Mamal Formation of the Perigondwana–redefined

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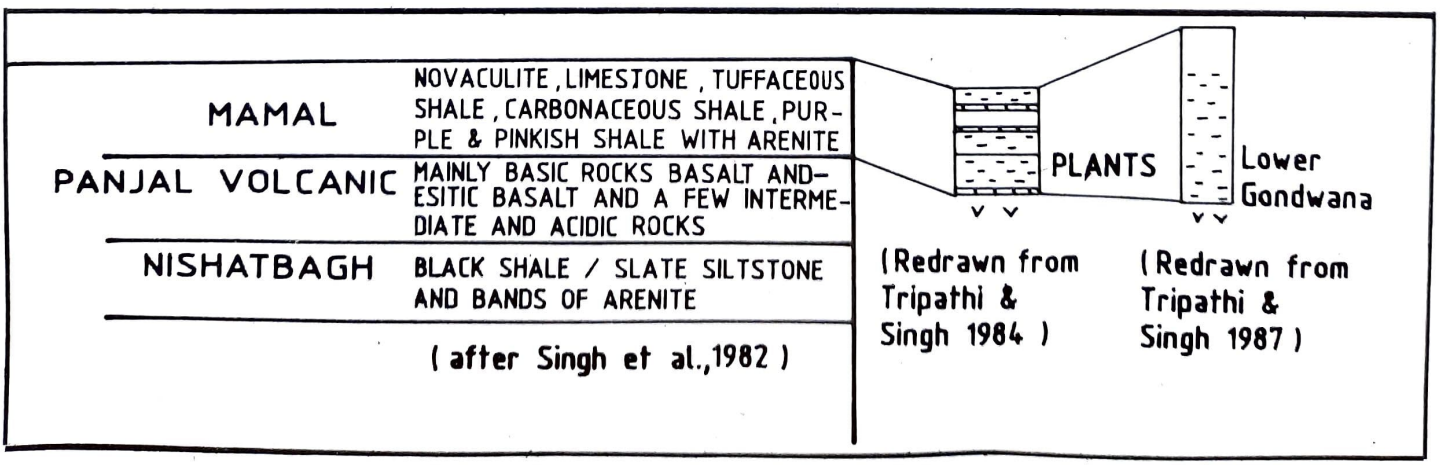
The Mamal Formation, uppermost formation of the Panjal Group in Kashmir is redefined. The nomenclatural status of the formation is accepted but its definition has been modified on the basis of lithology, relative position of different beds and the contained biota. The four beds recognized earlier, viz., Vihi, Marahoma, Munda and Mamal, have been redesignated as Risin, Marahom, Munda and Dunpathri Members. Additional reference sections have been proposed for the Mamal Formation taking into account the historical aspects and other criteria.

Key-words—India, Perigondwana, Mamal Formation, Panjal Volcanics, Gangamopteris Beds.

