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MEMOIRS

OF THE

GEOLOGICAL SURVEY OF INDIA

PALAEONTOLOGIA INDICA

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA

New Series

Vol. XLVI

PLATES 1 TO 21

THE UPPER PERMIAN AND LOWER TRIASSIC FAUNAS OF KASHMIR

Editors

KEIJI NAKAZAWA

Kyoto University, Japan

AND

HARI MOHAN KAPOOR

Geological Survey of India



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Palaeontologia Indica

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THE UPPER PERMIAN AND LOWER TRIASSIC FAUNAS OF KASHMIR

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Dedicated

to

The friendship and understanding

of the

Indian and Japanese Geoscientists

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ERRETA

FOREWORD

The varied geological formations of India possess a wealth of palaeobiological data which need synthesis in solving some of the global stratigraphical problems. One such problem is the Permian—Triassic Boundary, which is also the Era Boundary between the Palaeozoic and the Mesozoic. The life that flourished during the Permian and Triassic times is documented by the fossils comprising varied groups of animals and these reveal a great biological revolution. The Himalaya, particularly the Kashmir region, offers an unique scope for the study of this Era Boundary.

The Kashmir region was selected on the basis of a world-wide review of the stratigraphic successions comprising Permian-Triassic fossils, and these were studied in detail by the team headed by Prof. K. Nakazawa of Kyoto University, Japan and by Shri H. M. Kapoor of the Geological Survey of India. This collaborative programme, lasting for nearly ten years, has resulted in an informative and exhaustive monograph on the Upper Permian and Lower Triassic faunas of Kashmir, and this is being published now as a Palaeontologia Indica. *I am happy to dedicate this publication to the cause of friendship and understanding between the geoscientists of India and Japan.*

V. S. KRISHNASWAMY

Director General

Geological Survey of India

Dated, Calcutta

2nd March, 1978

INTRODUCTORY NOTE

The geological history during Permian and Triassic Systems all over the world supply us interesting records of life, climate and geography. It is also well known that greatest faunal change or biological evolution in the geological past took place during the transition from the Paleozoic to Mesozoic. But, we are not yet in general agreement how to decide the Permian-Triassic boundary. To solve this problem, a team of Japanese geologists was organized to study in detail the Late Permian and Early Triassic Systems of Kashmir in India, the Salt Range in Pakistan, Abadeh and Julfa regions in Iran and several other countries in cooperation with the geological surveys or institutions of the respective countries.

In Kashmir, Japanese and Indian geologists worked for three seasons, i.e., 1969, 1971 and 1972. Main work was carried out in 1969, but lacunae were filled in 1971 and 1972.

The members of the investigating party till the finalisation of the present work were as follows :

Japan : Drs. K. Nakazawa, D. Shimizu, Y. Nogami and T. Tokuoka of Kyoto University, Drs. T. Maegoya and S. Nohda of Kyoto Industrial University, Dr. K. Ishii of Osaka City University (now Himeji Institute of Technology), Dr. Y. Bando of Kagawa University, Dr. S. Sakagami of Ehime University (now Chiba University), Dr. M. Murata of Kumamoto University, Dr. Y. Okimura of Hiroshima University and Dr. K. Nakamura of Hokkaido University.

India : H. M. Kapoor of Geological Survey of India, Lucknow now Central Headquarters, Calcutta.

Recently, during August and September, 1977, Mr. T. Matsuda of Osaka City University with Mr. H. M. Kapoor made an additional collection of samples from Upper Permian and Lower Triassic formations of Kashmir to establish conodont biostratigraphy. The purpose is to study in detail the changes in conodont fauna with time.

The stratigraphical, biostratigraphical and sedimentological studies including the historical review have already been made by Nakazawa et al. (1975). However, for convenience a summary of the findings has been included in the part I of this memoir.

This memoir contains the palaeontological studies made by Y. Okimura and K. Ishii (Foraminifera), M. Kato (Coral), S. Sakagami (Bryozoa), D. Shimizu (Brachiopoda), K. Nakazawa (Bivalvia), Y. Bando (Ammonoidea) and M. Murata (Gastropoda and Conodontophorida). Most of the collections described here are from two sections of Kashmir, viz., Guryul Ravine located abut 16 kilometres southeast of Srinagar and the Spur, three kilometres north of Barus situated about 15 kilometres south-southeast of Guryul Ravine. A few fossils from Pahlgam and Pastannah have also been described.

A part of the entire collection has already been described earlier. These include the Permian shark tooth by Kapoor and Sahni (1971), some Permian foraminifers by Okimura et al. (1975), Permian *Cyclolobus* by Furnish et al. (1973) and the Lower Triassic ammonoids of Pir Panjal by Kapoor and Bando (1974). A description of *Claraia* (Bivalvia) by Nakazawa along with Iranian species has been published in 1977 in the Dr. Orlov Commemoration Volume of the Palaeontological Society of India (1977). In addition to these contributions, Permian and Triassic conodonts collected by Teichert et al. (1970) from Guryul Ravine has been reported by Sweet (1973). The previous published work of the team, as well as work quoted in above paragraphs are included in next page.

All the illustrated specimens are the repository of the Palaeontology and Stratigraphy Division of the Geological Survey of India, Calcutta.

The memoir consists of three parts—Part I, deals with the stratigraphy of the Guryul Ravine and the Spur three kilometres north of Barus ; Part II, relates to faunal considerations and descriptions of fossils of eight groups viz. foraminifers, corals, bryozoans, brachiopods, bivalves, gastropods, cephalopods and conodonts. Part III, is the analysis of the fauna of Kashmir with special reference to the problems of Permo-Triassic boundary.

February 10, 1978

Keiji Nakazawa,
Kyoto University
AND
Hari Mohan Kapoor,
Geological Survey of India

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The success of the Indo-Japanese team for the scientific cause is due to the very active co-operation received from the Geological Survey of India and the Ministry of Education, Government of Japan. They contributed to the team financial, materialistic and moral supports. Government of Japan needs further appreciation for providing additional funds for the laboratory investigations. All the members are obliged to both the governments and as a token of friendships among geoscientists of both the nations, this memoir has been dedicated to the 'friendship and understanding of the Indian and Japanese Geoscientists'.

The Directors General of the Geological Survey of India from 1968 to 1978 (Mr. G. C. Chaterji, Mr. M. S. Balasundaram, Dr. M. K. Roychowdhury, Mr. C. Karunakaran, Mr. V. K. S. Varadan and Mr. V. S. Krishnaswamy), Deputy Directors General of Northern Region (Dr. M. K. Roychowdhury, Mr. V. K. S. Varadan, Mr. V. S. Krishnaswamy and Mr. K. D. Shukla), Directors of Kashmir Circle (Mr. T. K. Kurien, Mr. G. M. Banerjee and Mr. M. N. Sehgal), Director of Palaeontology and Stratigraphy (Mr. M. V. A. Sastry), Director of International Wing (Mr. R. K. Sundaram), Officer-in-Charge of Palaeontlogy Division of Northern Region (Mr. J. P. Srivastava, Mr. R. N. Shrivastava and Dr. A. K. Chatterjee) and several other colleagues from Geological Survey of India and geological institutes of Japan including universities of Japan gave co-operation, support, guidance and useful suggestions to the workers for which the team is extremely grateful to all of them. The authors are also obliged to their colleague Mr. Amarnath Mukharjee of Publication Division, Geological Survey of India in making corrections in the manuscript. They are also thankful to Mr. Tapan Kumar Ghosh of Publication Division, GSI, for going through the proofs.

Lastly, the team is again obliged to the Government of Japan for providing financial support for inviting Indian Member, Mr. H. M. Kapoor from India to Japan in 1976, for finalisation of work and manuscript.

THE UPPER PERMIAN AND LOWER TRIASSIC FAUNAS OF KASHMIR

ABSTRACT

The Memoir incorporates the palaeontological details, based on the collections mainly from two sections viz. Guryul Ravine and the spur three kilometres north of Barus, Kashmir, made by Indo-Japanese team between 1969 and 1972. The study is aimed to resolve the problem of the boundary between Permian and Triassic Systems. The stratigraphical findings and conclusions have already been published by Nakazawa et al. (1975).

The descriptions of species recorded in this Memoir include 17 genera (9 species) of foraminifers, 1 species of coral, 12 genera (14 species) of bryozoans, 18 genera (9 species) of brachiopods, 17 genera (32 species) of bivalves, 4 genera (4 species) of gastropods, 16 genera (29 species) of cephalopods and 3 genera (6 species) of conodonts. Most of the fossils belong to the Upper Permian Zewan Formation and the lower division of the Lower Triassic within the Khunamuh Formation (lower part). A few fossils from the upper division of Lower Triassic (Smithian or Owenitan stage) from Khunamuh Formation are also referred to and have been described, besides a few forms from other areas of Kashmir.

Among these, 2 bryozoans, 2 bivalves, 1 gastropod and 1 ammonoid are new species. Fifteen species of foraminifers, one of coral, 10 of bryozoans, 20 of bivalves, 4 of gastropods, 10 of ammonoids and 1 of conodont are newly recorded from Kashmir. A revision of 14 known species of bivalves from Kashmir is also made. Besides, status of subgenus *Retispira* has been raised to the generic rank ; a review of *Otoceras woodwardi* and *Paranorites* has been made and a new subgenus *Pseudoproptychites* of genus *Proptychites* has been erected. The age of *Glomospirella shengi* Ho and *Nodosaria grandis* Lipina has been revised on the basis of these findings from Kashmir.

Description of each group is accompanied by faunal affinities. Foraminifer assemblage suggests two different types of faunas present in the Late Permian of Kashmir. Solitary coral is characterstic of the rim of Gondwana and is of deep and/or cold water environment. Bryozoans suggest close relationship with Middle Productus Limestone of Salt Range and Amarassi beds of Timor. Brachiopods are uniformly distributed in the Zewan Formation and do not suggest their suitability in sub-divisions, however the stunted forms of the brachiopods in the Khunamuh Formation associated with Triassic type bivalve are of significance ; a few brachiopods have also been recorded from the *Otoceras* Zone. Bivalves indicate 2 zones of Permian and 5 of the lower division of the Lower Triassic ; two Permian bivalves found in the Lower Triassic is suggested to be derived secondarily from the Permian strata. Gastropods are correlatable to those found in Chhidruan beds of Salt Range. *Warthia*, a gastropod in Lower Triassic appears to be a straddler. Five distinct ammonoid zones of the Lower Triassic have been distinguished in Kashmir, 4 refer to the lower division, while one to the Owenitan or Smithian stage. Among conodonts, 4 zones and two sub-zones could be recognised.

Collectively, considering the faunal assemblages, the Upper Permian beds show four divisions designated as Divisions I to IV, and correspond to different litho-units. First three units are present in the Zewan Formation and the last one corresponds to the basal unit of the Khunamuh Formation. The Lower Triassic Khunamuh Formation, so far studied has established 5 ammonoid, 5 bivalve and 3 conodont zones. It has been proposed that the boundary between the Late Permian and the Early Triassic in Kashmir be drawn at the base of the *Otoceras woodwardi* Zone. This conclusion is however, based on major considerations related with the problem.

PART I

STRATIGRAPHY OF UPPER PERMIAN AND LOWER TRIASSIC IN KASHMIR

BRIEF NOTE ON THE STRATIGRAPHY OF GURYUL RAVINE AND THE SPUR THREE KILOMITRES NORTH OF BARUS

By

H. M. KAPOOR

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LUCKNOW, INDIA

AND

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BRIEF NOTE ON THE STRATIGRAPHY OF GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

INTRODUCTION

The formations referable to Late Carboniferous and Early Permian constitute a common geological history, hence they have been put under the Panjal Group. This group is represented by marine and non-marine fossiliferous rocks, volcanic flows and pyroclastics. Late Carboniferous and Early Permian consist of Agglomeratic Slate (divisible into two divisions, lower 'diamictite' and upper 'pyroclastic' ; Kapoor and Shah, 1979 ; Nakazawa and Kapoor, 1979), non-marine Permian Gondwana with distinct five floral beds and Panjal Volcanic Rocks (Panjal Trap), (Table 1).

TABLE 1

Stratigraphy and Fossil Zones of Early Permian in Kashmir

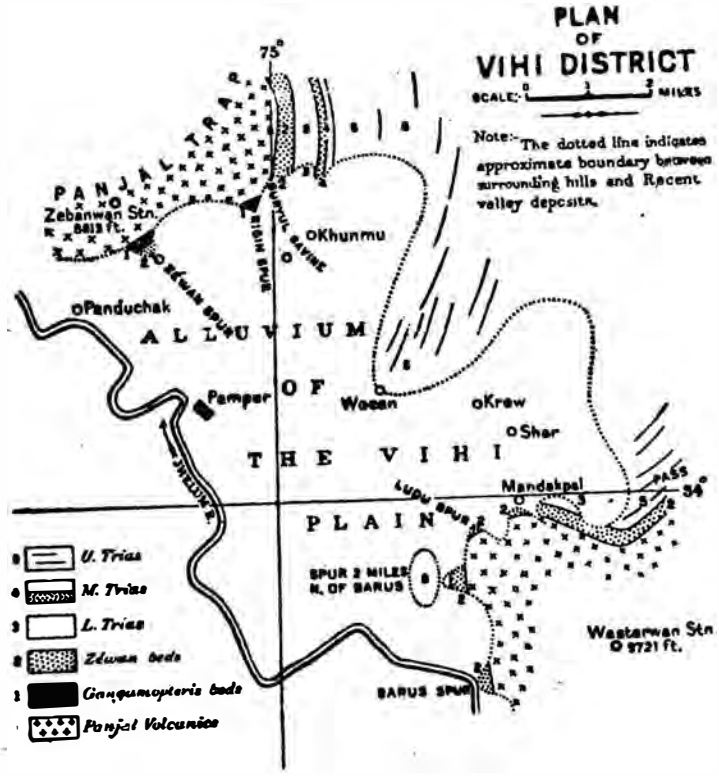
Stratigraphy			Faunal/ floral zones
		Zewan Formation Disconformity in most part, conformable with Mamal beds.	Varied Upper Permian marine faunas.
Artinskian to Kazanian	Panjal volcanic rocks (Panjal Trap)	Mamal beds (PG)	*Glossopteris, Pecopteris* and northern type' flora
		Munda beds (PG)	*Glossopteris, Pecopteris*
		Marahama beds (PG)	*Gangamopteris, Glossopteris*
		volcanic flow	
		Vihi beds (PG)	*Gangamopteris*, tetrapods, fishes
		Thick flows with inter-trappeans and flow agglomerates	
		Nishatbagh beds (PG)	*Ganggmopteris, Cordaites*
Sakmar.- Artinsk.	Agglomeratic Slate	volcanic flow II	
		'pyroclastic division' (600m.)	4. *Bucaniopsis-Warthia* assemblage zone 3. *Praeundulomya* - 'Spirifer' assemblage zone 2. *Taeniothaerus - Buxtonia - Polypora* assemblage zone
		volcanic flow I	
Late Carb.- Asselian.		'diamictite division' (900m.)	Barren zone 1. *Eurydesma - Deltopecten* assemblage zone *Fenestella* zone
		Fenestella Shale	

(PG) - Permian Gondwana

The sediments of Late Permian to Early Jurassic, on the otherhand, exhibit continuous marine deposition and therefore formations of these periods are collectively designated under

Vihi Group. There are, however, a few reported occurrences of volcanic flows within the Triassic System.

The Upper Permian in Kashmir, like other parts of the Himalaya, consists purely of marine sediments and is known as the Zewan Formation. The contact of the Zewan Formation with the underlying beds in most part of the Kashmir, is also assumed to be disconformable (Kapoor, 1979) except in the upper Liddar valley, where the topmost sedimentary layers of the Mamal beds, (Permian Gondwana) show the presence of marine fossils.



Text Figure 1. Geology around Vihi plain. (Reproduced from Middlemiss, *Rec. Geol. Surv. India*, Vol. 37, Pt.4., Pl. 14 ; 1909). Krew of the above figure is Khreuh of the present text as well as Weean is Wuyan and the Spur 2 miles N. of Barus is the Spur 3 kilometres north of Barus.

The Triassic System of Kashmir is divisible into Lower (Khunamuh Formation), Middle (Khreuh Formation) and Upper (Wuyan Formation) based on lithology and faunal assemblage. The Upper Triassic sediments are followed by Lower Jurassic, Wumuh Formation.

The lower boundary of the Lower Triassic in Kashmir has been revised by Nakazawa et al. (1975) mainly on the basis of two standard sections of Kashmir, viz. Guryul Ravine and the Spur 3 kilometres north of Barus. (Text Fig. 1). The details of these sections have already been published by Nakazawa et al. (1975). In both the sections, the Panjal Trap, the Permian Gondwana (Vihi Bed = Gangamopteris bed), the Zewan Formation, the Khunamuh Formation, the Khreuh Formation and the Wuyan Formation are exposed. However, at present we confine only to the Zewan and Khunamuh Formations because of the significance of the boundary problem between the Permian and Triassic Systems for which this work is meant.

GURYUL RAVINE

ZEWAN FORMATION

The Zewan Formation, 97.3 metre thick, has been divided into four members, A to D, and each member into several units as shown in Table 2, Plate 1 and Text Fig. 2. A short description of these members is given below.

Member A is composed mainly of carbonate rocks accompanied by sandy shale. Its subdivisions, A_1 to A_4, indicate a slight lithological facies change. Foraminifers and bryozoans are common throughout the member.

Member B differs from Member A in its predominance of shale and poor content of carbonate rocks. It is further divisible into three units, B_1 to B_3. Fossils are rare excepting trace fossils which are commonly found throughout this member.

Member C is characterised by rhythmic alternation of calcareous sandstone and sandy shale, in which shale is predominant. Brachiopods, bivalves and other groups are rather common, especially in the upper half.

TABLE 2

Divisions of Zewan Formation at Guryul Ravine

(Reproduced from Nakazawa et al. 1975)

Member D	(Beds 32-46 ; 18.2 m)	Thick-bedded, sandy limestone and calcareous sandstone, partly convoluted and nodular, intercalating thin shale layers.
Member C	(Beds 26-31 ; 23.2 m)	Alternation of calcareous sandstone and sandy shale, predominant in the latter.
Member B (29.3 m)	Unit B_3 (Beds 24-25)	Alternation of thick-bedded sandy shale and sandstone, intercalating calcareous sandstone, 6.4 m.
	Unit B_2 (Bed 23)	Alternation of calcareous sandstone and sandy shale, 2.1 m.
	Unit B_1 (Beds 21-22)	Sandy shale, 20.8 m.
Member A (26.6 m)	Unit A_4 (Bed 20-2-4)	Calcareous sandstone and micaceous sandy shale, 5.8 m.
	Unit A_3 (Bed 20-1)	Calcareous sandstone and micaceous shale, 3 m.
	Unit A_2 (Beds 18-19)	Thick-bedded, sandy limestone, 9.6 m.
	Unit A_1 (Beds 14-17)	Calcareous sandstone and alternation of sandy limestone and shale, 8. 2 m.

Member D is mainly represented by thick-bedded sandy limestone. Sandy shale along with laminated muddy sandstone is present occassionally in the lower part, while calcareous sandstone and muddy sandstone are predominant in the upper part. Bivalves and gastropods become more common than brachiopods. Text Figure 2 shows the lithological column of the Zewan Formation of the Guryul Ravine section.

KHUNAMUH FORMATION

The Khunamuh Formation overlies conformably the Zewan Formation with a rather abrupt change in lithology. The formation is composed of alternations of limestone and black shale. In general, it represents the Lower Triassic strata except for the basal part which belongs to latest Permian in age. This formation is divisible into six members, namely E to J, based on gradual increase in limestone content (Plate 1, Text Figs. 3, 4). Table 3 summarises the division of this Formation and the individual members are described below.

Member E is composed of alternations of shale with subordinate limestone. It is further subdivided into three units, namely E_1 to E_3, based on the different lithological nature of shale. Unit E_1 commonly contains brachiopods and bivalves which show a latest Permian age; and ammonoids, bivalves and conodonts, are most predominant fossils in other members.

Member F is made of alternation of shale and limestone, (each of 5 to 10 cm thick); and Member G consists mostly of limestone intercalating with thin shale partings. Ammonoids and bivalves are common in Member F, while ammonoids are rarely found in Member G.

Member H is characterised by alternation of limestone, shale and calcareous or muddy sandstone. It contains abundant ammonoids. This was designated as Meekoceras bed by Middlemiss (1910).

Member I is formed of alternation of limestone and shale, where thickness of limestone layers varies from 10 to 30 cm and shale layer is less than 10 cm.

