PALEOGENE FORAMINIFERA AND PALEOECOLOGY OF THAR COAL BASIN, SINDH, PAKISTAN

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Abstract

Foraminifera consisting dominantly of agglutinated forms have been observed in the Thar Coal Basin sediments. Many of these benthic forms are of small size. The preservation of fauna is rather poor; generally the specimens are strongly crystallized and partly crushed.

For this study 100 samples from 10 exploratory boreholes, drilled by Geological Survey of Pakistan, were obtained. However fossils were recorded from 30 samples of 6 boreholes that consist of mainly the forms belonging to the genera Haplophragmeides, Ammobaculites, Trochomina, Osangularia, Ammosphaeraidina, together with the rare occurrence of calcarious benthic foraminifers.

These foraminifers thrived in strongly different ecological conditions as far as salinity and bathymetry are concerned; other paleoecological factors have been responsible for the occurrence of agglutinated foraminifera along with non-agglutinated forms. These fauna as a whole indicated the deposition in a shallow inner neritic marine waters. The sediments are dark gray mudstone / siltstone with abundant organic matter. The depositional environment probably was one of the poorly oxygenated, slowly circulating bottom water with high CO_2 content resulting from the decomposition of organic matter.

The coal-bearing sequence as a whole indicates repeatedly oscillating environment ranging from delta plain marshes/ swamps to prodelta conditions.

Stratigraphic data derived from the foraminiferal studies indicates that the coal-bearing rocks of Thar Coal field are of late Paleocene to early Eocene age.

Introduction

The Thar Coal field is located in the eastern part of Sindh province, Pakistan (Fig. 1) in the Thar Desert. Discovery of this huge coal deposit is the most important discovery after the Sui Gas field in the context of energy resources of Pakistan.

The coal occurs at an average depth of 170mm. Previous work (Ahmed and Zeigham 1993) indicated, on the basis of correlation via seismic sections; only the coal-bearing interval is of Jurrasic age. The geology of Thar Desert is poorly understood as the area is covered by dune sand to an average depth of approximately 80m.

Fig. 1. Index Map of Pakistan showing the studied areas

The only outcrop of the bedrock in the Thar Desert of Pakistan is found at Nagarparkar (Fig. 2)

The coalfield rests upon a structural plate form in the eastern part of the desert. The discovery of thick coal beds, based on the geophysical logging of SAZDA ground water holes (Mehtab et al 1993) and interpretation of logging data of ground water holes (Zeigham, and Mehtab 1992), promoted detailed investigation for coal potential in the area. Ahmed and Zeigham (1993) provide a good representation of surface geology of the Thar Desert.

The available seismic records in Thar Coal field area were designed for oil and gas exploration at depth. For this reason Ahmed and Zeigham (1993) reported that the thickest coal in the Thar field is Jurrasic in age based on the physical tracing of geological contacts on seismic sections.

Paleontological studies of the cutting samples from the same coal-bearing strata indicate the coal to be of late Paleocene-early Eocene age (San Filip *et al* 1993).