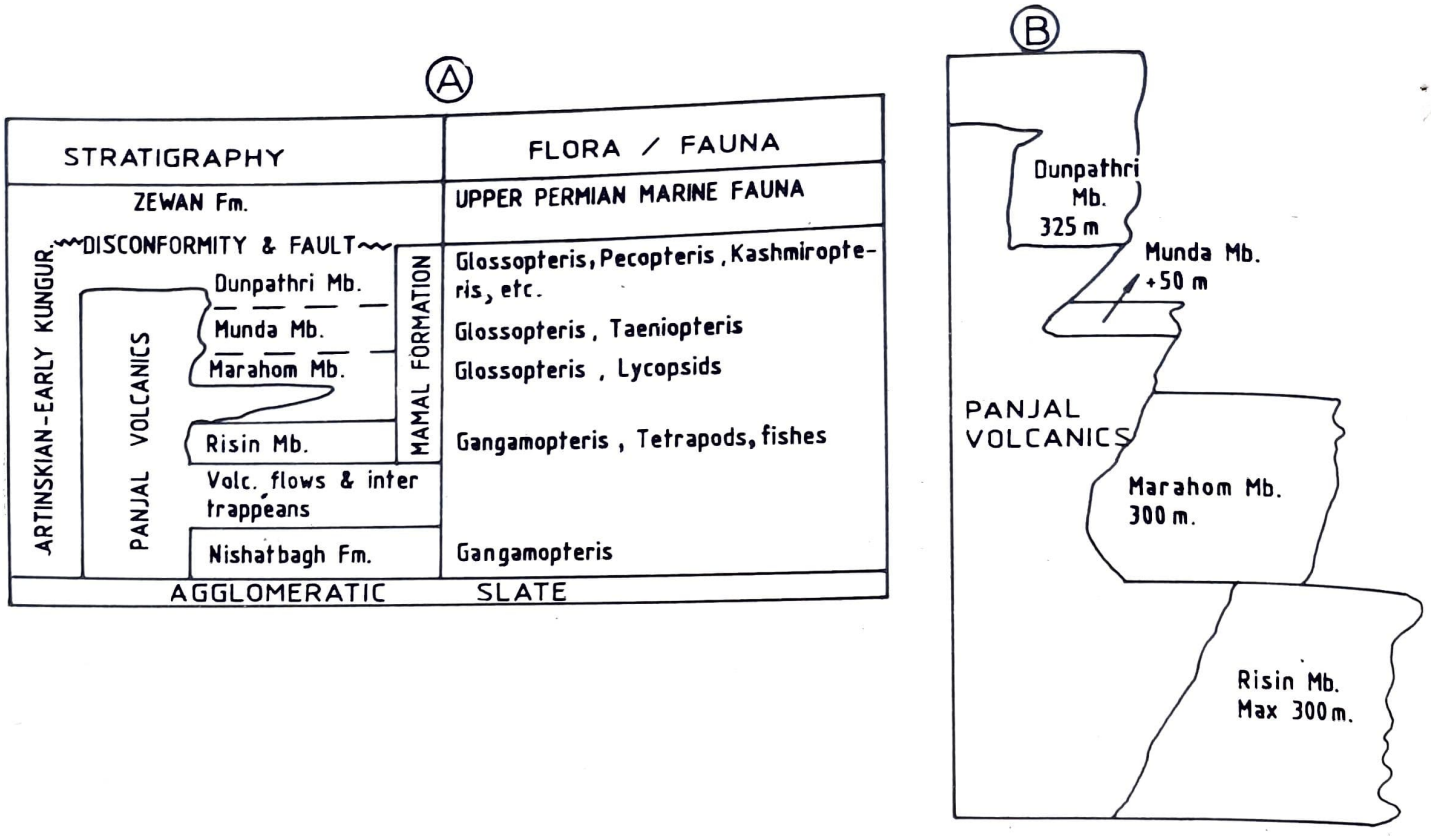
INTRODUCTION

THE PANJAL Group developed as a result of Late Carboniferous—Early Permian epeirogeny in the Perigondwana and comprises Agglomeratic Slate with marine Eurydesma-Stepanoviella Fauna, terrigenous Nishatbagh Formation, Panjal Volcanics, and terrigenous Mamal Formation. The unit Mamal Formation was proposed by Singh, Maithy and Bose (1982) for the plant-bearing horizons overlying the Panjal Volcanics. The terrigenous sedimentaries contain elements of the Glossopteris Flora because of which a Gondwanan affinity is assumed for the Panjal Group.

The four plant-bearing beds, that is, the Vihi, Marahoma, Munda and Mamal, overlying the Panjal Volcanics in ascending order and earlier recognised by Kapoor (1979) as independent entities, were supposed by Singh *et al.* (1982) to occupy the same stratigraphic level. According to them "Lithostratigraphically all these plant bearing beds do not occur together but occupy the same stratigraphic level, i.e. between the underlying Panjal Volcanic and overlying Zewan Formation." They further remarked that "the section at Mamal is very rich in plant fossils and as such we consider it as the type section which is here being designated as Mamal Formation". Their proposal to recognise the four plant-beds as part of a single formation, though appropriate yet lacked clarity of concept regarding its spatial and temporal extent. They did not take into account the gradual change in the florisitc composition from one bed to the other, as also the



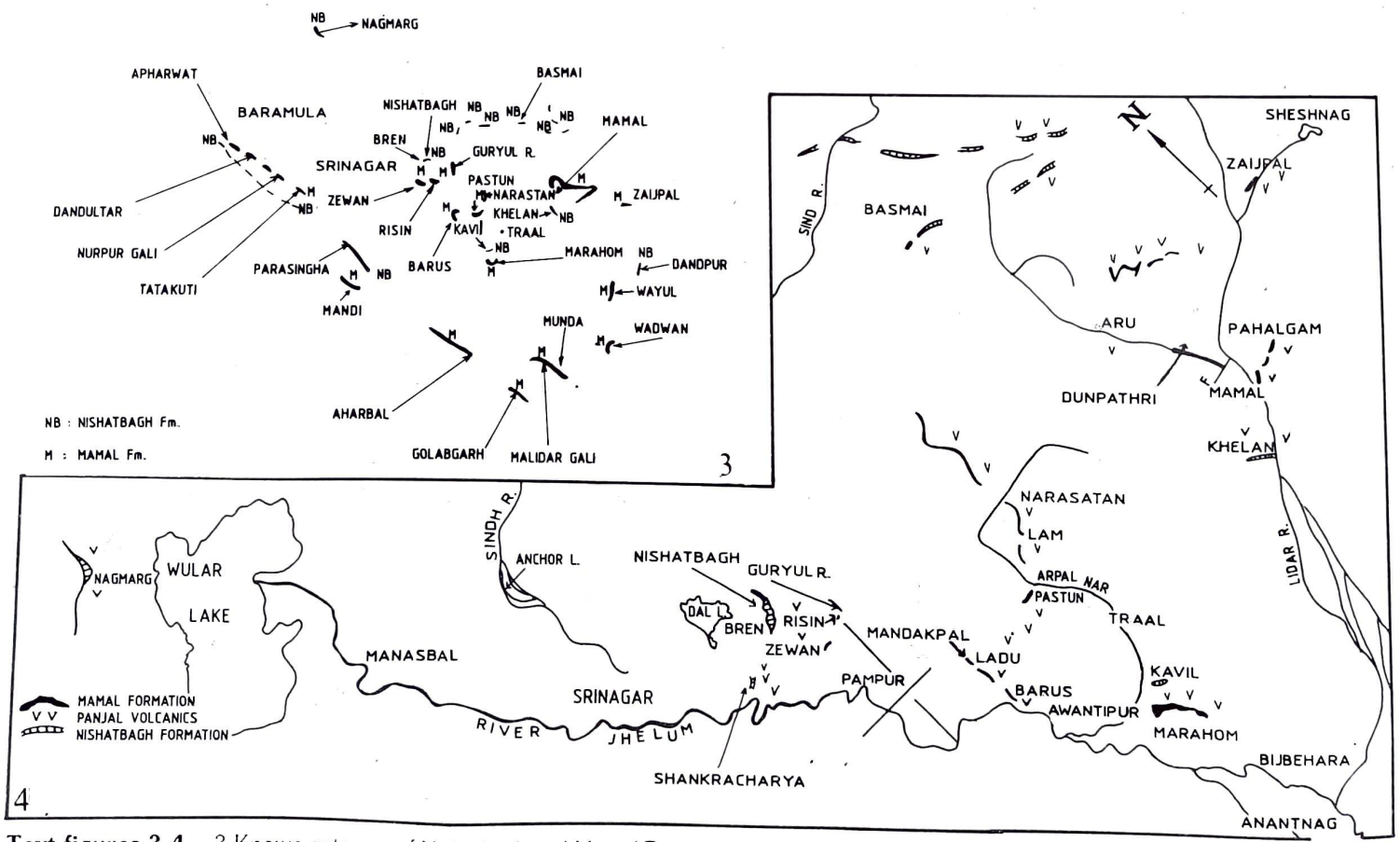
Text-figure 1. Position of the Mamal Formation according to earlier authors.



