

4. PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY

4.1 A review of the existing Paleogene zonal schemes

There are two standard Paleogene zonal schemes established in the low latitude regions. One is represented by Bolli's zonation and its revised one (Bolli, 1957, 1966; Toumarkine and Luterbacher, 1985). The other one is the P-zonation of Blow (1979) and its modification by Berggren et al. 1988; 1995). For the Paleocene zonation, Berggren and Norris (1997) however, the clad and stratigraphic ranges of many Paleocene species differ from Blow's original description. Recently, Berggren and Norris (1997) and Olsson et al. (1999) published the updated versions for the Paleocene P-zonal system biostratigraphy and the phylogeny.

The Paleocene-Eocene fauna recovered from the Dunghan, Shaheed Ghat, Baska and Kirhtar Formations contains abundant tropical and subtropical indices, and is thought to have lived in tropical-subtropical Tethyan waters. Hence, the international zonal schemes of Berggren et al. (1995), Toumarkine and Luterbacher (1988), Berggren and Norris (1997) and Olsson et al. (1999) are applicable to the fauna recovered from the Sulaiman Range (Figure 8).

4.2 Field study and sample collection

In the field, lithofacies were identified and named by their characters like grain size, fresh and weathering colour, minerals assemblage, surface textures

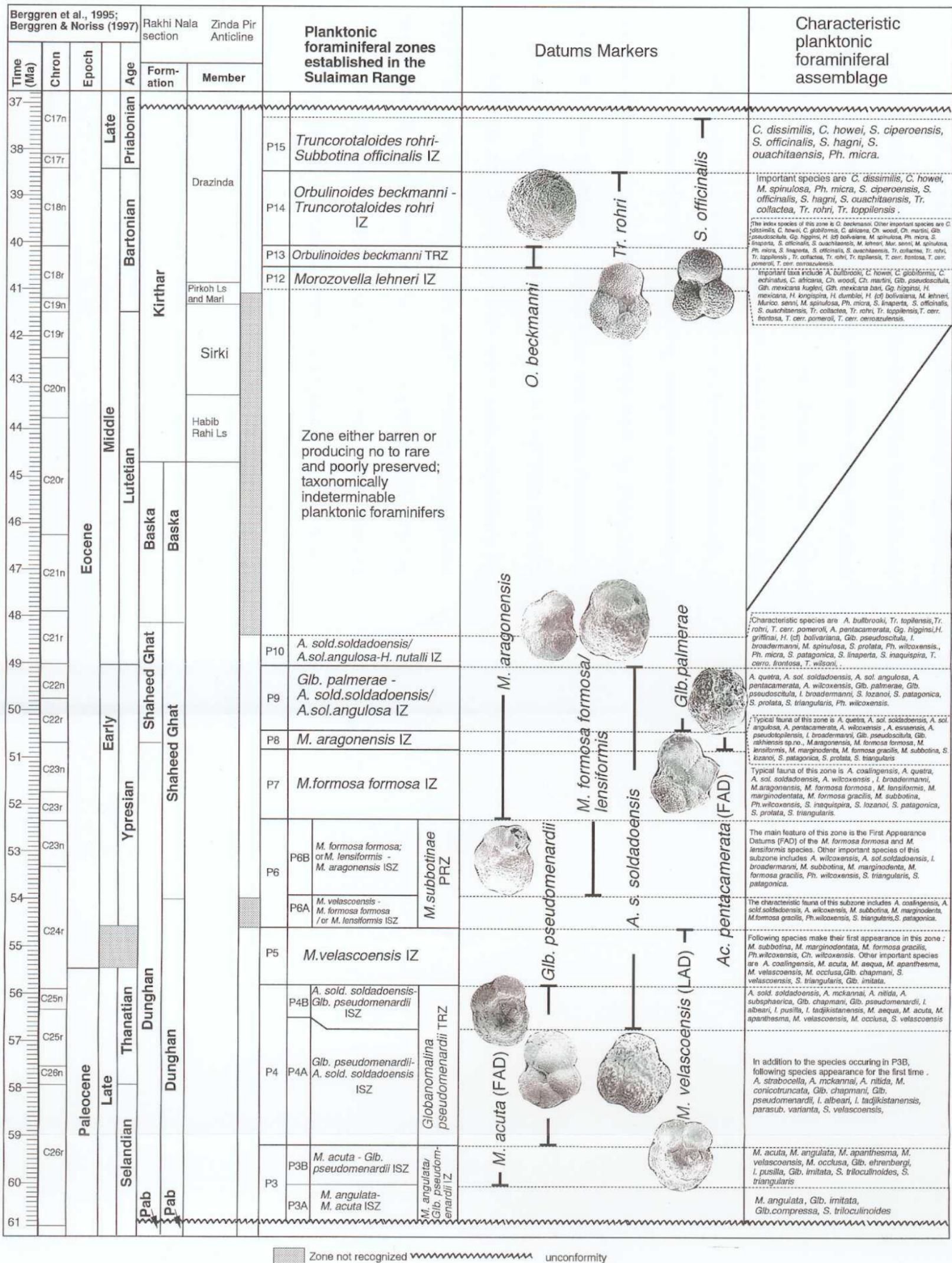


Figure 8. Correlation of the Paleogene lithostratigraphic units exposed in the Rakhi Nala section and in the Zinda Pir Anticline, Sulaiman Range, Southern Indus Basin, Pakistan. This figure also shows established planktonic foraminiferal biostratigraphic zones and the criteria (datum markers) used for the definition of the bio-zones along with other characteristic planktonic foraminiferal assemblage used for the definition of the bio-zones established in the Sulaiman Range, Southern Indus Basin, Pakistan.

