

TIME-HIATUS AT THE OLIGOCENE/EOCENE BOUNDARY IN SIND

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Evidence has been presented to show that, contrary to the earlier belief, the Khirthar Limestone is not wholly of Middle Eocene age but ranges up into the Oligocene. The Colombo Plan Survey has designated the Middle Eocene part of the Khirthar Limestone as Khirthar Member and the Oligocene part as the Gorag Member. The two Members are apparently conformable, but detailed faunal investigation has shown that there is a time-hiatus between the two as the faunas representing the greater part of the Auversian and the entire Bartonian Stages of Europe are missing.

Introduction

In Sind, which is the type area for the Tertiary succession of West Pakistan, the Middle Eocene and the Oligocene Epochs are represented by the Khirthar and Nari Limestones. The boundary between the two is taken at a place where the massive, hard, grey coloured Khirthar Limestone is replaced by the relatively soft, brownish coloured Nari Limestone. Until recently the Khirthar Limestone was regarded as wholly of Middle Eocene age.^{2,4,5,6} During the course of examination of material from the Khirthar and Nari Limestones from a number of localities in Sind including the type Gaj River Section, the writer found that the Oligocene/Eocene boundary lies within an apparently conformable sequence of the Khirthar Limestone and does not conform with the litho-stratigraphic boundary between the Khirthar and Nari Limestones. The Khirthar Limestone, therefore, ranges in age from the Middle Eocene to the Oligocene. The Photographic Survey Corporation of Canada redesignated the Khirthar Limestone as Brahui Limestone and subdivided it into a lower Khirthar Member containing Eocene fauna and an Upper Gorag Member containing Oligocene fauna (Ref. 1, p. 96).

Further detailed study carried out by the writer at the British Petroleum Research Centre, Sunbury, England on collections made by Messrs Pakistan Petroleum Limited from the Gaj River Section and Badhra area, has shown that despite the apparent conformity of the Eocene and Oligocene parts of the Khirthar Limestone, faunal evidence suggests a time-hiatus between the two. In the Gaj River Section a large part of the Upper Eocene and Lower Oligocene are missing; while in the Badhra area the Middle Eocene is directly succeeded by the Middle Oligocene.

The Upper Eocene is not of widespread occurrence in West Pakistan. It has been recognised by Eames³ from the Rakhi Nala Zinda Pir area and from the Shirani area a little to the

north. The writer recognised Limestone of Upper Eocene age from West of Marap, Baluchistan (Map ref. 34L/2), where it is about 40 feet in thickness and has been designated by Photographic Survey Corporation of Canada as Wakabi Limestone (Ref. 1, p. 175). The fauna in these localities includes, among others, the typical Upper Eocene genus *Pellatispira* which has not been reported from any locality in Sind. The presence of a break at the Oligocene/Eocene boundary in Sind has, therefore, been long suspected.

Faunal Evidence

A. Gaj River.—The fauna recorded from the Khirthar Limestone of Gaj River Section is shown in Fig. 1.

The basal 200 ft of the Khirthar Limestone (Sample Nos. FB.B. 5090—FB.B. 5087) contains the typical Lutetian larger foraminifera as follows:

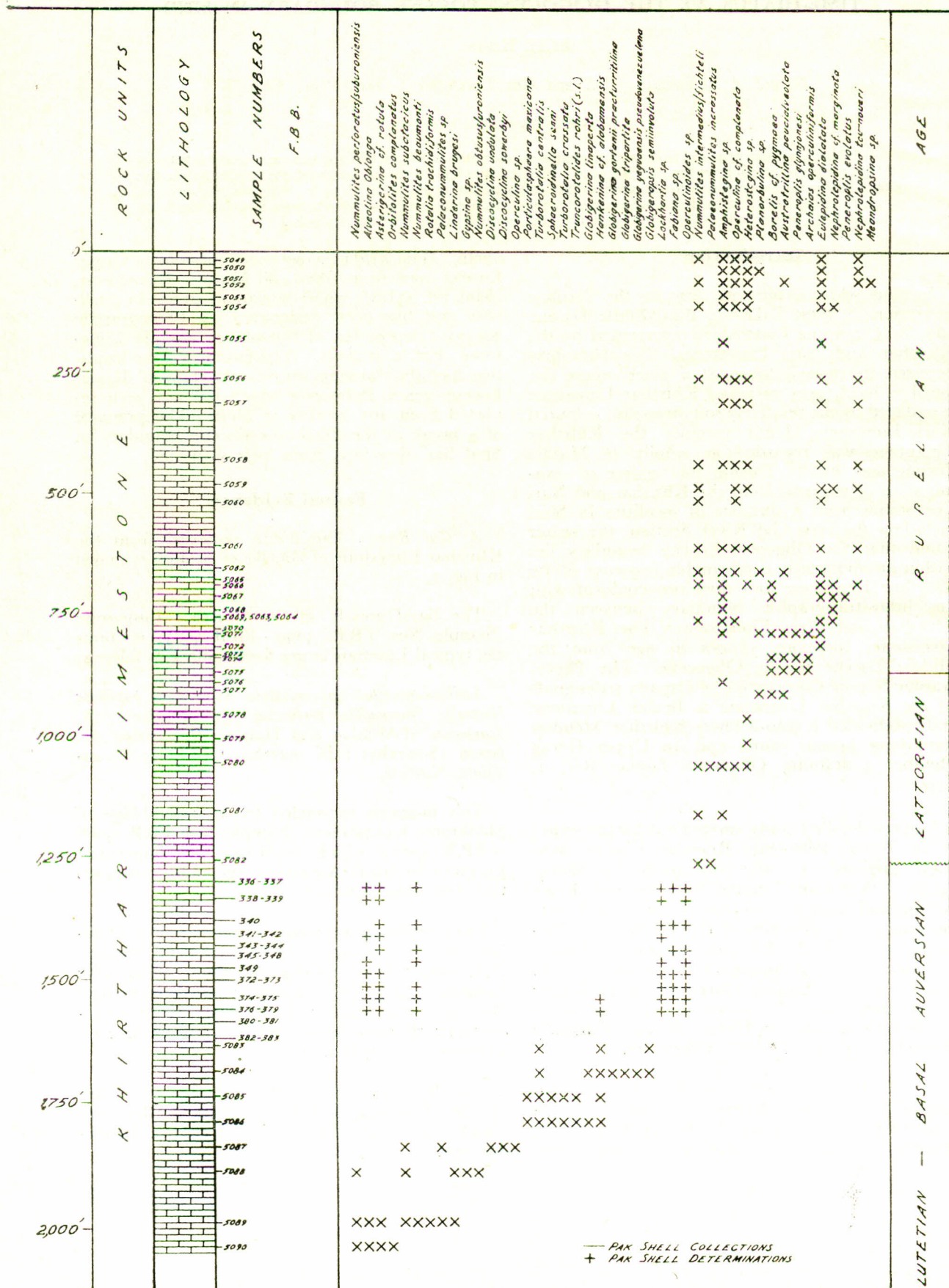
Assilina cancellata/subcancellata, Nuttall; *A. papillata* Nuttall; *Nummulites perforatus* (de Montfort); *N. beaumonti*, d'Archiac and Haime; *Discocyclina dispansa*, (Sowerby); *D. sowerbyi*, (Nuttall); *D. undulata*, Nuttall;

This fauna is succeeded by an assemblage of planktonic foraminifera (Sample Nos. FB.B. 5086—FB.B. 5083) which indicates an uppermost Lutetian to basal Auversian age, and comprises the following species:

Porticulasphaera mexicana, (Cushman); *Turborotalia centralis*, (Cushman and Bermudez); *T. crassata*, (Cushman); *Truncorotalides rohri*, (Bolli); *Globigerina linaperta*, Finlay; *G. yeguaensis pseudovenezuelana*, Weinzierl and Applin; *G. tripartita*, (Koch); *Globigerapsis* cf. *semivoluta*, (Keijzer); *Hantkenina* cf. *alabamensis*, Cushman.