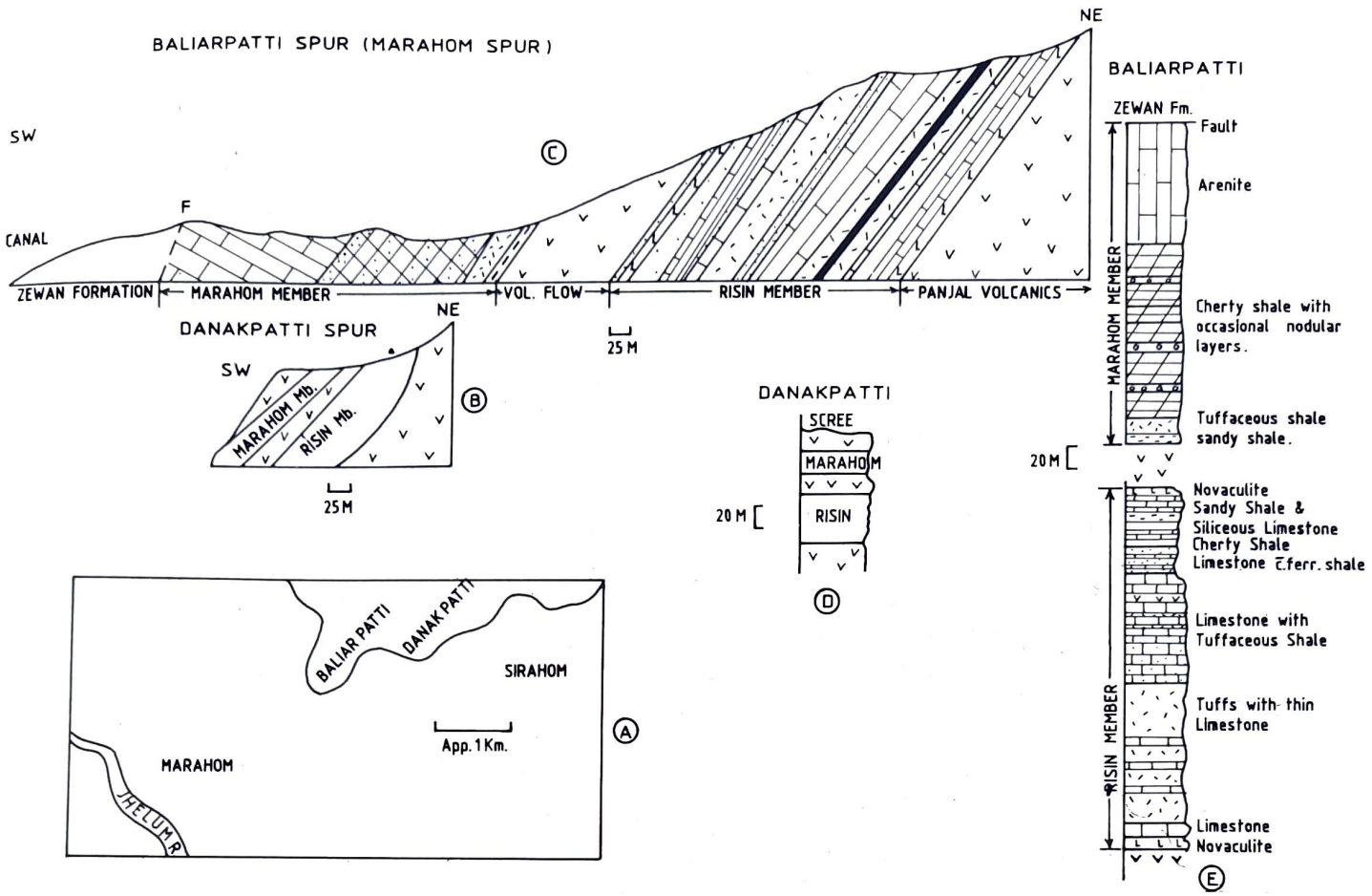
Text-figure 2 A-B. Position of the Mamal Formation in relation to the Panjal Volcanics.

depositional history based on mapping, lithology and palaeontology. It is worthwhile to mention that Wadia (1928), Hazra and Prasad (1957, 1963), and Chakraborty (1968) all agree that different plant beds do not occupy the same level.

Earlier, Ahmad *et al.* (1978) placed the Nishatbagh



Text-figures 3-4. 3.Known outcrops of Nishatbagh and Mamal Formations; 4. Details of outcrops of Nishatbagh and Mamal Formations in the Kashmir Valley.



