out of the above nannoplankton species, *Micula murus* first appears at the base of nannoplankton zone NC23<sup>1</sup> and CC26<sup>2</sup> and vanishes at the top of it. The base of zone CC26 practically coincides with the base of

*Abathomphalus mayaroensis* zone of planktonic foraminifera. Therefore the first occurrence of *Micula murus* establishes Late Maastrichtian age of the infratrappean.

The sediments between the depth interval 3360–65 m just above the trap yielded the following nannofossils: *Cruciplacolithus primus* (5–8  $\mu$ ), *Prinsius dimorphosus*, *Thoracosphaera operculata*, *Coccolithus pelagicus*, *Braarudosphaera bigelowii*. Out of these species, *Cruciplacolithus primus* and *Prinsius dimorphosus* are age-diagnostic. Relatively large *Cruciplacolithus primus* (5–8  $\mu$ ) ranges from NP1 to NP2 zone and *Prinsius dimorphosus* ranges from upper part of NP2 to lower part of NP4. The concurrent ranges of these two species of nannoplankton date these sediments as equivalent to upper part of NP2 : *Cruciplacolithus tenuis* zone of upper part of Early Danian age (written communication Kathorina Van Salis, 1993).

The extensive foraminiferal study of infratrappean, intertrappean and supratrappean beds are made in Palakollu-A, Elamanchili-A and Modi-A wells of Krishna-Godavari basin<sup>3</sup>. It shows the oldest flow was post *A. mayaroensis* zone (66.5 m.y. to 67.5 m.y.). The base of the *A. mayaroensis* zone nearly coincides with the base of *Micula murus* zone. The youngest flow was reported pre P2 zone (60.2 to 61.4 m.y.) of standard

