The Palaeobotanist **35**(1) : 73-84, 1986.

Fossil floras of Kutch-Part VI. Jurassic dinoflagellates

K. P. Jain, B. N. Jana & Hari K. Maheshwari

ABSTRACT

Jain, K. P., Jana, B. N. & Maheshwari, Hari K. (1986). Fossil floras of Kutch-Part VI. Jurassic dinoflagellates. *Palaeobotanist* **35**(1) : 73-84.

Fossil dinoflagellate cysts and acritarchs have been reported and described from the various members of the Jhuran Formation exposed at a number of localities in the Kutch Basin. The assemblage comprises 31 species referable to 24 genera. On the basis of qualitative and quantitative analyses the age of the dinoflagellate assemblage has been concluded to be Upper Oxfordian to Kimmeridgian, probably extending up to *Pectinatites pectinatus* zone.

Key-words—Palynology, Dinoflagellates, Acritarchs, Jhuran Formation, Jurassic (India).

K.P. Jain, B. N. Jana & Hari K. Maheshwari, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India.

साराँश

कच्छ के अश्मित वनस्पतिजात. भाग 6—जूराई युगीन घूर्णीकशाभ पुटीयाँ

कृष्ण प्रसाद जैन, बृजेन्द्र नाथ जाना एवं हरिकृष्ण माहेश्वरी

कच्छ द्रोणी में कई स्थानों पर विगोपित झुरान शैल-समूह के विभिन्न सदस्यों से अश्मित घूर्णीकशाभ पुटीयाँ एवं ऐक्रीटार्क अभिलिखित किये गये हैं। इस समुच्चय में 24 प्रजातियों की 31 जातियाँ विद्यमान हैं। गुणात्मक एवं परिमाणात्मक विश्लेषणों के आधार पर घूर्णीकशाभ समुच्चय की आयु उपरि ऑक्सफ़ोर्डियन से किम्मेरिडजियन, सम्भवतया पैक्टीनेटाइटिस पैक्टीनेटस मंडल तक विस्तृत, आँकी गई है।

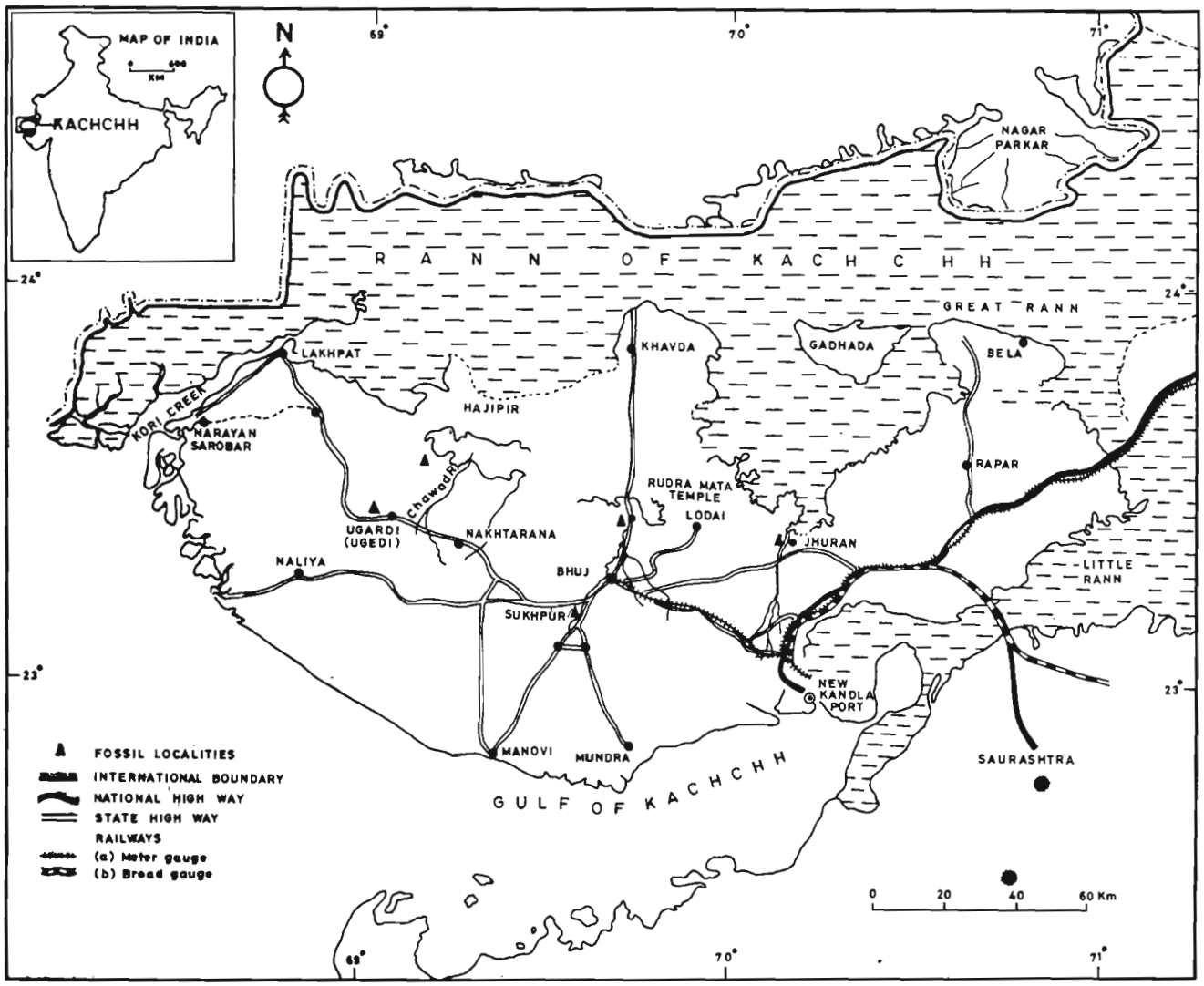
INTRODUCTION

THE massive deposits of Mesozoic sediments of Kutch Basin attracted many palynologists to work on various aspects since 1964. Most of the workers, however, concentrated on the spores and pollen grains and in palynological assemblage from the traverse Orara-Bhoyad (correct name : Orira-Bhurud) noted a few dinoflagellate cysts. Venkatachala (1967) also illustrated some microplankton along with spores and pollen grains from Walkamata (Correct name : Walkamota) belonging to the Bhuj Formation. Venkatachala and Kar (1968) described a few dinoflagellate cysts from Jhuran Formation exposures around Rudra Mata Temple. The present paper deals with a rich microplankton assemblage comprising 24 genera and 31 species recovered from the surface and sub-surface exposures of Jhuran Formation from the following localities (Map 1).