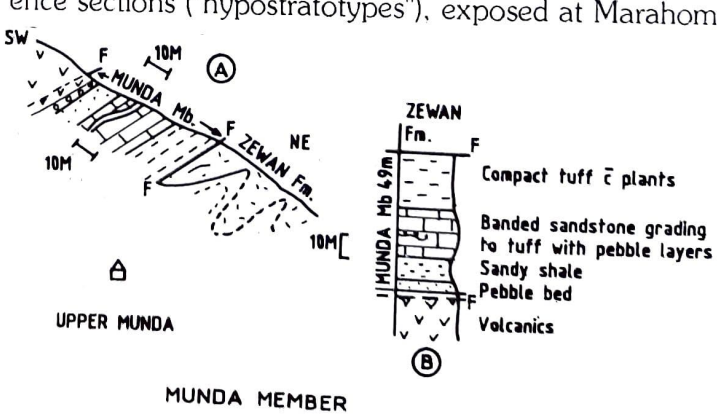
Text-figures 5 A-E. A. Baliarpatti and Danakpatti spurs at Marahom; B. C. Cross-sections of Danakpatti and Baliarpatti spurs, respectively; D. E. Columnar-sections of Danakpatti and Baliarpatti spurs, respectively.

Formation exposed at Kavil in Tral Valley at the same stratigraphic level as the Vihi Beds exposed at Marahom in the Liddar Villey. They probably did not take into account the thick volcanic flow separating the Kavil and Marahom beds. Ahmad's (1987) view that the Vihi Bed and the *Eurydesma-Deltopecten* horizon of the Agglomeratic Slate are more or less contemporaneous, being manifestations of marine and fresh-water environments, respectively is also not tenable. Infact, the cross-section between Bren and Zewan shows a clear demarcation of the four formations, viz., Agglomeratic Slate, Nishatbagh, Panjal Volcanics and Mamal Formations.

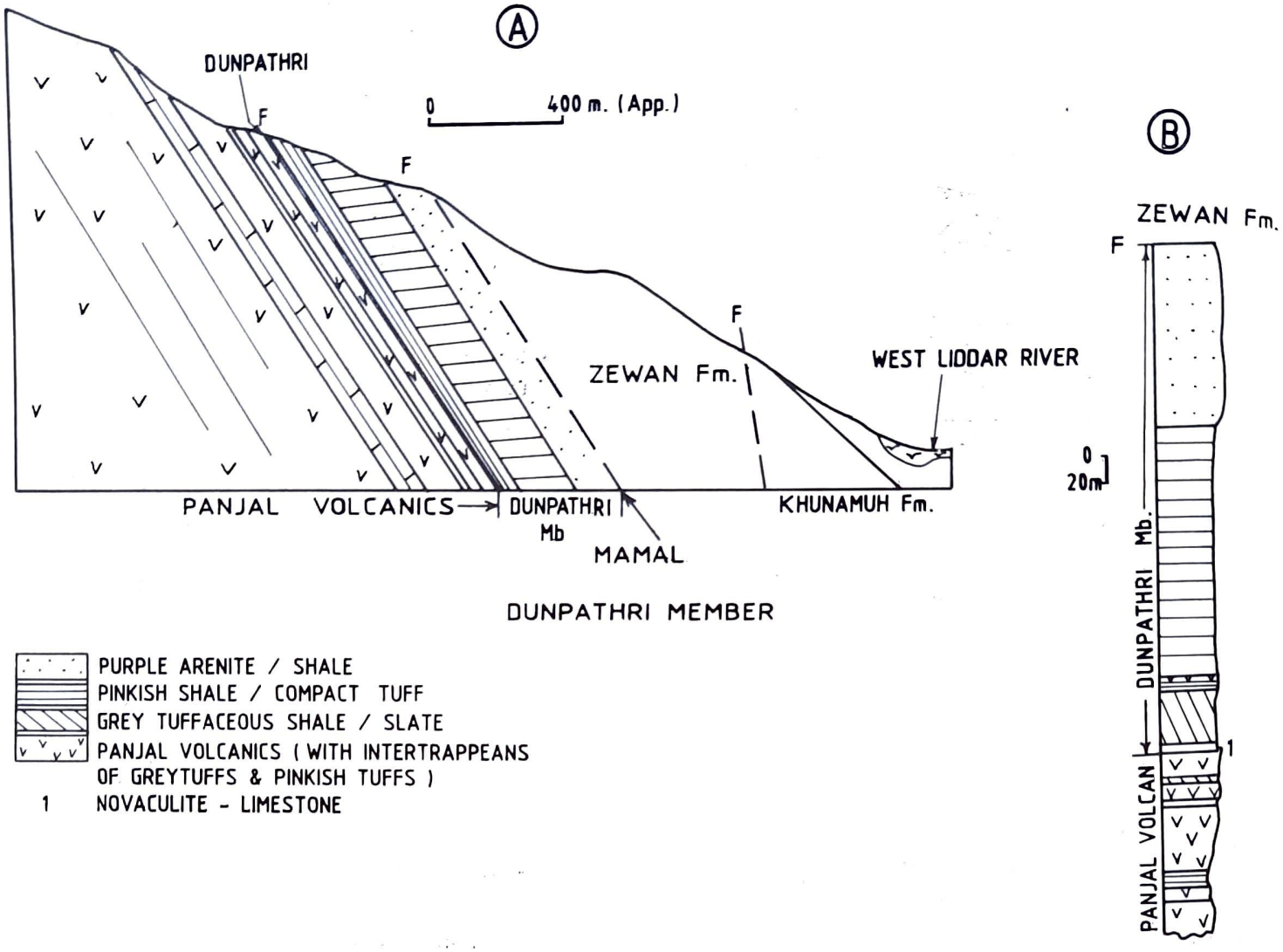
Singh *et al.* (1982) have not given lithological details or a litho-column for the Mamal Formation. The Mamal section is mentioned as the stratotype, though the flora reported is primarily from the Mamal Bed only; only one specimen is recorded from Marahom but its stratigraphical location is not given. It would thus seem that their Mamal Formation is synonymous with the Mamal Bed of Kapoor (Text-fig. 1). Acordingly, the thickness of the Mamal Formation comes to about 325 metres, whereas the total thickness encompassing all the four plant-beds should average out to more than a thousand metres (Text-fig. 2).