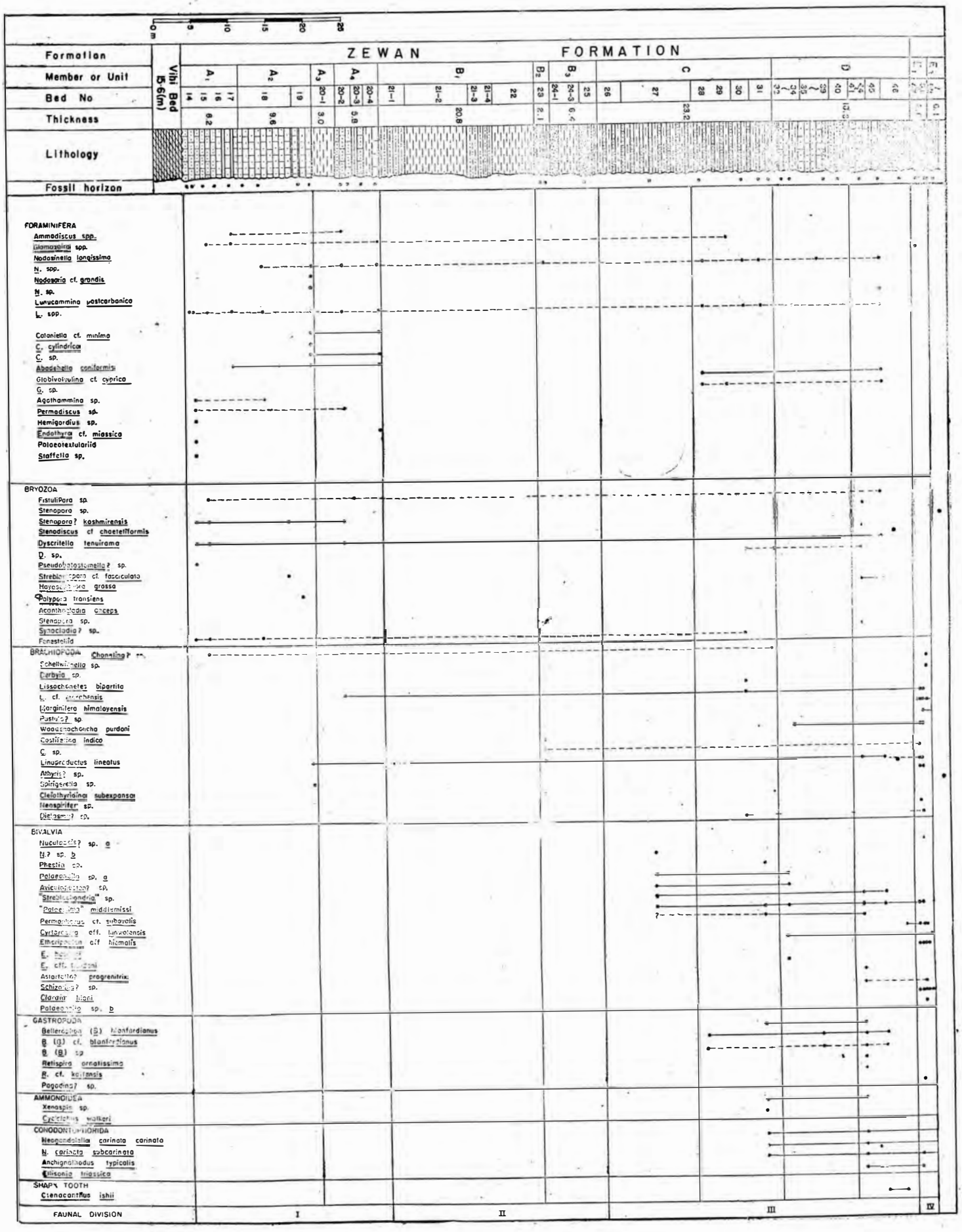
TABLE 3

Divisions of Khunamuh Formation at Guryul Ravine

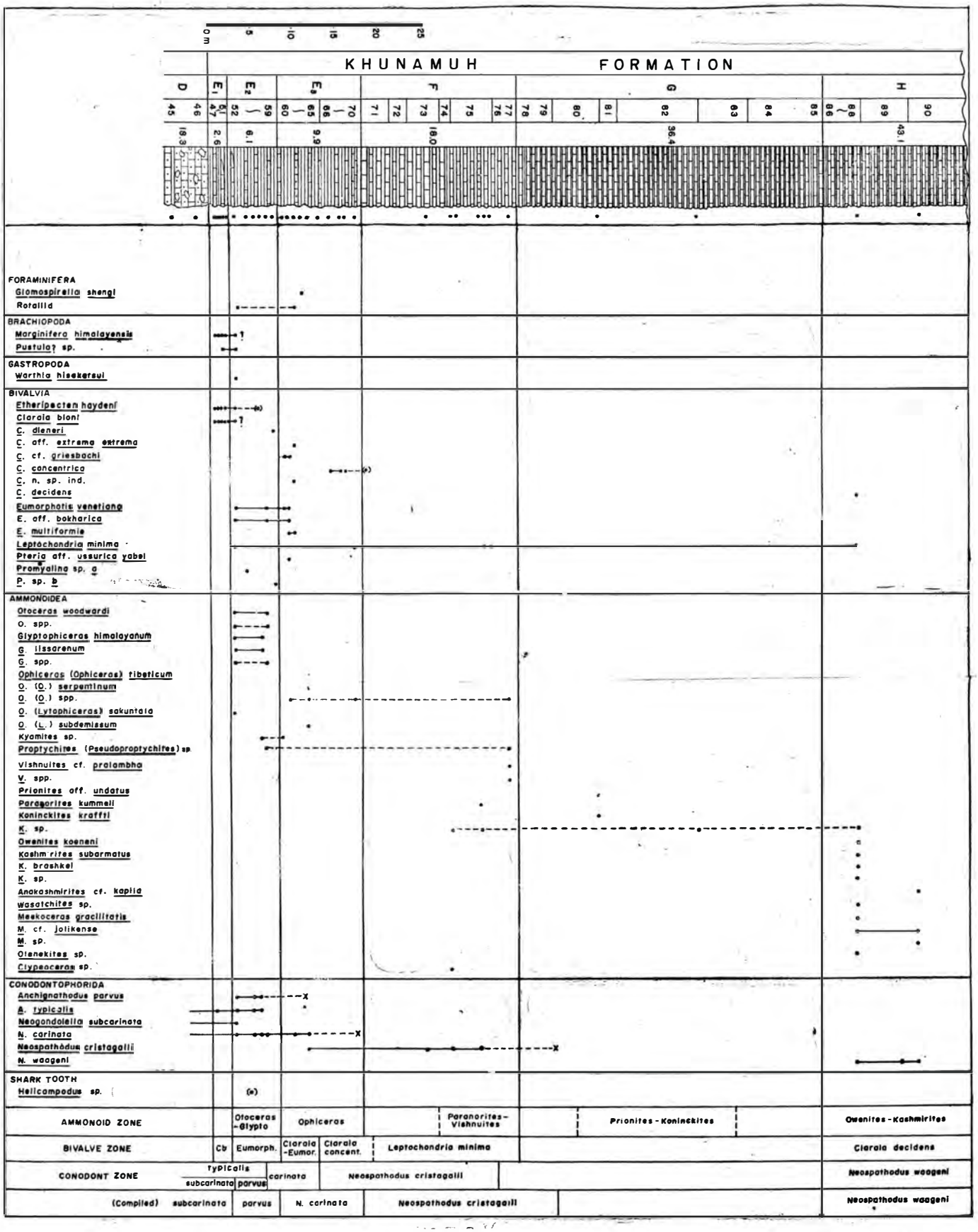
(Reproduced from Nakazawa et al. 1975)

Member J	(Bed 95)	Muddy calcareous sandstone alternating with thin shale, more than 15 m.
Member I	(Beds 92-94)	Alternation of limestone and shale, 8.4 m.
Member H	(Beds 86-91)	Lower 12 m. alternation of limestone and shale, upper 32 m. sandstone and shale intercalating limestone.
Member G	(Beds 78-85)	Bedded limestone with thin shale parting, 36.4 m.
Member F	(Beds 71-77)	Alternation of limestone and shale, 18.8 m.
Member E	(Beds 47-77, 18.6m)	
	Unit E_3 (Beds 60-70)	Alternation of shale and subordinate limestone, 9.9 m.
	Unit E_2 (Beds 52-59)	Flaggy shale intercalating thin limestone, 6.1 m.
	Unit E_1 (Beds 47-51)	Black shale intercalating thin limestone, 2.6 m.

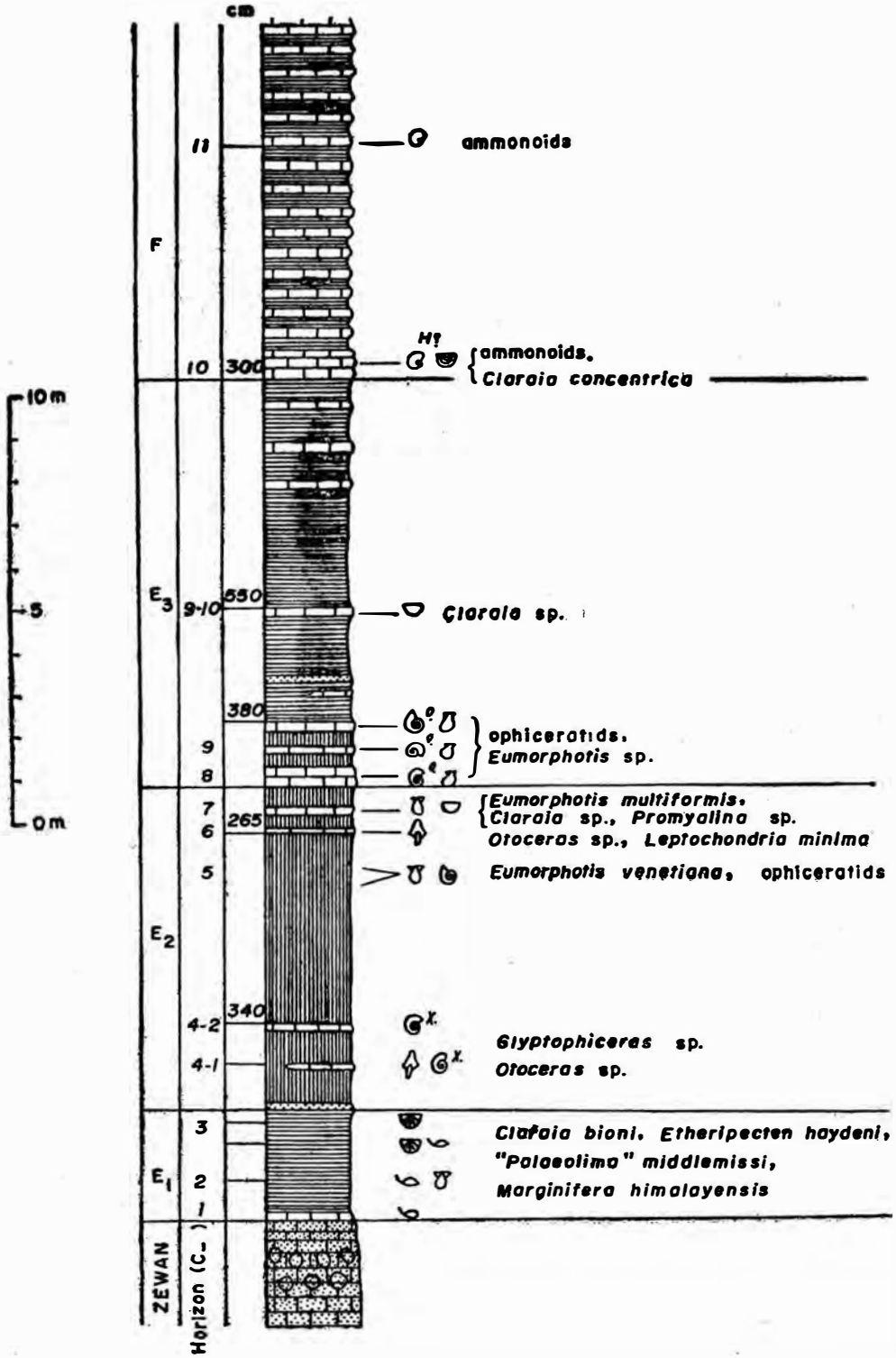
The youngest Member J is represented by alternation of muddy, calcareous sandstone and very thin shale.



Text Figure 2. Columnar section and range chart of marine fossils of the Upper Permian at Guryul Ravine.



Text Figure 3. Columnar section and range chart of marine fossils of the Lower Triassic at Guryul Ravine. ? exact horizon unknown ; ( ) occurrence at the the Third Spur. × occurrence after Sweet (1970).



Text Figure 4. Columnar section and fossil occurrences of the Khunamuh Formation at the Third Spur, Guryul Ravine.

THE SPUR THREE KILOMETRES NORTH OF BARUS

This section, though not so clear as that of the Guryul Ravine section shows abundance of fossil fauna and clear zones of the Zewan Formation. It is important as a supplementary section.

Zewan Formation

Like Guryul Ravine, the Zewan Formation of this section is also divisible into five members, namely a to e, each member has been further subdivided into several units, based on their lithological characters as shown in Table 4 and Text Figure 5. In general, the Zewan Formation at this place differs a little from that of the Guryul Ravine in its poor development of carbonate rocks and predominance of clayey sediments. Fossils are less common than the Guryul Ravine section except in the lowermost Member a, where foraminifers, bryozoans, crinoids and brachiopods are common.

Table 4

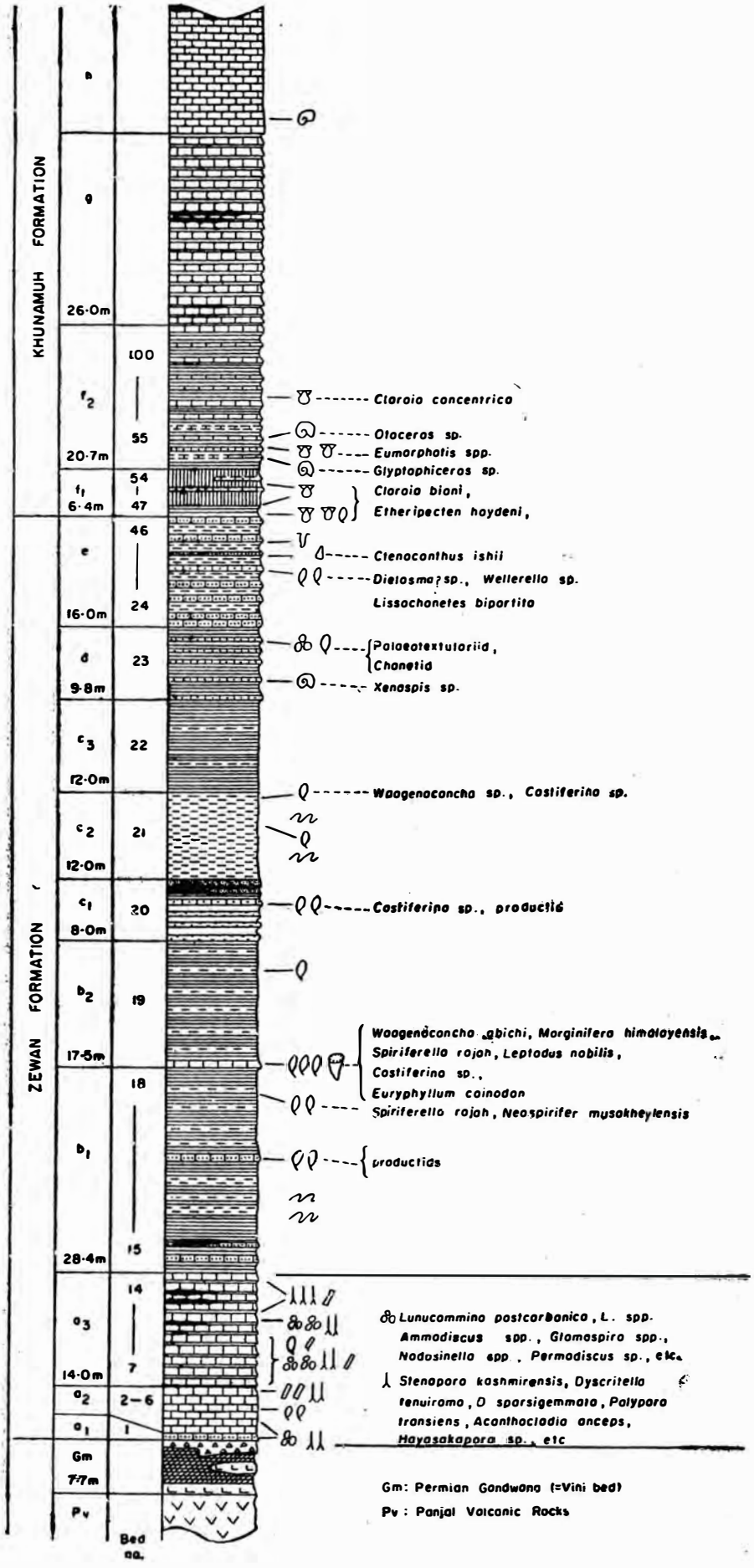
Divisions of Zewan Formation at the Spur Three Kilometres North of Barus

(Reproduced from Nakazawa et al. 1975)

Member e	(Beds 24-46)	Alternation of calcareous sandstone and shale with limestone, 16.0 m.
Member d	(Bed 23)	Dark grey shale with limestone, 9.8 m.
Member c	(Beds 20-22)	Composed mainly of shale, sandy shale and sandstone, 31.8 m
Unit c_3	(Bed 22)	Micaceous shale, 11.8 m.
Unit c_2	(Bed 21)	Micaceous sandy shale, 12.0 m.
Unit c_1	(Bed 20)	Sandstone and subordinate shale with limestone, 8.0 m.
Member b	(Beds 15-19)	Micaceous shale or sandy shale with muddy limestone, 45.9 m.
Unit b_2	(Bed 19)	Calcareous shale and micaceous sandy shale, 17.5 m.
Unit b_1	(Beds 15-18)	Micaceous shale, 28.4 m.
Member a	(Beds 1-14)	Cyclic alternation of sandy limestone and shale with calcareous sandstone at the base, 21.2 m.

Khunamuh Formation

The Khunamuh Formation is very similar in lithology to that of Guryul Ravine section and consists of alternations of limestone and shale, but owing to soil cover exposures are not very clear. As in the case of Guryul Ravine, it is also divided here into three members, namely f to h, which is based on the amount of limestone content as shown in the Text Fig 5. The lowermost unit f_1 belongs to the Permian.



Text Figure 5. Columnar section and fossil occurrences at the Spur three kilometres north of Barus (fossil names slightly emended from Fig. 10, Nakazawa et al. 1975).

CORRELATION OF SECTIONS AT GURYUL RAVINE AND THE SPUR THREE KILOMETERS NORTH OF BARUS AND THEIR VERTICAL CHANGE OF LITHOLOGY

Correlation : Though there is a little difference in the lithology of these two sections, in the Zewan Formation, still their possible correlation based on lithology and fossil contents can be made and is reproduced here in Table 5.

TABLE 5

Correlation of Guryul Ravine and the Spur Three Kilometres North of Barus

(Reproduced from Nakazawa et al. 1975)

	Guryul Ravine	*Spur 3 km North of Barus*	
Khunamuh Formation	Member H Member G Member F Member E	Member h Member g Member f	Lower Triassic
Zewan Formation	Member D Member C Member B Member A	Member e Members c, d Member b Member a	Upper Permian
Vihi bed (Permian Gondwana)			
Panjal Volcanic Rocks (Panjal Trap)			

TABLE 6

Litho-Stratigraphic Change of Carbonate Rocks at Guryul Ravine

(Reproduced from Nakazawa et al. 1975)

Member		*Fossils and Fossil Fragments*	*Terrigenous Contents*	*Folk's Classification*
E—I	F_2	ammonoids, bivalve (arranged parallel to bedding)	T_1	biomicrudite
D	F_1	brachiopod, bivalve, gastropod (arranged parallel to bedding)	T_2 and T_3	biomicrudite
C	F_1	brachiopod, bivalve, gastropod (arranged parallel to bedding)	T_3	biomicrudite
B		(no carbonate rocks contained)		
A	F_1	brachiopod, bryozoa, crinoid (not so fragmented and poorly oriented)	T_2 and T_3	biomicrudite and/or fossiliferous intramicrudite (sometimes poorly washed biosparudite)

F : indicates the existence of organic skeletons, mostly fragmentary.

F_1 : thick skeletons (>0.1 mm)—sessile shells (brachiopod and bryozoa), molluscan shells, some foraminiferal tests, etc. (mostly neritic organisms).

F_2 : thin skeletons (<0.1 mm)—shells of ammonoids and some bivalves, some foraminifera, etc. (mostly more off-shore organisms).

T : indicates percentage of terrigenous detrital materials.

T_1 : terrigenous materials less than 4%, limestone

T_2 : terrigenous materials between 4% and 18%, mostly sandy limestone

T_3 : terrigenous materials between 18% and 30%, calcareous sandstone

T_4 : terrigenous materials more than 30%, sandstone

Vertical Change of Lithology : Broadly speaking, the Zewan Formation begins with limestone and sandy limestone succeeded by terrigenous clastic sediments represented by sandstone, sandy shale and shale, and ends with sandy limestone intercalating with small amount of terrigenous materials. On the other hand, the Khunamuh Formation consists of alternations of limestone and shale with increasing limestone upward.

A detailed sedimentological analysis was carried out for the Guryul Ravine section, especially from Member C of the Zewan Formation to Member I of the Khunamuh Formation. The characterstics of carbonate rocks of different layers of each member or unit is summarized in Tables 6 and 7.

It was first clarified in the previous paper (Nakazawa et al. 1975) that the alternation of limestone and shale in the Khunamuh Formation is mostly caused by turbidity current. The following environment of the sedimentary sequence was inferred taking the fossil assemblage and lithology into consideration.

TABLE 7

Occurrence of Carbonate Layers at Guryul Ravine
(Reproduced from Nakazawa et al. 1975)

	lithofacies	*bed-thickness of carbonate layers*
Khunamuh	Rhythmic alternation of limestone and shale (developing in abundant sedimentary structures)	5—20 cm
Zewan		
Member D	Thick-bedded sandy limestone (large-scale convolute bedding and nodular limestone in the uppermost part)	thick-bedded
Member C	Rhythmic alternation of calcareous sandstone and sandy shale (developing in sedimentary structures)	10—20 cm
Member B	Poor in carbonate rocks, only in the upper part alternations of calcareous sandstone and shale	10 cm
Unit A_4	(Upper) thin-bedded limestone in sandy shale	5—10 cm
	(Lower) calcareous sandstone with thin shale	5—10 cm
Unit A_3	Poor in carbonate rocks	
Unit A_2	Thick-bedded sandy limestone, in the upper part alternating with thin shale (sometimes parallel and cross laminated)	thick-bedded
Unit A_1	(Upper) alternation of sandy limestone and shale	10—20 cm
	(Lower) thick-bedded, calcareous sandstone (with exotic pebbles)	thick-bedded
Vihi bed (Permian Gondwana)	(Lower) pelletal or oolitic limestone (now altered to novaculite)	

The first stage of the Zewan Formation indicates a shallow, neritic environment relatively free from terrigenous materials. The second stage is characterised by a supply of rich terrigenous sediments and is inferred to be under infra-neritic to shallow bathyal condition. The last stage of the Zewan Formation is again represented by the development of carbonate rocks and shows shallowing of the sea. The rapid deepening of the sedimentary basin is observed in the next Khunamuh Formation and is indicated by a development of limestone turbidite and pelagic shale. A common occurrence of benthic molluscs, however, suggests a bathyal environment rather than an abyssal one. The rapid change of lithofacies took place in the earliest Khunamuh Formation (latest Permian).

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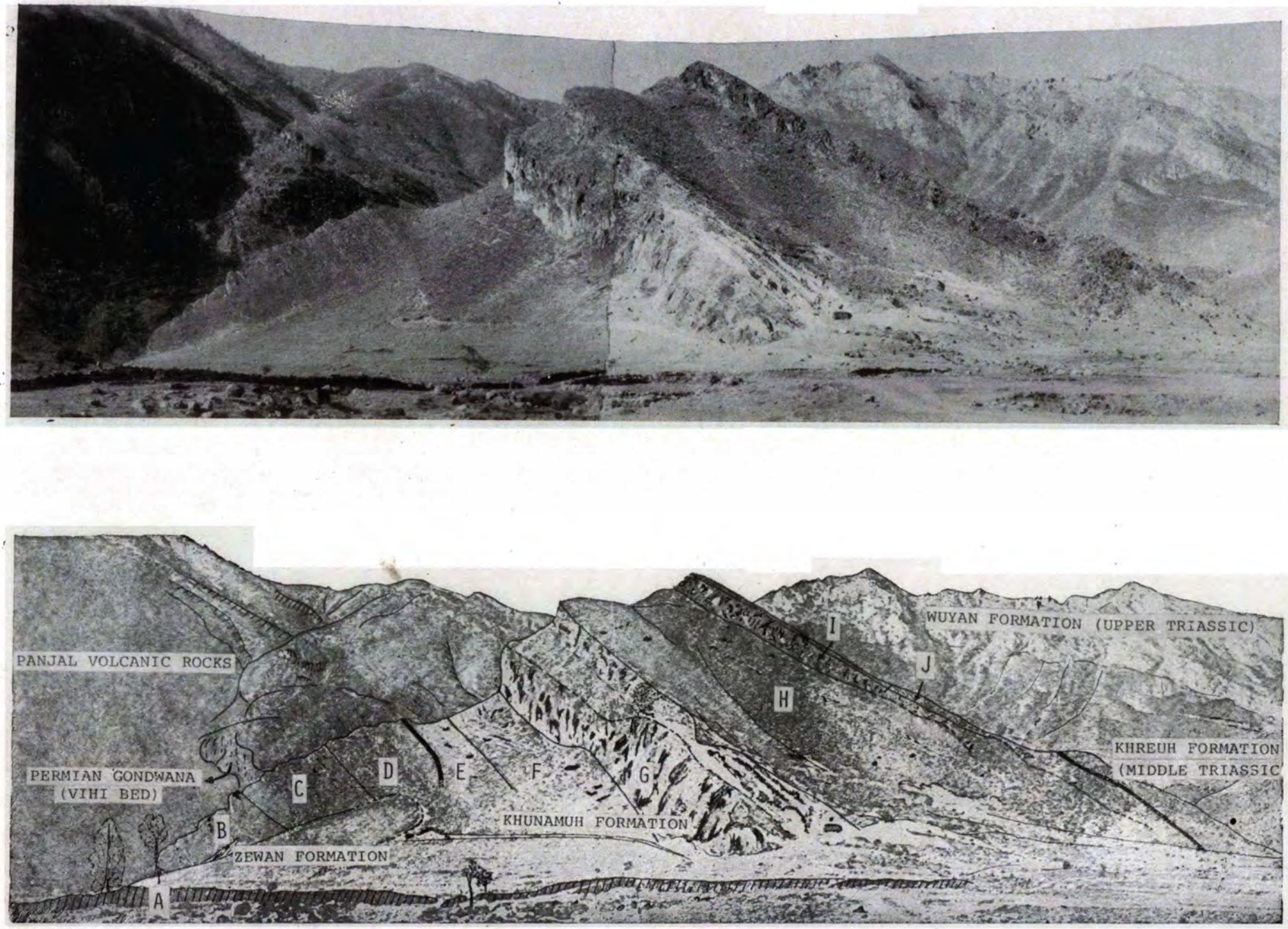
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PLATE 1

Guryul Ravine, Kashmir.

