PALYNOLOGY OF THE MESOZOIC SEDIMENTS OF KUTCH, W. INDIA. 10. PALYNOLOGICAL ZONATION OF KATROL (UPPER JURASSIC) AND BHUJ (LOWER CRETACEOUS) SEDIMENTS IN KUTCH, GUJARAT

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ABSTRACT

Palynological fossils from 9 exposures representing Katrol (Upper Jurassic) and 5 representing Bhuj (Lower Cretaceous) sediments in Kutch are studied. The dispersed spores and pollen are referred to 65 genera and 161 species besides hystrichosphaerids, dinoflagellates and microforaminifera. It is observed that on the basis of presence or absence of spore-pollen genera Upper Bhuj sediments (viz. Walkamata and Dayapar sections) can be distinguished from the Katrol sediments; but the fossils of Lower Bhuj sediments (viz. sediments from Trombau and Pat river sections) are closely comparable to those occurring in Katrol sediments. The Katrol sediments can, however, be distinguished from the Lower Bhuj sediments on the basis of 11 restricted species. Three palynological zones established here point out the gradual change of flora during the Upper Jurassic and Lower Cretaceous times in Kutch.

INTRODUCTION

THE Mesozoic sediments of Kutch, (Gujarat state, India) are well developed attaining an estimated thickness of 1,800 metres (*see* WAAGEN & STOLICZKA, 1873; OLDHAM, 1893; VREDENBERG, 1910; RAJ NATH, 1932, 1942; SPATH, 1933; WADIA, 1957 and PODDAR, 1959). They are divided into four major divisions, i.e. Patcham, Chari, Katrol and Umia Series in the ascending order. Raj Nath (1932) separated Ukra and Bhuj beds from Umia beds and gave the latter the status of a Series.

The Katrol sediments lie unconformably over the Dhosa Oolite, the uppermost bed of the Chari Series. Waagen (1873) divided the Katrol into two divisions; the lower composed of red ferruginous and yellow sandstone and the upper consisting of sandstones and shales. Raj Nath (*l.c.*) on the basis of lithology divided the Katrol into four groups: K_1-Lower Katrol — mainly shales; K_2-Middle Katrol — mainly sandstones; K_3-Upper Katrol — mainly shales; K_4-hard sandstones. He suggested Kimmeridgian age for the Lower and Middle Katrol and Portlandian for the Upper (Gajansar bed).

The Bhuj Series which is generally known as Umia plant bearing beds are very important as they constitute the topmost beds of the Gondwana succession in India. This is composed of ferruginous beds of coarse sandstone in the lower part and coarse, white sandstone with inerlaminated sandy shales in the upper part. Raj Nath (1932) recognized three horizons in the Bhuj Series: the upper *Palmoxylon* beds; the middle *Ptilophyllum* beds and the lower *Zamia* beds. Raj Nath (*l.c.*) on the basis of Palm remains in the upper zone [identified as *Palmoxylon mathurii* by Sahni (1932)] attributed a Middle Cretaceous (Post Aptian) age to the upper beds.

Feistmantel (1876) based on a study of Umia plant fossils of Kutch compared them with the Oolitic flora of Europe and assumed that those beds of Kutch are Bathonian in age. The data on the problem of age are summarized in Table 1.

Singh, Srivastava and Roy (1964); Venkatachala (1969) and Venkatachala and Kar (in press) on the basis of palynological studies concluded that the Bhuj Series is of Lower Cretaceous age. The present paper deals with an appraisal of the distribution of palynological fossils in Katrol and Bhuj sediments around Bhuj (TEXT-FIG. 1). Data from nine measured sections of Katrol sediments (VENKATACHALA, KAR & RAZA, 1969) and five of Bhuj sediments (VENKATACHALA, *l.c.*, VENKATACHALA & KAR *l.c.*) are used for this compilation (TEXT-FIG. 1). The details concerning the sections measured, samples investigated and the systematic palynology are given in the above papers.

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PALYNOLOGICAL COMPOSITION

The following spore-pollen taxa are present in the assemblage (for distribution *see* TABLE 2):