Sample FB.B. 5082, from 780 ft above the base of the Khirthar Limestone contains the first *Nummulites fichteli*, Michelotti indicating a Lattorfian age.

FIG. 1.—PALAEOONTOLOGICAL RANGE TABLE. GAJ RIVER (Scale 1" to 250 ft.) map ref, 35N/1



— PAK SHELL COLLECTIONS
 + PAK SHELL DETERMINATIONS

LUTETIAN — BASAL AUVERSIAN LATTORFIAN RUPELIAN

FIG. 2.—PALAEOONTOLOGICAL RANGE TABLE. GRATA NALA (Scale 1" to 50 ft.) Map ref, 35 N/12

	ROCK UNITS	LITHOLOGY	SAMPLE NUMBERS FBB		AGE
0			5768, 5769, 5770 5772 5773-5774-5775 5776-5777 5778-5779 5781 5782 5783-5784 5785 5786-5787	<i>Nummulites gizehenensis</i> (meg.) <i>Nummulites beunmonti</i> <i>Assulina papillata</i> / <i>Sub papillata</i> <i>Assulina oblonga</i> <i>Fasculina glabosa</i> <i>Orbitulites complanatus</i> <i>Coskindina</i> sp. <i>Rotalia trachidi formis</i> <i>Linderina brugesi</i> <i>Linderina</i> sp. <i>Dicynonoides cooki</i> <i>Nummulites pinyolai</i> <i>Nummulites acutus</i> <i>Archeas operculini formis</i> <i>Peneroplus blymingtonesi</i> <i>Præoperopliamina delicata</i> <i>Paracommulites incrassatus</i> <i>Borelis pygmaea</i> <i>Peneroplus evolutus</i> <i>Amphisferina</i> sp. <i>Planorbolina</i> sp. <i>Austrotrillinga paucicostolata</i> <i>Nummulites intermedius/fichteli</i> <i>Eulepidina dilatata</i> <i>Operculina cf. complanata</i> <i>Sypnina</i> sp.	
50'			5788-5789 5791 5792 5908 5909-5910 5910 5911-5912 5913-5914		
100'			5915 5916 5917 5918 5919 5920-5921 5922 5923 5924 5925 5926 5927		
150'			5928 5929 5930 5931 5932 5933		
200'			5934 5935 5936 5937 5938 5939 5940 5941 5942 5943 5944 5946 5946		
250'					
291'					

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FIG. 3.—PALAENTOLOGICAL RANGE TABLE. NIRANI NALA (Scale:- 1" to 50 ft.) Map ref, 35 N/12

	ROCK UNITS	LITHOLOGY	SAMPLE NUMBERS FBB		AGE
0'	NARI LST.		5793		
			5794-5796		
			5797, 5798		
			5799		
			5800-5801		
			5802-5804		
			5805-5807		
			5808, 5809		
50'			5810		
			5811		
			5812		
			5813		
			5814, 5815		
			5816, 5817		
			5818		
			5819, 5820		
			5821		
			5822		
100'			5823, 5824		
			5825		
			5826, 5827		
			5828, 5829		
			5830, 5831		
			5832		
150'			5833		
			5834, 5835		
			5836, 5837		
			5838		
			5839		
200'					
			5847		
			5848		
			5849		
			5850		
			5851		
			5852		
			5853		
			5854		
250'			5855		
			5856		
			5857		
			5858		
300'			5859		
			5860		
			5861		
			5862		
			5863		
350'			5864		
355'			5865		