It is thus necessary that the Mamal Formation be properly defined giving salient lithological details, and the lower and upper contacts.

According to our concept "The Mamal Formation is composed mainly of tuffaceous suite of rocks, stratigraphically positioned between older Panjal Volcanics and younger Zewan Formation. The formation comprises four members, namely, Risin, Marahom, Munda and Dunpathri, which developed concurrently in lagoonal and lacustrine environments during the Panjal Volcanic extrusive episode." No single section exposes the complete succession and therefore a couple of reference sections ("hypostratotypes"), exposed at Marahom



Text-figure 6 A-B. Cross-and columnar-sections, respectively of the Upper Munda outcrop.



Text-figure 7 A-B. Cross- and columnar-sections, respectively of the Mamal-Dunpathri outcrop.

and Upper Munda, are proposed to substantiate the stratotype exposed at Mamal.

Mamal Formation

1907 Gangamopteris Bed, Hayden.
1907 Gangamopteris Series, Hayden.
1909 Gangamopteris Bed, Middlemiss.
1912 Lower Gondwana, Seward.
1928 Lower Gondwana (Damuda Series), Wadia.
1977 Permian Gondwana, Kapoor & Shah.
1982 Mamal Formation, Singh *et al.*

Etymology—Name drived after Mamal Village near Pahlgam.

Lithology—Mainly variants of volcanogenic ashes, occasionally mixed with argillaceous and arenaceous materials. The lower units are sometimes interbedded with calcareous rocks. Novaculite and limestone complex developed at the base in the Risin and Dunpathri Members in the Valley, while conglomerates developed in the Pir Panjal and Mandi-Pira Parautochthone.

Contact relationship—Lower contact (base of the Risin Member) is apparently conformable with the flows of the Panjal Volcanics. Upper contact (top of the Dunpathri Member) is para-unconformable and is marked by a strike fault.

Environment—Lacustrine, except in the early part of the Risin Member of the valley which is lagoonal.

Geomorphic expression—Two distinct geomorphic features are seen. i) beds dipping away from the ridge usually exposed on spur with undulating topography (e.g., Zewan, Risin, Marahom Spur and the upper part of the Mamal-Dunpathri Section). ii) beds dipping towards the ridge form escarpments or high angle slopes.

Distribution—Kashmir Valley (Vihi, Traal, Liddar, Wadwan, etc.), Pir Panjal and Mandi-Pira Parautochthone also in Bhallesh-Chamba Basin (Text-figs 3-4).

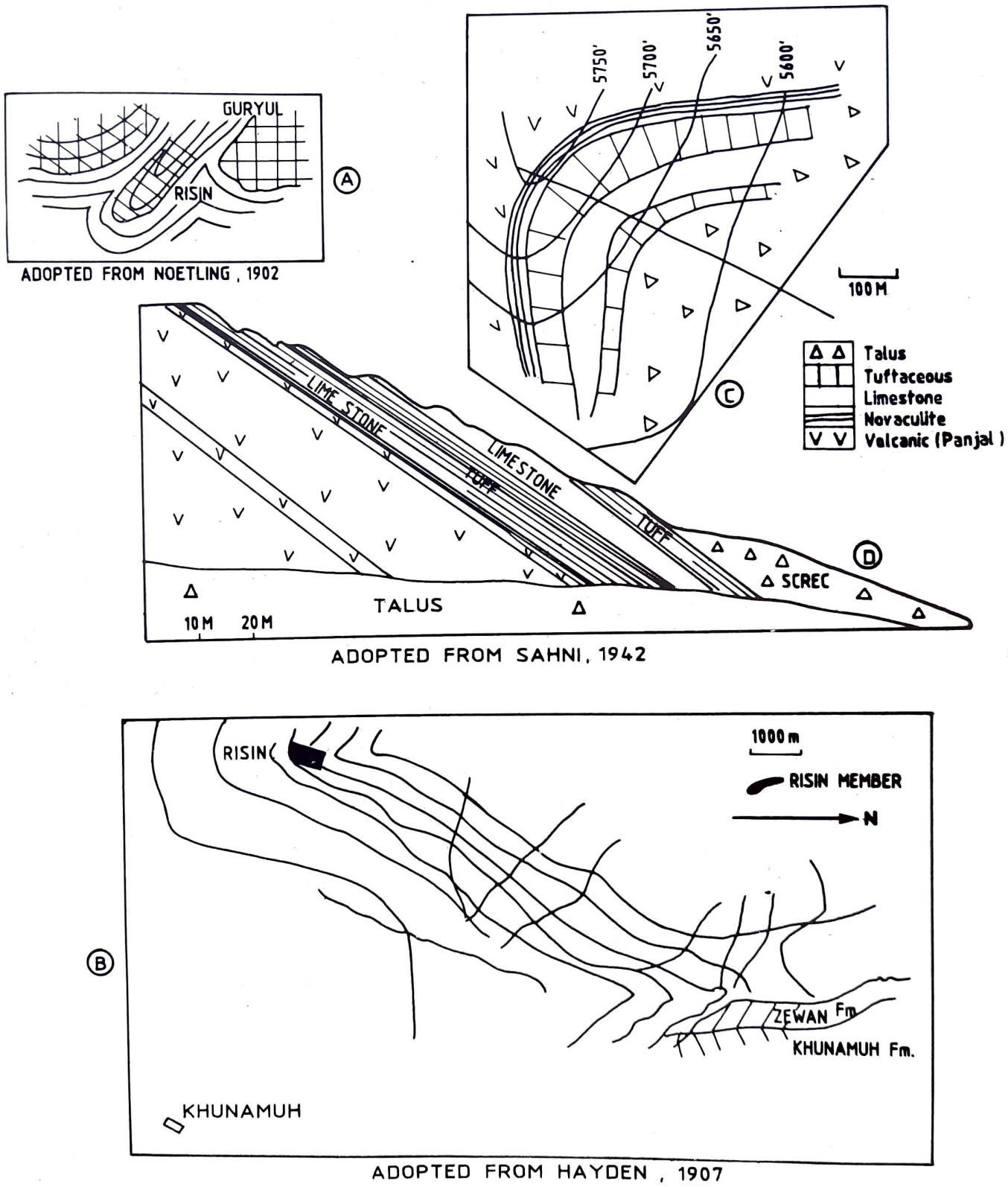
Stratotype—Marahoma Section (Text-fig. 5).