Deltoidospora rhytisma Rouse
Cyathidites australis Coup.
Cyathidites minor Coup.
C. punctatus (Delc. & Sprum.) Delc. *et al.*
C. concavus (Bolkhov.) Dettm.
C. asper (Bolkhov.) Dettm.
C. cutchensis Singh *et al.*
C. pseudopunctatus Singh *et al.*
C. grandis Singh *et al.*
C. rajmahalensis Sah & Jain
C. medicus Sah & Jain
C. trilobatus Sah & Jain
C. flavatus Venkat. *et al.*
Biretisporites potoniaei Delc. & Sprum.
B. spectabilis Dettm.
B. convexus Venkat. *et al.*
Biretisporites sp.
Alsophilidites exilis Sah & Jain
A. bellus Venkat. *et al.*
Alsophilidites sp.
Gleicheniidites senonicus Ross.
G. cercenidites (Cooks.) Dettm.
Concavisporites crassus Venkat. *et al.*
Todisporites major Coup.
T. minor Coup.
T. psilatus Venkat. *et al.*
Dictyophyllidites pectinataeformis Bolkhov.
Dictyophyllidites sp.
? *Appendicisporites* sp.
Osmundacidites wellmanii Coup.
O. minutus Sah & Jain
O. indicus Singh *et al.*
Lophotriletes sp. 1
Lophotriletes sp. 2
Stereisporites sp.
Concavissimisporites verrucosus (Delc. & Sprum.) Delc. *et al.*
C. crassatus (Delc. & Sprum.) Delc. *et al.*
C. penolaensis Dettm.
C. punctatus (Delc. & Sprum.) Singh
C. variverrucatus (Coup.) Singh
C. cutchensis Venkat.
C. subverrucosus Venkat.
C. plexus Venkat. *et al.*
Impardecispora apiverrucata (Coup.) Venkat. *et al.*
I. uralensis (Bolkhov. ex Poc.) Venkat. *et al.*
I. purverulentus (Verbits.) Venkat. *et al.*
I. trioreticulosus (Cooks. & Dettm.) Venkat. *et al.*
Baculatisporites comaumensis (Cooks.) Pot.
Neoraistrickia truncatus (Cooks.) Pot.
Ceratosporites kutchensis Venkat.
Pilosisporites notensis Cooks. & Dettm.
P. grandis Dettm.
Bhujiasporites hirsutus Venkat. *et al.*
Leptolepidites sp.
Foveosporites canalis Balme.
Lycopodiacidites asperatus Dettm.
L. subtriangulus Venkat. *et al.*
L. paucimurus Venkat. *et al.*
Lycopodiacidites sp.
Lycopodiumsporites austroclavatidites (Cooks.) Pot.
L. circolumensis Cooks. & Dettm.
L. facetus Dettm.
L. eminulus Dettm.
L. baculatus Venkat. *et al.*
L. minutus Venkat. *et al.*
Lycopodiumsporites sp.
Foveotriletes parviretus (Balme) Dettm.
F. kutchensis Venkat.
F. triangulus Venkat. *et al.*
F. foveolus Venkat. *et al.*
Klukisporites scaberis (Cooks. & Dettm.) Dettm.
K. punctatus Venkat.
K. apunctus Venkat. *et al.*
Microreticulatisporites uniformis C. Singh
Staplinisporites caminus (Balme) Poc.
Polycingulatisporites reduncus (Bolkhov.) Venkat.
Cicatricosisporites australiensis (Cooks.) Pot.
C. ludbrooki Dettm.
Cicatricosisporites sp.
Annulispora folliculosa (Rogal.) de Jersey
Trilobosporites hannonicus Delc. *et al.*
Matonisporites kutchensis Venkat.
Boseisporites praeclarus (Dev) Singh *et al.*
B. insignitus Venkat.
B. punctatus Venkat.
B. lobatus Venkat.
B. minutus Venkat.
Sestrosporites pseudoalveolatus (Coup.) Dettm.
Coronatispora perforata Dettm.
C. telata (Balme) Dettm.
Foraminisporis sp.
Cingulatisporites sp.
Murospora punctatus Venkat.
Ischyosporites crateris Balme
Densoisporites velatus Weyl. & Kreig.
Contignisporites glebulentus Dettm.
C. cooksonii (Balme) Dettm.
C. fornicatus Dettm.
C. multimuratus Dettm.
C. detmannii Singh & Kumar