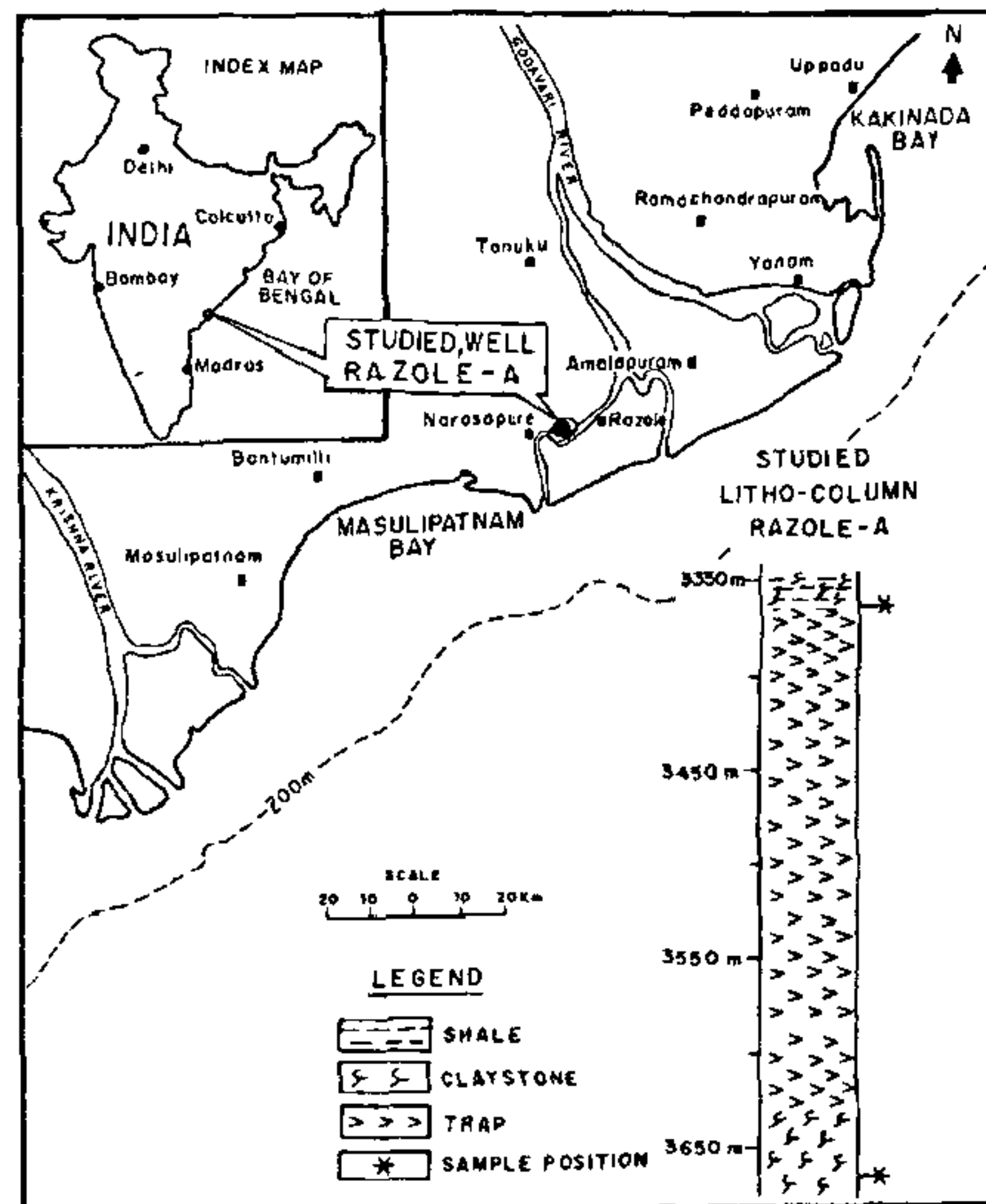
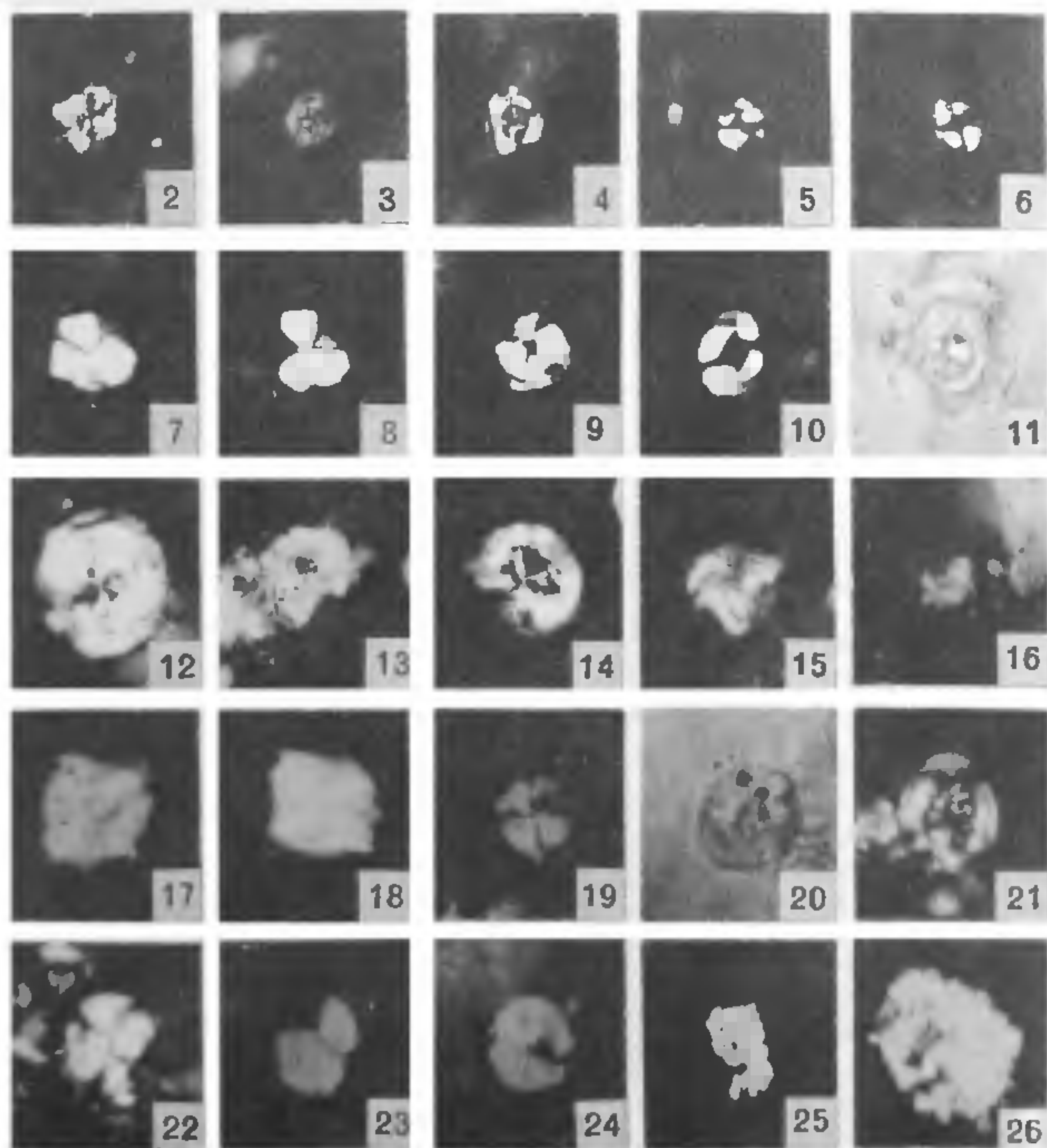