1. Jhuran River Section—About 50 km east-south-east of Bhuj Town and about 3 km west of the Village Jawahar Nagar.
2. Exposure near Rudra Mata Temple—About 100 m north of Rudra Mata Dam.
3. Sukhpur Nala Section—10 km from Bhuj Town on the left side of Bhuj-Mandvi road.
4. Hajipir Road Section—About 21 km from Bhuj-Lakhpat road on way to Hajipir.
5. Ugedi well cutting—The well is about 5.5 km north of Ugedi and on the eastern side of the Bhuj-Lakhpat road.

The dinoflagellate cysts and acritarchs were isolated from rock samples following conventional method of maceration. The slides were prepared by using polyvenyl alcohol and were mounted in Canada balsam.

The photomicrographs were taken on Agfa ortho 25 or Ilford 35 mm negative films with a Carl Zeiss Amplival



Map 1

microscope and automatic camera attachment. The negatives were printed by using different grades of Agfa Brovira glossy paper.

The slides bearing figured specimens have been deposited in the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATICS

Division—*Pyrrhophyta* Pascher, 1914
Class—*Dinophyceae* Fritsch, 1929
Order—*Peridiniales* Schutt, 1896
Family—*Gonyaulacystaceae* Sarjeant & Downie emend. Sarjeant & Downie, 1974

Genus—*Gonyaulacysta* Deflandre ex. Norris & Sarjeant emend. Sarjeant, 1982

Gonyaulacysta jurassica subsp. *jurassica* Deflandre emend. Sarjeant, 1982

Pl. 2, figs 15, 22; Pl. 3, fig. 44.

1968 *Gonyaulax jurassica* Deflandre, in Venkatachala & Kar, *Curr. Sci.*, **37** : 409, figs 1, 2; Kutch Basin, Jhuran Formation (Upper Jurassic).
1978 *Gonyaulacysta* (al. *Gonyaulax*) *jurassica* (Deflandre) Norris & Sarjeant, in Jain, *Aspects & Appraisal of Indian Palaeobotany*, p. 587, table 1.

Dimensions :

Overall size of the cyst	— 114 × 72 μm
Overall size of endoblast	— 90 × 60 μm
Size of apical horn	— 22 × 10 μm

Gonyaulacysta sp. cf. *G. perforans* (Cookson & Eisenack) Sarjeant, 1969

Pl. 1, fig 2; Pl. 2, figs 26, 27

Description—Cyst mostly elongate to ovoidal in shape, epi-and hypo-cyst almost equal in size, apical horn short; paracingulum present; paratabulation incomplete, postcingular paraplates when present elongate; paraplate boundaries marked by membranous porate crests, extending beyond body margin (4 to 6 μm), best seen around antapex. Archaeopyle precingular (3″).

Dimensions :

Overall cyst size — 74 × 60 μm
Length of apical horn — up to 10 μm

Remarks—The Kutch forms are comparable with *G. perforans* (Cookson & Eisenack) Sarjeant (1969) and show closest resemblance to the specimens described and illustrated by Ioannides *et al.* (1976, p. 454; pl. 3, figs 3,4) as *Gonyaulacysta* cf. *perforans* and Gitmez and Sarjeant (1972, pp. 202-203; pl. 4, fig. 6), both from Kimmeridgian of England.

Gonyaulacysta ehrenbergii Gitmez, 1969

Pl. 2, figs 25, 30

Dimensions :

Overall size of cyst — 90 × 70 μm
Length of apical horn — up to 10 μm

Remarks—The taxonomic status of the genus *Millioudodinium* Stover & Evitt (1978) is doubtful *sensu* Duxbury (1980, p. 122). *G. ehrenbergii* is, therefore, retained here for the time being. This species has been described from the basal Kimmeridgian of France.

Genus—*Spiniferites* Mantell emend. Sarjeant, 1970

Spiniferites sp.

Pl. 3, fig. 39

Description—Cyst skolochorate, central body ovoidal, 44 × 52 μm in size, with clearly defined reflected paratabulation of the genus, periphragm and endophragm appressed, paraplate boundaries indicated by variably developed sutural crests or low membranes, processes typically short, distally closed with briefly bifid or trifid distal ends.

Genus—*Leptodinium* Klement emend. Sarjeant, 1982

Leptodinium eumorphum (Cookson & Eisenack) Sarjeant, 1969

Pl. 1, figs 6, 13

Dimensions :

Overall size of cyst — 88 × 72 μm

Remarks—Cookson and Eisenack (1960, p. 246) reported this species from Oxfordian-Kimmeridgian of western Australia.

Genus—*Tubotuberella* Vozzhennikova emend. Sarjeant, 1982

Tubotuberella apatela (Cookson & Eisenack) Ioannides, Stavrinos & Downie emend. Sarjeant, 1982

Pl. 1, fig. 7

Dimensions :

Overall size of cyst —80-95 × 45-60 μm

Remarks—Presence of an opisthopyle in the present forms of *T. apatela* is common to *G. jurassica* but possesses no paratabulation. This species is quite common in Oxfordian-Lower Kimmeridgian sediments of western Australia.

Genus—*Egmontodinium* Gitmez & Sarjeant, 1972

Egmontodinium polyplacophorum Gitmez & Sarjeant, 1972

Pl. 2, fig. 16; Pl. 3, fig. 42

Dimensions :

Overall size of cyst —70-85 × 42-54 μm
Maximum height of crest —4 μm

Remarks—This species has been reported from the Kimmeridge Clay (*Pectinatus* Zone). In Kutch Basin, this species is common in samples of Lower Member of the Jhuran Formation.

The Kutch specimens show some resemblance to *Meiourogonyaulax* sp. described and illustrated by Gitmez (1969, p. 278; pl. 13, fig. 10) from the basal Kimmeridgian of Scotland, in its shape, size and to some extent in the distribution of paraplates but differs mainly in having anterior and posterior circle paraplates.

Genus—*Occisucysta* Gitmez, 1970

Occisucysta sp.

Pl. 2, fig. 21

Description—Cyst proximate, subspherical, apical horn short and stout; paracingulum present, dividing cyst into smaller epicyst and large hypocyst; paratabulation indistinct due to unsatisfactory preservation; periphragm granular, paraplate boundaries ornamented with short spines. Archaeopyle broad, made up of two precingular paraplates (2″ & 3″).