Mummulites girgheas (nsp.)*Assilina operculata* subsp. *novata**Mummulites pinioides**Arvelina oblonga**Orbitolites complanatus**Rotaria trochidiformis**Lindermia brugesi**Costaolina* sp.*Mummulites acutus**Dichocanus* sp.*Florsulina globosa**Loxarthra* sp.*Assilina cancellata* subsp. *cancellata**Archonas operculiformis**Peneropsis glymptonesis**Austrorillina paucicostata**Amphitegula* sp.*Præ-Aegyptianna delicata**Peneropsis avolatus**Planorbolina* sp.*Boettgeriella pygmaea**Boettgeriella pygmaea* sp. *incrassata**Lepidocyclina* (S.L.) sp.*Euleptodina dilatata**Mummulites intermedius* *fichteli**Gyrosina* sp.*Operculina* cf. *complanata*

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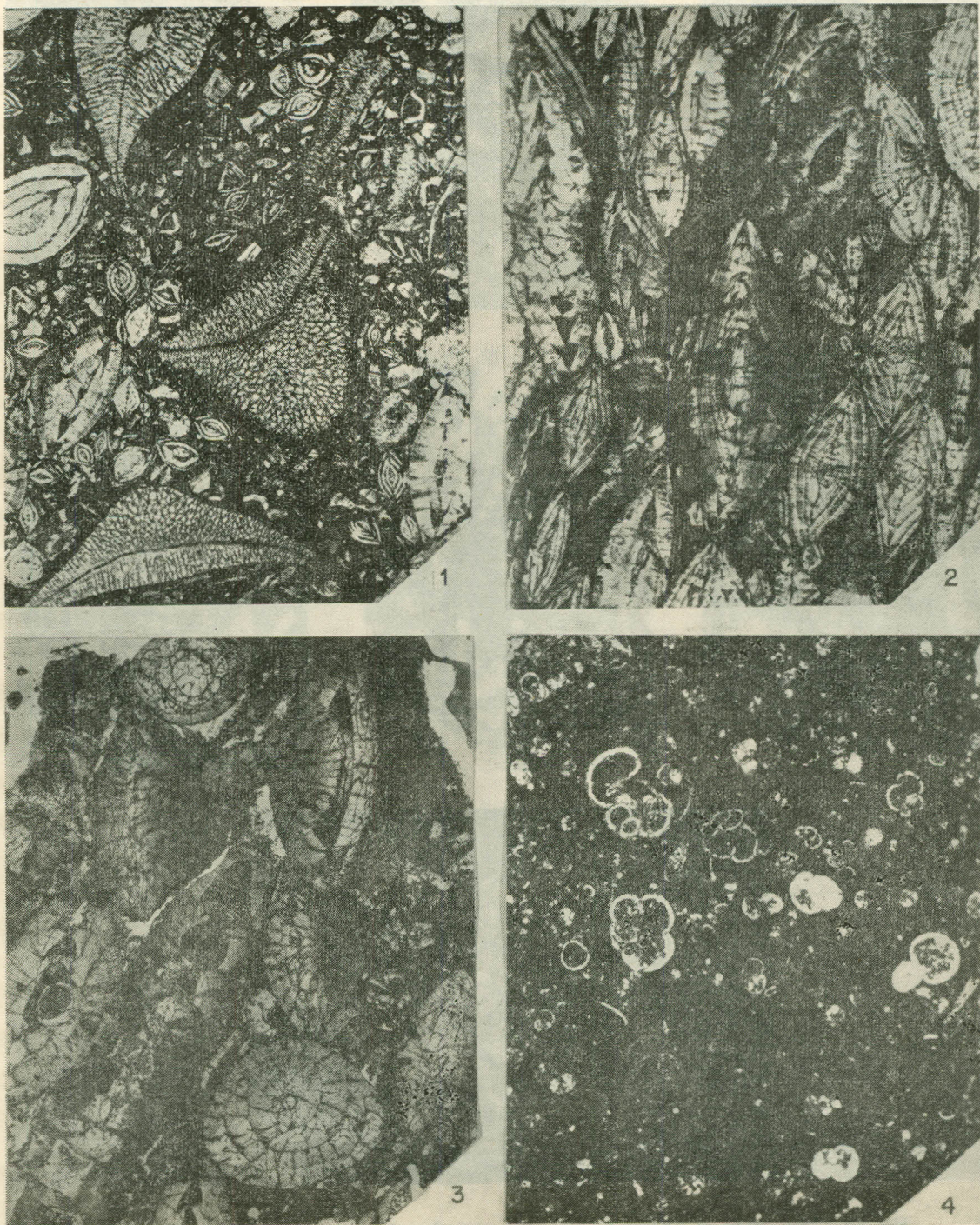
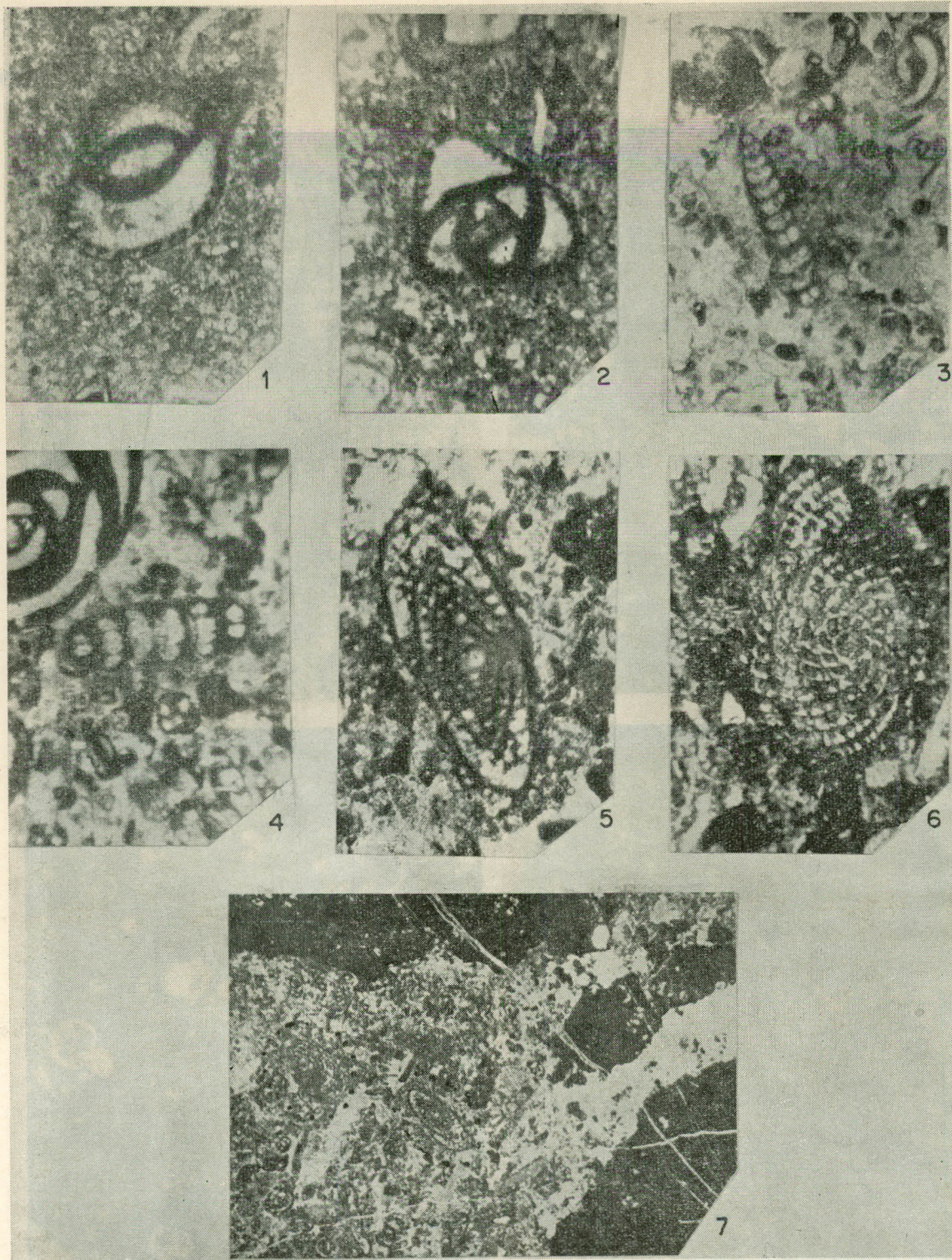