and other morphological features such as mode of occurrence (thin or thick bedded). Route maps (Figs. 3, 4) were prepared and sections were measured to understand the horizontal and vertical lithological changes. Other field data like trends of different lithological units (dip and strike) were also measured using clinometer. Special attention was paid to note any larger fauna (larger foraminifera, molluscs etc.) and in the observation of sedimentary structures like ripple marks, cross-bedding, graded bedding, conglomerate and trace fossils etc.

In order to avoid the effect of surface weathering, samples were taken from fresh exposures after sufficient digging. Samples collected from the Rakhi Nala section were coded R for the Dunghan, Shaheed Ghat and Baska Formations whereas for the Kirthar Formation, Rk code was used. For the samples collected from the Zinda Pir Anticline, codes ZPE and ZPW were used, respectively for eastern and western sections. In the field samples, each of them weighing around 500 grams was collected. From the Dunghan Formation, samples were collected at an interval of 1 to 5m whereas an interval of 5 to 15m was adopted for the Shaheed Ghat, Baska and Kirthar Formations where the sequence was very thick.

4.3 Laboratory methods

Different methods used in the extraction of microfauna and for the preparation of the thin-sections are given as below.

4.3.1 Thin section studies

To interpret the depositional environment, petrographic studies were done under the optical microscope. For this purpose, thin sections were prepared from hard siltstone/ mudstone and interbedded limestone facies. Photomicrographs were also taken to illustrate different typical microfacies and their characteristics (Plates 13 to 20).

4.3.2 Extraction of planktonic and benthic foraminifera

Because the siltstone/ mudstone samples were very hard, all samples (each weighing 100g) were first treated with sodium sulfate (Na_2SO_4), and later with tetraphenylborate (NaTPB). The disaggregated samples were washed using 63 μm sieve.

Population counts for planktonic foraminifers are based on random splits of 200 to 300 specimens. To avoid juvenile forms, only specimens over 150 μm were picked and identified, however, the samples were scanned for small sized species. Most of the species were photographed (Plates 20 to 38) using a scanning electron microscope (SEM).