Dimensions :

Overall size of cyst —78 × 78 μm
Length of apical horn —up to 10 μm

Remarks—The present forms have been attributed to *Occisucysta* Gitmez (1970) in view of broad precingular archaeopyle made of two paraplates (2″ & 3″). It differs from *Occisucysta* sp. described by Gitmez (1969, p. 269, pl. 7, fig. 8) from the Lower Kimmeridgian of England in having shorter apical horn, otherwise it is quite comparable.

Family—Apteodiniaceae Eisenack emend. Sarjeant & Downie, 1972

Genus—*Apteodinium* Eisenack, 1958

Apteodinium granulatum Eisenack, 1958
Pl. 2, fig. 31

Dimensions :

Overall cyst size	—86 × 76 μm
Length of horn	— up to 8 μm

Remarks—Gitmez (1969) reported *A. granulatum* from the basal Kimmeridgian of England and France.

Apteodinium sp. A
Pl. 1, fig. 9

Description—Cyst ovoidal, small, double-walled, periphragm smooth, apical horn short having knob at distal end; paracingular region marked by the presence of a thick band. Archaeopyle precingular (3″).

Dimensions :

Overall size	— 62 × 42 μm
Length of apical horn	— up to 10 μm

Remarks—The present form differs from the known species of the genus in its small cyst size, thick paracingular band and typically short apical horn with distal knob.

Genus—*Ellipsoidictyum* Klement, 1960

Ellipsoidictyum cinctum Klement, 1960
Pl. 2, figs 17, 24

Dimensions :

Overall cyst size	—50-65 × 38-50 μm

Remarks—The Kutch forms though are within the size range of *Ellipsoidictyum cinctum* described from the Upper Jurassic of north-west Germany (Gocht, 1970, p. 152), yet occupy intermediate position when compared with West German and Australian forms (Klement, 1960; Cookson & Eisenack, 1960).

Family—*Canningiaceae* Sarjeant & Downie, 1966 emend. Sarjeant & Downie, 1974

Genus—*Escharisphaeridia* Erkmen & Sarjeant, 1980

Escharisphaeridia pocockii (Sarjeant) Erkmen & Sarjeant, 1980
Pl. 2, figs 19, 23

Dimensions :

Overall cyst size	—70-80 × 50-80 μm

Genus—*Sentusidinium* Sarjeant & Stover, 1978

Sentusidinium echinatum (Gitmez & Sarjeant) Sarjeant & Stover, 1978
Pl. 3, fig. 50

Dimensions :

Overall size of cyst	—64 × 70 μm
Length of spines	— up to 4 μm

Family—*Adnatosphaeridiaceae* Sarjeant & Downie, 1966

Genus—*Adnatosphaeridium* Williams & Downie, 1966

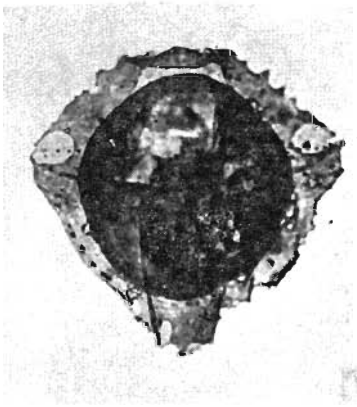
Adnatosphaeridium aemulum (Deflandre) Williams & Downie, 1969

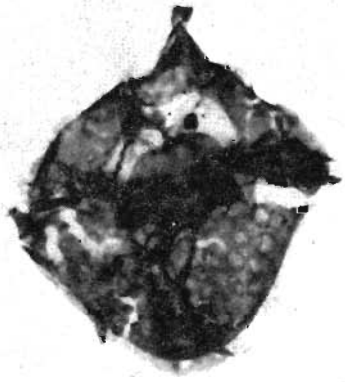
→

PLATE 1

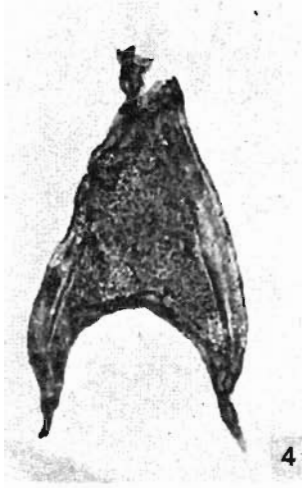
(All photomicrographs × 500)

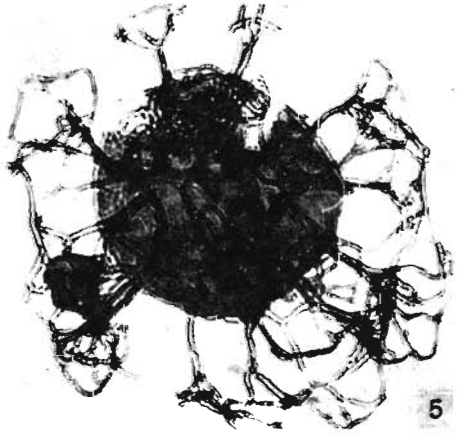
1. *Scriniodinium luridum* (Deflandre) Klement, 1960; slide no. BSIP 8559; co-ordinates : 107.5 × 17.5.
2. *Gonyaulacysta* sp. cf. *G. perforans* (Cookson & Eisenack) Sarjeant, 1969; slide no. BSIP 8565; co-ordinates : 93.8 × 5.0.
3. *Oligosphaeridium* sp.; slide no. BSIP 8566; co-ordinates : 104.6 × 15.0.
4. *Nannoceratopsis pellucida* Deflandre emend. Evitt, 1961; slide no. BSIP 8562; co-ordinates : 96.6 × 10.0.
5. *Adnatosphaeridium paucispinum* (Klement) Gitmez & Sarjeant, 1972; slide no. BSIP 8557; co-ordinates : 102.4 × 22.4.
6. *Leptodinium eumorphum* (Cookson & Eisenack) Sarjeant, 1969; slide no. BSIP 8561; co-ordinates : 104.6 × 15.0.
7. *Tubotuberella apatela* (Cookson & Eisenack) Ioannides *et al.* emend. Sarjeant, 1982; slide no. BSIP 8566; co-ordinates: 18.5.
8. *Nummus similis* (Cookson & Eisenack) comb. nov.; slide no. BSIP 8566; co-ordinates: 114.4 × 10.4.
9. *Apteodinium* sp. A; slide no. BSIP 8565; co-ordinates: 108.8 × 21.4.
10. *Prolixosphaeridium anasillum* Erkmen & Sarjeant, 1980; slide no. BSIP 8565; co-ordinates: 108 × 10.0.
11. *Verybachium valensii* (Valensi) Downie & Sarjeant, 1963; slide no. BSIP 8561; co-ordinates: 98.7 × 8.2.
12. *Adnatosphaeridium filamentosum* (Cookson & Eisenack) Williams & Downie, 1969; slide no. BSIP 8556; co-ordinates: 92 × 14.9.
13. *Leptodinium eumorphum* (Cookson & Eisenack) Sarjeant, 1969; slide no. BSIP 8561; co-ordinates: 110.5 × 12.2.
14. *Systematophora penicillata* (Ehrenberg) Sarjeant, 1980; slide no. BSIP 8557; co-ordinates: 92.0 × 14.9.