Figure 1. Map showing location of well Razole-A in the Krishna-Godavari Basin. The lithocolumn of Razole-A well between depth interval of 3350 and 3665 m is shown with the sample position marked by asterisk. Infratrappean sediments are between 3660 and 3665 m and supratrappean sediments between 3360 and 3365 m depth interval.

Table 1. Calcareous nannofossils recorded from Supratrappean and Infratrappean sediments of the Razole-A well, Krishna-Godavari Basin, India

Series	Age Stage	Razole-A Depth interval	Nannoplankton species	Nannoplankton zone	Time
Lower Paleocene	Danian (Upper part of Early Danian)	3360 m to 3365 m	<i>Cruciplacolithus primus</i> Perch- Nielsen 1977 (5-8 $\mu$ ) <i>Coccolithus pelagicus</i> (Wallich, 1877) <i>Prinsius dimorphosus</i> (Perch- Nielsen 1969) Perch-Nielsen 1971 <i>Braarudosphaera bigelowii</i> (Graanand Braarud 1935) Deflandre 1947 <i>Thoracosphaera</i> sp. <i>Placozygus sigmoides</i> (Bramlette & Sullivan 1961) Romein 1979	Upper part of NP2: <i>Cruciplacolithus</i> <i>tenuis</i> (After Martini 1971)	63.6 m.y. (Top of <i>Cruciplacolithus</i> <i>tenuis</i> zone)
Trap (3365-3633 m)					
Upper Cretaceous	Maastrichtian (Late)	3660 m to 3665 m	<i>Micula murus</i> (Martini, 1961) Bukry, 1973 <i>M. decussata</i> Vekshina 1959 <i>Cyclagelosphaera reinhardtii</i> (Perch Nielsen 1968) Romein 1977 <i>Prediscosphaera cretacea</i> (Arkhangelsky 1912) Gartner 1968 <i>Stradneria crenulata</i> (Bramlette & Martini 1964) Noel 1970 <i>Watznaueria barnesae</i> (Black in Black & Barnes, 1959) Perch-Nielsen 1968 <i>Arkhangelskiella</i> sp. <i>Gartnerago</i> sp.	NC23: <i>Micula murus</i> (After: Roth, 1978)	67.4 m.y. (Base of <i>Micula</i> <i>murus</i> zone)



Figures 2-26. Nannoplankton from supratrappean and infratrappean of Razole-A subsurface, Krishna-Godavari basin. All figures are  $\times 1500$  and documented under cross nicol except Figure 11 which is under polarized light. Supratrappean nannofossils: 2-4, *Cruciplacolithus primus*; 5, 6, 9, *Prinsius dimorphosus*; 7, 8, *Braarudosphaera bigelowii*; 10, *Coccolithus pelagicus*; 11, 12, *Cruciplacolithus* sp.; 13, *Placozygus sigmoides*; 14, *Prediscosphaera cretacea*; 15, *Micula murus*; 16, 17, *Micula* sp.; 18, *Micula decussata*; 19, *Cyclagelosphaera reinhardtii*; 20, 21, *Stradneria crenulata*; 22, *Watznaueria barnesae*; 23, 24, *Gartnerago* sp.



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 age<sup>4</sup>. The present study very precisely suggests that Deccan volcanism initiated<sup>5</sup> 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 workers<sup>3</sup>.