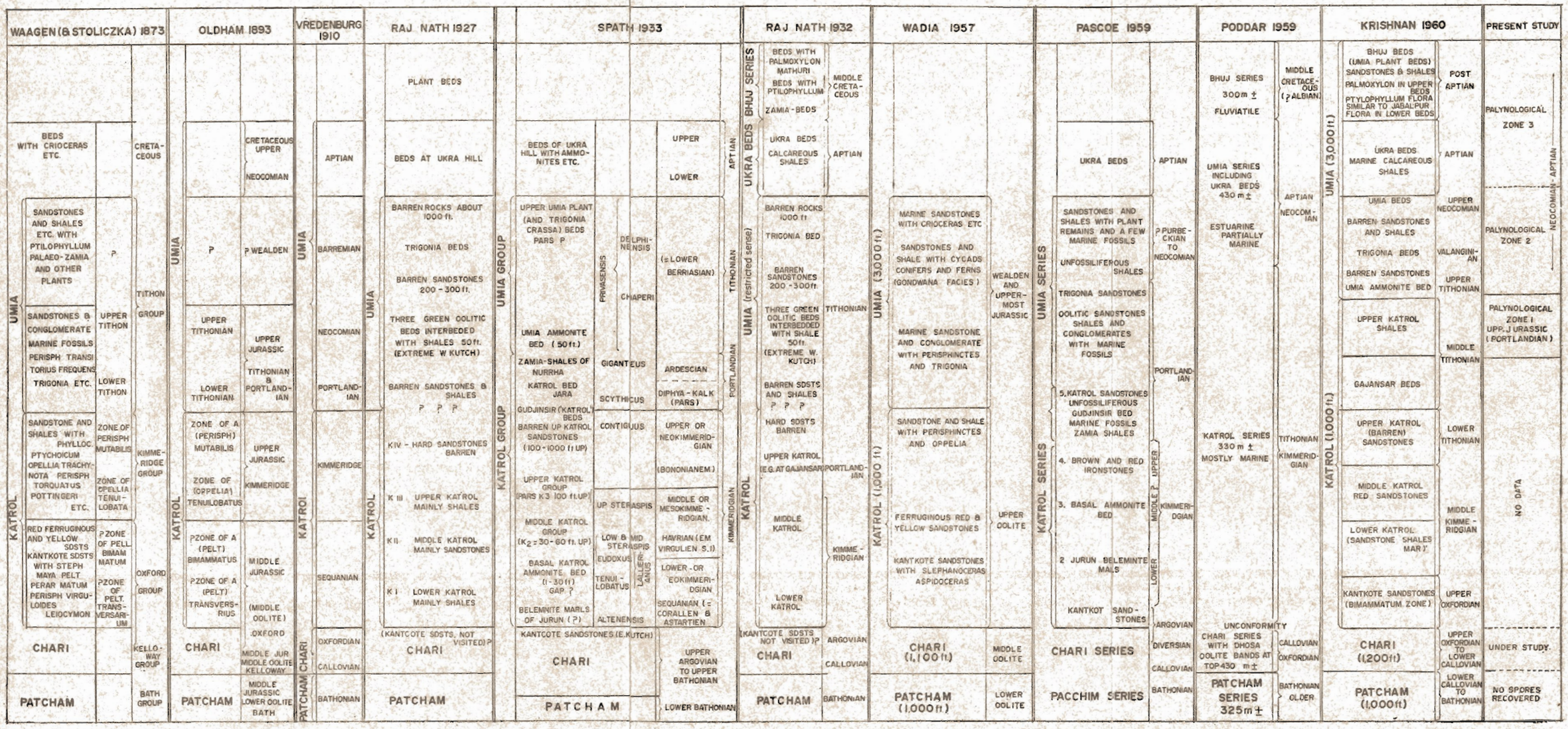
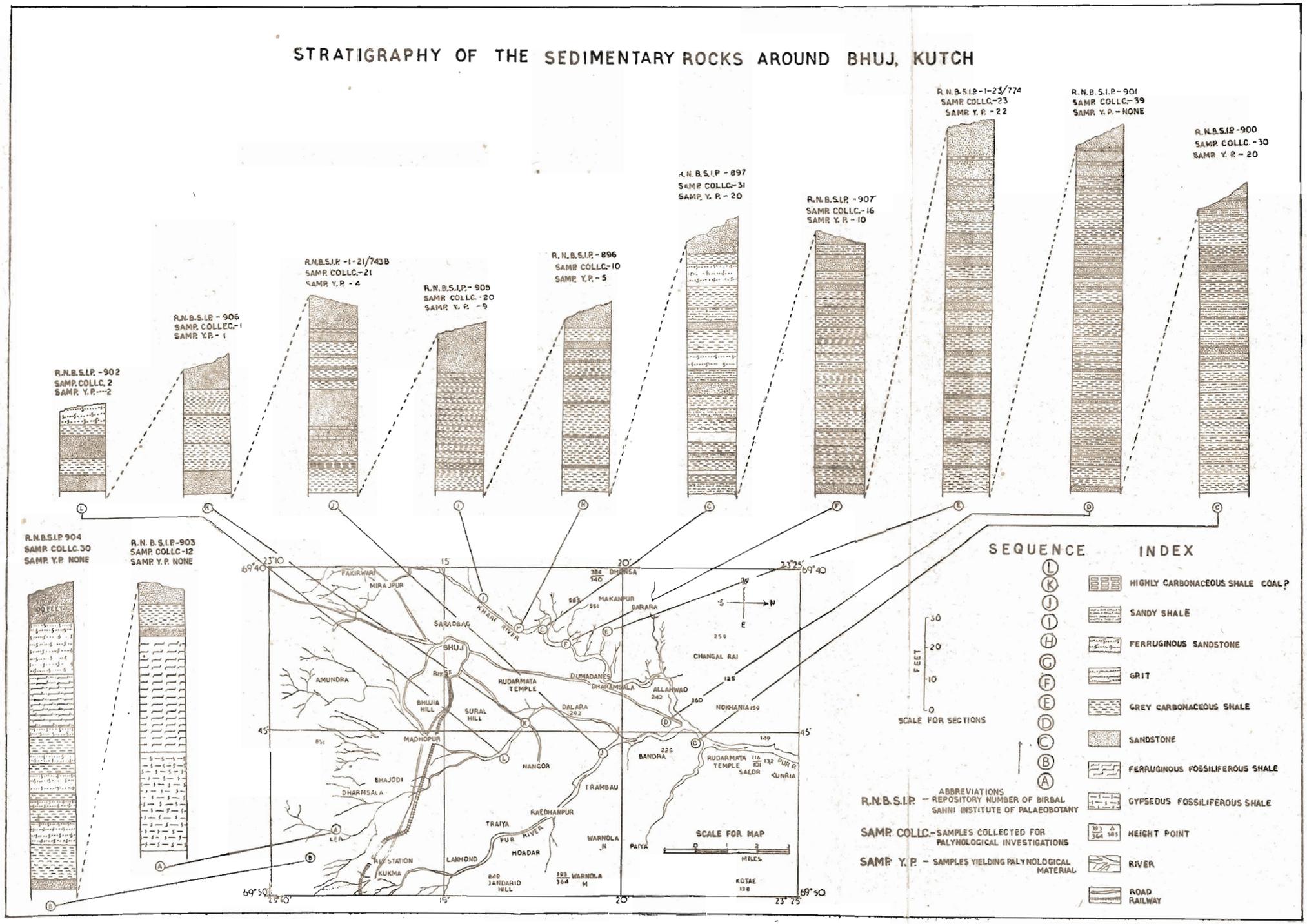