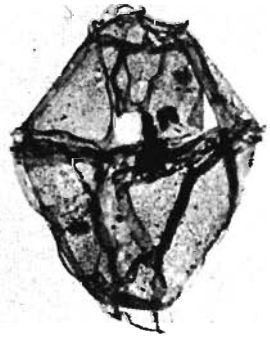

1


2


3


4


5


6

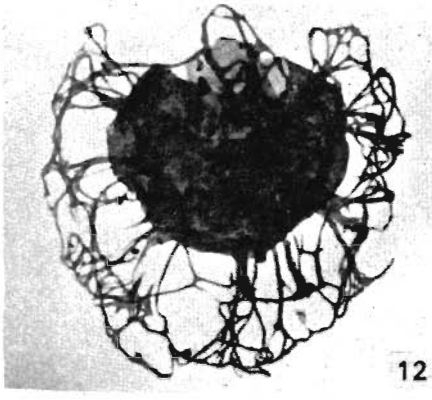

7

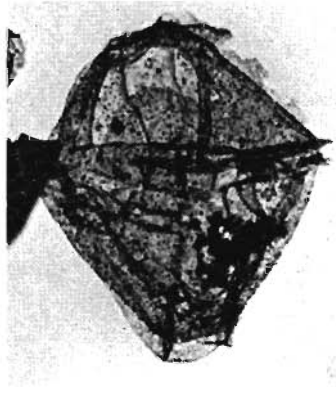

8


9


10


11


12


13

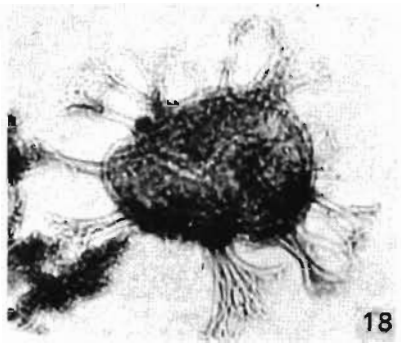

14

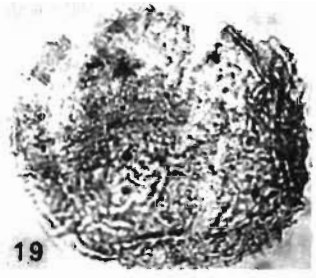
PLATE 1

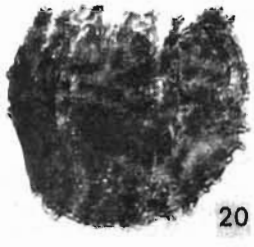

15


16


17


18

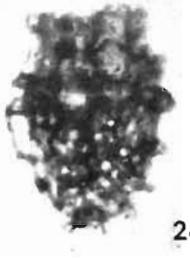

19


20


21


22

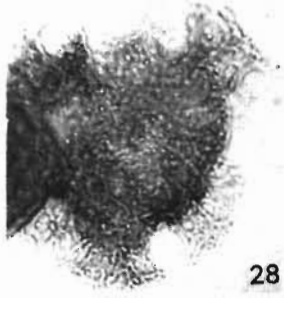

23


24


25

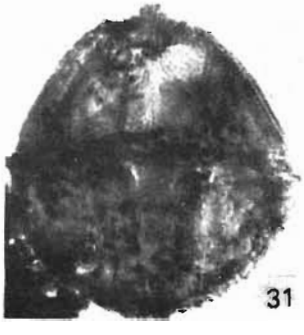

26

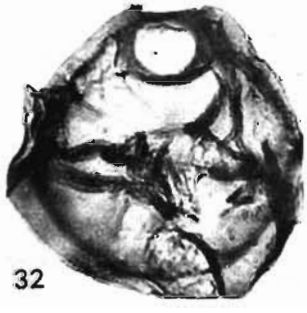

27


28


29


30


31


32

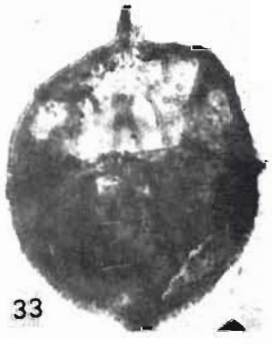

33

PLATE 2

Pl. 3, fig. 34

1968 *Hystrichosphaeridium aemulum* Deflandre: Venkatachala & Kar; *Curr. Sci.* **37** : p. 409, fig. 3; Kutch Basin, Jhuran Formation (Upper Jurassic).
1974 *Cannosphaeropsis aemulum* (Deflandre) Deflandre, 1947: Jain, *Aspects & Appraisal of Indian Palaeobotany*, p. 591, table 1.