Upper Permian Zewan Formation (A—D) and Lower Triassic Kunamuh Formation; distant view of Panjal Volcanic Rocks and Permian Gondwana (Vihi bed) (left hand) and Middle Triassic Khreuh Formation and Upper Triassic Wuyan Formation (right hand). [Modified from Plate 1, Nakazawa et al., 1975]



KAPOOR AND NAKAZAWA : Guryul Ravine, Kashmir

PART II

FAUNAS OF ZEWAN AND KHUNAMUH FORMATIONS

UPPER PERMIAN AND LOWER TRIASSIC FORAMINIFERA FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

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UPPER PERMIAN AND LOWER TRIASSIC FORAMINIFERA FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

INTRODUCTION

The only published record on the Permian foraminifers from Kashmir is that of Srivastava and Mandawal (1966). They isolated foraminifers from a limestone of the lower part of the Zewan Formation exposed at the Zewan Spur and briefly described them with line-drawing figures. This collection includes :

Involutina semiconstrictus Loeblich and Tappan.
Involutina longexertus Gutshick and Treckman.
Textularia sp. *A* and *B*.
Tolypammina sp.
Agathammina sp.
Spiroculina sp.
Triloculina sp
Trochammina sp.
Nodosaria sp.

The present study of the Foraminifera, however, is based on the examination of the thin sections of limestones from the Guryul Ravine and the Spur 3 kilometres north of Barus.

Foraminifers are common in the lowermost limestone layers of the Zewan Formation, i. e., Member A of the Guryul Ravine and Member 'a' of the Spur 3 kilometres north of Barus. The positions of limestone (Bed numbers) which have yielded foraminifers are given in Table 8.

A thin section of limestone from Member A of the Guryul Ravine section having an area of 2.5 cm by 3.5 cm shows ten individuals ; while other Members do not show more than three individuals in the same area of observation. The tests of the foraminifers are generally fragmented ; moreover those of sessile forms (such as *Glomospira*, *Agathammina* and *Hemigordius*) are made of some constituents of limestone. Recrystallization has caused shell-microstructure to be very poorly preserved. It is sometimes difficult to differentiate *Nodosaria* from *Nodosinella* and *Glomospira* from *Agathammina*, due to recrystallization.

FAUNAL CONSIDERATION

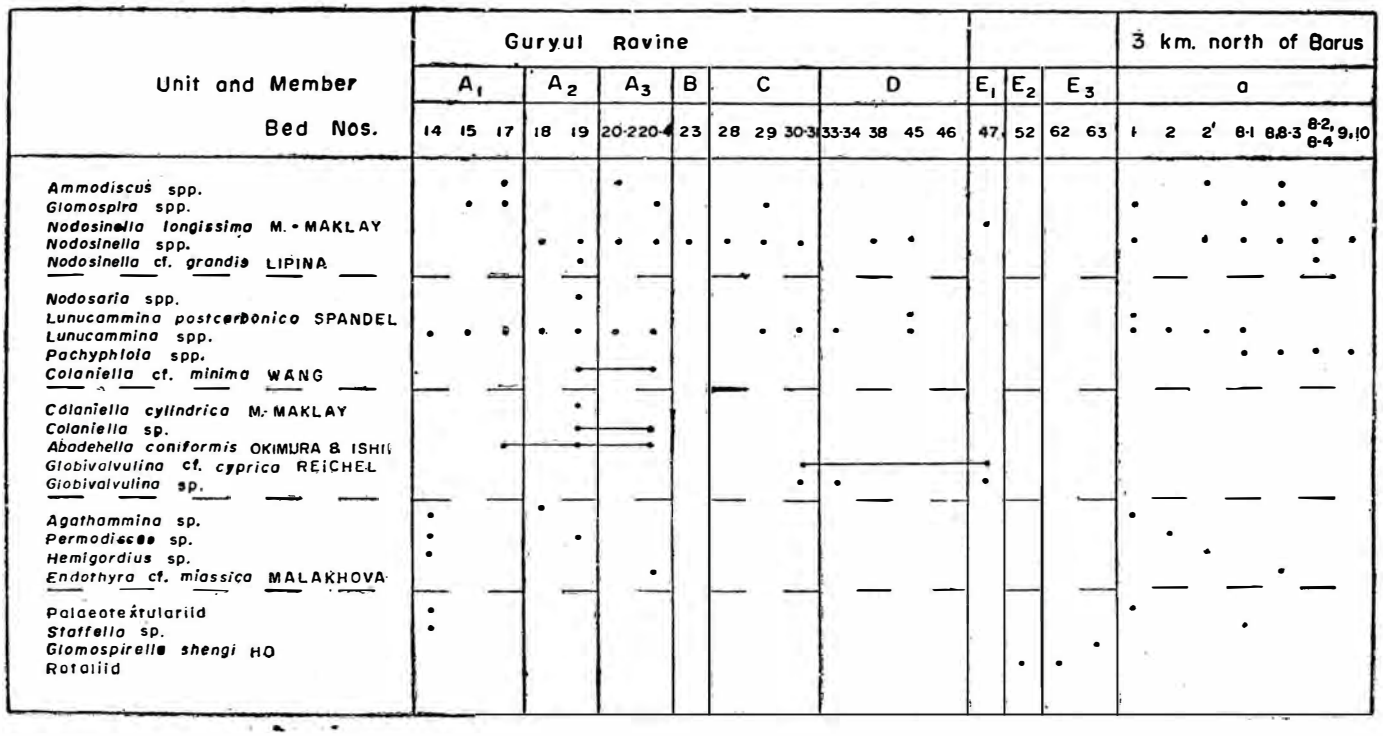
Seventeen genera of Forminifera are present in the Zewan Formation of the Guryul Ravine, while ten in the same formation at the Spur 3 kilometres north of Barus. Out of these only nine genera could be identified up to specific level. In Khunamuh Formation foraminiferal distribution appears to be extremely rare ; only one species *Glomospirella shengi* Ho was obtained from Bed 63 (Unit E_3 of the Guryul Ravine) and a rotaliid ? from Bed 52 (Unit E_2 of the Guryul Ravine) and Bed 62 (Unit E_3 of the Guryul Ravine).

Two different foraminiferal faunas have been distinguished in the Zewan Formation (Table 8). One fauna is confined to the Member A, while the other to Members C and D. Unit E_1 of the Khunamuh Formation, which refers to the latest Permian, is however scarce in the foraminifera.

The first fauna contains 12 forms belonging to 10 genera. It consists mainly of various shell-forms. On the other hand, the second fauna is represented by a few long ranging foraminifers characterised by uniserial arrangement of chambers.

TABLE 8

RANGE CHART OF FORAMINIFERS IN THE GURYUL RAVINE AND THE SPUR THREE KILOMETERS NORTH OF BURUS



It is worthwhile to mention here, that such a change in foraminiferal fauna in Kashmir is similar to that of Transcaucasia which was first noticed by Reitlinger (1965)*. The Araxian fauna of Transcaucasia is represented by uniserial or tubular shell-foraminifers of long range belonging to *Nodosaria*, *Lunucammina, Hemigordius* etc., and it considerably differs from the underlying Chanackhchinian fauna that consists of various shell-forms such as, *Paraglobivalvulina*, *Dagmarita*, *Tristix*, *Padangia*, *Rectglandulina, Pachyphloia*, *Robuloides*, *Eocristelaria* etc. The Chanackhchinian fauna differs also from that of the lowermost Zewan fauna of Kashmir in its generic composition. This probably suggests that these two regions of Tethys likely represent two different palaeobiogeographic provinces.

The foraminiferal fauna of the Zewan Formation, although poorly represented, the presence of *Colaniella* cf. *minima, C. cylindrica* and *Abadehella coniformis* bears special importance for reviewing the age of the Zewan Formation. As discussed earlier by Ishii et al. (1975), the stratigraphic distribution of the Permian colaniellids is limited in the *Lepidolina kumaensis* Zone to the *Palaeofusulina sinensis-Colaniella parva* Zone in Japan (Ishii et al. 1975), *Lepidolina multiseptata* Zone in Cambodia, and *Palaeofusulina bella-Colaniella media* Zone in Malaysia (Aw et al. 1976).

The Zewan fauna lacks the evolved forms of *Colaniella, C. parva* group, which characterises the upper limit of the range of *Colaniella* (Ishii et al. 1975). Based on the foraminiferal faunas, the lowermost member of the Zewan Formation, that is, Member A or a, is most probably correlatable with the Abadehian of Iran, the *Lepidolina kumaensis* Zone of

* Reitlinger (1965) divided the Dzhulfian into the upper Araxian and the lower Chanackhchinian. The latter corresponds to the *Codonofusiella-Reichelina* beds of Dzhulfa region which were referred to the lowermost Dzhulfian by Ruzhentsev and Sarycheva (1965), and was included in the Khachikian by Arakelian et al. (1964), Stepanov et al. (1969) and Waterhouse (1972).

Japan, and the lower Wuchiapingian of China. Hence, the main part of the Zewan Formation is considered here, to be Araxian or younger, and the middle Wuchiapingian or younger.

The presence of *Glomospirella shengi* Ho in Bed 63 (Unit E_3 ; *Ophiceras* Zone) of the Guryul Ravine is interesting, as this species is reported so far only from Middle to Upper Trias of Chialingching limestone in China, but the Guryul Ravine record is undoubtedly of the Lower Trias.

SYSTEMATIC DESCRIPTION

Family Nodosariidae EHRENBERG, 1838

Genus *Nodosaria* LAMARCK, 1812

Nodosaria sp. cf. *Nodosaria grandis* LIPINA

PLATE 2, Fig. 2

Compare :

1949. *Nodosaria grandis* LIPINA, *Trudy IGN. Acad. Nauk USSR, Byp.* Vol. 105, *Geol. Ser.*, No. 35, p. 220, pl. 4, Figs. 19-20.

1962. *Nodosaria grandis,* POTIEVSKAYA, *Acad. Nauk. USSR. Kiev, Inst. Geol. Sci. Trudy, Ser. Strat. Paleont.*, No. 44, p. 74, pl. 6, Figs. 12-16.

Material : Two nearly longitudinal sections and an oblique section of the species from Bed 19 (Unit A_2) of the Zewan Formation at the Guryul Ravine and Bed 8-2, (Unit a_3), Zewan Formation, at the Spur 3 km north of Barus were examined. Some specimens of this species may be grouped together with *Nodosinella* spp., because the wall structure is indistinct due to weak recrystalization.

Description : Test small, elongate cuneiform, slightly curved, tapering uniformly towards the proloculus in the early stage but cylindrical form in the later stage ; consisting of 9 chambers, uniserially arranged, gradually and regularly increased in size. Shape of chamber subround, but chamber-floor fairly convexed. Sutures between the chambers weakly compressed. Wall calcareous, thick, consisting mainly of radial laminated calcite. Aperture single, round form with radial incisions, opening at the central part of the last chamber.

Dimensions : Maximum length 0.98 mm and maximum width 0.22 mm in the nearly longitudinal sections. (Pl. 2, Fig. 2).

Remarks : The holotype specimen of *Nodosaria grandis* LIPINA is illustrated by the oblique section, therefore complete identification is rather difficult and avoided. This species is closely allied to *Nodosaria longissima* SULEIMANOV, but *Nodosaria grandis* LIPINA is smaller than the *Nodosaria longissima* SULEIMANOV in the longitudinal length as well as the shape of chamber in *N. longissima* is semilunar unlike that of *N. grandis* where it is subround.

Age : In the earlier records this species is known only from the Lower and Middle Permian of the Donetz Basin and Bashkiria region, USSR, while in Kashmir it is present in the Upper Permian. The foraminiferal fauna associated with this species in Bed 19 of the Guryul Ravine is however, accompanied by *Colaniella, Abadehella* etc.

Horizon and Locality : Bed 19, Unit A_2, Member A, Zewan Formation, Guryul Ravine. Bed 8-2, Unit a_3, Member a, Zewan Formation, the Spur 3 km north of Barus.

Specimen (Slide) : GSI. Type No. 19282

Family Nodosinellidae RHUMBLER, 1895

Genus *Nodosinella* BRADY, 1876

Nodosinella longissima (M.-MAKLAY)

PLATE 2, Fig. 4

1960. *Nodosinella longissima* M.-MAKLAY, *Vses. Nauch, Issled. Geol. Inst. (VSEGEI), Min. Geol. Okhrana. Nedr. USSR,* Pt. 1, pp. 158-159, Pl. 27, Figs. 9 a-b, 10 a-b ; Pl. 28, Fig. 3.

Material : A longitudinal and a nearly longitudinal sections were examined from Bed 47 of the Guryul Ravine.

Description : Test large, elongate cuneiform, strongly tapering towards the proloculus in the early stage, and rather cylindrical in the later stage ; consisting of 15 chambers of semilunar shape. Chambers of uniserial arrangement strongly overlapped ; sutural compression between the chambers not observed, but the lateral sides smooth. Septa long, slightly domed. Wall calcareous, consisting of outer thin microgranular and inner thick fibrous calcite layers. Aperture single, round form, which may have some incisions, opening at the central domed end of the last chamber.

Dimensions : Maximum length 1.3 mm and maximum width 0.3 mm in the longitudinal sections. (Pl. 2, Fig. 4).

Remarks : In the original description of the type of this species, only four specimens with the outer views and a longitudinal section have been illustrated. Accordingly, the details of morphological characters of other sections are not yet known.

The specimen in hand is closely allied to *Nodosaria longissima* SULEIMANOV in respect to its shell being rectilinearly uniserial, and arrangement of chambers is elongate cuneiform of nearly same size ; but it differs in double layered wall. *Nodosaria longissima* SULEIMANOV is characterised by the sutural compression between the chambers.

Age : Nodosinella longissima (M.-MAKLAY) is reported only from the Kazanian (Upper Permian) of the Russian Platform.

Horizon and Locality : Bed 47, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen (Slide) : GSI. Type No. 19284

Genus *Lunucammina* SPANDEL, 1898

Lunucammina postcarbonica (SPANDEL)

PLATE 2, Fig. 13

1901. *Geinitzina postcarbonica* SPANDEL, *Naturh. Ges. Nurn-Berg, Festschr. Saecular-Feier*, pp. 189-190, Tf. 8 a-d.

1905. *Geinitzina postcarbonica*, CHAPMAN and HOWCHIN, *New South Wales. Geol. Surv. Mem., Pal.*, No. 14, p. 17, Pl. 4, Fig. 3.

1925. *Geinitzina postcarbonica*, LANGE, *Geol. Minjub. Genoot. Nederl. Kol., Verh., Geol. Ser.*, Vol. 7, Pt. 3, pp. 226-227, Pl. 1, Fig. 18.

1960. *Geinitzina postcarbonica*, LORIGA, *Soc. Pal. Ital., Boll.*, Vol. 1, No. 1, p. 64, Pl. 5, Fig. 5.

1962. *Geinitzina postcarbonica*, SCHERP, *Forschr. Geol. Rheinland Westfalen*, Vol. 6, pp. 297-298, Pl. 9, Figs. 18 a-b, 19 a-b, 22 a-b.

1965. *Geinitzina postcarbonica*, GIVRIEUX and DESSAUVAGIE, *Maden Tetkik Arama Enst., Yayinlar.*, No. 124, pp. 34-35, Pl. 1, Figs. 1-13, 16-17, 20-25, 26-30 ; Pl. 2, Figs. 1-4, 7-10, 13 ; Pl. 3, Figs. 1-4 ; Pl. 8, Fig. 4.

Material : Two nearly longitudinal sections (Bed 45 of the Guryul Ravine) and a tangential section (Bed 1 of the Spur 3 kilomitres north of Barus) were examined. Some oblique sections which could not be identified for the specific level are grouped together with *Lunucammina* spp.

Description : Test small, cuneiform with median longitudinal depression ; in the tangential section cocoon-shape and in the lateral section strongly tapered. 8-11 chambers uniserially arranged, and partly show a pseudobiserial appearance. Chambers broad, low, arched and strongly overlapped ; their central area convexed outward and lateral and fairly curved inward. Wall calcareous, consists of two layers of inner thin microgranular and outer thick radial striate or fibrous calcite. Aperture single, may be round form with some incisions, opening at the indented central part of the convexed terminal chamber.

Dimensions : Maximum length 0.8 mm and maximum width 0.7 mm in the figured specimen of nearly longitudinal section (Pl. 2, Fig. 13) ; maximum width 0.25 mm in the tangential section.

Remarks : The shell-form and size of this species fairly vary among the different materials, according to previous workers, however, the indented nature of the apertural part in the centre of bowlshaped chamber is characterstic of the species. With this diagnostic character, *Lunucammina postcarbonica* in the present material can easily be distinguished from other species.

Age : Geological occurrences of this species are known from the Middle Carboniferous to Upper Permian. The material from the Guryul Ravine and the Spur 3 kilometres north of Barus are closely allied to many illustrated specimens from the Bellerophon limestone (Upper Permian) of Central Anatolia, Turkey (Givrieux and Dessauvagie, 1965).

Horizon and Locality : Bed 1, Member a, Zewan Formation, the Spur 3 kilometres north of Barus. Bed 45, Member D, Zewan Formation, Guryul Ravine.

Specimen (Slide) : GSI Type No. 19292

Family Colaniellidae FURSENKO, 1939

Genus *Colaniella* LIKHAREV, 1939

Colaniella sp. cf. *Colaniella minima* WANG

PLATE 2, Figs. 6 and 7

Compare :

1966. *Colaniella minima* WANG, *Act. Paleont. Sinica*, Vol. 14, No. 2. p. 211 (in Chinese), p. 219 (in English), Pl. 1, Figs. 1-9

1975. *Colaniella minima*, ISHII, OKIMURA and NAKAZAWA, *Journ. Geosci. Osaka City Univ.*, Vol. 19, Art. 6, pp. 124-127, Pl. 2, Fig. 4, Pl. 3, Figs. 1-3.

1976. *Colaniella* sp. cf. *Colaniella minima*, OKIMURA, *Jour. Geol. Hiroshima Univ.* Vol. 7, No. 4, pp. 203-216, Pl. 21.

Material : A longitudinal, a nearly longitudinal and two oblique sections from Beds 19 and 20-4 of the Guryul Ravine were examined.

Description : Test small, conoidal, gradually tapering in the early part and slightly inflate in the terminal part. Strongly overlapped 11 chambers, bowl-shaped, uniserially and rectilinearly arranged, gradually increasing in size ; central part of chamber-floor flattened, and slightly convexed ; lateral part inclined to about 40 degrees. Wall calcareous, ambiguous in structure due to weak recrystalization, probably it consists of an outer thick vitreous and inner thin microgranular layers. Longitudinal plain partitions radially arranged, and their thickness nearly corresponds to the chamber-height, their numbers not known due to the absence of cross section. A stellate aperture formed by central margins of plain partition, opens on the central flattened part of the last chamber.

Dimensions : Longitudinal diametre 0.81 mm and maximum width 0.44 mm ; and the form ratio 1.9 in the figured longitudinal section (Pl. 2, Fig. 6).

Remarks : The longitudinal sections of this species from the Guryul Ravine exhibit all the morphological characters comparable to those of *Colaniella minima* WANG, but in the absence of cross sections, in which the characters of plain partitions are observed gives hesitation to workers to include specimens with certainty within this species.

Age : This species is recorded only from the middle part of the Upper Permian of Xikou of Shanxi and Xufuling of Jiangxi, China, and from the *Palaeofusulina simplex-Colaniella minima* and *P.* aff. *sinensis-C. parva* Zone of the Upper Permian of Japan.

Horizon and Locality : Bed 19, and Bed 20-4, Unit A_2, Member A, Zewan Formation, Guryul Ravine.

Specimens (Slide) : GSI. Type No. 19286, 19287

Colaniella cylindrica M.-MAKLAY

PLATE 2, Fig. 8

1954. *Colaniella cylindrica* M.-MAKLAY, *Trudy Vses Nauch Issled. Geol. Inst.* (*VSEGEI*), pp. 54-55, Pl. 8, Figs. 2-8.

1966. *Colaniella cylindrica*, WANG, *Act. Paleont. Sinica*, Vol. 14, No. 2, p. 212, Pl. 2, Fig. 1.

1975. *Colaniella cylindrica*, ISHII, OKIMURA and NAKAZAWA, *Jour. Geosci. Osaka City Univ.*, Vol. 19, Art. 6, pp. 124-127, Pl. 4, Fig. 1.

Material : A nearly longitudinal section of the later stage and an oblique section of the species could be examined from Bed 19 of the Guryul Ravine.

Description : Test large, slightly curved, cylindrical in the later stage and may taper towards the proloculus in the early stage. Chambers uniserially arranged, composed of five chambers in the cylindrical part ; strongly overlapped, bowl-shaped, fairly large in height, and its central part broadly flattened but in the lateral part highly inclined from the apertural margin. Longitudinal plain partitions developed and probably radially arranged ; but it is indistinct due to the absence of cross section. Wall calcareous, composed of two layers ; the outer thick and vitreous and the inner very thin and microgranular. A stellate aperture formed by assemblage of central margin of plain partitions, opens at the central flattened part of last chamber.

Remarks : This species is clearly distinguished from other species by its cylindrical test with longitudinal plain partitions of the later stage.

Age : This species was described from the Upper Permian Nikitin Formation of the northern Caucasus, USSR, from the upper part of the Upper Permian of Xikou of Shanxi, China where it is associated with *Colaniella xikouensis* WANG, *C. nana* M.-MAKLAY, *C. inflata* (WANG) and *Palaeofusulina* sp., and also known from the *Palaeofusulina sinensis-Colaniella parva* Zone of the Maizuru Group of Japan *Colaniella inflata*, *C. xikouensis*, *C. parva* (COLANI) and *Palaeofusulina* aff. *sinensis* SHENG.

Horizon and Locality : Bed 19, Unit A_2, Member A, Zewan Formation, Guryul Ravine.

Specimen (Slide) : GSI Type No. 19288

Family Tetrataxidae GALLOWAY, 1933

Genus *Abadehella* OKIMURA AND ISHII, 1975

Abadehella coniformis OKIMURA AND ISHII

PLATE 2, Figs. 16 and 18

1975. *Abadehella coniformis* OKIMURA and ISHII, *Mem. Fac. Sci., Kyoto Univ. Ser. Geol. Mineral.*, Vol. 41, No. 1, p. 43, Pl. 2, Figs. 1-5, 7-8 ; Pl. 3, Fig. 1, Pl. 4, Figs. 2-4.

1975. *Abadehella coniformis*, ISHII, OKIMURA and NAKAZAWA, *Jour. Geosci. Osaka City Univ.*, Vol. 19, Art. 6. Pl. 3, Fig. 1, Pl. 4, Fig. 9, Pl. 4, Fig. 13.

1977. *Abadehella* cf. *coniformis* AW, ISHII and OKIMURA, *Trans. Proc. Palaeont. Soc. Japan*, N. S., No. 104, p. 413-414, Pl. 43, Fig. 18.

Material : Two nearly axial sections from the Bed 19 and two oblique sections from Bed 17 and 20-4 of the Guryul Ravine were examined.