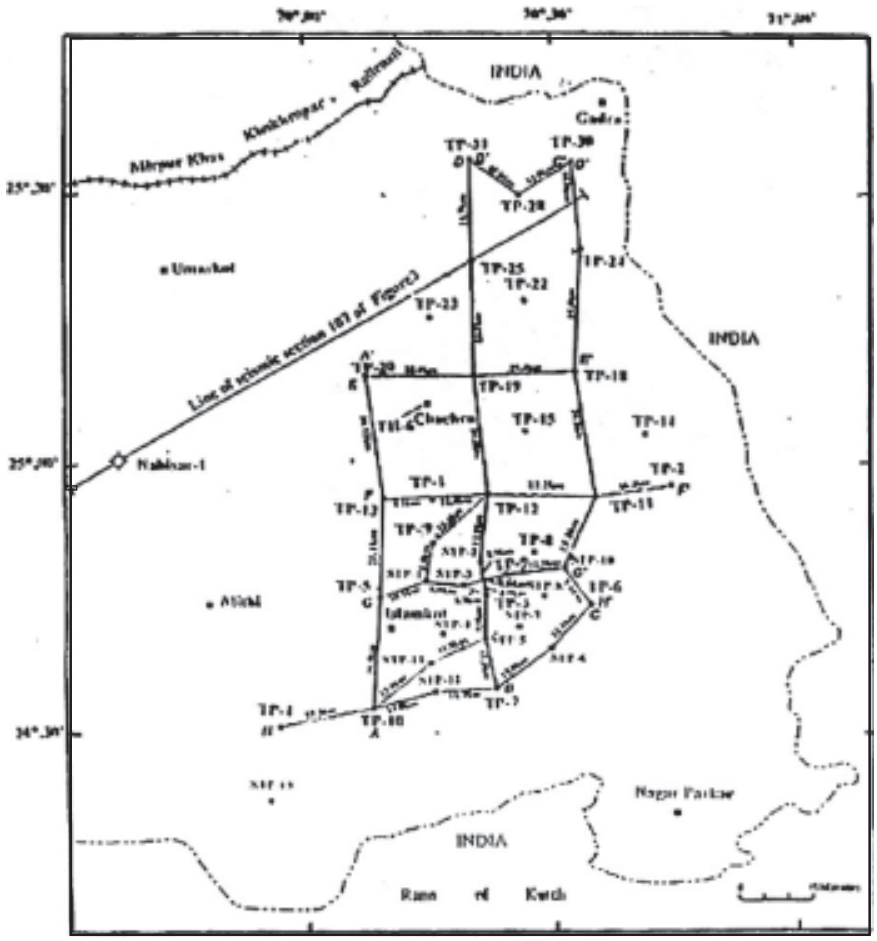

Fig. 2. Map showing the location of different wells

Additional studies of fossils from marine inter-beds in the coal bearing sequence from several test holes in the western part of the field are now in progress and these studies will more narrowly define the age of the coal-bearing rocks of Thar coal field.

Material and Methods

The studied drill holes are located at the south east and south west of the Thar Coal field. Samples were collected from the Geological Survey of Pakistan, Core Laboratories. Core samples were taken from drill hole STP-1, STP-4, STP-7, STP-8, STP-9, STP-10, STP-12, STP-13, TP-3, and TP-5. (Fig.2).

About one hundred samples were collected from 10 holes and prepared for study. Most of these were unfossiliferous. Only six drill holes yielded benthic forams, these are poorly preserved and small in size. No planktonic forams were present in the studied material.

Mostly all the collected samples are shales with high organic content and rare sandstones.

Laboratory techniques

Each sample was broken into small fragments about 5mm maximum in dimension, and about 80 grams was processed.

The samples were dried in an oven at 75° C overnight and were processed by Sodium Sulphate and Neptha methods.

Sodium Sulphate Method

After being dried, the rock samples were added in the boiling oversaturated Sodium Sulphate solution and were cooled to room temperature. The solution was decanted to get mother solution. After that the samples were left for a few days and were washed through a 200-mesh sieve. The residue was redried.

Naptha Method

After being dried, the samples were added to organic solvent Naptha at room temperature. The Naptha was taken back by filtering, and boiling water was added. The samples were boiled to remove Naptha completely, then again washed through 200-mesh sieve. The washed material was dried in the oven. Samples were picked for foraminifera.

The identified specimens were coated with gold and photographed by using the Zeiss DSM 940 Scanning Electron Microscope in the SEM Lab of University College London.

Benthic Foraminifers from the Thar Coal Basin

About 30 genera of benthic foraminifera with agglutinated forms with very rare calcarious tests were recorded from the six bore holes of the Thar Coal Basin. These assemblages were recorded from STP-1, STP-7, STP-9, STP-10, STP-13 and TP-5 bore holes.

Below is the list of genera of benthic foraminifera.

STP-1 and STP-10

Trochammina sp1
Trochammina sp2
Haplophragmoides sp1
Haplophragmoides sp2
Haploohragmoides sp3
Haplophragmoides sp4
Coryphostoma sp.
Epistomina sp1
Epistomina sp2
Gyroidinoides sp1
Gyroidinoides sp2
Gyroidinoides sp3

Osangularia sp2
Quadrimorphina sp1
Quadrimorphina sp2
Praebulimina sp.
Cibicides sp.
Globorotalites sp.
Anomalinoides sp.
Eponoides sp1
Buccierenata sp.
Tritaxia sp.
Cassidulina sp.
Marssonella sp.
Sphaerommina sp.