Dimensions :

Overall size of cyst including processes	—90-130 × 86-120 μm
Diameter of cyst without processes	—40-66 μm
Process length	— up to 35 μm

Adnatosphaeridium paucispinum (Klement) Gitmez & Sarjeant, 1972

Pl. 1, fig. 5

Dimensions :

Spherical body diameter	— up to 60 μm
Overall body size	— 38-50 × 50-62 μm
Process length	— 20-40 μm

Adnatosphaeridium filamentosum (Cookson & Eisenack) Williams & Downie, 1969

Pl. 1, fig. 12

Dimensions :

Spherical body diameter	— 55-65 μm
Process height	— up to 45 μm

Family—Systematophoraceae Sarjeant & Downie, 1974

Genus—*Systematophora* Klement, 1960

Systematophora penicillata (Ehrenberg) Sarjeant, 1980

Pl. 1, fig. 14; Pl. 2, fig. 18

Dimensions :

Overall cyst size including process	— 80 × 80 μm
Cyst size without processes	— 44 × 44 μm
Process complex	— up to 20 μm long

Systematophora orbifera Klement, 1960

Pl. 2, fig. 28; Pl. 3, fig. 53

Dimensions :

Overall cyst size including process	— 120 × 90 μm
Cyst size without processes	— 80 × 60 μm

Genus—*Prolixosphaeridium* Davey *et al.*, 1966

Prolixosphaeridium anasillum Erkmen & Sarjeant, 1980

Pl. 1, fig. 10; Pl. 3, fig. 45

Dimensions :

Cyst size	— 32-48 × 22-28 μm
Process length	— 10-14 μm

Remarks—The Kutch specimens resemble best the Lamberti Zone specimens in shape, size and process distribution (Sarjeant, 1961, 1976). The known stratigraphical range of *Prolixosphaeridium anasillum* is from Upper Callovian to Upper Kimmeridgian (Erkmen & Sarjeant, 1980, p. 65).

Family—Endoscriniaceae Vozzhennikova, 1965 emend. Sarjeant & Downie, 1974

Genus—*Scriniodinium* Klement, 1957

Scriniodinium luridum (Deflandre) Klement, 1960

Pl. 1, fig. 1; Pl. 3, fig. 37

←

PLATE 2

(All photomicrographs × 500)

15, 22. *Gonyaulacysta jurassica* subsp. *jurassica* Deflandre emend. Sarjeant, 1982; slide no. 8557; co-ordinates: 104.7 × 10.0 and 108.6 × 15.0 respectively.
16. *Egmontodinium polyplacophorum* Gitmez & Sarjeant, 1972; slide no. BSIP 8562; co-ordinates: 99.0 × 20.4
17. *Ellipsoidictyum cinctum* Klement, 1960; slide no. BSIP 8559; co-ordinates: 116.6 × 13.7.
18. *Systematophora penicillata* (Ehrenberg) Sarjeant, 1980; slide no. BSIP 8556; co-ordinates: 92.0 × 22.0.
19, 23. *Escharisphaeridia pocockii* (Sarjeant) Erkmen & Sarjeant, 1980; slide no. BSIP 8559; co-ordinates: 96.4 × 8.0.
20. *Form A*; slide no. BSIP 8559; co-ordinates: 108.5 × 4.0.
21. *Occisucysta* sp.; slide no. BSIP 8559; co-ordinates: 178.5 × 13.7.
24. *Ellipsoidictyum cinctum* Klement, 1960; slide no. BSIP 8569; co-ordinates: 125.0 × 8.0
25, 30. *Gonyaulacysta ehrenbergii* Gitmez, 1969; slide no. 8560; co-ordinates: 122.0 × 17.0 and 128.0 × 15.0.
26, 27. *Gonyaulacysta* sp. cf. *G. perforans* (Cookson & Eisenack) Sarjeant, 1969; slide no. BSIP 8565; co-ordinates: 126.3 × 12.7 and 95.0 × 15.2 respectively.
28. *Systematophora orbifera* Klement, 1960; slide no. BSIP 8558; co-ordinates: 106.6 × 14.9.
29. *Scriniodinium dictyotum* subsp. *papillatum* Gitmez, 1970; slide no. BSIP 8563; coordinates: 118.4 × 14.6.
31. *Apteodinium granulatum* Eisenack, 1958; slide no. BSIP 8559; co-ordinates: 108.1 × 4.3.
32. *Nummus similis* (Cookson & Eisenack) comb. nov.; slide no. BSIP 8557; co-ordinates: 103.4 × 15.7.
33. *Apteodinium* sp. B; slide no. BSIP 8565; co-ordinates: 108.8 × 21.4.

1970 *Endoscrinium luridum* (Deflandre) Vozzhennikova, 1967; Gitmez, *Bull. Br. Mus. nat. Hist. (Geol)* **18**(7) : 302-303, pl. 2; text-fig. 28.

Dimensions :

Overall size	— 80-90 × 80-100 μm
Endoblast size	— 58-70 × 56-74 μm

Remarks—The Kutch forms show marked resemblance to the figured specimens of *Scriniodinium luridum* from France (Deflandre, 1938, pl. 5, figs 4, 6), Germany (Klement, 1960, pl. 1, figs 2, 3) and Australia (Cookson & Eisenack, 1960, pl. 37, fig. 10). Status of the genus *Endoscrinium* as enumerated by Stover and Evitt (1975, p. 187) is maintained here, rejecting the view of Lentin and Williams (1981, p. 97).

Scriniodinium dictyotum subsp. *papillatum* Gitmez, 1970

Pl. 2, fig. 29; Pl. 3, figs 40, 47

Dimensions :

Overall cyst size	— 65-70 × 50-60 μm

Family—Broomeaceae Eisenack, 1969 emend. Sarjeant & Downie, 1974

Genus—*Broomea* Cookson & Eisenack, 1958 emend. Lentin & Williams, 1976

Broomea ramosa Cookson & Eisenack, 1958

Pl. 3, figs 41, 49

Dimensions :

Overall cyst length	— 124 μm
Overall cyst breadth	— 32 μm
Body size of cyst	— 90 × 32 μm
Length of apical horn	— 24 μm
Length of antapical appendages	— up to 10 μm

Family—Membranilanaciaceae Eisenack, 1963 emend. Sarjeant & Downie, 1966

Genus—*Chlamydophorella* Cookson & Eisenack, 1958

Chlamydophorella wallala Cookson & Eisenack, 1960

Pl. 3, fig. 48

Dimensions :

Overall cyst size (without operculum)	— 76 × 66 μm
Process length	— 6-10 μm

Family—Pareodiniaceae Gocht, 1957 emend. Sarjeant & Downie, 1974

Genus—*Pareodinia* Deflandre emend. Wiggins emend. Stover & Evitt, 1978

Pareodinia ceratophora Deflandre emend. Gocht, 1970

Pl. 3, fig. 35

Dimensions :