Description : Test small to moderate in size, conical shape, trochospirally coiled with 10 whorls ; lateral slope smooth in the early stage but slightly uneven in the later stage ; apertural part fairly concave. 1.5-2 chambers for each whorl, gradually and uniformly increase in size throughout the growth ; subdivided into small chamberlets by a few plain partitions which develop perpendicularly to the chamber-floor and made of microgranular calcite. Wall calcareous, consisting of outer layer of thin dark microgranular and inner layer of thick fibrous calcite. Aperture opens into umbilicus beneath valvular projection.

Dimensions : Maximum width 0.89 mm, maximum height 0.36 mm, and apical angle of 95 degree – measured with large angle because of the nearly axial section in the figured specimen (Pl. 2, Fig. 16).

Remarks : This species is clearly distinguished from other species of *Abadehella* by its small size, typical conical shape, less number of plain partitions and smooth lateral slope.

Age : *Abadehella coniformis* occurs in abundance in the lower part of the Abadeh Formation in the stratotype locality of the Upper Permian-Abadehian, in Central Iran ; it rarely occurs in the Upper Permian of Kelantan, northern Malaysia and is associated with *Palaeofusulina* aff. *bella* SHENG, *Colaniella media* M.-MAKLAY, *C. parva* (COLANI) etc. In Japan this species was reported from the *Lepidolina kumaensis* Zone and *Palaeofusulina simplex-Colaniella minima* Zone (Ishii et al., 1975).

Horizon and Locality : Beds. 17 (A_1), 19 (A_2) and 20-4 (A_4) of Member A, Zewan Formation, Guryul Ravine.

Specimen (Slide) : G. S. I, Type No. 19296, 19297

Family Endothyridae BRADY, 1884

Genus *Endothyra* PHILLIPS, 1846

Endothyra miassica MALAKHOVA

PLATE 2, Fig. 23

1965. *Endothyra miassica* MALAKHOVA, *Acad. Nauk, USSR, Ural Fil. Trudy, Inst. Geol.*, Byp. 74, p. 164, Pl. 3, Figs. 1-4, 7-9.

1975. *Endothyra miassica,* ISHII, OKIMURA and NAKAZAWA, *Jour. Geosci. Osaka City Univ.*, Vol. 19, Art. 6, Pl. 2, Fig. 8.

Material : Two horizontal axial sections and an oblique section from Bed 20-4 (A_4) of the Guryul Ravine and the Spur 3 kilometres north of Barus were examined.

Description : Test small, discoidal and umbilicate on one side only. The plectogyroid coiling of 2.1 volutions small in the total angular distortion ; 10 chambers in the last whorl. Chambers not swollen but slightly compressed between the last and penultimate chambers. The septa long in proportion to the height of chambers, slightly curved, highly inclined towards anterior. Wall calcareous, its structure not visible due to poor preservation of the specimen (although, in the original description of the species it is structureless). Aperture low, slit-like, situated at the base of apertural face of the last chamber.

Dimensions : Maximum diametre 0.54 mm and the diametre perpendicular to the maximum diametre 0.41mm in the horizontal axial section. (Pl. 2, Fig. 23).

Remarks : The specimen from the Guryul Ravine differs only slightly from the original definition of *Endothyra miassica* MALAKHOVA. The present specimens have long septa, while other important charaters are similar to the original.

Age : According to the original description of this species, it is associated with Upper Permian smaller foraminifers viz. *Glomospira hemigordiformis* TSCHERD and *Hemigordius schulunbergi* (HOWCHIN). This species is also illustrated from the *Lepidolina kumaensis* Zone of Sakashu, Tokushima Prefecture, Japan.

Horizon and Locality : Bed 20-4, Unit A_4, Member A, Zewan Formation, Guryul Ravine. Bed 8-3, Unit a_3, Member a, Zewan Formation, the Spur 3 km north of Barus.

Specimen (Slide) : G. S. I. Type No. 19303

Family Biseriamminidae TSCHERNYSHEVA, 1941

Genus *Globivalvulina* SCHUBERT, 1920

Globivalvulina sp. cf. *Globivalvulina cyprica* REICHEL

PLATE 2, Figs. 10-11

Compare :

1946. *Globivalvulina cyprica* REICHEL, *Eclog. Geol. Helv.*, Vol. 38, No. 2, pp. 554-555, Figs 39 a-f.

1975. *Globivalvulina cyprica*, OKIMURA, *Mem. Fac. Sci. Kyoto Univ. Ser. Geol. Mineral.*, Vol. 41, No. 2, pp. 33-34, Pl. 1, Fig. 15.

1975. *Globivalvulina cyprica*, ISHII, OKIMURA and NAKAZAWA, *Jour. Geosci. Osaka City Univ.*, Vol. 19, Art. 6, Pl. 2, Fig. 9.

Material : A nearly sagittal and a parallel section from Bed 45 and an oblique section from Bed 28 of the Guryul Ravine were examined.

Description : Test relatively small, ovoid in shape, slightly trochospiral in the early stage and planispiral in the later stage ; biserial succession of chambers arranged along an axis of biseriality that draws an open helicoid curve. Chambers made of five or more in number in each row, fairly overlapped ; the ratio of height to breadth of chambers gradually enlarged throughout the growth stage, and the last chamber slightly inflated. Wall calcareous, moderate in thickness, microgranular, with inner thin fibrous layer partially. Aperture probably lobate, opening on somewhat concave apertural face.

Dimensions : Longest diametre perpendicular to the coiling axis of the mature stage 0.28 mm and maximum width 0.2 mm in the nearly sagittal section (Pl. 2, Fig. 10). Maximum width 0.25 mm in the parallel section (Pl. 2, Fig. 11).

Remarks : Although, the specimens from the Guryul Ravine are closely allied to *Globivalvulina cyprica* REICHEL in its important characters of the sagittal section, but are smaller than the type specimens known from the Permian of the Cyprus Island.

Age : The associated foraminifers with *Frondicularia* and *Hemigordiopsis*, listed by Reichel (1946), are the important indicators of the Upper Permian. The specimens from the Salamis Island of Greece are also associated with Upper Permian foraminifers like *Colaniella cylindrica* M.-MAKLAY, *C. inflata* (WANG), *C. parva* (COLANI) and *Dagmarita* sp. In Japan this species is known from the *Lepidolina kumaensis* and *Palaeofusulina simplex-Colaniella minima* Zones.

Horizon and Locality : Bed 28, Member C and Bed 45, Member D, Zewan Formation, Guryul Ravine.

Specimens (Slide) : G. S. I. Type No. 19290, 19291

Family Ammodiscidae REUSS, 1862

Genus *Glomospirella* PLUMMER, 1945

Glomospirella shengi HO

PLATE. 2, Fig. 12

1959. *Glomospirella shengi* Ho, *Act. Palaeont. Sinica*, Vol. 7, No. 5, p. 413, Pl. 5, Figs. 20-25.

Material : A single specimen in Bed 63 (Unit E_3) of the Guryul Ravine.

Description : Test small, oval in the horizontal axial section. Tubular second chamber trochospirally coiled in the early stage, and planispirally coiled with two volutions in the later stage. Wall calcareous, microgranular, very thin. Apertural opening situated at the end of the tubular second chamber.

Dimensions : Maximum diametre 0.21 mm and diametre perpendicular to the maximum diametre 0.17 mm (Pl. 2, Fig. 12).

Remarks : This species is clearly distinguished from other species by its small size and less number of whorl.

Age : The previous record of this species is from the T^1_{2-3} horizon of the Middle Triassic of Shen-Teng-Shan, southwest of Lung-Chang, China. The present record modifies the range of this species, down to the Lower Triassic as evidenced from its biostratigraphical distribution in the Guryul Ravine.

Horizon and Locality : Bed 63, Unit E_3, Member E. Khunamuh Formation, Guryul Ravine.

Specimen (Slide) : G. S. I. Type No. 19293

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PLATE 2

Fig. 1 *Stafella* sp.

Oblique section. × 85. Bed 8-3 Unit a_3 Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19281.

Fig. 2 *Nodosaria* sp. cf. *Nodosaria grandis* LIPINA.

Slightly oblique longitudinal section. × 85. Bed 8, Unit a_3, Member a Zewan Formation at the Spur 3 km north of Barus. GSI. Type No. 19282.

Fig. 3 *Nodosaria* sp.

Nearly longitudinal section. × 85. Bed 19, Unit A_1, Member A, Zewan Formation at the Guryul Ravine. GSI. Type No. 19283.

Fig. 4 *Nodosinella longissima* M.-MAKLAY.

Slightly oblique section. × 50. Bed 47, Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19284.

Fig. 5 *Nodosinella* ? sp.

Longitudinal section. × 50. Bed 8, Unit a_2, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19285.

Figs. 6-7 *Colaniella* sp. cf. *Colaniella minima* WANG.

Nearly longitudinal section. × 50. Both from Bed 19, Unit A_2, Member A, Zewan Formation at the Guryul Ravine. GSI. Type Nos. 19286, 19287.

Fig. 8 *Colaniella cylindrica* M.-MAKLAY.

Slightly oblique longitudinal section. × 50. Bed 19, Unit A_2, Member A, Zewan Formation at the Guryul Ravine. GSI. Type No. 19288.

Fig. 9 *Ammodiscus* sp.

Axial section. × 100. Bed 20, Unit A_3, Member A, Zewan Formation at the Guryul Ravine. GSI. Type No. 19289.

Figs. 10-11 *Globivalvulina* sp. cf. *Globivalvulina cyprica* REICHEL.

10. Nearly sagittal section. × 85. 11. parallel section. × 85. Both from Bed 45, Member D, Zewan Formation at the Guryul Ravine. GSI. Type Nos. 19290, 19291.

Fig. 12 *Glomospirella shengi* HO.

Cross section. × 100. Bed 63, Unit E_3, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19293.

Fig. 13 *Lunucammina postcarbonica* (SPANDEL).

Slightly oblique section. × 50. Bed 1, Unit a_1, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19292.

Figs. 14-15 *Lunucammina* spp.

Nearly longitudinal sections. × 50. Bed 14, Unit A (Fig. 15), Member A, Bed 45, Member D, (Fig 14), Zewan Formation at the Guryul Ravine. GSI. Type Nos. 19294, 19295.

Figs. 16-18 *Abadehella coniformis* OKIMURA and ISHII.
Nearly axial sections. × 85. Bed 19, Unit A_2, Member A, Zewan Formation at the Guryul Ravine. GSI. Type Nos. 19296, 19297.

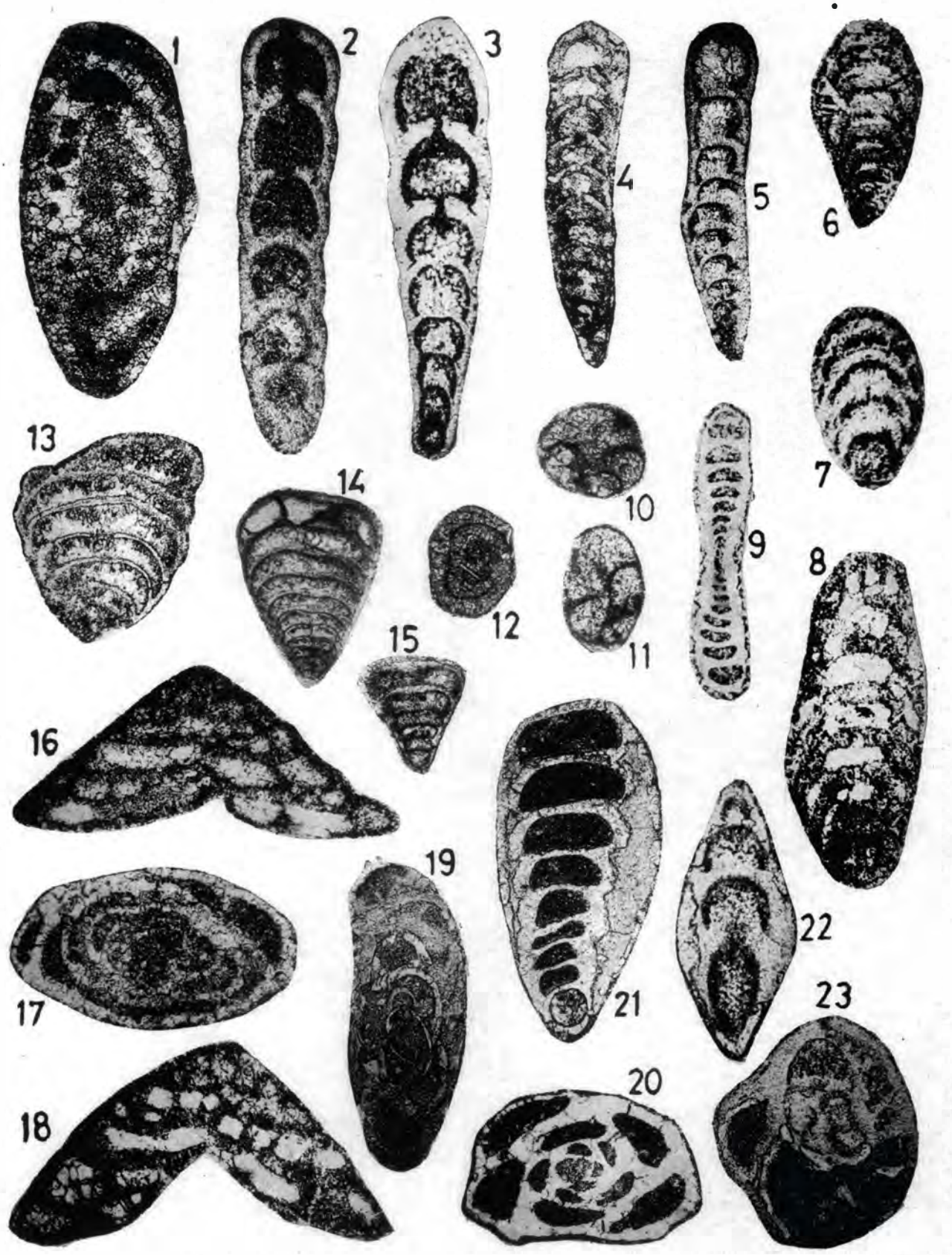
Fig. 17 *Hemigordius* sp.
Cross section. × 50. Bed 8, Unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19298.

Figs. 19-20 *Agathammina* spp.
19. Cross section. × 50. Bed 14, Unit A_1, Member A, Zewan Formation at the Guryul Ravine. GSI. Type No. 19299.

20. Cross section. × 50. Bed 1, Unit a_1, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19300.

Figs. 21-22 *Pachyphloia* spp.
21. Longitudinal section. × 85. 22. Lateral section. × 85. Both from Bed 8, Unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type Nos. 19301, 19302.

Fig. 23 *Endothyra miassica* MALAKHOVA.
Horizontal axial section. × 85. Bed 18-3 Unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19303.



OKIMURA AND ISHII : Foraminifers from Kashmir

ANTHOZOA

EURYPHYLLUM (RUGOSA) FROM KASHMIR

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EURYPHYLLUM (RUGOSA) FROM KASHMIR

Corals are in general very scarce in the Himalayan region. A team of Indian and Japanese geologists working in Kashmir collected two fragments of a solitary coral, new to Kashmir and also to Himalaya, from Bed 19 of Unit b_2 of the Late Permian, Zewan Formation at a locality 3 kilometres north of Barus (Nakazawa et al. 1975). The systematic description of the coral has already been published by Kato (1976).

The coral is identified as *Euryphyllum cainodon* (DE KONINCK) (Kato, 1976), and is here included in this Memoir for the sake of faunal details (Plate 3).

Although *Euryphyllum* is not very indicative of age, the occurrence of this coral is quite interesting in two ways. First it clearly denotes that the area must have occupied the then northern rim of Gondwana, where *Euryphyllum* fauna has been commonly found. Second, lacking in normal dissepimentarium, the coral indicates an environmental condition of so-called *Cyathaxonia* fauna (Hill, 1948) which was said to be inhabited under comparatively deep and/or cold water.

Horizon and Locality : Bed 19, Unit b_2, Member b, Zewan Formation, Spur 3 kilometres north of Barus.

Specimen :* GSI. Type Nos. 19501 (UHR 19807), 19502 (UHR 19808)

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*Kato (1976) earlier described these specimens with Nos. UHR 19807 and 19808 and now revised to GSI. Type Nos. 19501 and 19502 in Geological Survey of India's repository.

PLATE 3

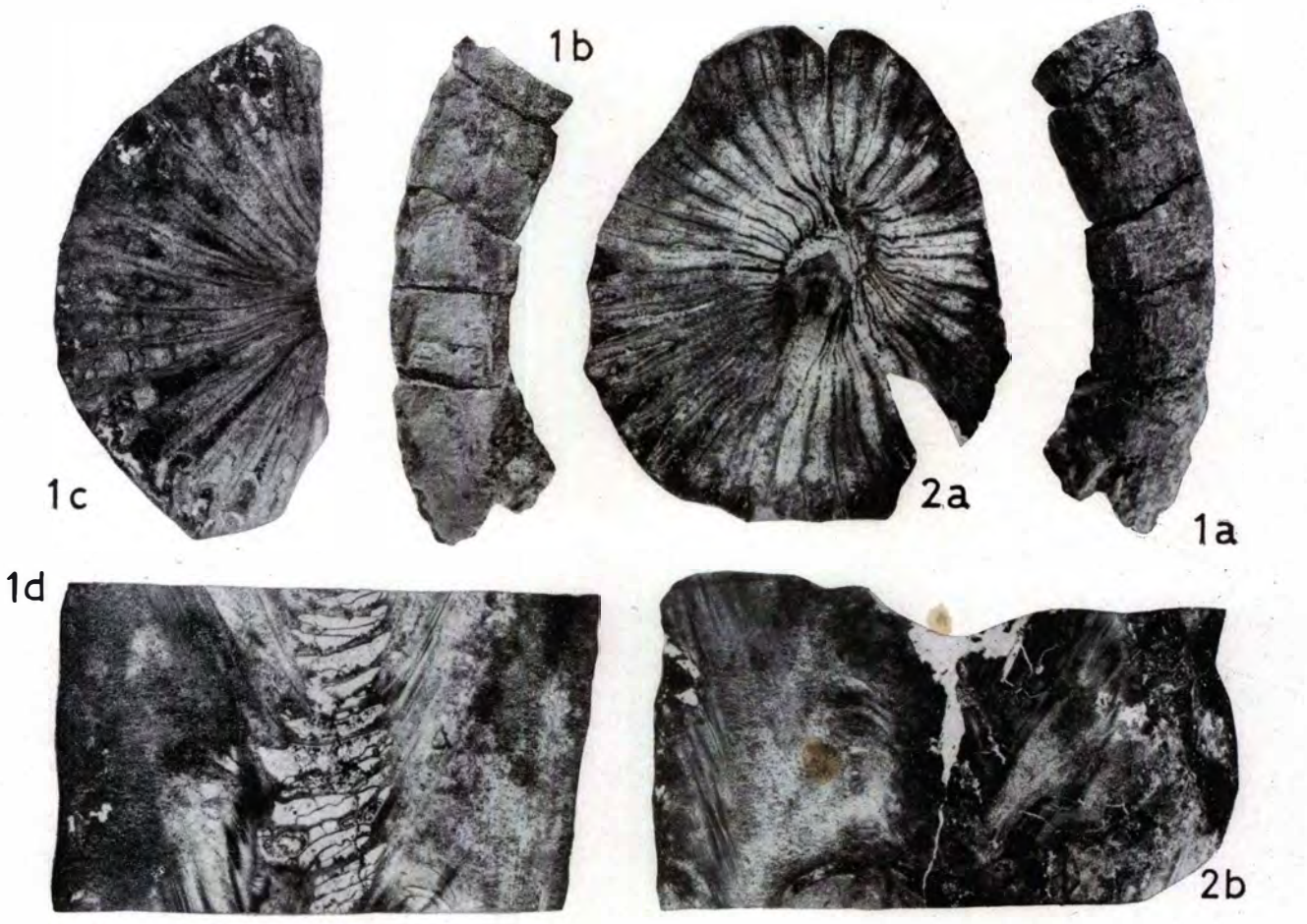
Fig. 1. *Euryphyllum cainodon* (DE KONINCK).

a. External surface of a corallite. x 1.
b. The same corallite from the other side which is deeply weathered as to show longitudinal characters. x 1.
c. Transverse section. x 4.
d. Longitudinal section. x 4.
GSI. Type No. 19501 (UHR 19807).

Fig. 2. *Euryphyllum cainodon* (DE KONINCK).

a. Transverse section. x. 4.
b. Longitudinal section. x 4.
GSI. Type No. 19502 (UHR 19808).

(Figured specimens are collected from Bed 19, unit b_2, Member b, Zewan Formation at the Spur, 3 kilometres north of Barus)



KATO : *Euryphyllum* from Kashmir

BRYOZOA

UPPER PERMIAN BRYOZOA FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

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UPPER PERMIAN BRYOZOA FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

INTRODUCTION

The bryozoan fauna from the Zewan Formation of Kashmir has previously been described by Diener (1899, 1915). The present article, however, describes the fossil bryozoans collected from the Guryul Ravine and also from the Spur 3 kilometres north of Barus between 1969 and 1972. The current study is based on the examination of thin sections of the limestones from the Permian Zewan Formation. The details of the bryozoan structures are not clear on the surface specimens, however thin slides of limestone show clear development of the structures.

FAUNAL CONSIDERATION

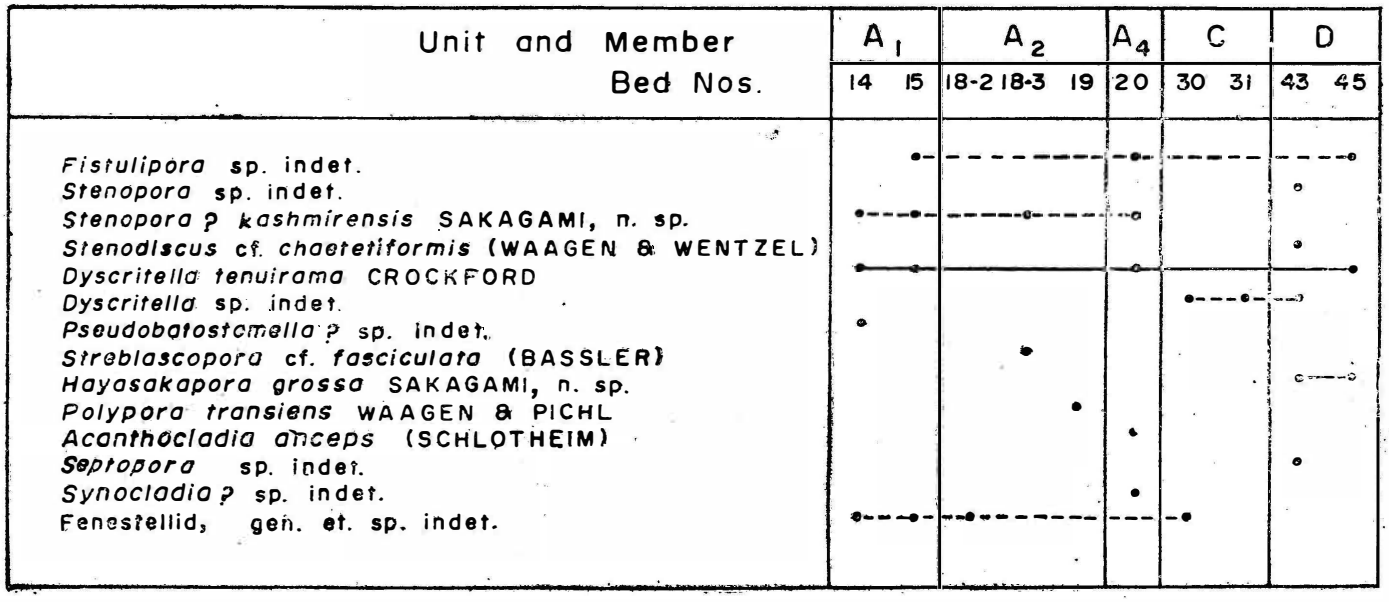
The distribution of the bryozoans in the Zewan Formation at the Guryul Ravine and the Spur 3 kilometres north of Barus is given in the range charts (Tables 9 and 10). The bryozoan fauna in the Guryul Ravine is represented by more than 14 species (12 genera) and that in the Spur 3 km north of Barus by 12 species (8 genera).