STP-7 and TP-5

Ammobaculites sp.
Trochamminoides sp.
Triphotrocha sp.
Ammosphaeroidina sp.
Tochimminula sp.
Buccierenata sp.
Epistomina sp.
Buliminella sp.
Lenticulina sp.
Ammonia sp.
Eponoides sp2
Trochammina sp4
Trochammina sp5
Trochammina sp6
Trochammina sp7
Haeglundina sp.
Arenobulimina sp.
Haplophragmoides sp5
Tritaxia sp2

STP-9 and STP-13

Trochammina sp8
Trochammina sp10
Trochammina sp11
Lenticulina sp2
Lenticulina sp3

Tritaxia sp3
Haplophramoides sp.
Osangularia sp3
Osangularia sp4
Osangularia sp5
Spiroplectamina sp.
Globobulimina sp.
Gaudryina sp.

Agglutinated foraminifera (LeRay 1953) were found in 30 samples from 6 boreholes, out of hundred samples from 10 boreholes, the recorded assemblages (Nagappa, Y. 1959) consist of 30 genera, the main forms (Saida R. and Kenaway 1956, Tjalsman, R. C *et al* 1983) being *Trochammina* *(a) *Osangularia* **(c) *Haplophragmoides* (a) *Amosphaeroidina* (a) and *Lenticulina* (c).

The specimens could not be identified to species level due to their poor state of preservation.

Paleoecology

Benthic foraminifera are responsive to variation depositional environment (Kurreshy 1969, Phleger 1960, Murray 1973). Their distribution is controlled by various ecological factors among which the most important are temperature, salinity and oxygen. The preservation of the studied fauna indicates that these assemblages lived in strongly different environment as for as the physio-chemical factors (pH, eh and high organic carbon content) under which the agglutinated foraminiferal species preferably occur, favour the preservation of considerable amounts of organic matter during the deposition. The agglutinated foraminifera of the Thar Coal Basin preserved under low pH values, which are slightly acidic. Such low pH values are mainly result of high CO_2 content and low positive eh values, such low redox potential occur together with O_2 deposition in an under stagnant bottom water (Moor Ren 1975).

The agglutinated foraminifera in the studied sample are small, light amber to dark gray in color, are smooth walled, dominated by trochoid and planispiral form. These factors show that these sediments have been deposited in shallow inner nerritic sea. (Govidan and Bhandari 1988).

Conclusion

The occurrence of agglutinated assemblage consisting predominantly of planispiral forms (Haplophragmoides, Trochamminoides) and trochospiral forms (Trochammina) suggest the deposition of sediments. These sediments occurred in a shallow, inner neritic sea. Since the enclosing sediment is organic rich. The possible environment would be stagnant or slow moving bottom water with low dissolved oxygen and high CO_2 content, resulting from the deposition of organic matter.