Overall cyst size	— 70 × 40 μm
Length of apical horn	— 8-12 μm

Family—Hystrichosphaeridiaceae Evitt, 1963 emend. Sarjeant & Downie, 1974

Genus—*Tanyosphaeridium* Davey & Williams, 1966

Tanyosphaeridium torynum (Cookson & Eisenack) Stover & Evitt, 1978

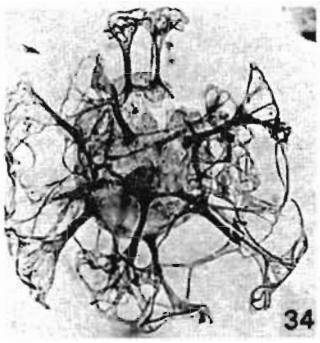
Pl. 3, fig. 36

→

PLATE 3

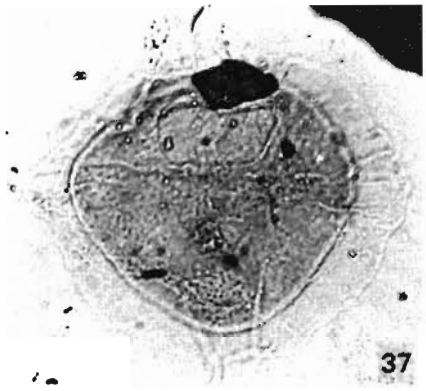
(All photomicrographs × 500)

34. *Adnatosphaeridium aemulum* (Deflandre) Williams & Downie, 1969; slide no. BSIP 8572; co-ordinates: 129.2 × 18.2.
35. *Pareodinia ceratophora* Deflandre emend. Gocht, 1970; slide no. BSIP 8570; co-ordinates: 103.3 × 16.0.
36. *Tanyosphaeridium torynum* (Cookson & Eisenack) Stover & Evitt, 1978; slide no. BSIP 8565; co-ordinates: 93.8 × 5.0.
37. *Scriniodinium luridum* (Deflandre) Klement, 1960; slide no. BSIP 8570; co-ordinates: 104.4 × 9.0.
38. *Ctenidodinium culmulum* (Norris) Lentin & Williams, 1973; slide no. BSIP 8569; co-ordinates: 125.4 × 16.0.
39. *Spiniferites* sp.; slide no. BSIP 8569; co-ordinates: 106.7 × 7.4.
40, 47. *Scriniodinium dictyotum* subsp. *papillatum* Gitmez, 1970; slide no. BSIP 8563; co-ordinates; 107.8 × 19.0 and 134.4 × 15.8 respectively.
41, 49. *Broomea ramosa* Cookson & Eisenack, 1958; slide no. BSIP 8566 & 8562; co-ordinates: 135.0 × 17.6 and 96.6 × 10.0 respectively.
42. *Egmontodinium polyplacophorum* Gitmez & Sarjeant, 1972; slide no. BSIP 8562; co-ordinates: 99.4 × 11.9.
43. *Oligosphaeridium* sp., slide no. BSIP 8566; co-ordinates: 93.7 × 8.2.
44. *Gonyaulacysta jurassica* subsp. *jurassica* Deflandre emend. Sarjeant, 1982; slide no. BSIP 8556; co-ordinates: 105.0 × 15.8.
45. *Prolixosphaeridium anasillum* Erkmen & Sarjeant, 1980; slide no. 8565; co-ordinates: 107.5 × 14.8.
46. cf. *Gonyaulacysta* sp.; slide no. BSIP 8569; co-ordinates: 103.6 × 11.5.
48. *Chlamydophorella wallala* Cookson & Eisenack, 1960; slide no. BSIP 8568; co-ordinates: 131.7 × 6.9.
50. *Sentusidinium echinatum* (Gitmez & Sarjeant) Sarjeant & Stover, 1978; slide no. BSIP 8571; co-ordinates: 116.3 × 18.8.
51, 52. *Surculosphaeridium vestitum* (Deflandre) Davey *et al.*, 1966; slide no. BSIP 8557; co-ordinates: 105.6 × 8.4 & 103.6 × 8.0 respectively.
53. *Systematophora orbifera* Klement, 1960; slide no. BSIP 8558; co-ordinates: 136.7 × 15.8.

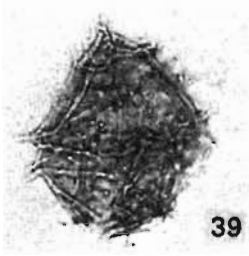

34


35


36


37

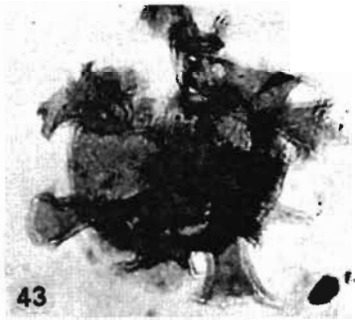

38


39


40


41


42


43


44

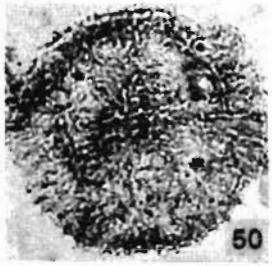

45


46


47


48


49


50


51


52


53

PLATE 3

Remarks—The transfer of *T. torynum* to *Eomontodinium* by Davey (1979, p. 60) is not acceptable due to lack of reticulation on the cyst surface of the holotype.

Genus—*Surculosphaeridium* Davey *et al.*, 1966

Surculosphaeridium vestitum (Deflandre) Davey *et al.*, 1966
Pl. 3, figs. 51, 52

Dimensions :

Size of cyst	— 70 × 65 μm
Length of process	—up to 16 μm

Remarks—*Surculosphaeridium vestitum* is common in the Oxfordian beds of Calvados, France (Deflandre, 1978). In Kutch Basin this species is frequent in the shale samples of Rudra Mata Temple (Jhuran Formation).

Genus—*Oligosphaeridium* Davey & Williams, 1966

Oligosphaeridium sp.
Pl. 1, fig. 3; pl. 3, fig. 43

Description—Body spherical, endophragm and periphragm thin, appressed; periphragm punctate; processes formed by periphragm alone, 14 in number with detached operculum. Process formula 4′, 6″, 6‴, 1p, 1⁗. Processes broad at base but distally variable in size, bearing aculeate spines which vary in length and breadth, sometimes short and broad.

Dimensions :

Diameter of cyst	— 45 to 60 μm
Size of processes	— 10 × 14 to 16 × 24 μm

Remarks—Present forms differ from the known species in process size variation and punctate periphragm.