TABLE 1 — Showing different opinions on the classification and correlation of the Mesozoic rocks in Kutch, Gujarat State, India.



TEXT-FIG. 1 — Showing the locality of the sections studied.

C. kutchensis Venkat. *et al.*
C. triletus Venkat. *et al.*
Contignisporites sp.
Cooksonites minor Venkat.
Coptospora kutchensis Venkat.
C. minutus Venkat. *et al.*
Katrolaites kutchensis Venkat. & Kar
Aequitriradites verrucosus (Cooks. & Dettm.) Cooks. & Dettm.
A. silchaensis Cooks. & Dettm.
Laevigatosporites sp.
Leschikisporis indicus Singh *et al.*
Thymospora sp.
Polypodiisporites sp.
**Applanopsis lenticularis* Dör.
A. trilobatus (Balme) Venkat. *et al.*
A. segmentatus (Balme) Venkat. *et al.*
A. monoalasporus (Dev) Venkat. *et al.*
A. lucidus (Poc.) Venkat. *et al.*
A. triletus (Singh *et al.*) Venkat. *et al.*
A. grandis (Sah & Jain) Venkat. *et al.*
A. punctatus Venkat. *et al.*
A. ovatus Venkat. *et al.*
A. granulatus Venkat. *et al.*
Alisporites grandis (Cooks.) Dettm.
A. thomasii (Coup.) Poc.
A. similis (Balme) Dettm.
Podocarpidites ellipticus Cooks.
P. multesimus (Bolkhov.) Poc.
P. ornatus Poc.
P. canadensis Poc.
P. minisulcus C. Singh
P. grandis Sah & Jain
P. cristiexinus Sah & Jain
Podocarpidites densus Venkat.
Platysaccus indicus Venkat.
Platysaccus sp.
Vitreisporites pallidus (Ressin.) Nils.
Microcachryidites antarcticus Cooks.
Microcachryidites sp.
Podosporites tripakshi Rao
P. microsaccatus (Coup.) Dettm.
Podosporites sp.
Ginkgocycadophytus nitidus (Balme) de Jersey
Ginkgaletes sp.
Cycadopites gracilis Sah & Jain
Ephedripites sp.
Classopollis classoides (Pf.) Poc. & Jans.
C. obidoensis Groot & Groot
Araucariacites australis Cooks.
A. cooksonii Singh *et al.*
Araucariacites sp.
Laricoidites indicus Singh *et al.*
L. communis Sah & Jain
L. kutchensis Venkat. *et al.*
Exesipollenites sp.
Schizosporis reticulatus Cooks. & Dettm.
S. sprigii Cooks. & Dettm.
S. laevigatus Venkat.