Reference sections—Upper Munda, and Mamal-Dunpathri sections (Text-figs 6-7).

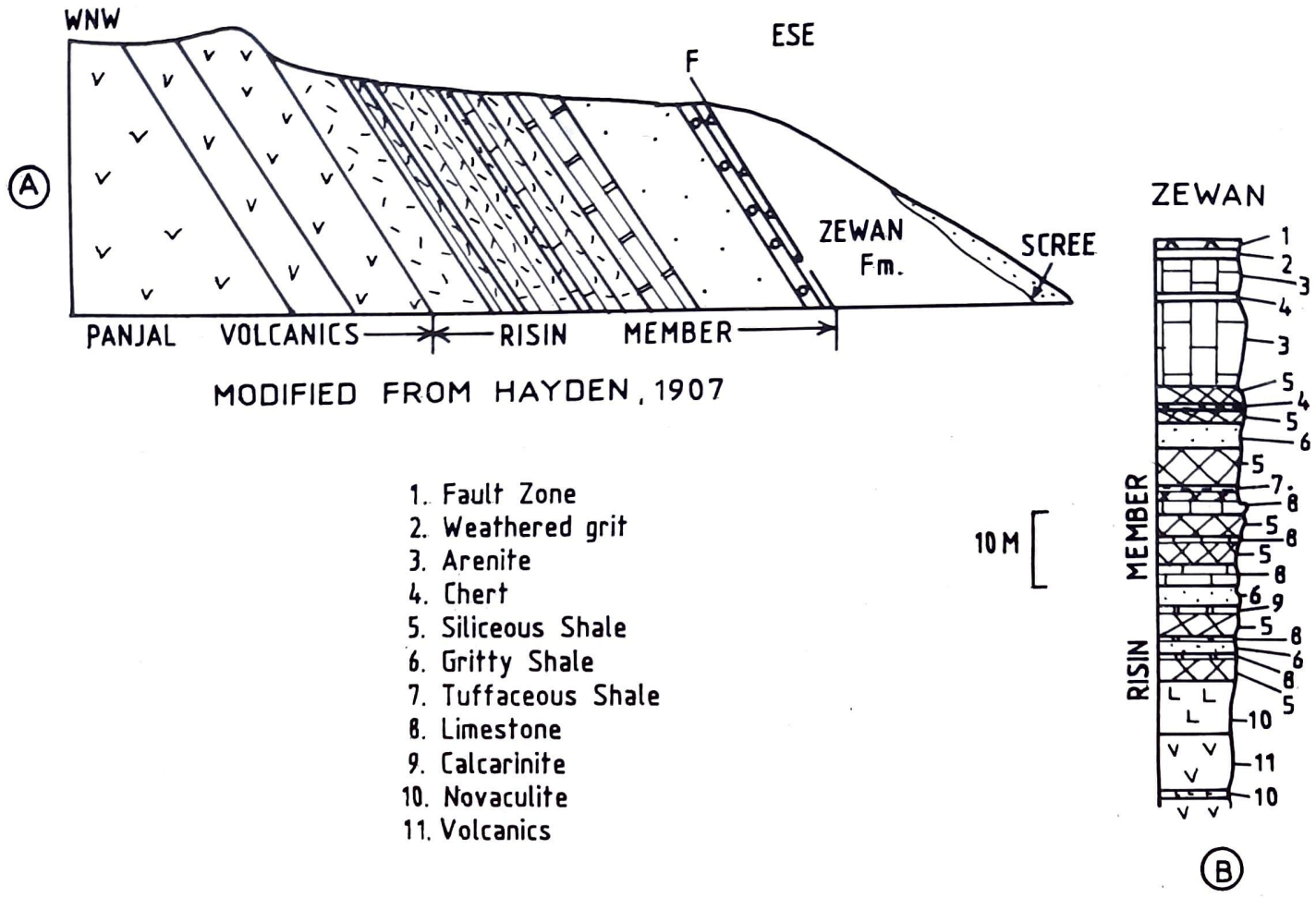
Salient characteristics of individual members are as follows:

Risin Member (=Vihi Bed)

1907 Gangamopteris Series, Hayden.
1909 Gangamopteris Bed, Middlemiss.
1979 Vihi Bed, Kapoor.



Text-figure 8 A-D. Risin Spur — maps and cross-section.