Family—Ctenidodiniaceae Sarjeant & Downie emend. Sarjeant & Downie, 1974

Genus—*Ctenidodinium* Deflandre emend. Gocht, 1970

Ctenidodinium culmulum (Norris) Lentin & Williams, 1973
Pl. 3, fig. 38

Dimensions :

Overall cyst diameter	— 20-30 μm

Order—Nannoceratopsiales Piel & Evitt, 1980

Family—Nannoceratopsitaceae Deflandre emend. Piel & Evitt, 1980

Nannoceratopsis pellucida Deflandre emend. Evitt, 1961
Pl. 1, fig. 4

Dimensions :

Overall cyst size	— 100 × 42 μm

ACRITARCHS

Genus—*Veryhachium* Deunff emend. Downie & Sarjeant, 1963

Veryhachium valensii (Valensi) Downie & Sarjeant, 1963
Pl. 1, fig. 11

Dimensions :

Cyst size	— 25 × 25 μm
Length of spine	— up to 25 μm

Genus—*Nummus* Morhan, 1968

Nummus similis (Cookson & Eisenack) comb. nov.
Pl. 1, fig. 8; Pl. 2, fig. 32

1960 *Leiosphaeridia similis* Cookson & Eisenack, *Palaeontology*, **2** : 254, pl. 38, fig. 14.

Dimensions :

Diameter of shell	— 80 × 80 μm
Diameter of pylome	— 14 μm

DISCUSSION AND COMPARISON

The three dinocyst assemblages, which have been identified, represent Lower, Middle and Upper members respectively of the Jhuran Formation. The distribution of different species of dinocysts in various samples and their geological ranges have been plotted in Table 1.

In overall aspect the Kutch dinocyst assemblages show a distinct similarity with Upper Jurassic dinoflagellate cyst assemblage described from southern Germany by Klement (1969), specially in the common occurrence of the genera *Adnatosphaeridium*, *Scriniodinium*, *Systematophora*, *Gonyaulacysta* and *Ellipsoidictyum*.

A comparison with Upper Oxfordian-Lower Kimmeridgian dinocyst assemblage described by Cookson and Eisenack (1958, 1960) from western Australia also shows a close resemblance. The common elements of the two assemblages are, viz., *Leptodinium eumorphum*, *Scriniodinium dictyotum*, *Scriniodinium luridum*, *Tubotuberella apatela*, *Tanyosphaeridium torynum*, *Nummus similis*, *Chlamydophorella wallala*, *Gonyaulacysta jurassica*, *Broomea ramosa*, *Adnatosphaeridium aemulum* and *Nannoceratopsis pellucida*.

Wiseman (1980) distinguished seven palynological assemblage zones in the Upper Jurassic and Early Cretaceous in the Carnarvon Basin, western Australia. The

TABLE 1—DISTRIBUTION OF DINOFLAGELLATE CYST AND ACRITARCH TAXA IN THE JHURAN FORMATION, KUTCH

LITHOSTRATIGRAPHIC UNITS		JHURAN FORMATION					Geologic ranges of Dinocyst and Acritarch taxa (Sarjeant, 1979; Sarjeant & Gitmez, 1972)
		Lower	Middle Member			Upper	
Sl. No.	Dinocyst and Acritarch Taxa / Locality Name & Number	Jhuran River (2401)	Jhuran River Section (2401)	Sukhpur Nala Section (2405)	Rudra-Mata Temple Section (2205)	Ugedi well (2086)	
1.	*Pareodinia ceratophora*	C		C			Pre-Bajocian-Cretaceous
2.	*Ellipsoidictyum cinctum*	R		R			Callovian-Kimmeridgian
3.	*Occisucysta* sp.	R		R			
4.	*Apteodinium granulatum*	R			C		Probably Upper Oxfordian to Portandian
5.	*Escharisphaeridia pocockii*	R					Bathonian onwards
6.	*Sentusidinium echinatum*	R	C				Kimmeridgian
7.	*Gonyaulacysta ehrenbergii*	R	R	C			Kimmeridgian (*P. baylei* to *P. rotunda* Zone)
8.	*Scriniodinium luridum*	C	R	C	C		Oxfordian-Kimmeridgian
9.	*Leptodinium eumorphum*	C	R	C	C		Oxfordian-Kimmeridgian
10.	*Egmontodinium polyplacophorum*	C	R	R			Kimmeridgian (Basal)
11.	*Veryhachium valensii*	R		A			Oxfordian-Kimmeridgian
12.	*Nannoceratopsis pellucida*	A	R	R			Bathonian-Kimmeridgian (*P. baylei* Zone)
13.	*Adnatosphaeridium aemulum*	R		A	A		Callovian-Kimmeridgian (*P. baylei* Zone)
14.	*Gonyaulacysta jurassica jurassica*	R		A	A	C	Callovian-Kimmeridgian (*P. pectinatus*
15.	*Scriniodinium dictyotum papillatum*	R				R	Oxfordian-Kimmeridgian
16.	*Nummus similis*			C			Upper Jurassic (Cookson & Eisenack, 1960)
17.	*Surculosphaeridium vestitum*			C	C		Callovian-Oxfordian
18.	*Adnatosphaeridium filamentosum*			C			Callovian-Oxfordian
19.	*Adnatosphaeridium paucispinum*			C			Callovian-Oxfordian
20.	*Gonyaulacysta* sp. cf. *G. perforans*			R		R	?Kimmeridgian-Portlandian
21.	*Systematophora orbifera*			C	C	C	Kimmeridgian (*P. wheatleyensis* Zone to Portlandian)
22.	*Systematophora penicillata*					C	Oxfordian-Early Kimmeridgian
23.	*Oligosphaeridium* sp.					C	Kimmeridgian (*P. wheatleyensis* Zone to *T. giganteus* Zone)
24.	*Tanyosphaeridium torynum*					C	
25.	*Prolixosphaeridium anasillum*					C	Basal Kimmeridgian
26.	*Chlamydophorella wallala*					C	Kimmeridgian
27.	*Ctenidodinium culmulum*					C	Kimmeridgian-Portlandian
28.	*Spiniferites* sp.					R	
29.	*Tubotuberella apatela*					C	Oxfordian-Middle Kimmeridgian
30.	*Apteodinium* sp.					R	
31.	*Broomea ramosa*					C	Kimmeridgian (*P. wheatleyensis* Zone to Upper Portlandian & later)

R = Rare; C = Common; A = Abundant

Assemblage Zones I and II of Wiseman (1980) need special reference here. Assemblage Zone I is characterised by the occurrence of the following dinocyst elements : *Nannoceratopsis pellucida, Scriniodinium (Endoscrinium) luridum, Ellipsoidictyum cinctum, Psaligonyaulax apatela, Adnatosphaeridium filamentosum, Gonyaulacysta ambigua, Pyxidiella pandora, Pareodinia ramosa, Adnatosphaeridium aemulum, Gonyaulacysta jurassica.* All of these species are long ranging, occurring in sediments older than Assemblage Zone I and extending into Assemblage Zone II. Apart from these, the Assemblage Zone II consists of some other taxa, e.g. *Omatia butticula* in its upper part. It also includes *Systematophora penicillata (S. fasciculigera), Tanyosphaeridium (Prolixosphaeridium) torynum, Peridictyocysta mirabilis, Bourkidinium* sp. cf. *B. granulosum, Heslertonia teichophora* and *Tenua atlantica.*

The age derivation for Assemblage Zone I as Early Oxfordian or older is tentative (Wiseman, 1980, p. 342). The Assemblage Zone II has been dated to range from Late Oxfordian to Tithonian.