**Applanopsis* is now regarded as junior synonym of *Callialasporites* Dev. 1961.

The fossils belonging to the following major groups are distributed as follows:

Groups	Affinity	Katrol (U. Jurassic)		Bhuj (L. Cretaceous)	
		Genera	Species	Genera	Species
Trilete	Pteridophytic spores & some Bryophytic spores	21	64	40	63
Monolete	Pteridophytic — Polypodiaceous affinity	2	2	3	3
Hilate	Pteridophytic — Lycopodian affinity and questionable Bryophytic affinity	2	3	3	4
Monosaccate	Gymnospermous affinity	1	10	1	5
Bisaccate	do	2	11	4	8
Polysaccate	do	2	3	2	4
Monocolpate	Gymnospermous — Cycadalean affinity	—	—	2	3
Polyplicate	Gymnospermous — Ephedralean affinity	—	—	1	1
Operculate	Gymnospermous — Cheirolepidaceae	1	2	1	2
Alete	Gymnospermous — Araucarian affinity	2	4	2	3
Incertae sedis	*Schizosporis* and *Exesipollenites*	2	2	1	4

The pteridophytic spores are dominant in Bhuj sediments. Spores of Cyathiaceae, Matoniaceae, Dicksoniaceae, and other tree ferns besides Gleicheniaceae, Osmundaceae, Schizeaceae, Lycopodiaceae (trilete, monolete and hilate spores) comprising both lycopodian and selaginellalian groups, and Polypodiaceae are well represented. Hilate spores of questionable bryophytic affinity are well represented in the Bhuj sediments while they are not frequent in the older Katrol sediments.

Coniferous pollen of saccate, operculate and alete types and cycadalean pollen of colpate, polyplicate types are also commonly found in both Bhuj and Katrol sediments. Coniferous pollen in some sections dominate the assemblage.

PALYNOLOGICAL ZONATION

The palynological assemblage can be divided into 3 zones on the basis of presence and absence of taxa, starting and the ending points of taxa (TABLE 2).

Zone 1

The following species are restricted to this zone:

Cyathidites punctatus, C. concavus, C. rajmahalensis, C. medicus, C. flavatus, C. trilobatus, Biretisporites potoniaei, B. convexus, Alsophilidites exilis, Gleicheniidites cercenidites, Todisporites psilatus, Osmundacidites minutus, Lophotriletes sp. 1, *Lophotriletes* sp. 2, *Concavissimisporites penolaensis, C. punctatus, C. plexus, C. variverrucatus, Impardecispora uralensis, Pilosisporites grandis, Lycopodiumsporites austroclavatidites, L. baculatus, Foveotriletes triangulus, F. foveolus, Klukisporites scaberis, K. apunctus, Matonisporites kutchensis, Boseisporites minutus, Contignisporites glebulentus, C. multimuratus, C. detmannii, C. psilatus, C. triletes, C. kutchensis, Coptospora minutus, Katrolaites kutchensis, Callialasporites lenticularis, C. monoalasporus, C. grandis, C. punctatus, C. lucidus, C. ovatus, C. granulatus, C. thomasii, Podocarpidites multesimus, P. ornatus, P. canadensis, P. minisulcus, P. grandis, P. ellipticus, P. cristiexinus, P. densus, Cycadopites gracilis, Laricoidites communis, L. kutchensis,* and *Exesipollenites* sp.

From the above list it is apparent that the genera, *Cyathidites, Concavissimisporites, Contignisporites, Callialasporites* and *Podocarpidites* play an important role in recognizing this assemblage. They are represented by a good number of species. *Katrolaites* and *Exesipollenites* are not in great abundance, but are significant in this assemblage. All the above listed species are not present in all the exposures of the Katrol sediments representing Zone 1. The following species are present in all the study sections (*see* TABLE 1) and thus are here considered important taxa of the Katrol assemblage:

Cyathidites minor, Concavissimisporites punctatus, Boseisporites minutus, Contignisporites glebulentus, Callialasporites lenticularis, C. grandis, C. punctatus, C. lucidus, C. ovatus, Podocarpidites multesimus, and *Laricoidites communis.*

Zone 2

The following taxa are restricted to Zone 2:

Cyathidites cutchensis, C. pseudopunctatus, C. grandis, Concavisporites indicus, Foveotriletes kutchensis, Cicatricosisporites australiensis, Murospora punctatus, Ischyosporites crateria, Aequitriradites verrucosus, Platysaccus indicus, Platysaccus sp., *Gynkgaletes* sp., *Schizosporis reticulatus,* and *S. sprigii.*

This zone is a transitional one between the typical Katrol and Bhuj assemblages. This zone can, however, be distinguished by the presence of above mentioned species.

Zone 3

The following taxa are restricted to this zone:

Deltoidospora rhytisma, Biretisporites sp., *Alsophilidites densus, Aslophilidites* sp., *Gleicheniidites senonicus, Dictyophyllidites* sp., ? *Appendicisporites* sp., *Stereisporites* sp., *Baculatisporites comaumensis, Neoraistrickia truncatus, Ceratosporites kutchensis, Pilosisporites notensis, Leptolepidites* sp., *Foveosporites canalis, Microreticulatisporites uniformis, Staplinisporites caminus, Polycingulatisporites reduncus, Annulispora folliculosa, Trilobosporites hannonicus, Sestrosporities pseudoalveolatus, Coronatispora perforata, C. telata, Foraminisporis* sp., *Cingulatisporites* sp., *Thymospora* sp., *Microcachryidites* sp., *Ginkgocycadophytus nitidus, Cycadopites* sp., *Ephedripites* sp., *Classopollis obidoeniis* and *Schizosporis* sp.