GURYUL RAVINE

Dyscritella tenuirama found at the Spur 3 kilometres north of Barus also occurs commonly throughout the Beds 14 to 45 of the Guryul Ravine. The specimens identified as *Stenopora ? kashmirensis* SAKAGAMI, n.sp. is similar to *Stenopora parvulipora* BASSLER of the Permian

TABLE 9

RANGE CHART OF THE UPPER PERMIAN BRYOZOANS IN THE GURYUL RAVINE



Amarassi beds described from the Timor island and is found throughout the Beds 14 and 20. *Streblascopora fasciculata*, present in Bed 18, was originally described from the Permian Basleo

beds of Timor island and subsequently described from the Kazansky Formation (Upper Guadalupian) of the Russian Platform and also from the Gnishik horizon (Guadalupian) of Trans-Caucasia by Shishova (1965). *Hayasakapora* sp. indet. (Pl. 5, Fig. 9) from Bed 30, is ill-preserved and indeterminable, but the genus is common in the Upper Permian of Japan and East Siberia. *Dyscritella* sp. indet. from Bed 31 is also ill-preserved and its specific identification is not possible. *Hayasakapora grossa* SAKAGAMI, n. sp. obtained from Beds 43 and 45 is similar to *H. gracilis* MOROZOVA from the Osakhtinsky horizon (Guadalupian) of Khabarovsk, Siberia, but it is a new form. *Stenodiscus chaetetiformis* (WAAGEN and WENTZEL) of Bed 43 can be referred to the original specimens from the Upper Productus Limestone of Salt Range. *Stenopora* sp. indet. (Pl. 5, Figs. 3, 4) and *Septopora* sp. indet. (Pl. 6, Fig. 8) from Bed 43 are not described herein because of poor-preservation and fragmentary nature ; the former seems to be near to *Stenopora ovata* which Waagen and Wentzel (1886) described from the Middle and Upper Productus Limestone of Salt Range and the latter is not unlike *Septopora neopavlowi* which Yang and Loo (1962) described from the Upper Permian (P_2^2) of Qilianshan, China. *Polypora transiens* WAAGEN and PICHL from Bed 19 and *Acanthocladia anceps* (SCHLOTHEIM) from Bed 20 are undoubtedly identical with those from the Spur 3 km north of Barus. *Synocladia ?* sp. (Pl. 6, Fig. 9) is only a bad oriented specimen, therefore the generic identification is questionable.

Based on the distribution of bryozoans as discussed above, the Beds 14 to 20 and also Bed 30 may be correlated with the Amarassi bed of Timor, and Bed 43 and Bed 45 to that of the Upper Productus Limestone of the Salt Range.

SPUR THREE KILOMETRES NORTH OF BARUS

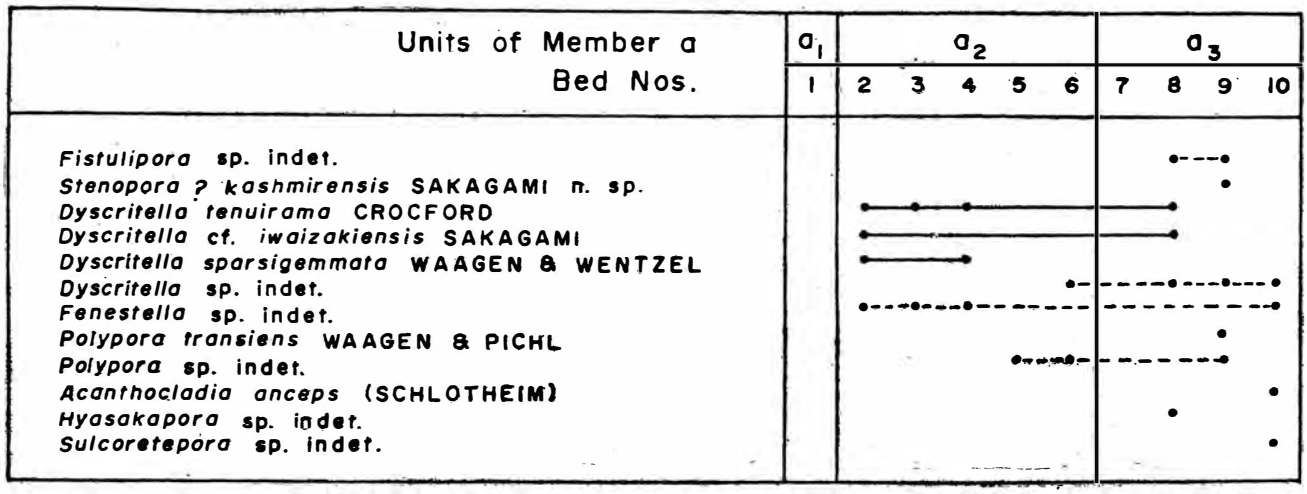
Dyscritella tenuirama CROCKFORD successively occurs from Beds 2 to 4 and Bed 8. This species was originally described from the Noonkanbah and Liveringa Formations (Artinskian to Lower Guadalupian) of Western Australia. It is also known from two areas from the formations of Penisular Thailand namely, the Khao Ta Mong Rai Limestone which is considered to be Upper Sakmarian to Lower Artinskian, and the Ko Muk Limestone which may be Upper Artinskian to Guadalupian in age. In association with *D. tenuirama*, *Dyscritella sparsigemmata* (WAAGEN and WENTZEL) is also recorded throughout the Middle and Upper Productus Limestone of the Salt Range (Beds 2 and 4). *Dyscritella* sp. cf. *D. iwaizakiensis* SAKAGAMI is almost identical with the original specimens known from the h member of the Iwaizaki Limestone in north-east Japan. The h member of the Iwazaki Limestone contains *Codonofusiella* sp., *Wentzelella prisca minor*, *Waagenophyllum* cf. *indicum*, many brachiopods, molluscs and other fossil remains and overlies the g member of the same formation yielding *Yabeina shiraiwensis* (= *Lepidolina multispetata shiraiwensis*) etc.

Stenopora ? kashmirensis SAKAGAMI, n. sp. in Bed 9 occurs also in Beds 18-3 at the Guryul Ravine. This species is similar to *Stenopora parvulipora* (BASSLER) from the Permian Amarassi bed of Timor island described by Bassler (1929). *Polypora transiens* WAAGEN and PICHL is identical with that of the original specimen described from the Middle Productus Limestone of Salt Range. *Acanthocladia anceps* (SCHLOTHEIM) is abundant in Bed 10 and has been widely known from the Permian strata of Europe and Salt Range. In Salt Range, *Acanthocladia anceps* was recorded from the Middle Productus Limestone by Waagen and Wentzel (1886).

Thus, it appears that the bryozoan fauna from Bed 2 to Bed 10 is very intimately related to that of Middle Productus Limestone of the Salt Range. The age, therefore may correspond to the Guadalupian.

TABLE 10

RANGE CHART OF THE UPPER PERMIAN BRYOZOANS IN THE SPUR THREE KILOMETRES NORTH OF BARUS



SYSTEMATIC DESCRIPTION

Family Stenoporidae WAAGEN AND WENTZEL, 1886

Genus *Stenopora* LONSDALE, 1844

Stenopora ? kashmirensis SAKAGAMI, n. sp.

PLATE 5, Figs. 6-8

Diagnosis : Ramose *Stenopora*, with cylindrical branches usually 2 to 4 mm in diameter. Monilae poorly developed in earlier part of mature wall. Acanthoecia small, abundant, arranged in one row. Diaphragm absent.

Material : Nine sections from five horizons at the Spur 3 kilometres north of Barus and the Guryul Ravine were examined.

Description : Zoaria consisting of cylindrical stems, usually 2.2 to 3.5 mm in diameter, but 4.3 mm in maximum. Zooecial wall thin in immature region becoming more rapidly thick in mature region. Zooecial apertures may be arranged without special regularities. In longitudinal section, zooecial tubes trend parallel to longitudinal direction of zoarium in immature region, curve more rapidly outward and making nearly right angle with surface. Monilae poorly developed in earlier part of mature wall but indistinct in many cases. In tangential section, the tubes elliptical and their shorter diameter 0.110 to 0.180 mm, longer one 0.180 to 0.240 mm. Length of mature tube ranging from 0.5 to 1.00 mm, but 1.3 mm in maximum length of one specimen and diameter of immature zone ranging from 0.8 to 1.5 mm, 2.00 mm in maximum. Ratio of half diameter of zoarium to thickness of mature zone varying from 1.7 : 1 to 2.2 : 1 measured on eight specimens. Mesoecia rather well developed, circular or elliptical in tangential section, varying size, their diameter ranging from 0.030 to 0.100 mm, but occassionally almost closed by tissues. Very small and abundant acanthoecia arranged in one row are observed in interzooecial tissue.

Dimensions : TABLE 11

TABLE 11

MEASUREMENTS OF *Stenopora* ? *kashmirensis* SAKAGAMI, n. sp., (in mm)

Specimen No.	A-9a GSI. 19321	A-9b	A-9c	B-14-4a
Orientation of section	L	L	Tr	L, T
Diameter of zoarium	2.9	2.5	2.4	2.6-3.1
Diameter of immature zone	1.0	0.8-0.9	1.1	1.0-1.5
Thickness of mature zone	0.9	0.6-0.9	0.6-0.7	0.6-0.8
Diameter of zooecium (shorter)	0.140-0.180	0.110-0.150	0.150	0.140-0.180
Diameter of zooecium (longer)	0.200-0.240	0.160-0.220	—	0.200-0.240
Diameter of mesoecium	0.050-0.080	0.040-0.070	—	0.050-0.080

L : Longitudinal Section Tr : Transverse Section T : Tangential Section Ob : Oblique Section

Discussions : The present form is not unlike *Stenopora parvulipora* (BASSLER) which was originally described from the Amarassi bed of Timor island. It differs only in the size of zoarium and arrangement of acanthoecia. The zoarial diameter of the present form extends from 2.2 to 4.3 mm in maximum instead of being about 2 mm as in *S. parvulipora*, and also the arrangement of acanthoecia seems to be more densely developed than that of the latter species. Because the monilae is poor or almost absent, the present species is questionably referred to the genus *Stenopora.*

Horizon and Locality : Bed 9 (Unit a_3), Member a, Zewan Formation at the Spur 3 kilometres north of Barus. Beds 14, 15 (Unit A_2), 18 (Unit A_2) and 20 (Unit A_4), Member A, Zewan Formation, Guryul Ravine.

Specimen (Slides) : GSI. Type Nos. 19320 (Paratype), 19321 (Holotype)

Genus *Stenodiscus* CROCKFORD, 1945

Stenodiscus sp. cf. *Stenodiscus chaetitiformis* (WAAGEN AND WENTZEL)

PLATE 5, Figs. 1-2

Compare :

1886. *Stenopora chaetetiformis* WAAGEN and WENTZEL, *Palaeont. Indica,* Ser, 13, Vol. 1, Pt, 6, p. 890-891, Pl. CXI, Figs. 1-2.

Material : A single transverse section and some fragmentary tangential sections were examined.

Description : Zoarium consisting of a cylindrical stem, 6 mm in diameter. No surface specimen could be examined, but the tangential section suggests that zooecial apertures are arranged without any special regularities. Zooecial tubes may be gradually curved outward. Length of mature tube rather short for zoarial diameter, 0.50 to 0.75 mm. Ratio of half diameter of zoarium to length of mature zone ranging from 6 : 1 to 4 : 1. Zooecial wall thin in immature

TABLE 11—*contd.*

B-14-6a	B-15-1a	B-18-3b	B-18-3c GSI. 19320	B-20-4-1a
Tr	Tr	Ob	Ob	L
4.3	3.5	2.6	2.2	3.0
2.0	1.5	?	?	1.5
1.0-1.3	0.8-1.0	?	ca. 0.5	0.7-0.8
0.150-0.180	0.150-0.180	0.110-0.150	ca. 0.170	0.120-0.150
—	—	—	—	0.180-0.220
?	?	0.050-0.080	0.050-0.100	0.030-0.100

region and rather rapidly thickening to posterior end of mature wall. Monila well developed throughout mature wall. Very thin diaphragm scarcely present. In tangential section, zooecial tube nearly circular or elliptical with irregular margin in some cases, shorter diameter 0.140 to 0.200 mm, longer one 0.180 to 0.250 mm, 7 to 8 zooecia per 2 mm diagonally. Mesoecia commonly developed, acanthoecia disposed in interzooecial tissue, but most of them obscured by secondary mineralization. Outside diameter of acanthoecium ranges from 0.020 to 0.030 mm.

Dimensions : TABLE 12

TABLE 12

MEASUREMETS OF *Stonodiscus* cf. *chaetetiformis* { WAAGEN AND WENTZEL } (in mm)

Specimen No.	B-43-2	B-43-3 GSI. 19315	B-43-9a GSI. 19316	B-45-2a
Orientation of section	T	T	Tr	T
Diameter of zoarium	—	—	6.0	—
Diameter of immature zone	—	—	ca. 4.8	—
Thickness of mature zone	—	—	0.50-0.75	—
Diameter of zooecium (shorter)	0.140-0.180	0.150-0.200	0.140-200	0.160-0.200
Diameter of zooecium (longer)	—	0.180-0.250	—	0.200-0.250
Diameter of mesoecium	ca. 0.050	0.040-0.060	—	0.060-0.080
Diameter of acanthoecium (inner)	?	?	—	?
Diameter of acanthoecium (outer)	ca. 0.030	ca. 0.020	—	0.020-0.030
No. of zooecia per 2 mm longitudinally	7-8	7-8	—	7-8

T : Tangential Section Tr : Transverse Section

Remarks : In spite of the highly mineralised conditions of the specimens, they can easily be identified as *Stenodiscus chaetetiformis* (WAAGEN and WENTZEL) which was described from the Upper Productus Limestone of Khund Ghat and Jabi in Salt Range, occurring above the Cephalopod bed. Judging from Waagen and Wentzel's (1886) description, the present form shows a slight difference from *S. chaetetiformis*, in having the shorter zooecial diameter.

Since the diaphragm is distinctly present (not scarcely developed) in this species it is better to be included within the Genus *Stenodiscus*. The specimen from Bed 45 (Member D) although small and fragmentary in the tangential section, still it can easily be referred to the present species. It has all the essential characters.

Horizon and Locality : Bed Nos. 43 and 45, Member D, Zewan Formation at the Guryul Ravine.

Specimen (Slide) : GSI. Type Nos. 19315, 19316

Genus *Dyscritella* GIRTY, 1911

Dyscritella tenuirama CROCKFORD

PLATE 4, Figs. 5-9

1957. *Dyscritella tenuirama* CROCKFORD, *Bur. Min. Res. Geol. Geoph., Australia, Bull.*, No. 34, p. 52-53, Pl. 13, Figs. 1-2.

1968. *Dyscritella tenuirama*, SAKAGAMI, *Geol. Paleont. S. E. Asia*, Vol. 5, p. 54-55, Pl. 8, Figs. 4-8.

1970. *Dyscritella* cf. *tenuirama*, SAKAGAMI, *Geol. Paleont. S. E. Asia*, Vol. 8, p. 50-51, Pl. 7, Fig. 7.

Material : Eleven thin sections were examined.

Description : Zoarium a cylindrical stem, 1.3 to 1.9 mm in diameter. Zooecial tubes trend parallel to longitudinal direction of zoarium in immature region, curve gradually outward and making nearly right angle with surface. Thickness of mature zone usually 0.40 to 0.50 mm. Ratio of half diameter of zoarium to thickness of mature zone varying from 1.6 : 1 to 3.0 : 1 measured in nine specimens. Zooecial wall thin in immature region, gradually, thickening to mature wall. Zooecial tube elliptical in tangential section, shorter diameter 0.126 mm in average, ranging from 0.110 to 0.150 mm ; longer diameter 0.190 mm in average, ranging from 0.140 to 0.250 mm. Mesoecia sparsely developed, their diameter ranging from 0.030 to 0.100 mm. Well developed acanthoecia disposed usually at each point of intersection of zooecial tube, surrounded by concentric tissue, outside diameter near surface ranging from 0.050 to 0.100 mm and inside diameter less than 0.010 mm.

Dimensions : TABLE 13

TABLE 13

MEASUREMENTS OF *Dyscritella tenuirama* CROCKFORD (in mm)

Specimen No.	A-2b	A-2c	A-2d	A-2e GSI. 19310	A-3top-a GSI. 19308	A-3top-b
Orientation of section	L	Ob	Tr	Ob	L	Tr
Diameter of zoarium	1.9	1.8	1.3	1.3	1.5	1.9
Diameter of immature zone	ca.1.0	—	—	—	ca. 0.70	ca. 1.1
Thickness of mature zone	0.40-0.45	ca. 0.50	—	—	ca. 0.40	ca. 0.4
Diameter of zooecium (shorter)	0.110-0.150	—	0.130-0.150	0.110-0.140	0.110-0.140	0.110-0.140
Diameter of zooecium (longer)	0.200-0.250	—	—	0.150-0.170	0.180-0.230	—
Diameter of mesoecium	0.100	—	—	ca. 0.050	0.030-0.040	?
Diameter of acanthoecium (inner)	ca.0.010	—	—	?	less than 0.010	—
Diameter of acanthoecium (outer)	0.050-0.100	—	—	0.050-0.090	0.050-0.100	—

L : Longitudinal Section, Ob : Oblique Section, Tr : Transverse Section

Remarks : The specimens or the present species were originally described by Crockford (1957) from the Noonkanbah and Liveringa Formations of Western Australia. In the present collection, they have most common vertical and lateral distribution. There is a considerable variation in the zoarial diameter ; ranging from 1.3 to 1.9 mm. The inner structures, however cannot be distinguished entirely with each others. The present specimens agree with Crockford's description and figures of the species.

Horizon and Locality : Beds 2, 3, 4 (Unit a_2), 8 (Unit a_3), Member a, Zewan Formation at the Spur 3 kilometres north of Barus. Beds 14, 15 (Unit A_1), Bed 20 (Unit A_4), of Member A and Bed 45 of Member D, Zewan Formation at the Guryul Ravine.

Specimen (Slide) : GSI. Type Nos. 19308, 19309, 19310, 19311

Dyscritella sp. cf. *Dyscritella iwaizakiensis* SAKAGAMI

PLATE 4, Figs. 11-12

Compare :

1961. *Dyscritella iwaizakiensis* SAKAGAMI, *Palaeont. Soc. Japan*, Spec. Papers No. 7. p. 28-29, Pl. 11, Figs. 1-4 ; Pl. 12, Figs. 1-2 ; Pl. 13, Figs. 1-2.

Material : Three oblique sections were examined.

Description : Zoarium a cylindrical stem, 2.4 to 3.1 mm in diameter. Zooecial tubes curved gradually outward from the immature to mature regions. Thickness of mature zone 0.8 to 0.9 mm and ratio of half diameter of zoarium to thickness of mature zone 1.5 : 1 to 2.0 : 1. Zooecial wall is thin in immature region, becoming gradually thick in mature region. Zooecial tube elliptical in tangential section, 0.130 to 0.180 mm in shorter diameter. Mesoecia seem to be rarely developed, elliptical in tangential section and its shorter diameter 0.030 to 0.080 mm. Well developed acanthoecia disposed usually at each point of intersection of zooecial tube, surrounded by concentric fibrous tissue, outside less than 0.010 mm.

TABLE 13—(*Contd.*)

A-4b GSI. 19311	A-8-3a	A-8-3b	B-14-la	B-15a	B-20a	B-45-4a GSI. 19309
Tr	Ob	L	L	L	Tr	L
1.3	1.8	1.6	1.3	1.5	1.8	1.3
0.75	0.6	0.6	0.7	0.7	0.6	0.5
—	ca. 0.6	0.5	0.3	0.4	0.5	0.3-0.4
—	0.110-0.150	0.110?	ca. 0.110	0.110-0.150	0.110-0.150	0.100-0.140
—	0.140-0.170	0.200?	ca. 0.200	0.180-0.200	—	ca. 0.200
—	0.050	?	?	0.050	0.050-0.080	rarely obs.
—	0.010	?	0.010	0.010	—	less than 0.010
—	0.050	?	0.070	0.050-0.070	—	ca. 0.060

Dimensions : TABLE 14

TABLE 14

MEASUREMETS OF *Dyscritella iwaizakiensis* SAKAGAMI (in mm)

Specimen No.	A-2a GSI. 19314	A-8 GSI. 19313	A-8-4
Orientation of section	Ob, L	Ob	Ob
Diameter of zoarium	2.4	3.0	3.1
Diameter of immature zone	ca. 1.0	0.9	1.3
Thickness of mature zone	ca. 0.8	0.9-1.0	0.8-0.9
Diameter of zooecium (shorter)	0.110-0.140	0.150-0.180	0.130-0.160
Diameter of zooecium (longer)	0.150-0.200	?	?
Diameter of mesoecium	0.030-0.050	0.040-0.080	0.040-0.070
Diameter of acanthoeciumn (inner)	ca. 0.010	less than 0.010	less than 0.010
Diameter of acanthoecium (outer)	0.050-0.080	ca. 0.060	0.050-0.070
No. of acanthopores surrounding zooecial aperture	?	5-6	4-5

Ob : Oblique Section, L : Longitudinal Section

Remarks : Dyscritella iwaizakiensis was described originally from the h member of the Iwaizaki Limestone, Japan. This species is nearest to *Dyscritella tenuirama* CROCKFORD in the essential characters, however, it can be distinguished from the latter species by the larger diameter of zoarium.

Horizon and Locality : Bed 2 (Unit a_2) and Bed 8 (Unit a_3), Member a, Zewan Formation at the Spur 3 kilometres north of Barus.

Specimen (Slide) : GSI. Type Nos. 19313, 19314

Dyscritella sparsigemmata (WAAGEN AND WENTZEL)

PLATE 5, Fig. 5

1886. *Geinitzella columnaris* var. *ramosa sparsigemmata* WAAGEN and WENTZEL, *Paleont. Indica,* Ser. 13, Vol. 1, Pt. 6, p. 883, Pl. 112, Figs. 1 a-d, 4 ; Pl. 113, Figs. 1 a-e.

1894. *Geinitzella columnaris* var. *ramosa sparsigemmata*, NETSCHAJEW, *Soc. Nat. Kazan, Mem.*, 34, Pt. 6, p. 112, Pl. 1, Fig. 21.

1895. *Geinitzella columnaris* var. *ramosa sparsigemmata*, STUCKENBERG, *Com. Geol. Mem.*, Vol. 10, Pt. 3, p. 229, Pl. 24, Fig 9.

Material : One transverse and one oblique sections were examined.

Description : Zoaria probably cylindrical stems, about 4.0 and 3.8 mm respectively in diamater. Mature zone of tube about 1.2 to 1.5 mm long. Ratio of half diameter of zoarium to thickness of mature zone 1.3 : 1 to 1.6 : 1. Zooecial wall thin in immature region and thickening rapidly to posterior end of mature wall. In tangential section, zooecial tubes usually elliptical, but irregularly rounded near surface, their shorter diameter of zooecial tube ranging from 0.150 to 0.220 mm. Mesoecium commonly developed and variable in form and size.

Acanthoecia well developed, surrounded by thick concentric fibrous tissue, their inner diameter ranging from 0.015 to 0.025 mm and outer one ranging from 0.080 to 0.100 mm.