The occurrence of *Omatia montgomeryii* and *O. (Herendeenia) pisciformis* in the upper part of Assemblage Zone II compares well with the recent finds from Upper Jurassic of Tethys Himalayas (Jain *et al.*, 1984), where the microplankton Assemblage Zone containing *Omatia* spp. is placed in lower part of Upper

Tithonian. *Omatia* is totally absent in all the three assemblages recovered from the Jhuran Formation.

The Ugedi dinocyst assemblage representing the Upper Member of Jhuran Formation is devoid of *Omatia* but includes *Tanyosphaeridium torynum*, *Oligosphaeridium* sp. and *Broomea ramosa* which indicate a Kimmeridgian aspect whereas two older dinocyst assemblages representing the Lower and Middle members of the Jhuran Formation on the basis of overall aspect of dinocyst element (Table 1) suggest an Upper Oxfordian-Lower Kimmeridgian age.

With this dinocyst data in hand from Jhuran Formation, it is concluded that the age of the Jhuran Formation ranges from Upper Oxfordian to Kimmeridgian probably extending up to *Pectinatites pectinatus* zone.

REFERENCES

Biswas, S. K. 1977. Mesozoic rock stratigraphy of Kutch, Gujarat. *Q. Jl geol. Min. metall. Soc. India* **49** : 1-51.

Cookson, I. C. & Eisenack, A. 1958. Microplankton from Australian and New Guinea Upper Mesozoic sediments. *Proc. R. Soc. Vict.* **70**(1) : 19-79.

Cookson, I. C. & Eisenack, A. 1960. Upper Mesozoic microplankton from Australia and from New Guinea. *Palaeontology* **2** : 243-261.

Davey, R. J. 1979. The stratigraphic distribution of dinocysts in the Portlandian (latest Jurassic) to Barremian (Early Cretaceous) of northwest Europe. *Am. Assoc. Strat. Palynol. Contr.* Ser. **5B** : 48-81.

Deflandre, G. 1938. Microplankton des mers Jurassiques conservé dans les marnes de Villers-Sur-mer (Calvados). Étude liminaire et considérations générales. *Trans. Str. zool. Wimereux.* **13** : 147-200.

Duxbury, S. 1980. Barremian phytoplankton from Speeton, East Yorkshire. *Palaeontographica* **173B** : 107-146.

Erkmen, U. & Sarjeant, W. A. S. 1980. Dinoflagellate cysts, acritarchs and tasmanitids from the upper most Callovian of England and Scotland : with a reconsideration of the "*Xanthidium pilosum*" problem. *Geobios.* **13**(1) : 45-99.

Gitmez, G. U. 1970. Dinoflagellate cysts and acritarchs from the basal Kimmeridgian (Upper Jurassic) of England, Scotland and France. *Bull. Br. Mus. nat. Hist. (Geol.)* **18**(7) : 231-331.

Gitmez, G. U. & Sarjeant, W. A. S. 1972. Dinoflagellate cysts and acritarchs from the Kimmeridgian (Upper Jurassic) of England, Scotland and France. *Bull. Br. Mus. nat. Hist. (Geol.)* **21**(5) : 171-257.

Gocht, H. 1970. Dinoglagellaten-Zysten aus dem Bathonium des Erdolfelds Aldorf (NW-Duetschland). *Palaeontographica* **129B** : 125-165.

Ioannides, N. S., Stavrions, G. N. & Downie, G. 1967. Kimmeridgian microplankton from Clavells Hard, Dorset, England. *Micropaleontology* **22** : 443-478.

Jain, K. P. 1974. Fossil dinoflagellates, acritarchs, tasmanitids and calcareous nannoplankton, pp. 586-602. in: *Aspects and Appraisal of Indian Palaeobotany*, (eds) K. R. Surange *et al.* Birbal Sahni Institute of Palaeobotany, Lucknow.

Klement, K. W. 1960. Dinoflagellaten und Hystrichosphaerideen aus dem unteren und mittleren Malm Südwestdeutschlands. *Palaeontographica* **114A** : 1-104.

Lentin, J. K. & Williams, G. L. 1981. Fossil dinoflagellates : Index to genera and species. *Bedford Inst. Oceanogr. Rep. Ser. BI-R-81-12*, **7** : 1-345.

Rawat, M. S. 1967. Jurassic microplanktons from Kutch, India. *Palynol. Bull.* **2 & 3** : 45-49.

Rawat, M. S. 1968. Plant microfossils from sediments exposed along Orara Bhoyad Traverse, Kutch, India, with a discussion on the age of the deposits. *J. Palynol.* **4** : 84-90.

Stover, L. E., & Evitt, W. R. 1978. Analyses of pre-Pleistocene organic walled dinoflagellates. *Stanford Univ. Publ., Geol. Soc.* **15** : 1-300.

Venkatachala, B. S. 1967. Palynology of the Umia plant beds of Kutch, western India, 1. Stratigraphic palynology of the Bhuj exposures near Walkamata (Kutch District, Gujarat State). *Rev. Palaeobot. Palynol.* **5** : 169-177.

Venkatachala, B. S. & Kar, R. K. 1968. Dinoflagellate and hystrichosphaerid fossils from Katrol (Upper Jurassic) sediments of Kutch, W. India. *Curr. Sci.* **37** : 408-410.

Wiseman, J. F. 1980. Palynostratigraphy near the Jurassic-Cretaceous boundary in the Carnarvon Basin, western Australia. *Proc. IV int. palynol. Conf., Lucknow (1976-77)* **2** : 330-349.