FORMATION	KATROL						BHUJ			
PALYNOLOGICAL ZONATION	ZONE 1					ZONE 2			ZONE 3	
	SECTION C(1900)	SECTION E (1774)	SECTION G (1897)	SECTION H(1896)	SECTION I (1905)	SECTION J (1743)	SECTION K (1905)	SECTION L(1902)	WALKAMATA	DAYAPAR
ALISPORITES GRANDIS										
MICROCACHRYIDITES ANTARCTICUS										
APPLANOPSIS TRILOBATUS										
ARAUCARIACITES AUSTRALIS										
CONTIGNISPORITES COOKSONII										
CYATHIDITES AUSTRALIS										
COPTOSPORA KUTCHENSIS										
APPLANOPSIS MONOALASPORUS										
CLASSOPOLLIS CLASSOIDES										
APPLANOPSIS SEGMENTATUS										
APPLANOPSIS DAMPIERI										
ARAUCARIACITES COOKSONII										
APPLANOPSIS TRILETES										
CYATHIDITES MINOR										
KLUKISPORITES PUNCTATUS										
BOSEISPORITES MINUTUS										
CONTIGNISPORITES GLEBULENTUS										
APPLANOPSIS LENTICULARIS										
APPLANOPSIS LUCIDUS										
APPLANOPSIS GRANDIS										
APPLANOPSIS PUNCTATUS										
APPLANOPSIS OVATUS										
APPLANOPSIS GRANULATUS										
PODOCARPIDITES MULTERIMUS										
LARICOIDITES COMMUNIS										
OSMUNDACIDITES WELLMANII										
CYATHIDITES ASPER										
BOSEISPORITES PUNCTATUS										
MATONISPORITES KUTCHENSIS										
FOVEOTRILETES TRIANGULUS										
KATROLAITES KUTCHENSIS										
PODOCARPIDITES MINISULCUS										
CONCAVISSIMISPORITES SUBVERRUCOSUS										
CONCAVISSIMISPORITES PENOLAENSIS										
CYATHIDITES FLAVATUS										
PILOSISPORITES GRANDIS										
FOVEOTRILETES PARVIRETUS										
CYATHIDITES RAJMAHALENSIS										
CONCAVISSIMISPORITES PUNCTATUS										
LYCOPODIACIDITES ASPERATUS										
CYATHIDITES CONCAVUS										
CONTIGNISPORITES FARNICATUS										
IMPARDECISPORA TRIORETICULOSUS										
BOSEISPORITES PRAECLARUS										
BOSEISPORITES INSIGNITUS										
BOSEISPORITES LOBATUS										
IMPARDECISPORA APIVERRUCATA										
CONCAVISSIMISPORITES CRASSATUS										
CONCAVISSIMISPORITES KUTCHENSIS										
CONCAVISSIMISPORITES VERRUCOSUS										
LARICOIDITES INDICUS										
BIRETISPORITES CONVEXUS										
FOVEOTRILETES FOVEOLUS										
KLUKISPORITES SCABERIS										
KLUKISPORITES APUNCTUS										
CONTIGNISPORITES DETMANII										
CONTIGNISPORITES TRILETES										
COPTOSPORA MINUTUS										
PODOCARPIDITES CANADENSIS										
PODOCARPIDITES GRANDIS										
LARICOIDITES KUTCHENSIS										
BIRETISPORITES SPECTABILIS										
GLEICHENIIDITES CERCENIDITES										
CONTIGNISPORITES MULTIMURATUS										
TODISPORITES PSILATUS										
CONCAVISSIMISPORTES PLEXUS										
LYCOPODIACIDITES PAUCIMURUS										
LYCOPODIACIDITES SUBTRIANGULUS										
CONTIGNISPORITES PSILATUS										
ALISPORITES THOMASII										
PODOCARPIDITES ORNATUS										
EXESIPOLLENITES SP.										
BHUJIASPORITES HIRSUTUS										
LOPHOTRILETES SP.1										
LOPHOTRILETES SP.2										
IMPARDECISPORA URALENSIS										
SCHIZOSPORIS LAEVIGATUS										
LYCOPODIUMSPORITES EMINULUS										
CYATHIDITES MEDICUS										
ALSOPHILLIDITES EXILIS										
LYCOPODIUMSPORITES AUSTROCLAVATIDITES										
LYCOPODIUMSPORITES BACULATUS										
CONTIGNISPORITES KUTCHENSIS										
TODISPORITES MINOR										
IMPARDECISPORA PURVERULENTUS										
PODOCARPIDITES DENSUS										
CYATHIDITES PUNCTATUS										
BIRETISPORITES POTONIAEI										
CONCAVISSIMISPORITES VARIVERRUCATUS										
PODOCARPIDITES CRISTIEXINUS										
DICTYOPHYLLIDITES PECTINATAEFORMIS										
VITREISPORITES PALLIDUS										
LESCHIKISPORIS INDICUS										
ALISPORITES SIMILIS										
PODOSPORITES SP.										
OSMUNDACIDITES INDICUS										
CICATRICOSISPORITES SP.										
LYCOPODIUMSPORITES SP.										
COOKSONITES MINOR										
CYATHIDITES TRILOBATUS										
OSMUNDACIDITES MINUTUS										
LYCOPODIUMSPORITES MINUTUS										
PODOSPORITES TRIPAKSI										
CYCADOPITES GRACILIS										
CYATHIDITES CUTCHENSIS										
CYATHIDITES PSEUDOPUNCTATUS										
CYATHIDITES GRANDIS										
MUROSPORA PUNCTATUS										
CICATRICOSISPORITES LUDBROOKI										
LYCOPODIUMSPORITES FACETUS										
CONCAVISPORITES INDICUS										
PLATYSACCUS INDICUS										
SCHIZOSPORIS RETICULATUS										
SCHIZOSPORIS SPRIGII										
DENSOISPORITES VELATUS										
LAEVIGATOSPORITES SP.										
FOVEOTRILETES KUTCHENSIS										
CICATRICOSISPORITES AUSTRALIENSIS										
PLATYSACCUS SP.										
ISCHYOSPORITES CRATERIS										
AEQUITRIRADITES VERRUCOSUS										
LEPTOLEPIDITES SP.										
FORAMINISPORIS SP.										
THYMOSPORA SP.										
CYCADOPITES SP.										
CLASSOPOLLIS OBIDOENSIS										
DELTOIDOSPORA RHYTISMA										
BIRETISPORITES SP.										
GLEICHENIIDITES SENONICUS										
DICTYOPHYLLIDITES SP.										
APPENDICISPORITES SP.										
STEREISPORITES SP.										
BACULATISPORITES COMAUMENSIS										
NEORAISTRICTIA TRUNCATUS										
CERATOSPORITES KUTCHENSIS										
PILOSISPORITES NOTENSIS										
FOVEOSPORITES CANALIS										
MICRORETICULATISPORITES UNIFORMIS										
STAPLINISPORITES CAMINUS										
POLYCINGULATISPORITES REDUNCUS										
ANNULISPORA FOLLICULOSA										
TRILOBOSPORITES HANNONICUS										
SESTROSPORITES PSEUDOLVEOLATUS										
CORONATISPORA PERFORATA										
CORONATISPORA TELATA										
EPHEDRIPITES SP.										
ALSOPHILLIDITES DENSUS										
ALSOPHILLIDITES SP.										
MICROCACHRYIDITES SP.										
GINKGOCYCADOPHYTUS NITIDUS										
SCHIZOSPORIS SP.										
TODISPORITES MAJOR										
LYCOPODIACIDITES SP.										
LYCOPODIUMSPORITES CIRCOLUMENUS										
CINGULATISPORITES SP.										
AEQUITRIRADITES SILCHAENIS										
POLYPODIISPORITES SP.										
PODOCARPIDITES ELLIPTICUS										
PODOSPORITES MICROSACCATUS										
GYNKGALETES SP.										
ARAUCARIACITES SP.										