Dimensions : TABLE 15

TABLE 15

MEASUREMENTS OF *Dyscritella sparsigemmata* (WAAGEN AND WENTZEL) (in mm)

Specimen No.	A-2-1	A-4'a GSI. 19319
Orientation of section	Ob	Tr
Diameter of zoarium	4.0	3.8
Diameter of immature zone	1.3	ca.1.7
Thickness of mature zone	1.2-1.5	1.2-1.5
Diameter of zooecium (shorter)	0.150-0.200	0.180-0.220
Diameter of mesoecium	ca. 0.080	?
Diameter of aconthoecium (inner)	0.015-0.025	?
Diameter of acanthoecium (outer)	0.080-0.100	?
No. of acanthopores surrounding zooecial aperture	5-7	?

Ob : Oblique Section Tr : Transverse Section

Remarks : The present specimens are quite identical with *Dyscritella sparsigemmata* in all the essential characters, which Waagen and Wentzel (1886) described originally under the name of *Geinitzella columnaris* var. *ramosa sparsigemmata* from some localities in the Salt Range. The Salt Range specimens are known from the Middle to Upper Productus Limestone. The present species differs from *Dyscritella tenuirama* by the larger diameter of zoarium and irregularly rounded zooecial form in the tangential section near surface.

Horizon and Locality : Bed 2 and Bed 4 of Unit a_1, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.

Specimen (Slide) : GSI. Type No. 19319

Family Rhabdomesidae VINE, 1883

Genus *Streblascopora* BASSLER, 1952

Streblascopora sp. cf. *Streblascopora fasciculata* (BASSLER)

PLATE 4, Fig. 10

Compare :

1929. *Streblotrypa fasciulata* BASSLER, *Palaeont. Timor*, Vol. 16, Pt. 28, p. 66, Pl. 229 (15), Figs. 4-5.

1952. *Streblascopora fasciculata* BASSLER, *Jour. Washington Acad. Sci.*, Vol. 42, Pt. 12, p. 358 (as the genotype newly established).

1965. *Streblascopora fasciculata,* SHISHOVA, *Paleont. Zyr.*, No. 2, p. 58-59, Pl. 6, Fig. 2.

1970. *Streblascopra fasciculata,* MOROZOVA, *Akad. Nauk, USSR,* No. 122, p. 150-151, Pl. 27, Fig. 3.

Material : A single obliquely transverse section was examined.

Description : Zoarium 1.3 mm in diameter, central bundle 0.45 mm in diameter and ratio of zoarial diameter to central bundle 2.9 : 1. Zooecial tube probably nearly straight in inner region, bends outward rapidly at posterior end of outer region of tube. Length of outer region of tube about 0.25 mm. Number of tubes in central bundle about 6, measured in longitudinal section. Shorter diameter of zooecial tube ranging from 0.110 to 0.120 mm. Mesoecia arise from base of mature wall, usually arranged in 2 rows longitudinally. Diameter of mesoecia ranging from 0.030 to 0.040 mm. Diaphragm not observed.

Dimensions : TABLE 16

TABLE 16

MEASUREMENT OF *Streblascopora* Cf. *fasciculata* (BASSLER) (in mm)

Specimen No.	B-18-3a GSI. 19312
Orientation of zoarium	Ob
Diameter of zoarium	1.3
Diameter of central bundle	0.45
Angle of zooecial tubes to central bundle	?
No. of tubes in central bundle in long section	ca. 6
Thickness of outer region	ca. 0.25
Diameter of zooecium (shorter)	0.110-0.120
Diameter of zooecium (longer)	?
Outside diameter of mesoecium	0.030-0.040

Ob : Oblique Section

Remarks : In spite of the single oblique section, the present form may be identified with *Streblascopora fasciculata* (BASSLER) which was originally described from the Upper Permian (Lower to Upper Guadalupian) of Timor, and also recently reported from Russian Platform and Trans-Caucasia.

Horizon and Locality : Bed 18, Unit A_2, Member A, Zewan Formation, Guryul Ravine.

Specimen (Slide) : GSI. Type No. 19312

Genus *Hayasakapora* SAKAGAMI, 1960

Hayasakapora grossa SAKAGAMI, n.sp.

PLATE 6, Figs. 1-2.

TABLE 17

MEASUREMENTS OF *Hayasakapora grossa* SAKAGAMI, n. sp. (in mm)

Specimen No.	B-43-4a	B-43-5a	B-43-7a GSI. 19323 (Holotype)	B-43-9a	B-43-9b GSI. 19324 (Paratype)
Orientation of zoarium	L	L	L	Tr	Tr
Diameter of zoarium	2.5	ca. 2.0	2.8	2.5	2.0-2.2
Diameter of zooecium (shorter)	0.120-0.130	0.130-0.160	0.150-0.200	0.150	0.120-0.150

L : Longitudinal Section, Ob : Oblique Section, Tr : Transverse Section.

Diagnosis : Ramose *Hayasakapora*, with cylindrical branches, 2 to 3 mm in diameter. Zooecial tubes arise radially at nearly right angle from a linear axis. Interzooecial tissue consisting of rather coarse, numerous pores arranged parallel to zooecial tubes.

Material : About 10 thin sections of zoaria were examined.

Description : Zoarium a cylindrical stem, no branched part observed. Diameter of zoarium ranging from 2.0 to 3.0 mm. Zooecial tube circular in tangential section, ranging from 0.120 to 0.200 mm, arises radially at nearly right angle from a linear axis in longitudinal section. Zooecial aperture seems to be regularly arranged longitudinally, intersecting rows, and surrounded by dense fibrous tissues consisting of rather coarse, numerous pores arranged parallel to zooecial tubes. Mesoecia not observed. Acanthopore-like small pores distributed at zooecial circumference but in many cases not observed.

Dimensions : TABLE 17

Remarks : The present form is similar to *Hayasakapora gracilis*, which Morozova (1966, 1970) described from the Osakhtinsky Formation (Upper Permian) of Khabarovsk kray, Siberia. It agrees in all the essential characters, however, the present form can be distinguished from the Russian form by the larger diameter of zoarium and zooecial tube.

Horizon and Locality : Beds 43 and 45 of Member D, Zewan Formation, Guryul Ravine.

Specimen (Slide) : GSI. Type Nos. 19323 (Holotype), 19324 (Paratype)

Family Fenestellidae KING, 1850

Genus *Polypora* M'COY, 1844

Polypora transiens WAAGEN AND PICHL

PLATE 6, Figs. 11-12

1885. *Polypora transiens* WAAGEN and PICHL, *Paleont. Indica*, Ser. 13, Vol. 1, Pt. 5, p. 795-796, Pl. 91, Figs. 3-5.

Material : Two tangential sections made out of one surface specimen, about 8 cm long and 5 cm wide from Guryul Ravine and a single fragmentary section from the Spur 3 kilometres north of Barus were examined.

Description : Width of branch 1.3 to 1.5 mm and about 5 to 5.5 per 10 mm in horizontal direction. Fenestrule elongately elliptical, the width about 0.5 mm and interval between dissepiments 1.4 to 1.8 mm in thin section of Guryul Ravine specimen. Dissepiments very short and the width about the same as that of branch. Zooecial tubes of both sides of branches strongly project into the dissepiments, so that in some cases the dissepiments are observed to

TABLE 17—(*Contd.*)

B-43-12	B-43-13	B-43-14a	B-43-14b	B-54-4b
L	L	Ob	Ob	L
2.5	3.0	2.7	?	2.0
0.120-0.150	0.150-0.180	?	0.140-0.200	0.120-0.150

be almost occupied by zooecial apertures in the upper level of tangential section. Zooecial tubes circular in tengential section near surface, usually rhomboidal at middle level of branch, and regularly arranged in alternating longitudinal series, usually 8 rows of each branch, but just after bifurcation 5 rows, 15 to 18 per 5 mm length of one row. Diameter of zooecial tube about 0.140 mm at upper level of branch, distance between zooecial apertures from centre about 0.300 to 0.380 mm measured along longitudinal row. Stereom covering reverse side of branch divided into two layers, the inner translucent coarse fibrous tissue and outer dark fibrous tissue with regularly arranged large conspicuous capillaries.

Dimensions : TABLE 18

TABLE 18

MEASUREMENTS OF *Polypora transiens* WAAGEN AND PICHL (in mm)

Specimen No.	A-9c GSI. 19334	B-19 GSI. 19333
	L	L
No. of branches per 10 mm horizontally	ca. 5 ?	5-5.5
No. of fenestrules per 10 mm length	?	3.5
No. of zooecia per 5 mm length	ca. 16-18	15-18
No. of rows of zooecia	usually 8	7-8
No. of zooecia per fenestrule	?	ca. 8
Width of branch (normal)	1.5	1.3-1.5
Width of fenestrule	0.7-0.8	ca. 0.5
Length of fenestrule	?	1.4-1.8
Width of dissepiment	0.9-1.0	ca. 1.2-1.5
Diameter of zooecia near surface	ca. 0.140	0.140-0.150
Distance between zooecia (centre to centre)	ca. 0.350	0.300-0.380

L : Longitudinal Section

Remarks : In the present specimen, the width of branch, number of zooecial rows in a branch and other essential characters agree with that of *Polypora transiens* which Waagen and Pichl (1885) described originally from the Middle Productus Limestone of the Salt Range, Pakistan. The very short and wide dissepiment may also be the conspicuous character of this species. However, the slight differences between the present specimen with that of Salt Range specimens are recognised as regard to the size and form of fenestrule. The fenestrule of the present form is smaller than that of the latter species.

Horizon and Locality : Bed 9, Unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus. Bed 19, Unit A_2, Member A, Zewan Formation, at the Guryul Ravine.

Specimen : GSI. Type Nos. 19333, 19334

Family Acanthocladiidae ZITTEL, 1880

Genus *Acanthocladia* KING, 1849

Acanthocladia anceps (SCHLOTHEIM)

PLATE 6, Figs. 5-7

1885. *Acanthocladia anceps* WAAGEN and PICHL, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 5, p. 812—814, Pl. 94, Figs. 1-3.

1930. *Acanthocladia anceps*, KORN, *K. Deusch. Naturforscher zu Halle, Nova Acta Leopoldina*, Vol. 6, p. 369, Pl. 4, Figs. 8-10.

1961. *Acanthocladia anceps*, DREYER, *Freiberger Fos. Sond.*, Heft C 111, p. 21-22, Pl. 9, Figs. 2-5.

Material : Many free specimens were obtained from the limestone by acid treatment. Two tangential sections were also examined.

Description : Zoarium consisting of pinnate, straight main branch and short lateral branches. Main branch ranging from 0.75 to 1.25 mm in width. Width of lateral branches narrower than that of main branch, ranging from 0.50 to 0.75 mm, extending alternately at an angle of 65 to 90 degree and at intervals of 0.35 to 0.65 mm, with 4 to 5 branches per 5 mm length of main branch. Zooecial tubes arranged in 3 longitudinal rows, not intersection throughout upper to lower levels of the main branch in tangential section, elliptical to oval at upper level, but elongated tetragonal or hexagonal at middle to lower levels. At upper level of branch of tangential section, shorter diameter of zooecial tube 0.080 to 0.090 mm, about 17 to 20 apertures per 5 mm length of one row and 5 per interval between lateral branches. Interspaces between zooecial appertures from centre about 0.250 to 0.350 mm longitudinally. Stereom covering reverse side of branch consisting of an inner light coloured tissue with fine striations and outer dark coloured coarser fibrous tissues with many fine granuless.

Dimensions : TABLE 19

TABLE 19

MEASUREMENTS OF *Acanthocladia anceps* (SCHLOTHEIM) (in mm)

Specimen No.	A-10b GSI. 19327, 19328	A-20-2 GSI. 19329
	T	T
No. of lateral branches in 5 mm of main branch	4-5	4
No. of zooecia per interval between lateral branches	4	4
No. of zooecia in 5 mm of main branches	20	17
No. of rows of zooecia	3	3
Intervals between lateral branches	ca. 0.5	ca. 0.5
Width of main branch	ca. 0.9	ca. 1.0
Width of lateral branch	ca. 0.7	ca. 0.6-0.7
Shorter diameter of zooecial aperture	0.080-0.090	0.080-0.090
Distance between zooecial apertures (centre to centre)	0.250-0.300	0.250-0.350
Angle between lateral branches and main branch	80°-90°	65°-80°

T : Tangential Section

Remarks : Since Schlotheim's description of the present species, it has also been reported from some localities in Europe and the Salt Range. Unfortunately, the author could not consult the original description and some other literature on the present species. However, the present form can safely be identified as *Acanthocladia anceps*, which was described from the middle part of the Middle Productus Limestone by Waagen and Pichl (1885).

Horizon and Locality : Bed 10, Unit a_3, Member a, Zewan Formation, Spur 3 kilometres north of Barus. Bed 20, Unit A_4, Member A, Zewan Formation, Guryul Ravine.

Specimen (Slide) : GSI. Type Nos. 19327, 19328, 19329

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PLATE 4

Fig. 1 *Fistulipora* sp. indet.

Longitudinal section. ×20. Bed 8, Unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19304.

Figs. 2-4 *Dyscritella* sp. indet.

Surface specimen. ×5. Bed 10, Unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type Nos. 19305, 19306, 19307.

Figs. 5-9 *Dyscritella tenuirama* CROCKFORD.

5. Typical longitudinal section. ×20. Bed 3, Unit a_2, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19308.

6. Longitudinal section. ×20. Bed 45, Member D, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19309.

7, 8. Longitudinal sections of the same zoarium. ×20. 7. from bed 2 (GSI. 19308) and 8. (GSI. 19310) from bed 3, unit a_2, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type Nos. 19308, 19310.

9. Obliquely transverse section. ×20. Bed 4, unit a_2, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19311.

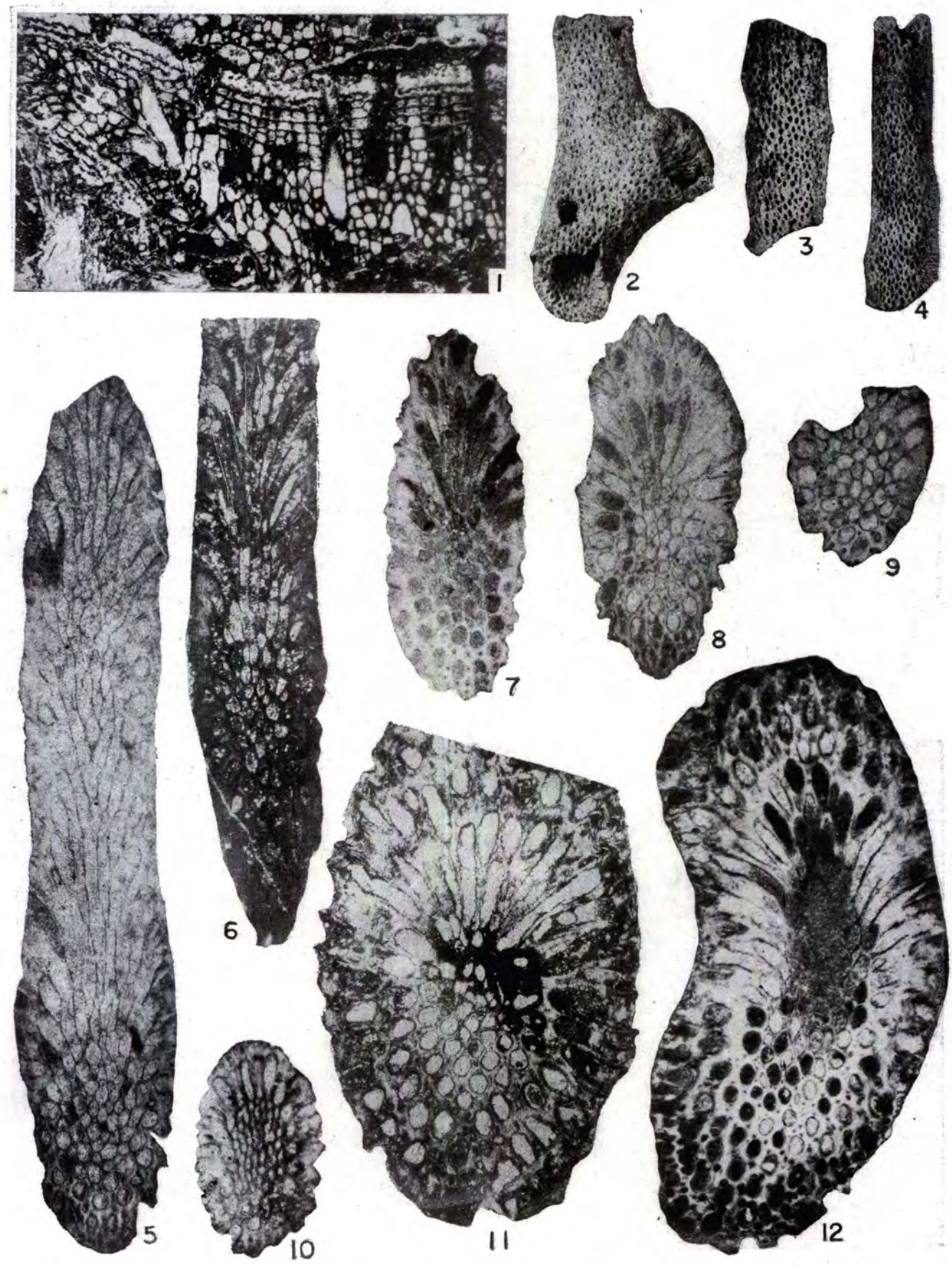
Fig. 10 *Streblascopora* sp. cf. *S. fasciculata* (BASSLER).

Oblique section. ×20. Bed 18, Unit A_2, Member A, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19312.

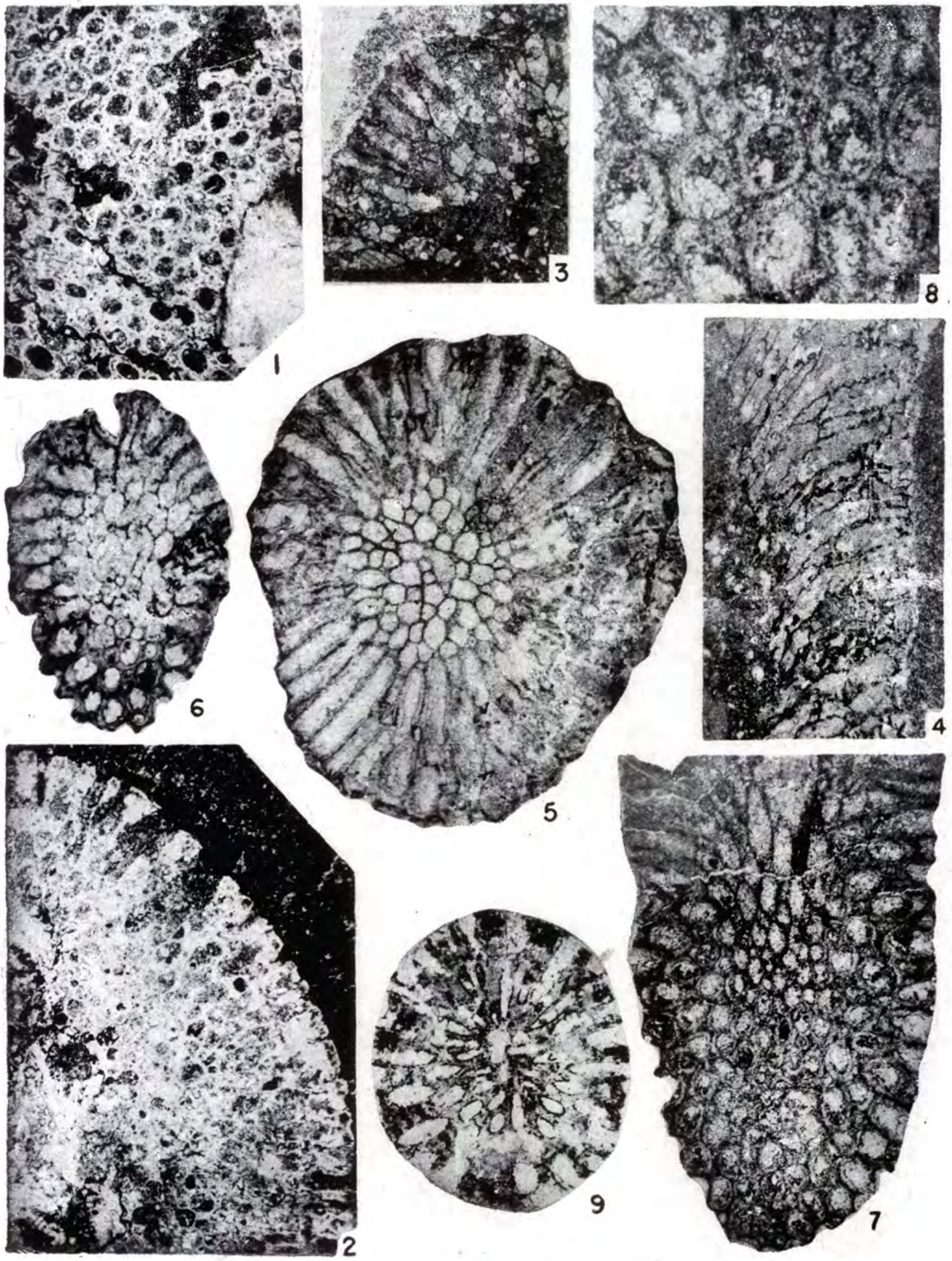
Figs. 11-12 *Dyscritella* sp. cf. *D. iwaizakiensis* SAKAGAMI.

11. Oblique section. ×20. Bed 8, unit a_3, Member a, Zewan Formation at the Spur 3 kilometers north of Barus.
GSI. Type No. 19313.

12. Obliquely longitudinal section. ×20. Bed 2, unit a_2, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19314.



SAKAGAMI : Upper Permian Bryozoans from Kashmir



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PLATE 5

Figs. 1-2 *Stenodiscus* sp. cf. *S. chaetetiformis* (WAAGEN and WENTZEL).

1. Tangential section. ×20. 2. Transverse section. ×20. Bed 43, Member D, Zewan Formation at the Guryul Ravine.
GSI. Type Nos. 19315, 19316.

Figs. 3-4 *Stenopora* sp. indet.

3. Transverse section. ×20. 4. Longitudinal section. ×20. Both the inner parts are obliterated. Bed 43, Member D, Zewan Formation at the Guryul Ravine.
GSI. Type Nos, 19317, 19318.

Fig. 5 *Dyscritella sparsigemmata* (WAAGEN AND WENTZEL).

Transverse section. ×20. Bed 4, unit a_2, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19319.

Figs. 6-8 *Stenopora ? kashmirensis* (SAKAGAMI) n. sp.

6. Oblique section, (paratype) ×20. Bed 18, unit A_2, Member A, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19320.

7. Obliquely longitudinal section. ×20. (Holotype).
GSI. Type No. (Holotype) 19321.

8. Enlarged tangential section (part of Fig. 7). ×60.

Fig. 9 *Hayasakapora* sp. indet.

Transverse section. ×20. Bed 30, Member C, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19322.

PLATE 6

Figs. 1-2 *Hayasakapora grossa* SAKAGAMI n. sp.

1. Longitudinal section, (Holotype). ×20. Bed 43, Member D, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19323 (Holotype).

2. Transverse section just after branched. ×20 (Paratype). Bed 45, Member D, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19324 (Paratype).

Figs. 3-4 *Fenestella* sp. indet.

3, 4. Surface specimens. ×5. Bed 10, unit a_3, Member a, Zewan Formation, at the Spur 3 kilometres north of Barus.
GSI. Type Nos. 19325, 19326.

Figs. 5-7 *Acanthocladia anceps* (SCHLOTHEIM).

5, 6. Surface specimens. ×5. Bed 10, unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type Nos. 19327, 19328.

7. Tangential section. ×20. Bed 20, unit A_4, Member A, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19329.

Fig. 8 *Septopora* sp. indet.