Fig. 1.—Thin section of Khirthar Limestone (lower part) from Gaj River with *Discocyclina* cf. *dispansa*, (Sowerbyi); *Nummulites beaumonti*, (meg.) d'Archiac and Haime; *Assilina subcancellata*, Nuttall; *Nummulites* sp; (Middle Eocene Sample No. FB.B.5110. $\times 6$)

Fig. 2.—Thin section of Khirthar Limestone (lower part) from Gaj River with *Assilina* cf. *subpapillata*, Nuttall; *Nummulites subatacicus*, Leymeri; (Middle Eocene). Sample No. FB.B. 5098. $\times 6$

Fig. 3.—Thin section of Khirthar Limestone (lower part) from Gaj River with *Assilina subcancellata*, Nuttall; *Nummulites perforata*, (de Montfort); *Akinocyclina* sp. (Middle Eocene). Sample No. FB. B. 5116. $\times 6$

Fig. 4.—Thin section of Khirthar Limestone (upper part) from Gaj River with planktonic foraminifera *Turborotalia centralis*, (Cushman and Brmudez); *Sphaeroidinella semni*; Beckmann; (Middle Eocene). Sample No. FB.B. 5086. $\times 25$



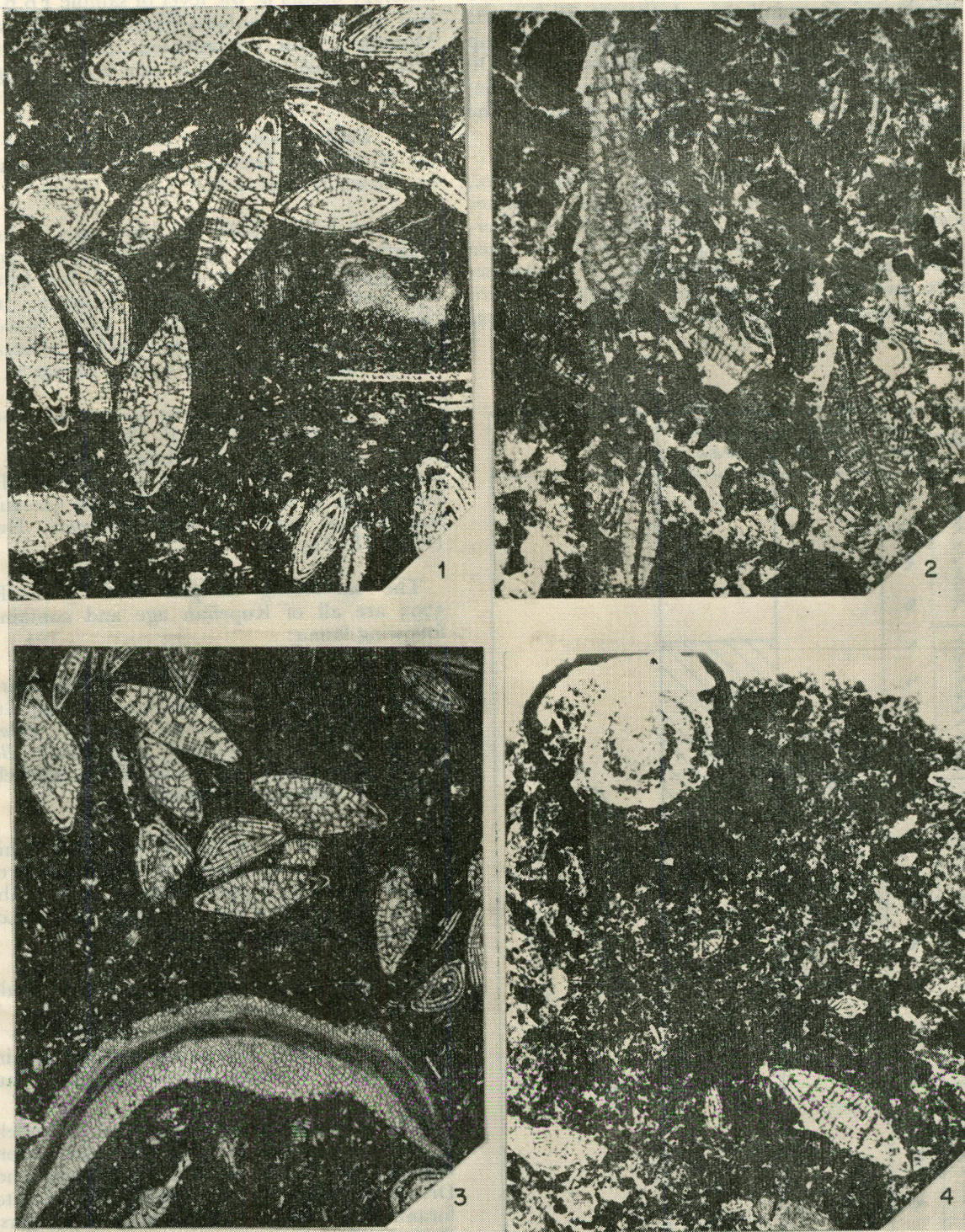
Figs 1-2.—Thin section of Khirthar Limestone (upper part) from Gaj River showing *Austrotrillina paucialveolata*, Grimsdale; (Middle Oligocene). Sample No. FB.B. 5075. $\times 30$