TABLE — Showing the three palynological zones and the distribution of fossils in the Katrol-Bhuj sediments studied.

The three palynological zones demarcated here show a gradual change of flora during the Upper Jurassic-Lower Cretaceous times (*see* TABLE 1). Zone 1 represents typical Katrol assemblage while Zone 3 the Bhuj assemblage; Zone 2 forming a transitional zone between the Katrol and the Bhuj Series. The palynological zonation can be summarized as follows:

Bhuj	Zone 3	Dayapar and Walkamata sections (Venkatachala, 1969)
Bhuj Transition	Zone 2	Sections at Pat River and Trambau Section nos. R.N.B.S.I.P. 906, 902, 743B
Katrol	Zone 1	Sections nos. R.N.B.S.I.P. 900, 901, 774, *907, 896, 897

The three palynological zones distinguished here also indicate environmental change from Katrol to Bhuj sediments. Gymnospermous pollen grains represented by *Ca.lialasporites, Alisporites, Podocarpidites, Platysaccus, Vitreisporites, Microcachryidites, Podosporites* representing upland floral elements and *Classopollis* representing coastal gymnospermous vegetation are well represented in Katrol sediments in quality as well as quantity meaning thereby that the sediments were derived from upland as well as coastal vegetation. It could be possible that the sediments were mainly composed of wash outs from rivers under predominately fresh water conditions and with marine influence at places (occurrence of hystrichosphaerids and dinoflagellates in section R.N.B.S.I.P. 900).