* (a) = Agglutinated,

** (c) = Calcareous.

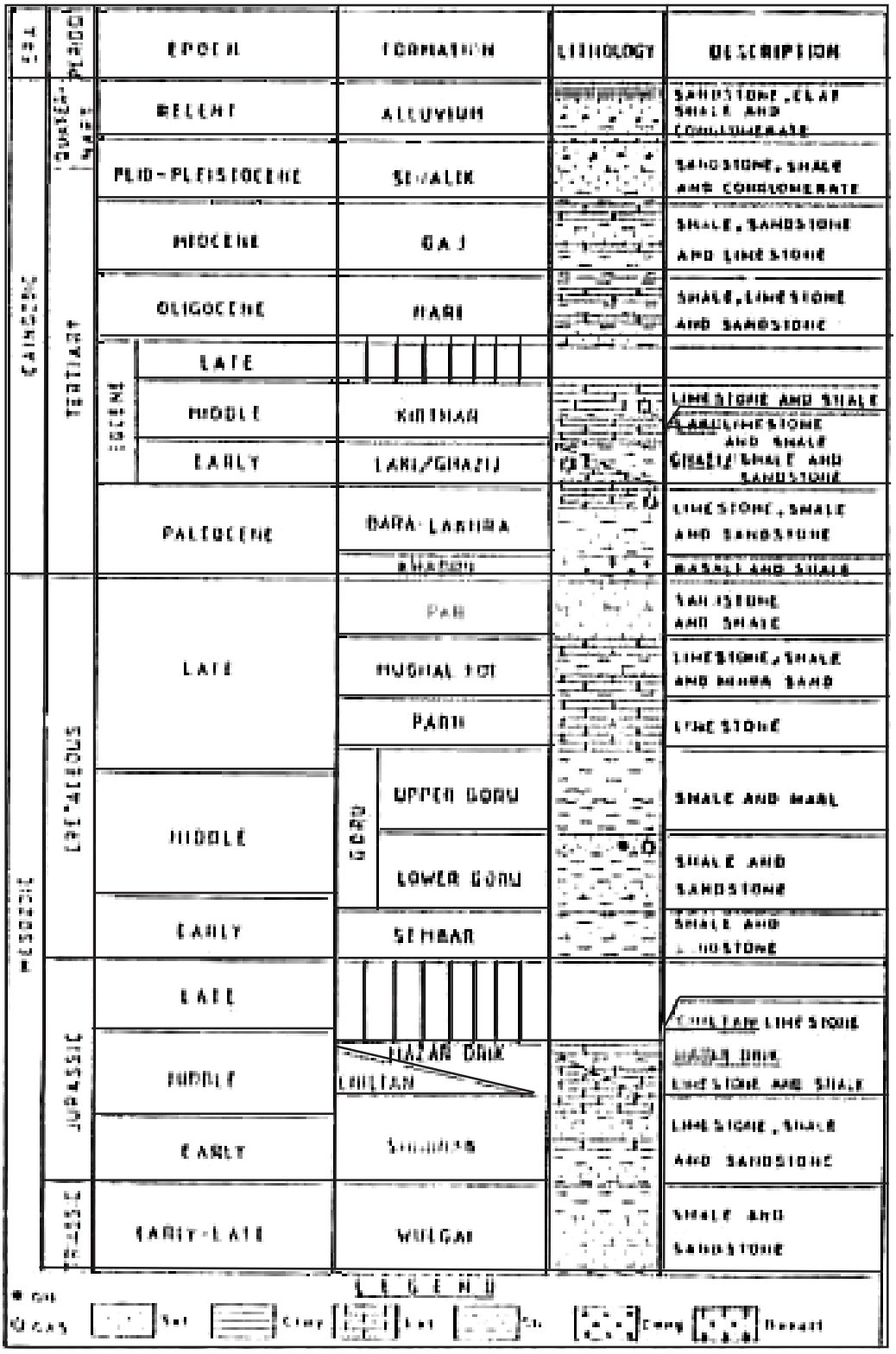

Fig. 3. Lithological Column of Thar Coal Field

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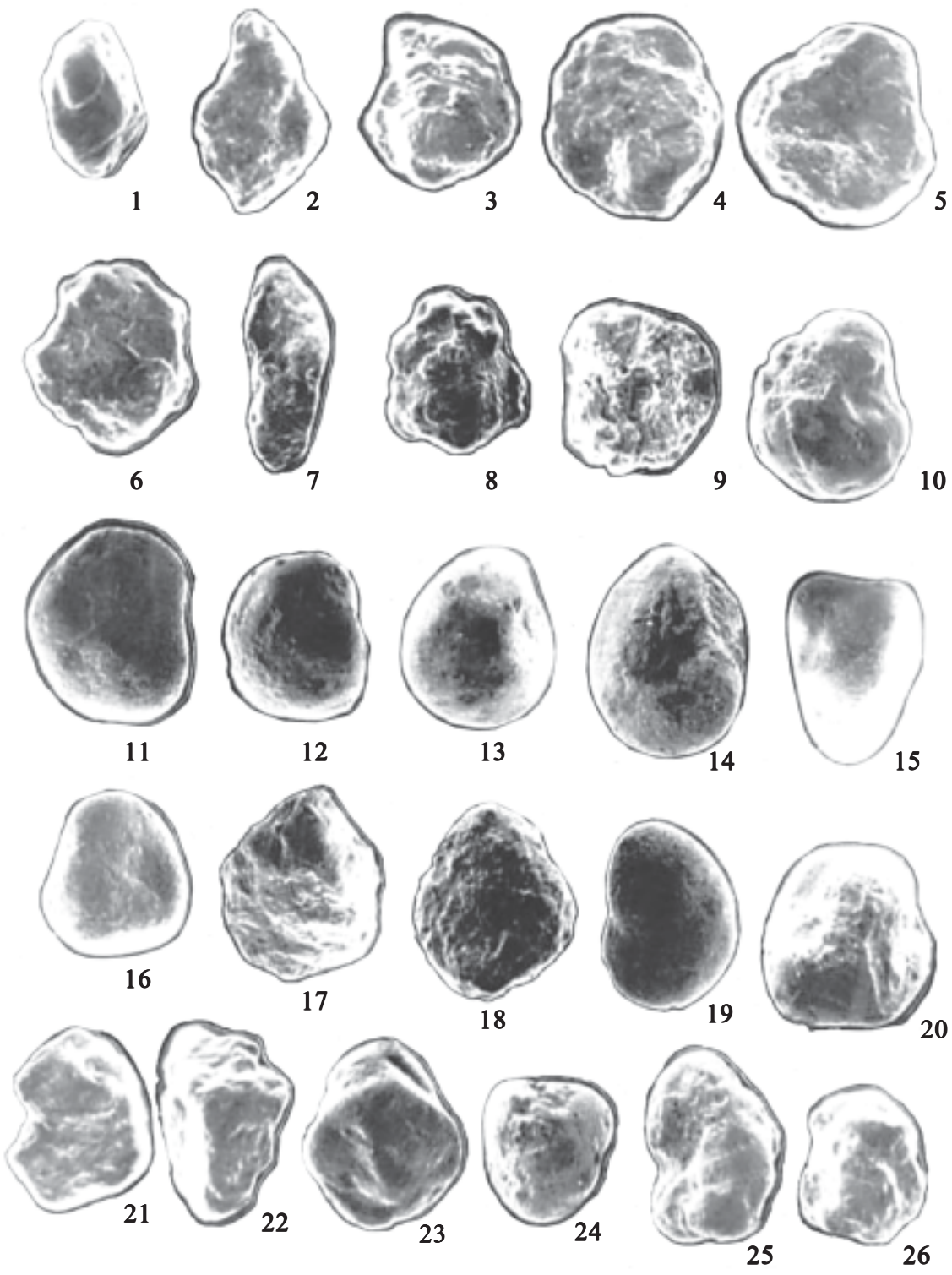
Plates