Figs. 3-4.—Thin section of Khirthar Limestone from Nirani Nala, Badhra anticline showing *Praerhapydionina delicata*; Henson; (Middle Oligocene). Sample No. FB.B. 5831. $\times 30$

Fig. 5.—Thin section of Khirthar Limestone from Nirani Nala, Badhra anticline showing *Peneroplis glynnjonesi*, Henson; axial section (Middle Oligocene). Sample No. FB. B. 5833. $\times 30$

Fig. 6.—Thin section of Khirthar Limestone from Nirani Nala, Badhra anticline showing *Peneroplis glynnjonesi*, Henson; oblique equatorial section (Middle Oligocene). Sample No. FB.B. 5825. $\times 30$

Fig. 7.—Thin section of Khirthar Limestone conglomerate from Nirani Nala, Bahra anticline showing reworked pebbles of probable Middle Eocene age in matrix with *Archaias operculiniformis*, Henson and *Peneroplis glynnjonesi*, Henson (Dotted Circles) (Middle Oligocene). Sample No. FB.B. 5833. $\times 7$



Figs. 1 and 3.—Thin section of Khirthar Limestone (upper part) from Gaj River with *Nummulites fichteli*, Michelotti; *Lepidocyclus* (*Eulepidina*) *dilatata*, (Michelotti); Middle Oligocene). Sample No. FB.B. 5061 $\times 6$

Fig. 2.—Thin section of Khirthar Limestone (upper part) from Gaj River with *Nephrolepidina tournoueri*, Lemoine; *Heterostegina* sp; *Operculina* sp. (Middle Oligocene). Sample No. FB.B. 5065. $\times 15$

Fig. 4.—Thin section of Khirthar Limestone (upper part) from Gaj River with *Nummulites fichteli*, Michelotti; *Paleonummulites incrassatus*, (Fichtell and Moll); and reworked *Nummulites perforatus*; (de Monfort); (Circled) showing disseminated iron ore, rugged edge and thick rim of calcite (Middle Oligocene). Sample No. FB.B. 5082. $\times 6$

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