The major palynological elements of the flora in the Trambau and Pat river (Bhuj Series) representing zone 2 are pteridophytic (Schizeaceous and others) spores represented by *Impardecispora, Trilobosporites, Foveotriletes, Concavisporites, Cicatricosisporites, Klukisporites, Murospora, Contignisporites, Aequitriradites, Cooksonites, Coptospora* which are well represented. *Callialasporites* representing pollen of gymnospermous upland vegetation also is dominant in the assemblage. Typical upland gymnospermous pollen of the type *Alisporites, Podocarpidites, Platysaccus, Vitreisporites, Microcachryidites, Podosporites* are not well represented. This assemblage suggests that the deposition took place in restricted swamps where the inflow material from other sources were not much and without any marine influence. The well preserved fossils also support this conclusion.

Palynological fossils in Dayapar and Walkamata sediments representing zone 3 show a marked marine influence. Pteridophytic spores of the type *Cicatricosisporites, Polycingulatisporites, Ceratosporites, Staplinisporites, Neoraistrickia, Leptolepidites, Trilobosporites, Sestrosporites, Coronatispora, Foraminisporis* which distinguish the assemblage are well represented. *Callialasporites, Podosporites, Alisporites, Microcachryidites* and *Classopollis* are in great abundance. The assemblage is associated with hystrichosphaerid and microforaminiferal remains thereby indicating that the deposition took place under predominately brackish conditions. The spores and pollen found in this assemblage are badly preserved also suggesting unfavourable condition of deposition.

*Not included in this report.

REFERENCES

COUPER, R. A. (1953). Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *N.Z. geol. Surv. palaeont. Bull.* **22**: 1-77.

DELCOURT, A. & SPRUMONT, G. (1955). Les spores et grains de pollen du Wealdien du Hainaut. *Mem. Soc. Belg. Geol.* **4**: 1-73.

DETTMANN, M. E. (1963). Upper Mesozoic microfloras from south-eastern Australia. *Proc. R. Soc. Vict.* **77** (1): 1-148.

DEV, S. (1961). The fossil flora of the Jabalpur Series-3. Spores and pollen grains. *Palaeobotanist.* **8** (1 & 2): 43-56.

FEISTMANTEL, O. (1876). Jurassic flora of the Kach. *Mem. geol. Surv. India, Palaeont. indica.* **2** (1): 1-80.

OLDHAM, R. D. (1893). A Manual of the Geology of India, 2nd. Ed. *Calcutta.*

POCOCK, S. A. J. (1962). Microfloral analysis and age determination of strata at the Jurassic-Cretaceous boundary in the western Canada plains. *Palaeontographica.* **111B**: 1-95.

PODDAR, M. C. (1959). Stratigraphy and oil possibilities in Kutch, western India. Proceedings of the Symposium. Development of

petroleum resources of Asia and Far East. *Min. Res. Ser.* **10**: 146-148.

RAJNATH (1932). A contribution to the stratigraphy of Cutch. *Q. Jl geol. Min. metall. Soc. India.* **4** (4): 161-174.

Idem (1942). The Jurassic rocks of Cutch — their bearing on some problems of Indian Geology. *Proc. Indian Sci. Congr. 29th Session. Pt.* II: 93-106.

SAHNI, B. (1932). *Palmoxylon mathuri*, a new species of petrified palms, from Cutch, western India. *Proc. Indian Sci. Congr.* **19**: 322.

SINGH, H. P., SRIVASTAVA, S. K. & ROY, S. K. (1964). Studies on the Upper Gondwanas of Cutch-1. Mio- and macrospores. *Palaeobotanist.* **12** (3): 282-306, 1963.

SPATH, L. F. (1933). Revision of the Jurassic Cephalopod Fauna of Katch (Cutch). *Mem. geol. Surv. India, Palaeont. indica.* **9** (2): 659-945.

VENKATACHALA, B. S. (1966). Palynology of the Mesozoic sediments of Kutch-9. Spores and pollen from the Bhuj exposures near Bhuj, Gujarat state. *Palaeobotanist.* **17** (2): 209-219.

VENKATACHALA, B. S. & KAR, R. K. (in press). Palynology of the Umia plant beds of Kutch, W. India-3. Palyonlogical fossils from the Bhuj exposures near Dayapar, Kutch district, Gujarat State.

VENKATACHALA, B. S., KAR, R. K. & RAZA, S. (1969). Palynology of the Mesozoic sediments of Kutch, W. India-10. Spores and pollen from Katrol exposures near Bhuj, Kutch district, Gujarat State. Ibid. **17**. (2): 184-201.

VREDENBURG, E. Q. (1910). A summary of the Geology of India. 2nd Ed. *Calcutta.*

WAAGEN, W. (1873). Jurassic fauna of Kutch. *Mem. geol. Surv. India, Palaeont. indica.* **1** (1): 1-49.

WADIA, D. N. (1957). Geology of India. *London.*

WYNNE, A. B. (1809). Preliminary notes on the geology of Kutch. *Rec. geol. Surv. India.* **2** (1): 1-289.