Tangential section. ×20. Bed 43, Member D, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19330.

Fig. 9 *Synocladia ?* sp. indet.

Tangential section. ×20. Bed 20, unit A_4, Member A, Zewan Formation at the Guryul Ravine.
GSI. Type No. 19331.

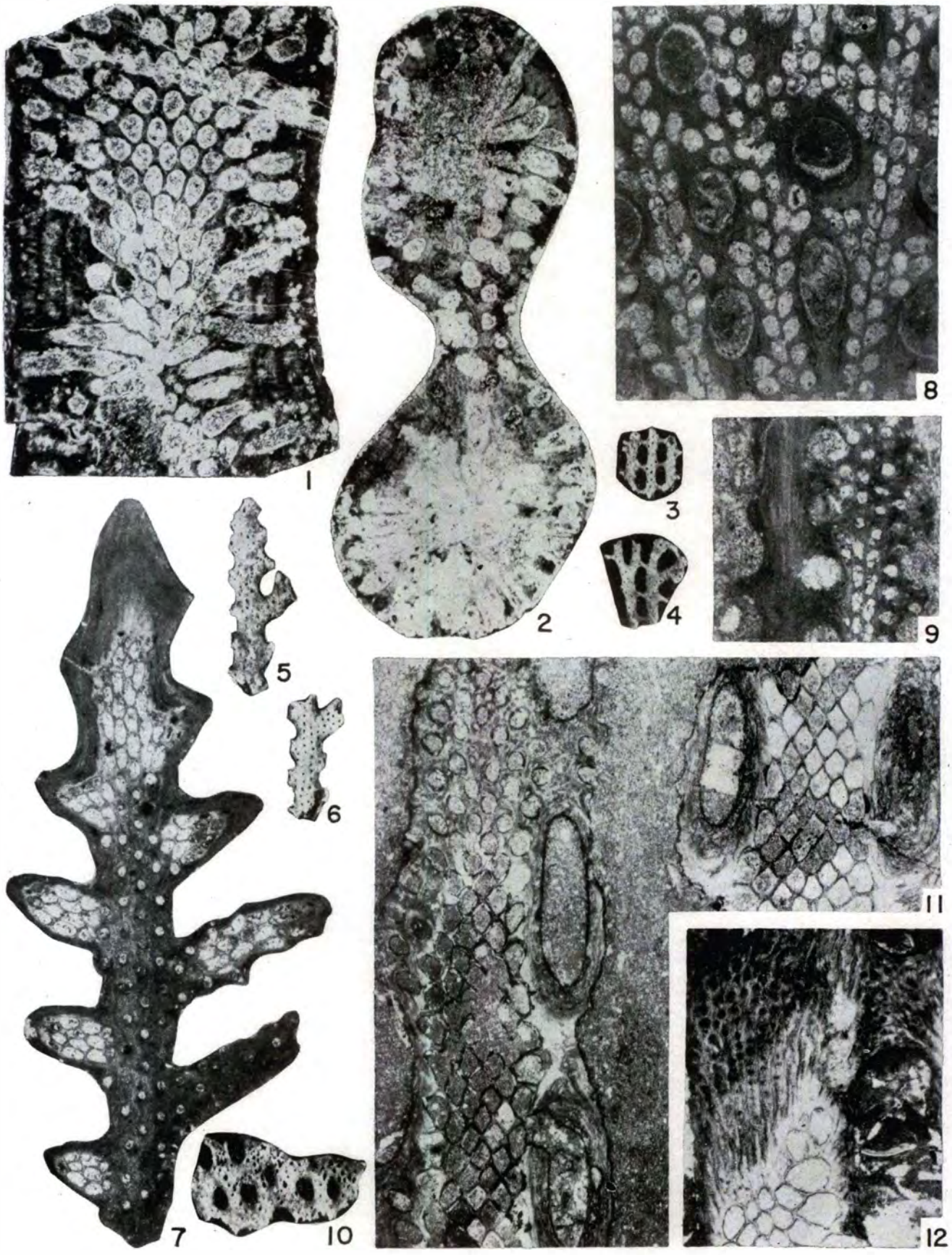
Fig. 10 *Polypora* sp. indet.

Surface specimen. ×5. Bed 10, unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19332.

Figs. 11-12 *Polypora transiens* WAAGEN AND PICHL.

11. Tangential section. ×20. Bed 19, unit A_2, Member A, Zewan Formation of the Guryul Ravine.
GSI. Type No. 19333.

12. A part of tangential section showing the internal structure of stereom. ×20. Bed 9, unit a_3, Member a, Zewan Formation at the Spur 3 kilometres north of Barus.
GSI. Type No. 19334.



SAKAGAMI : Upper Permian Bryozoans from Kashmir

BRACHIOPODA

UPPER PERMIAN BRACHIOPOD FOSSILS FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

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UPPER PERMIAN BRACHIOPOD FOSSILS FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

INTRODUCTION

Brachiopod fauna of the Zewan Formation of Kashmir has been described earlier by Davidson (1862), Verneuil (1867) and Diener (1899, 1915). The present article however, describes only those brachiopods, which were collected by the author and other members of the Indo-Japanese team working on the Permo-Triassic boundary problems in the Kashmir region. The material includes collections made between 1969 and 1972 by the survey party, from the Zewan Formation and the Khunamuh Formation at the Guryul Ravine and the Spur 3 kilometres north of Barus.

Distribution of different brachiopods in Zewan Formation and the Khunamuh Formation at the Guryul Ravine and the Spur three kilometres north of Barus is given in Table 20 and Table 21. The preservation of brachiopod fossils in the limestones of the Zewan Formation is fairly good and in other rocks it is poor to very poor.

FAUNAL CONSIDERATION

Brachiopods are, in general, distributed throughout the Zewan Formation as well as the basal member of the Khunamuh Formation, occurring both in Guryul Ravine and the Spur 3 kilometres north of Barus.

The Khunamuh Formation, of which the major part is Lower Triassic, however, includes in its basal units namely E_1 (Member E, Guryul Ravine) and f_2 (Member f, 3 kilometres north of Barus), a number of species of Permian type of brachiopods. These units are rich in brachiopod fauna.

TABLE 20

RANGE CHART OF THE UPPER PERMIAN BRACHIOPODS IN THE GURYUL RAVINE

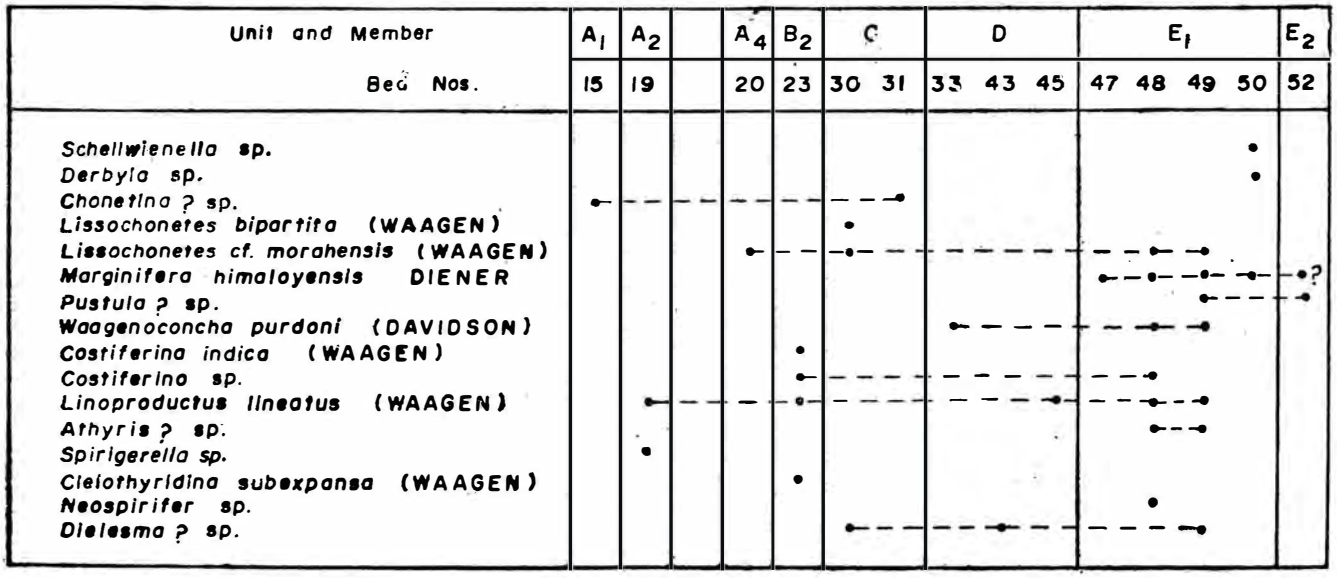


TABLE 21

RANGE CHART OF THE UPPER PERMIAN BRACHIOPODS IN THE SPUR THREE KILOMETRES NORTH OF BARUS

Unit and Member	b_1	b_2	c_1		e	
Bed Nos.	18	19	20		30	30
Lissochonetes bipartita (WAAGEN)					•	
Marginifera himalayensis (DIENER)		•				
Waagenoconcha abichi (WAAGEN)		•				
Wellerella sp.						•
Costiferina indica (WAAGEN)		•				
Costiferina sp.			•			
Spiriferella rajah (SALTER)	•----	-•				
Neospirifer musakheylensis (DAVIDSON)	•					
Dielesma? sp.						•

The *Otoceras* layer (Bed 52, Unit E_2, Guryul Ravine) of the Khunamuh Formation has yielded two brachiopods viz. *Pustula* ? sp. and *Marginifera himalayensis* (Nakazawa et al., 1975). The latter species has been lost in transportation. This was a fragmentary specimen. *Pustula* ? sp. is also solitary, fragmentary specimen and probably found due to reworking from Permian strata into this bed. In general *Otoceras* bed is rare in brachiopods.

The brachiopods of Unit E_1 (of the Guryul Ravine) and f_1 (at the Spur 3 kilometres north of Barus) are important, as they are significant in deciding the boundary between Permian and Triassic. Nakazawa et al. (1970) tentatively included this unit in Lower Triassic but later in 1975, they (Nakazawa et al., 1975) suggested it to be latest Permian. The brachiopods of this unit show reduction in their size (dwarf), perhaps due to quick environmental changes through which they have undergone at the time of Permian to Triassic turnover. Such dwarfing of brachiopods has also been noticed earlier in the Upper Permian Maizuru Group of Japan (Shimizu, 1961) and in the Upper Dzhulfian of Iran.

The Late Permian Zewan Formation is dominated by brachiopod fauna, represented by 18 species in the present collection.

The brachiopod faunas of Guryul Ravine and the Spur 3 kilometres north of Barus, are in general similar and have only slight differences. The following species found in the present collection from the Guryul Ravine are, absent in the collection from that of the Spur 3 kilometres north of Barus.

Chonetina ? sp., *Lissochonetes* cf. *morahensis, Linoproductus lineatus, Cleiothyridina* cf. *subexpansa, Sprigerella* sp., *Lissochonetes bipartita* and *Waagenoconcha purdoni.*

On the other hand, the following species could not be seen in the present collection of the Guryul Ravine and are present in the Spur three kilometres north of Barus:

Marginifera himalayensis, Waagenoconcha abichi, Neospirifer musakheylensis, Spiriferella rajah and *Dielasma ?* sp.

The brachiopod fauna of the Zewan Formation does not appear to be suitable for subdivisions of the formation. The species of the brachiopods are irregularly distributed both in space and time ; the different brachiopod layers are repeated several times and one fossil layer at one section does not have coincidence with the other section. Diener (1915) already felt this irregularity in distribution of the brachiopod fauna in the Zewan Formation and pointed out that different horizons made by Middlemiss (1910) are very closely related to each other and the Zewan beds may safely be considered as a single entity. The Zewan brachiopods, however, differ in size with those of basal Khunamuh Formation, in the former they being well developed while in latter they are generally dwarf.

SYSTEMATIC DESCRIPTION

Order	Strophomenida	OPIK, 1934
Suborder	Strophomenida	OPIK, 1934
Superfamily	Davidsoniacea	KING, 1850
Family	Meekellinae	STEHLI, 1954
Subfamily	Meekellinae	STEHLI, 1954
Genus	*Schellwienella*	I. THOMAS, 1910

Schellwienella sp.

PLATE 8, Fig. 11

Material : One ventral valve, incomplete internal mould.

Description : Outline of the shell oval with straight hinge line ; the maximum width of the valve at posterior part. Length of the hinge line, one third of the maximum width. The valve not so curved with round topped beak. Neither sinus nor sulcus developed. Entire surface covered by fine, distinct radiating striae and weak growth lines. Internally, two long dental plates run parallel from apex to a length, one third of entire length of the value.

Dimensions :

Length of the valve	28 mm (estimated)
Width of the valve	36 mm
Length of the hinge line	23 mm
Thickness of the valve	45 mm

Remarks : The outline of the shell of present species is similar to that of *Streptorhynchus mistus* REED (1944, p. 70, Pl. 3, Figs. 6-7) described from Lower and Middle Productus Limestone of Salt Range. However, there is no similarity in the internal characters between the two species.

Horizon and Locality : Bed 49-50, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19355

Family Orthotetidae WAAGEN, 1884
Subfamily Derbyiinae STEHLI, 1954
Genus *Derbyia* WAAGEN, 1884
Derbyia sp.

PLATE 8, Fig. 25

Material : An incomplete internal mould of the ventral valve.

Description : Shell small, laterally elongated oval in outline with flat beak. Hinge line straight and shorter than the maximum width of the valve. Valve not inflated but slenderly curved to the front. Thin and distinct median septum, length of median septum about one third of the shell length.

Dimensions :

Length of the shell	6.5 mm (estimated)
Width of the valve	9.5 mm (estimated)

Remarks : The shell form of the present specimen is similar to *Derbyia* sp. from the Upper Permian Maizuru Group of Japan described by Shimizu (1961), but the specimen in hand has more elongated oval outline.

Horizon and Locality : Bed 50, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19367

Suborder Chonetidina MUIR-WOOD, 1955
Superfamily Chonetacea BRONN, 1862
Family Chonetidae BRONN, 1862
Subfamily Anoplinae MUIR-WOOD, 1962
Genus *Chonetina* KROTOV, 1888

Chonetina ? sp.

PLATE 7, Fig. 14

Material : One incomplete dorsal valve.

Description : The shell outline transversely oval and slightly quadrated. Hinge line straight and possesses maximum width of the shell. Valve concave with flat visceral part, gently curving to the marginal part ; laterally curves less than longitudinal direction. Fold almost obsolete and frontal line of valve not vaulted. Ears not preserved. Valve surface entirely covered by fine radiating plications ; distinct at the visceral part and weak at the periphery ; concentric growth lines also present.

Dimensions :

Length of the valve	7.5 mm
Width of the valve	12 mm (estimated)

Remarks : The outline and the surface ornamentation of the species is similar to those of *Chonetes strophomenoides* described by Waagen (1882-1884) from the Middle Productus Limestone, it is however, not possible to have satisfactory determination due to poor preservation of the present specimen. It is also comparable with the *Chonetina substrophomenoides* (HUANG 1932, 1933) of the Upper Permian of China and from the Upper Permian Maizuru Group of Japan (Shimizu, 1961).

Horizon and Locality : Bed 15, Unit A_1, Member A (fragmentary specimen – not described) and Bed 31, Member C of the Zewan Formation at the Guryul Ravine.

Specimen : GSI. Type No. 19344

Subfamily Rugosochonetinae MUIR-WOOD, 1962

Genus *Lissochonetes* DUNBAR AND CONDRA, 1932

Lissochonetes bipartita (WAAGEN)

PLATE 7, Figs. 1-4

1884. *Chonetes bipartita* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 4, p. 624, Pl. 59, Figs. 1-2.

1961. *Lissochonetes bipartita*, SHIMIZU, *Mem. Coll. Sci., Univ. Kyoto, Ser. B.*, Vol. 27, No. 3, p. 320, Pl. 6, Figs. 27-29.

Material : Several specimens.

Description : Shell small, thin with oval outline. Ventral valve not inflated, slightly curved from apex to frontal margin. Apex not prominent. Hinge line straight and possesses a length less than the maximum width of the shell, about two third of width. Ear extremity rounded. Entire outline of valve quite oval.

Dorsal valve convex, curves shallower than ventral valve. Sinus of ventral valve sharp and shallow but the corresponding fold of dorsal valve wide and not distinct. Surface of valve smooth with fine radial striations.

Dimensions :

	Ventral valve	*Dorsal valve*
Length of shell	8.0 mm	8.0 mm
Width of shell	12.5 mm	12.0 mm
Length of hinge line	9.0 mm	10.0 mm

Remarks : Kashmir specimens have similar characters like those species described from Salt Range by Waagen (1882-1884) and that from Japan by Shimizu (1961).

Horizon and Locality : Bed 30, Member C, Zewan Formation, Guryul Ravine. Bed 30, Member e, Zewan Formation, the Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19335, 19336, 19337

Lissochonetes sp. cf. *Lissochonetes morahensis* (WAAGEN)

Compare :

1884. *Chonetes morahensis* WAAGEN, *Palaeont. Indica,* Ser. 13, Vol 1, Pt. 1, p. 62, Pl. 59, Figs. 6-8.

1961. *Lissochonetes morahensis*, SHIMIZU, *Mem. Coll. Sci., Univ. Kyoto, Ser. B, Vol.* 27, No. 3, p. 321, Pl. 16, Figs. 24-26.

Material : Several specimens.

Description : Shell outline quadrate and rounded. Hinge line straight, slightly shorter than the maximum width of shell. Ventral valve slightly inflated towords longitudinal and lateral directions. Ears flat and not elongated. Apex small and not prominent. Folds round and very low, diverge from apex to frontal margin ; sinus between them very shallow. Valve surface smooth with very fine growth lines.

Dimensions :

	A	*B*
Length of valve	7.5 mm	11.5 mm
Width of valve	11.0 mm	11.5 mm
Length of hinge line	9.5 mm	10.0 mm

Remarks : The quadrate outline, low and divergent folds of the present specimens show similarity with the species described by Waagen (1882-1884) ; unfortunately all the external characterstics in the present specimen are not clear, as also no dorsal valve could be collected.

Horizon and Locality : Bed 20-2, Unit A_4, Member A ; Bed 30, Member C of Zewan Formation and Unit A_3, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19338

Suborder	Productidina	WAAGEN, 1883
Superfamily	Productacea	GRAY, 1840
Family	Margiferidae	STEHLI, 1954
Subfamily	Marginiferinae	STEHLI, 1954
Genus	*Marginifera*	WAAGEN, 1884
Marginifera himalayensis		DIENER

PLATE 8, Figs. 1-8

1899. *Marginifera himalayensis* DIENER, *Palaeont. Indica.*, Ser. 15, Vol. 1, Pt. 2, p. 39, Pl. 2, Figs. 1-7 ; Pl. 6, Figs. 1-2.

1903. *Marginifera himalayensis,* DIENER, *Palaeont. Indica,* Ser. 15, Vol. 1, Pt. 5, p. 104, Pl. 5, Figs. 5-6 ; p. 129, Pl. 5, Fig. 27.

1915. *Marginifera himalayensis*, DIENER, *Palaeont. Indica,* NS, Vol. 5, Pt. 2, p. 79, Pl, 8, Fig. 9.

Material : Several specimens.

Description : Shell outline rectangular or quadrate. Ventral valve strongly inflated with prominent beak. Shell curvature regular in longitudinal direction. Deep sinus, commencing

from apex extending to middle part of shell, then becoming shallow and broad to the frontal margin. Hinge line straight at maximum width of shell. Wings large, prominent and pointed at their extremeties. Surface of ventral valve covered by radial striations. Near apex fine concentric lines becoming weak and obsolete to the frontal margin.

Outline of dorsal valve quadrate with pointed ears. Visceral part slightly concave, further valve strongly geniculated to the front. Visceral part of valve covered by reticulation and at marginal front only radial plications. In case of small specimens, reticulations rather distinct and characterised by more sharp concentric plications at the visceral part.

Dimensions : Dimensions of the species are variable. Normal to large size specimens are present in Unit b_2 of the Spur 3 kilometres north of Barus, (Pl. 8, Figs. 1-4). Small and rudimentary specimens are seen in Unit E_1 of the Guryul Ravine, (Pl. 8, Figs. 5-8). The dimensions are as follows :

	3 km. N. of Barus		*Guryul Ravine*
	Dorsal valve	Ventral valve	Ventral valve
Shell length	18·5 mm	27·5 mm	9·0 mm
Shell width	45·0 mm	50·0 mm	18·0 mm

Remarks : This species was differentiated by Diener (1899) from *Marginifera typica* WAAGEN (1882-1884) by deep sinus of the ventral valve and fold of the dorsal valve.

These specimens exhibit same characters of the species as that of the original species from Kuling Shale of Spiti (Diener, 1899). Smaller specimens collected from basal part of the Khunamuh Formation of the Guryul Ravine resemble with the larger forms in their shell characters, namely outline, strong geniculation, deep sinus of ventral valve and corresponding fold of dorsal valve. Unfortunately, no complete shell could be collected and external characters of ventral valve are not distinct.

Diener (1915, pp. 80-82, Pl. 8, Figs. 13-14) has described smaller species of *Spinomarginifera* (namely *Spinomarginifera* cf. *helica* and *Spinomarginifera* cf. *spinocostata*) from Kashmir, but these species do not show characters of this genus. Even now in recent survey this genus was also not found. The smaller specimens have characters of *Marginifera himalayensis*, except difference in the size. It may be possible to separate smaller species into subspecies when more well preserved specimens are collected.

Horizon and Locality : Bed 19, Unit b_2, Member b, Zewan Formation, Spur 3 kilometres north of Barus. Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19348, 19349, 19350, 19351, 19352, 19353

Family Echinochonchidae STEHLI, 1954

Subfamily Echinochonchinae STEHLI, 1954

Genus *Pustula* I. THOMAS, 1914 emended CHAO, 1927

Pustula ? sp.

PLATE. 8, Fig. 23

Material : Two fragmentary specimens from lower beds of Member E of Khunamuh Formation.

Remarks : Specimens are grouped under genus *Pustula* by their ornamentation of shell surface, which consists of distinct concentric ribs and radiating fine ribs ; the latter consisting of elongated spine bases. Some species of *Waagenoconcha* are also characterised by spine bases on radiating ribs, but they lack concentric ribs.

The associated fossils with this species are interesting. In Bed 49 of the Guryul Ravine, Permian brachiopods are found together with it (Plate 8, Fig, 23), but in Bed 52 (a limestone lense, where *Pustula* ? sp., is present) with the Early Triassic ammonite *Otoceras.*

Horizon and Locality : Bed 49 (Unit E_1), Bed 52 (Unit E_2), Member E, Khunamuh Formation, Guryul Ravine.

Specimens : GSI. Type No. 19365.

Subfamily Waagenochonchinae MUIR-WOOD AND COOPER, 1960

Genus *Waagenoconcha* CHAO, 1927

Waagenoconcha purdoni (DAVIDSON)

PLATE 8, Figs. 12-14

1862. *Productus purdoni* DAVIDSON, *Q. J. Geol. Soc. London,* Vol. 18, p. 31, Pl. 2, Fig. 5.

1884. *Productus purdoni,* WAAGEN, *Palaeont. Indica,* Ser. 13, Vol. 1, Pt. 4, p. 705, Pl. 73, Figs. 1-3.

1897. *Productus purdoni,* DIENER, *Palaeont. Indica,* Ser. 15, Vol. 1, Pt. 3, p. 21, Pl. 2, Figs. 1-2.

1966. *Waagenoconcha purdoni* WATERHOUSE, *JB. Geol. B. A. Sonderbd.* Vol. 12, p 23, Pl. 4, Figs. 2-3 ; Pl. 5, Figs. 2-3.