Plate No.1



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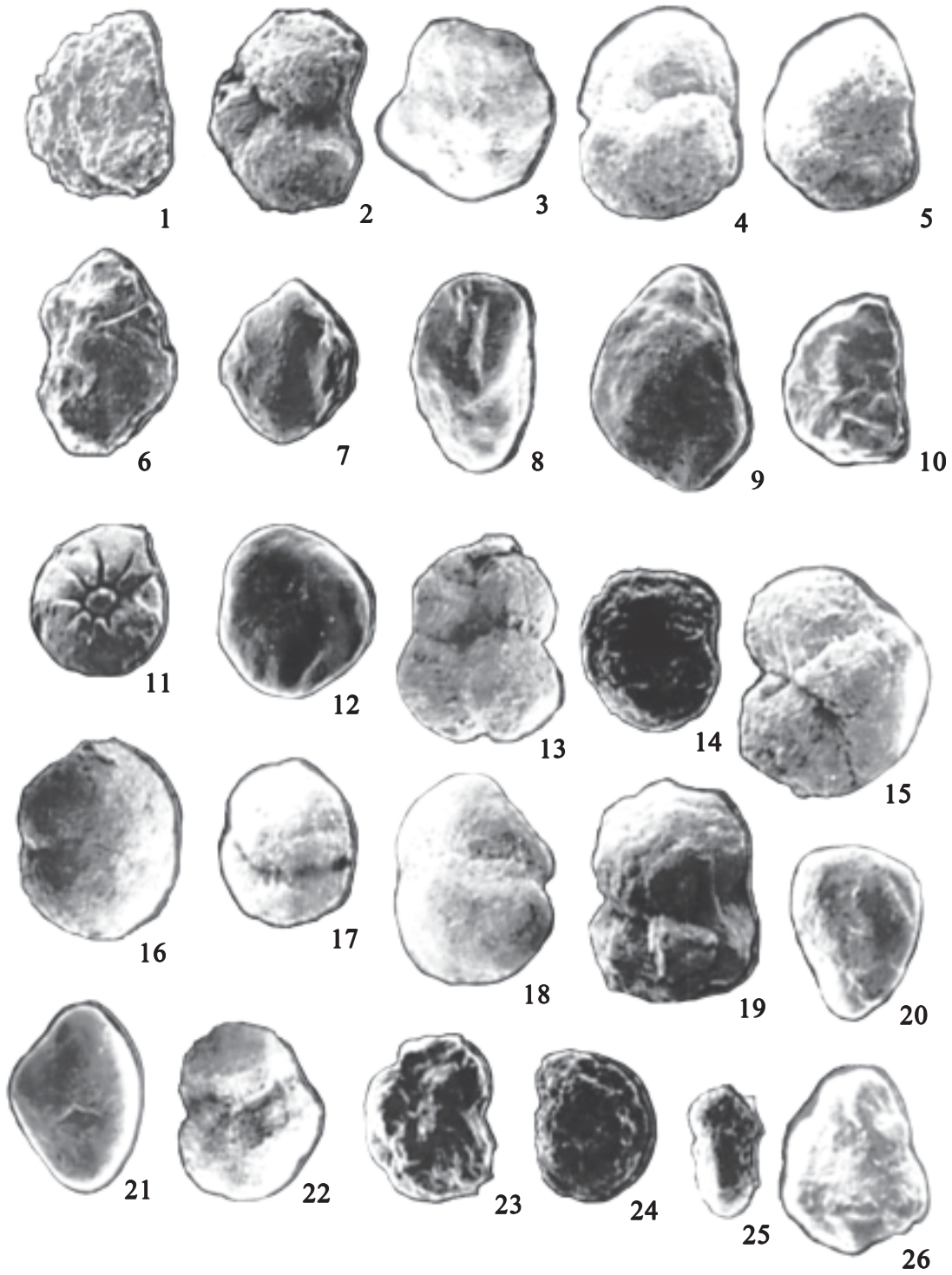