Text-figure 9 A-B. Cross- and columnar- sections, respectively of the outcrop at the Zewan Spur.

Etymology—After Risin Spur (Text-fig. 8). Noetling (1909) reported plant beds for the first time from this area.

Lithology—The member developed in the valley and Pir Panjal, and is characterised by thin beds of different tuffaceous rocks, such as, shales/slates, siliceous shales and cherty bands showing oscillating deposition. In the Valley, the basal part comprises a novaculite-limestone complex, whereas in the Pir Panjal the basal part has a conglomerate unit. Calcareous layers that are common in the Valley are only occasionally present in Pir Panjal.

Contact relationship—Lower contact apparently conformable with the Panjal Volcanics. Upper contact generally faulted.

Biota—Fauna comprises fishes and labyrinthodonts, and occasional insects. Flora is dominated by *Gangamopteris kashmirensis*; ginkgopsid and cordaitean leaves are also present. *Glossopteris* is absent.

Environment—Lagoonal.

Holostratotype—Marahom Spur, 350 m. (Text-fig.5).

Reference section—Zewan Spur, 278 m. (Text-fig.9).

Distribution—Kashmir (Vihi Valley, Traal Valley, Lower Liddar Valley), Pir Panjal (Golabgarh, Apharwat, Dandultar, Mandi).

Marahom Member

1979 Marahoma Bed, Kapoor.

Etymology—After Marahom Village.

Lithology—The member is dominated by thick tuffaceous slates in the lower part, and siliceous shales with a number of pebble layers in the upper part. Calcareous layers are absent.

Contact relationship—At Marahom Spur the contact with the underlying Risin Member defined by a volcanic flow; in Pir Panjal conformable with the Risin Member. Upper contact faulted.

Biota—Mainly species of the genera *Gangamopteris* and *Glossopteris*, leaves of former of comparatively large size. *Sphenopteris* and *Sphenophyllum*, latter a charac-

teristic element of the northern floras, also found.

Environment—Lacustrine.

Holostratotype—Marahom Spur, 300m. (Text-fig.5).

Distribution—Kashmir (Marahom Spur), Pir Panjal (Golabgarh, Apharwat, Tatakutti).

Munda Member

1979 Munda Bed, Kapoor.

Etymology—After Upper Munda Locality.

Lithology—Highly compact and compressed thick bedded tuffs, sandstones, and sandy shales. Base marked by a pebbly bed.

Contact relationship—Both lower and upper contacts faulted.

Biota—Rare *Gangamopteris; Glossopteris communis* dominant; *Taeniopteris* and *Pecopteris* also present.

Environment—Lacustrine.

Holostratotype—Upper Munda, 49 m.(Text-fig. 6).

Distribution—Northern slopes of Pir Panjal Range from Aharbal to Verinag.

Dunpathri Member

1979 Mamal Bed, Kapoor.
1982 Mamal Formation, Singh *et al.*

Etymology—After Dunpathri Meadow above Mamal Village.

Lithology—Thick-bedded tuffaceous slate, pinkish arenaceous shale, and purple arenite; at the base fine-grained compact novaculite and limestone.