Some of the calcareous nannofossils survived after the massive submarine volcanic eruption<sup>6</sup> or the extra-terrestrial impact<sup>7</sup>, 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 years<sup>8</sup>. 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

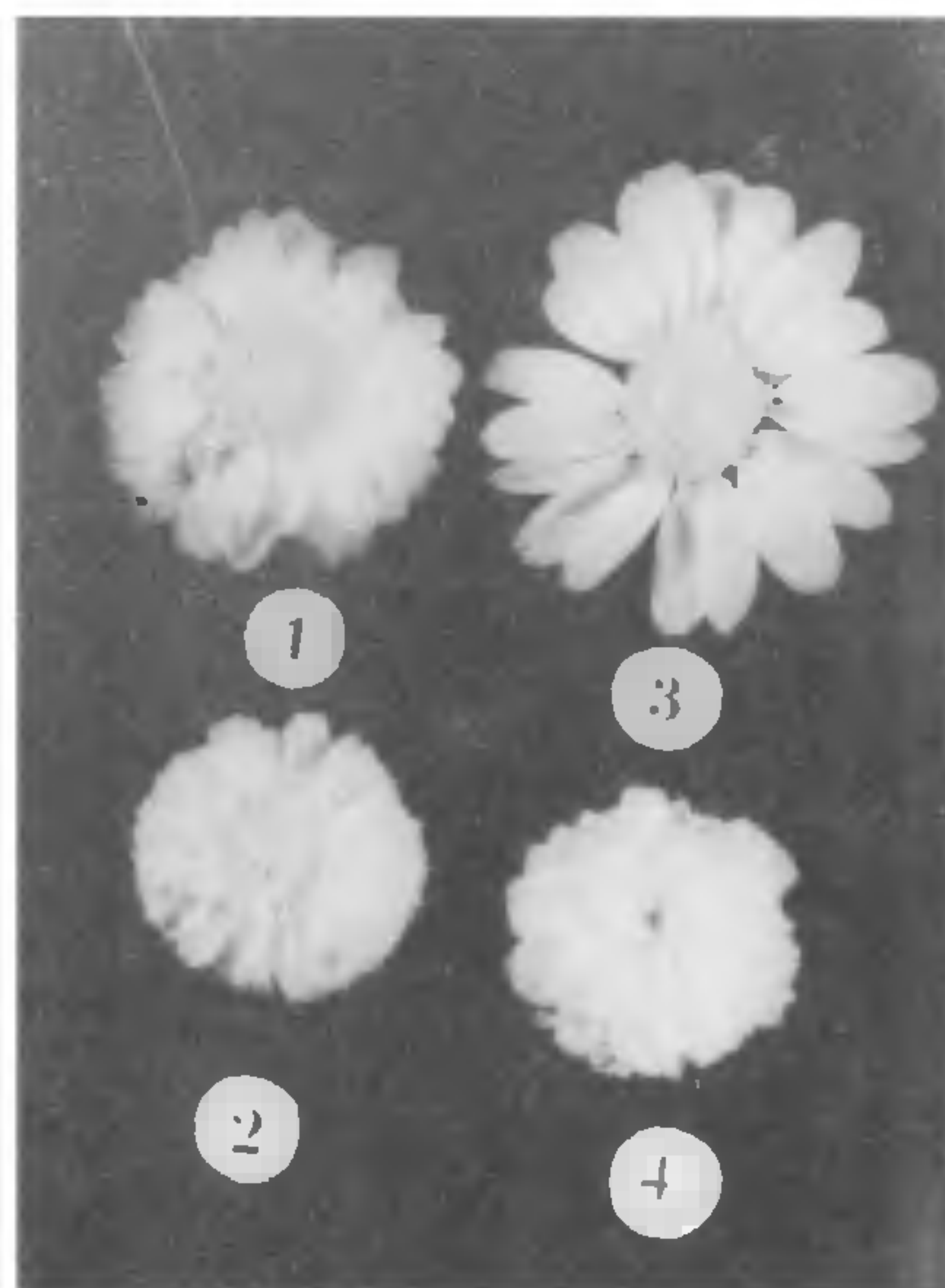


Figure 1. Four head types of *Chrysanthemum coronarium*.