Plate No.1

From STP-1 and STP-10

Figure no.	Name
1.	*Trochamina sp1* (STP-10)
2.	*Trochamina sp2* (STP-10)
3.	*Haplopharagmoides sp1* (STP-10)
4.	*Haplopharagmoides sp2* (STP-10)
5.	Haplopharagmoides sp3
6.	Haplopharagmoides sp4
7.	Coryphostoma sp
8.	*Epistomina sp1* (STP-10)
9.	*Epistomina sp2* (STP-10)
10.	*Gyroidinoides sp1* (STP-10)
11.	*Gyroidinoides sp2* (STP-10)
12.	*Gyroidinoides sp3* (STP-1)
13.	*Osangularia sp1* (STP-1)
14.	*Osangularia sp2* (STP-1)
15.	*Quadrimorphina sp1* (STP-10)
16.	*Quadrimorphina sp2* (STP-10)
17.	*Cibicides sp.* (STP-10)
18.	*Globorotalites sp.* (STP-1)
19.	*Anomalinoides sp.* (STP-1)
20.	*Eponoides sp.* (STP-1)
21.	*Buccierenata sp.* (STP-1)
22.	*Tritaxia sp.* (STP-1)
23.	*Cassidulina sp.* (STP-1)
24.	*Marssonella sp.* (STP-1)
25.	*Sohaerannuba sp.* (STP-10)
26.	*Ceritabulimina sp.* (STP-1)

Plate No. 2

From STP-7 and TP-5

Figure no	Name
1.	*Ammobaculites sp.* (STP-7)
2.	*Trochamminoides sp.* (TP-5)
3.	*Triphotrocha sp.* (TP-5)
4.	*Ammosphaeroidia sp.1* (TP-5)
5.	*Trochimminula sp.1* (TP-5)
6.	*Bucerinata sp.* (STP-7)
7.	*Epistomina sp.* (TP-5)
8.	*Buliminella sp.* (STP-7)
9.	*Lenticulina sp.1* (STP-7)
10.	*Lenticulina sp.2* (STP-7)
11.	*Ammonia sp.1* (TP-5)
12.	*Eponoides sp.2* (TP-5)
13.	*Trochammina sp.4* (TP-5)
14.	*Trochammina sp.5* (TP-7)
15.	*Trochammina sp.6* (TP-7)
16.	*Trochammina sp.7* (STP-5)
17.	*Ammspharoidina sp.3* (STP-5)
18.	*Ammspharoidina sp.4* (TP-5)
19.	*Ammspharoidina sp.* (STP-7)
20.	*Arenobulimina sp.1* (STP-7)
21.	*Arenobulimina sp.2* (STP-7)
22.	*Haplopragmoides sp.5* (TP-5)
23.	*Haplopragmoides sp.5* (TP-5)
24.	*Ammunigerina sp.* (TP-5)
25.	*Dorothia sp.* (TP-7)
26.	*Discammina sp.* (STP-7)