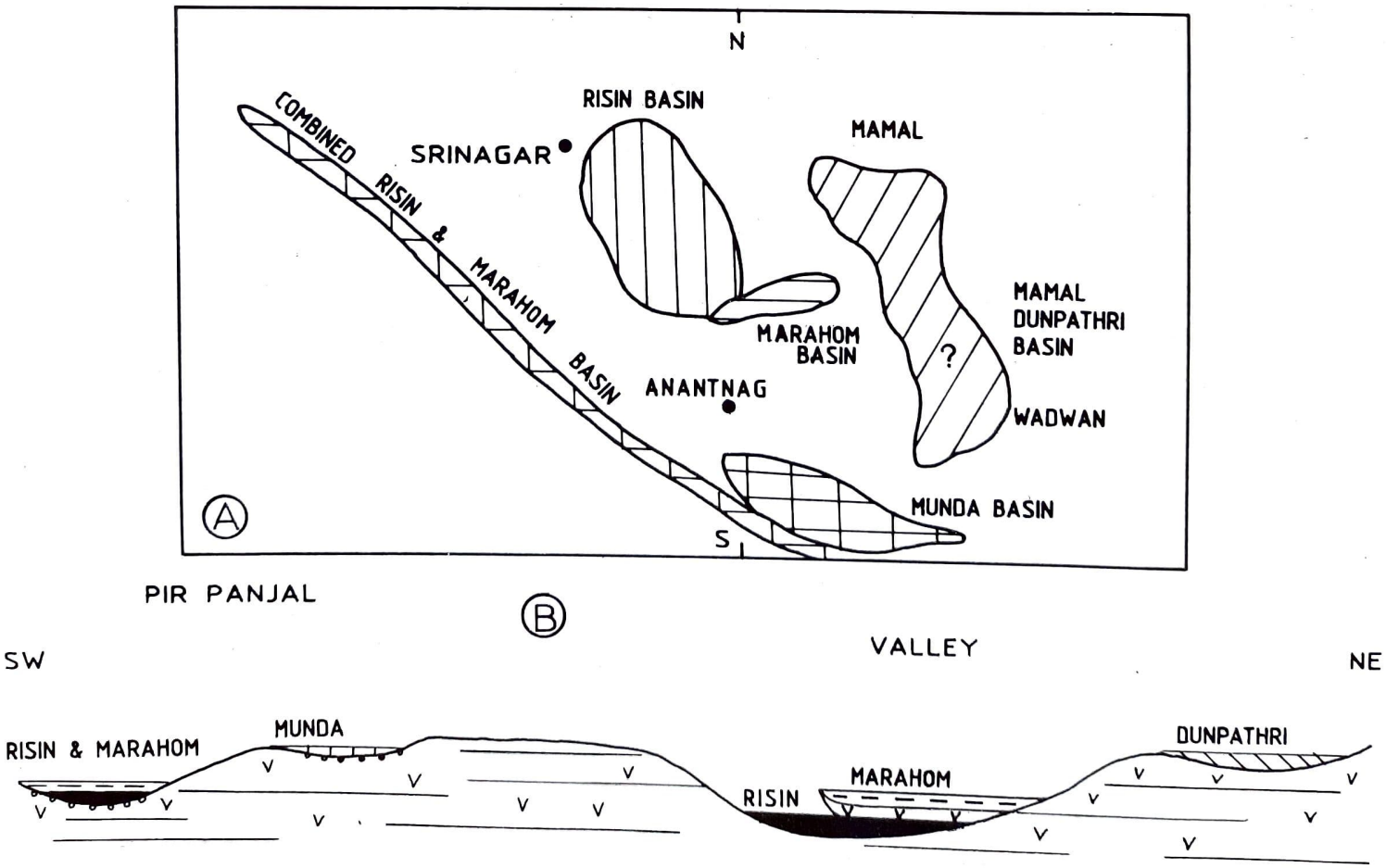
Contact relationship—Lower contact apparently conformable with volcanics, upper contact faulted.

Biota—Rare *Gangamopteris*, several species of *Glossopteris*, and some distinctive Cathaysian type forms, such as, *Lobatannularia*, *Kashmiropteris*, *Pecopteris (Rajahia)*, etc.

Environment—Lacustrine.

Holostratotype—Mamal-Dunpathri, 325 m. (Text-fig. 7).

Distribution—Kashmir (Upper Liddar Valley; pos-



Text-figure 10 A-B. Distribution of different depositional lakes as visualised from synthesis of the data.

sibly Wadwan Valley also).

REMARKS

The Mamal Formation has a special significance for palaeogeography of the Perigondwana during the early part of the Permian. Its status in time and space has to be understood for building the developmental history of the Kashmir Basin. The position of the plant-beds between the Panjal Volcanics and Zewan Formation relates only to the stratigraphic positioning in a broad sense and does not indicate synchronous deposition of the plant-beds as assumed by Singh *et al.* (1982).

Each of the four members had a distinct depositional history and biota. It is clearly seen in the Golabgarh Section of Pir Panjal, and the Marahom Section of Liddar Valley where the Risin and Marahom members are exposed in ascending order. At Marahom, the two members are separated by a volcanic flow and contain distinct floral elements, showing younging of horizons. The Dunpathri Member likewise has a distinct lithology and comparatively rich flora, most elements of which are not found elsewhere.

In Pir Panjal, the trap surface underwent weathering before deposition of Risin or Munda Members. In the Valley, weathering phase is replaced by the deposition of volcanogenic calcium carbonate subjected later to novaculitization. The novaculite of the Risin Member contains biota (Hayden, 1907) indicating a marine influence. The calcareous beds of the Member also indicate a marine environment. The limestone-novaculite complex with different physical characters developed at the base of Dunpathri Member, but without other calcareous beds.

The Panjal Volcanics formed the basement of lakes in which the Risin, Munda and Dunpathri Members were deposited. The basement for Risin and Munda Members was generally a basic suite of flows unlike that for Dunpathri Member which was acidic. The basic suite, having a wide lateral extent, represents the early and middle phases of Panjal Volcanics, and the acidic activity of limited distribution characterises the end phase (Nakazawa & Kapoor, 1973). The volcanics below the Risin Member are about 2,400 m., and about 2,800 m. below the Dunpathri Member. The varying thickness of the volcanics thus shows different levels of deposition. Intertrappeans are common both in the early and last phases of volcanic activity; those of early phase are mostly dark tuffaceous shale while the end phase intertrappeans are grey and pinkish tuffaceous arenites. In the middle phase intertrappeans are rare and of novaculite, except for the single record of brachiopod-bearing limestone at Barus. No flora has been recorded from the intertrappeans, so far. The intertrappeans of novaculite at Zewan Spur thus indicate relatively older position of the Risin Member as compared to the Dunpathri Member which has intertrappeans of the end phase. The volcanic activity continued even during the deposition of Dunpathri Member as is evidenced by the solitary flow in the pinkish shales. Text-figure 10 visualises the distribution of depositional lakes during different phases of volcanism.

The post-Mamal episode during "Middle" Permian has been of non-deposition and changes of topography due to weathering till Late Permian Tethys encroached and covered the area (Kapoor & Maheshwari, 1991). This is the reason for all the members of Mamal Formation being overlain by a marine sequence.

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