Material : Several specimens.

Description : Shell outline semicircular, wider than long. Ventral valve moderately inflated and longitudinally smoothely curved, in transverse direction it curves steep at the margin ; the middle part of the valve flattened and depressed. Apex pointed and overhangs on hinge line. Hinge line very short and slightly arched and extends a little at both ends to form very small wing. Sinus shallow and broad at frontal margin and almost obsolete near apex.

Dorsal valve almost flat, with subpentagonal outline, longer length than width, maximum width posteriorly. Hinge line shorter than shell width. Fold weak, from apex to the frontal margin forming gentle curved arch of frontal margin.

Dimensions :

	Ventral valve	Dorsal valve
Length	18·0 mm	22·5 mm
Width	23·5 mm	25·5 mm

Remarks : Specimens of the collection are comparable with that of *Productus purdoni* DAVIDSON and many other specimens of this species described from India. Reed (1944) distinguished many varieties of this species from Productus Limestone, it is however difficult to study the varieties of the specimens due to ill-preservation.

Horizon and Locality : Bed 33, Member D, Zewan Formation and Beds 48 and 49, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19356, 19357, 19358

Waagenoconcha abichi (WAAGEN)

PLATE 8, Fig. 16

1884. *Productus abichi* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 4, p. 697, Pl. 74, Figs. 1-6.

Material : One specimen.

Description : Shell outline more or less transversly oval, with short hinge line. Valve not inflated from apex to middle, curves abruptly to the frontal margin. Sinus shallow, commences near apex, becomes broad in the middle and forms a weak furrow at the frontal margin. Apex broad, not pointed and overhangs slightly on the hinge line. Ears small and not extended. Entire surface covered by tubercles ; tubercles long and arranged cinquintely or irregularly on concentric folds.

Dimensions :

Length of shell	31·0 mm
Width of shell	38·5 mm
Length of hinge line	19·5 mm
Thickness of shell	9·5 mm

Remarks : The specimen is identical with that of *Productus abichi* WAAGEN (1884) from Middle to Upper Productus Limestone, in its shell outline and ornamentation. Waagen also discriminated specimens having similar outline under *Productus serialis*, but differences in the two species are not of much significance. The specific designation is after Abich (1878), who described *Productus scabriculus* (MARTIN) from Permian of Armenian Djoulfa. These specimens possess a long median septum in the ventral valve and were redesignated to the Genus *Tschernyschewia* by Ruzhentsev and Sarytscheva (1965).

Horizon and Locality : Bed 19, Unit b_2, Member b, Zewan Formation, Spur 3 kilometres north of Barus.

Specimen : GSI. Type No. 19360

Family	Dictyoclostidae	STEHLI, 1954
Subfamily	Dictyoclostinae	STEHLI, 1954
Genus	*Costiferina*	MUIR-WOOD and COOPER, 1960

Costiferina indica (WAAGEN)

PLATE 7, Figs. 17-19

1884. *Productus indicus* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 4, p. 687, Pl. 70, Fig. 1 ; Pl, 71, Fig. 1.

1915. *Productus indicus*, DIENER. *Palaeont. Indica*, N S, Vol. 5, Pt. 2, p. 66, Pl. 6, Fig. 15.

1960. *Costiferina indica* MUIR-WOOD and COOPER, *Geol. Soc. Amer.* Mem. 81, p. 227, Pl. 95, Fig. 7 ; Pl. 103, Figs. 1-4, 6-7.

Material : Several specimens.

Description : Shell outline quadrate and size large. Ventral valve with highly convex visceral disc. Entire shell strongly convex and nearly spirally enrolled ; ears large. Ventral valve strongly convex and curvatures regular in both directions and anteriorly geniculated. Sinus shallow commences near apex, becomes wide and more shallow to the front. On the surface of ventral valve many coarse costae arranged and converging medially, becoming obsolete anteriorly. Brachial valve strongly concave with flat or slight concave visceral part and acutely geniculated along the opposite valve. Fold extremely weak and broad. Surface of dorsal valve covered by sharp reticulations at visceral part and on the trail by weak and radiating folds. Interior of ventral valve — dendritic, adductors set on median ridge, didductors broad and longitudinally ridged. In the dorsal valve cardinal process massive, ereceted and dorsally inclined with low and long median septum ; adductors large and dendritic. In some specimens looped brachial ridges.

Dimensions :

Length of shell (visceral part)	42 mm
Width of shell	56 mm
Length of hinge line	not measured

Remarks : Shell form, surface ornamentation and interna lstructures of present specimens are identical with that of *Productus indicus* WAAGEN (1884) described from Productus Limestone of Salt Range. *Costiferina spiralis* (WAAGEN) has similar globose shell form and shell ornamentation, but is distinguished by extended and enrolled ears.

Horizon and Locality : Bed 23, Unit B_2, Member B, Zewan Formation, Guryul Ravine. Bed 19, Unit b_2, Member b, Zewan Formation, Spur 3 kilometres north of Barus, (Pl. 7, Figs. 17-19).

Specimen : GSI. Type No. 19347

Further Comments : In addition to the above, several other specimens were collected from Bed 23 of Unit B_2 (Member B, Zewan Formation) GSI. Type No. 19346, (Pl. 7, Fig. 16) and Bed 48 of Unit E_1 (Member E, Khunamuh Formation) (GSI. Type No. 19345, Pl. 7, Fig. 15) at the Guryul Ravine. These can be referred to the above species, but are not exatctly determinable due to ill-preservation.

Family Linoproductidae STEHLI, 1954

Subfamily Linoproductinae STEHLI, 1954

Genus *Linoproductus* CHAO, 1927

Linoproductus lineatus (WAAGEN)

PLATE 7, Fig. 11, PLATE 8, Fig. 15

1884. *Productus lineatus* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 4, p. 673, Pl. 66, Figs. 1-2, Pl. 67, Fig. 3.

1915. *Productus cora,* DIENER, *Palaeont. Indica*, N S, Vol. 5, Pt. 2, p. 65, Pl. 6, Figs. 13-14.

1927. *Linoproductus lineatus,* CHAO, *Palaeont. Sinica*, Ser. B, Vol. 5, Pt. 2, p. 129, Pl. 15, Figs. 25-27.

Material : Several specimens.

Description : Shell outline mostly elongated oval, longer than wide. Ventral valve strongly inflated, equally curved in longitudinal and lateral directions. Hinge line long and straight and has greatest width of shell. Near the ends of hinge line the ventral valve flattened and forms spread wings. Apex pointed and enrolled, bent over hinge line. Near the apex, valve slightly flattened and forms shallow and broad sinus to the front. Entire surface of valve covered by fine, distinct radial striations and equally distributed on the entire valve. In some specimens concentric folds or plications scattered on surface and associated with fine growth lines.

Dorsal valve is not present in this collection.

Dimensions :

Length of the valve (visceral part)	26.5 mm
Width of the valve	36.0 mm

Remarks : The specimens are identical in the shell form with the species, described by Waagen (1884) from Salt Range. The species has been distinguished from *Productus cora* D'ORBIGNY by its sinus (Waagen 1884).

Horizon and Locality : Bed 19, Unit A_2, Member A ; Bed 23, Member B and Bed 45, Member D of the Zewan Formation ; Bed 48-49, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19342, 19359

Order	Rhynchonellina	KUHN, 1949
Superfamily	Rhynchonellacea	GRAY, 1848
Family	Wellerellidae	LIKHAREV, 1956
Subfamily	Wellerellinae	LIKHAREV, 1956
Genus	*Wellerella*	DUNBAR AND CONDRA, 1932

Wellerella ? sp.

PLATE 7, Fig. 12-13

Material : One specimen.

Description : Shell outline trapezoidal with round frontal line. Apex not thick and pointed and slightly curved on opposite valve. Ventral valve inflated, curves regularly in both directions. Sinus shallow, commences from middle part of valve and becomes wider to the front ; sinus has two rounded and distinct plications, forming round zigzag frontal line corresponding with three plications of drosal valve. Both wings of ventral valve show two weak plications. Dorsal valve slightly inflated and curves regularly in both directions but curvature weak than ventral valve. Shell surface entirely smooth. Internal structures not seen.

Dimensions :

Length of shell	14.0 mm
Width of shell	15.5 mm
Length of dorsal valve	12.5 mm
Thickness of shell	6.95 mm

Remarks : The specimen is similar to *Camarophoria biplicata* STRUCKENBERG from upper part of the Middle Productus Limestone of the Salt Range as described by Reed (1944, p. 137). The Salt Range species has more sharp and distinct plications in the sinus and the wings of the valves.

Horizon and Locality : Bed 31, Member e, Zewan Formation at the Spur 3 kilometres north of Barus.

Specimen : GSI. Type No. 19343

Order	Spiriferida	WAAGEN, 1883
Suborder	Athyrididina	BOUCOT, JOHNSON and STANTON, 1964
Superfamily	Athyridacea	M'COY, 1844
Family	Meristeridae	WAAGEN, 1883
Subfamily	Athyridinae	M'COY, 1844
Genus	*Athyris*	M'COY, 1844

Athyris ? sp.

PLATE 7, Fig. 6, PLATE 8, Figs. 9-10.

Material : A few specimens.

Description : Internal mould of dorsal valve ; shell outline subtriangular, posteriorly rounded, widest anteriorly ; frontal margin broadly undulated. Valve inflated, curves regularly in both directions. Fold of valve rounded, broad and not distinguished from wing of valve. Long and low median septum and posseses half length of valve.

Dimensions :

Length of valve	8.75 mm
Width of valve	11.0 mm

Remarks : Shell form of the small specimen is similar to *Composita* (*Spirigerella*) *subtriangularis* of Yunnan (Reed, 1927), which is cospecific with *Athyris* (*Composita*) *subtilia* HALL from the Zewan bed of the Guryul Ravine as described by Diener (1899). Diener's species has thicker and trapezoidal shell form and larger size than the present specimen. The same species has also been described by Huang (1932) from China as *Athyris subtriangularis*. Shape and size of present specimen also resembles with Chinese species.

Horizon and Locality : Unit E_1, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19339, 19354

Genus *Spirigerella* WAAGEN, 1833

Spirigerella sp.

PLATE 7, Figs. 7-8

Material : Several specimens.

Description : Shell globose and outline oval ; wider than long. Ventral valve inflated and longitudinal, curvature regular ; in lateral direction curves slightly and flat in the middle part, then bends down to lateral margins. Sinus shallow commencing at the middle of longitudinal curvature becoming wider to the frontal margin. Dorsal valve more inflated than opposite valve, curves in both directions. Fold strong and flat-topped and distinguished from both flanks of dorsal valve. Entire surface of shell covered by fine concentric growth lines.

Dimensions : Exact measurements are not possible as all the specimens are broken in one part or the other.

Remarks : Several incomplete valves of *Spirigerella* are present in the collection ; outermost layers of the shell are sometime stripped off. Though slightly inflated, the shell form resembles with that of *Spirigerella grandis* (DAVIDSON) from Productus Limestone of the Salt Range (Waagen, 1883, Pl. 36, Pl. 37, Fig. 1). Its general characters is more close to *Spirigera xetra* DIENER (1915, p. 91, Pl. 9, Figs. 13-17), of the Guryul Ravine as described by Diener. Diener pointed out that *S. xetra* of Kashmir can hardly be distinguished with *Spirigerella grandis* of Salt Sange.

Horizon and Locality : Bed 19, Unit A_2, Member A, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19340

Genus *Cleiothyridina* BUCKMAN, 1906

Cleiothyridina sp. cf. *subexpansa* (WAAGEN)

PLATE 7, Figs. 9-10

Compare :

1882. *Athyris subexpansa* WAAGEN, *Palaeont. Indica,* Ser. 13, Vol. 1, Pt. 4, p. 478, Pl. 39, Figs. 1-5.

1915. *Athyris subexpansa,* DIENER, *Palaeont. Indica,* N S, Vol. 5, Pt. 2, p. 94, Pl. 10, Fig. 4.

1966. *Cleiothyridina subexpansa* WATERHOUSE, *JB. Geol. B. A. Sonderbd.,* Vol. 12., p. 62, Pl. 8, Fig. 3 ; Pl. 10, Fig. 3.

Material : An internal mould of the ventral valve.

Description : Shell outline transversly oval. Valve not so inflated and curves longitudinally rather than lateral direction ; middle part flat, then curves gently to frontal and lateral margins. Beak thick, not prominent, with slender curve. Internally, broad didductor muscle scars present. Two dental plates diverge anteriorly.

Dimensions :

Length of valve	23.0 mm
Width of valve	30.5 mm

Remarks : Internal and external characters of the present specimen are similar to *Athyris subexpansa* of the Salt Range (Waagen, 1882), particularly in outline and curvature. Unfortunately surface of the wall is not well preserved and fragmentary external mould of valve shows fine growth lines.

Horizon and Locality : Bed 23, Unit B_2, Member B, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19341

Suborder	Spiriferidina	WAAGEN,	1883
Superfamily	Spiriferacea	KING,	1846
Family	Spiriferidae	KING,	1846
Genus	*Neospirifer*	FREDERIKS,	1919

Neospirifer musakheylensis (DAVIDSON)

PLATE 8, Fig. 24

1862. *Spirifer musakheylensis* DAVIDSON, *Q. J. Geol. Soc. Lond.*, Vol. 18, p. 28, Pl. 2, Fig. 2.

1883. *Spirifer musakheylensis*, WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 4, p. 512, Pl. 45, Figs. 1-6.

1899. *Spirifer musakheylensis*, DIENER, *Palaeont. Indica*, Ser. 15, Vol. 1, Pt. 3, p. 63, Pl. 5, Figs. 3-7.

1966. *Neospirifer musakheylensis* WATEERHOUSE, *JB. Geol. B.A.*, p. 33, Pl. 8, Figs. 1-2 ; Pl. 9, Figs. 1-4, Pl. 10, Figs. 1-2.

Material : One ventral valve.

Description : Valve outline elongately transverse ; hinge line extending to the greatest width of shell ; both extremeties of valve pointed. The valve slightly inflated longitudinally and less vaulted in transverse direction. Median sinus commences from apex and extends frontal margin ; median sinus narrow and sharp near apex, and becomes wide and round to the front. Apex pointed, not prominent, hangs over the hinge line. Area broad and elongated. Entire surface of valve covered by many weak striations and foldings ; concentric growth lines hardly visible.

Dimensions :

Length of valve	46.0 mm
Width of valve	96.0 mm
Thickness	14.0 mm
Apical angle	141°

Remarks : Although specimen of the collection has badly preserved ornamentation, still it can easily be recongnised to *Neospirifer musakheylensis*, a widely distributed species.

Horizon and Locality : Bed 18, Unit b_1, Member b, Zewan Formation, Spur 3 kilometers north of Barus.

Specimen : GSI. Type No. 19366

Order	Terebratulida	WAAGEN,	1883
Suborder	Terebratulidina	WAAGEN,	1883
Superfamily	Dielasmatacea	SCHUCHERT,	1913
Family	Dielsmatidae	SCHUCHERT,	1913
Subfamily	Dielsmatinae	SCHUCHERT,	1913
Genus	Dielasma	KING,	1859

Dielasma ? sp.

PLATE 8, Figs. 17-20

Material : Several incomplete ventral valves.

Description : Shell outline elongated oval, longer than wide, with tapered apex. Valve curves regularly in longitudinal direction, less curved in lateral direction. Sinus broad and very shallow, commencing at middle of valve and becoming more broad to the frontal margin forming a gentle curved arch at the front. Surface of shell quite smooth except very fine growth lines. Internal structure of valve not known.

Remarks : Specimens are comparable with *Dielasma latouchi* from Mandakpal, Kashmir (Diener, 1915, p. 97, Pl. 10, Figs. 13-14) in their shell form, but are smaller in size.

Horizon and Locality : Bed 43, Member D, Zewan Formation, Guryul Ravine. (Pl. 8, Figs. 17-18). Bed 31, Member e, Zewan Formation, Spur 3 kilometres north of Barus. (Pl. 8, Fig. 19).

Specimen : GSI. Type Nos. 19361, 19362

Further Comments : Specimens hardly comparable to *Dielasma* are also collected from Bed 30 (Member C), Bed 49 (Unit E_1, Member E) of the Guryul Ravine. In the Spur 3 kilometres north of Barus similar forms are found in Bed 50 of the Khunamuh Formation, GSI. Type No. 19363, (Pl. 8, Fig. 20).

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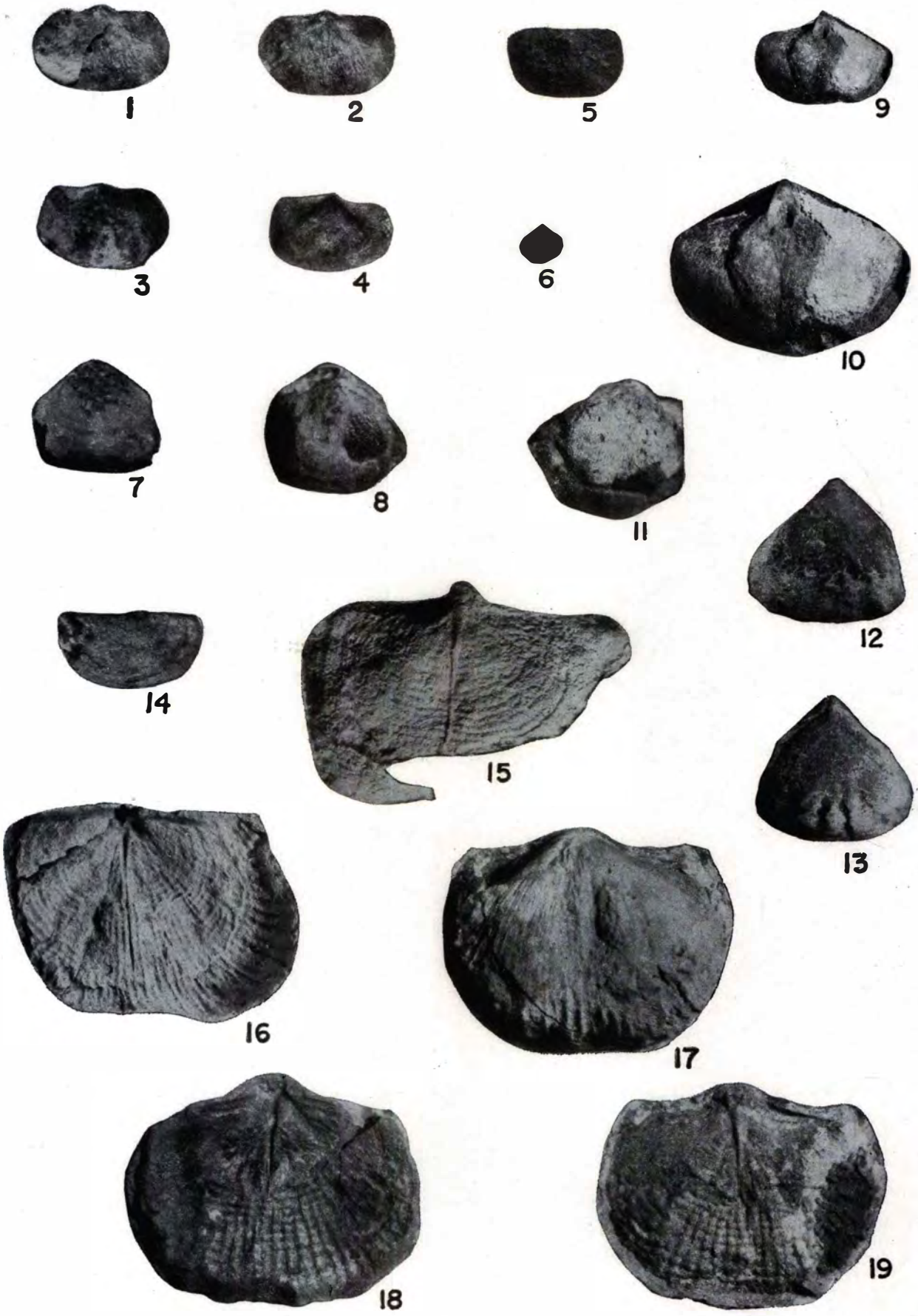
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SHIMIZU : Upper Permian Brachiopods from Kashmir

PLATE 7

Figs. 1-4. *Lissochonetes bipartita* (WAAGEN). × 2.

1. Broken ventral valve with internal mould. Bed 30, Member C, Zewan Formation, Guryul Ravine. 2. Same, shell removed. GSI. Type No. 19335. 3. Ventral valve. Bed 30, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19336. 4. Internal mould of dorsal valve. Bed 30, Member C of the Zewan Formation, Guryul Ravine. GSI. Type No. 19337.

Fig. 5. *Lissochonetes* sp. cf. *morahensis* (WAAGEN). × 2.

Internal mould of ventral valve. Unit E_1, Member E of the Late Permian part of the Khunamuh Formation, Guryul Ravine. GSI. Type No. 19338.

Fig. 6. *Athyris* ? sp. × 2.

Bed 48, Unit E_1, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19339.

Figs. 7-8. *Spirigerella* sp. × 1.

Ventral and dorsal views. Bed 19, Member A_2, Zewan Formation, Guryul Revine. GSI. Type No. 19340.

Figs. 9-10. *Cleiothyridina* sp. cf. C. *subexpansa* (WAAGEN). × 1.

9. Internal mould of ventral valve × 1. 10. Same enlarged. × 2. Bed 23, Unit B_2, Member B, Zewan Formation, Guryul Ravine. GSI. Type No. 19341.

Fig. 11. *Linoproductus lineatus* (WAAGEN). × 2.

Ventral valve. Bed 48, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19342.

Figs. 12-13. *Wellerella* ? sp. × 2.

Ventral and dorsal views. Bed 31, Member, Zewan Formation, Spur 3 kilometres north of Barus. GSI. Type No. 19343.

Fig. 14. *Chonetina* ? sp. × 2.

Dorsal valve. Bed 31, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19344.

Fig. 15. *Costiferina* sp. × 1.

Internal mould of dorsal valve. Bed 23, Member B, Zewan Formation, Guryul Ravine. GSI. Type No. 19345.

Fig. 16. *Costiferina* sp. × 1.

Internal mould of dorsal valve. Bed 48, Unit E_1, Member E, Khunamuh Formation of the Guryul Ravine. GSI. Type No. 19346.

Figs. 17-19. *Costiferina indica* (WAAGEN). × 1.

17. Ventral view. 18. Internal view of dorsal valve. 19. External mould of same valve. Bed 19, Unit b_2, Member b, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19347.

PLATE 8

Figs. 1-4 *Marginifera himalayensis* DIENER. × 1.

1. Ventral view. 2. External mould of dorsal valve. 3. Internal mould of dorsal valve, frontal view. 4. External mould of dorsal valve, frontal view. (All specimens are different). Bed 19, Unit b_2, Member b, Zewan Formation, the Spur 3 kilometres north of Barus. GSI. Type Nos. 19348, 19349, 19350, 19351.

Figs. 5-8 *Marginifera himalayensis* DIENER. Rudimental specimens.

5. External mould of dorsal valve. ×1 6. Same enlarged. × 2. 7. Internal mould of ventral valve. × 1. 8. Same enlarged. × 2. Both specimens from Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19352, 19353.

Figs. 9-10 *Athyris* ? sp.

9. Internal mould of dorsal valve. × 1. 10. Same enlarged. × 2. Unit E_1, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19354.

Fig. 11 *Schellwienella* sp. × 1.

Internal mould of Ventral valve. Bed 49/50, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19355.

Figs. 12-14 *Waagenoconcha purdoni* (DAVIDSON). x 1.

12. Ventral valve. 13. Internal mould of ventral valve. Both specimens from Beds 48/49, Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type Nos. 19356, 19357. 14. Dorsal valve. Bed 33, Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19358.

Fig. 15 *Linoproductus lineatus* (WAAGEN). x 1.

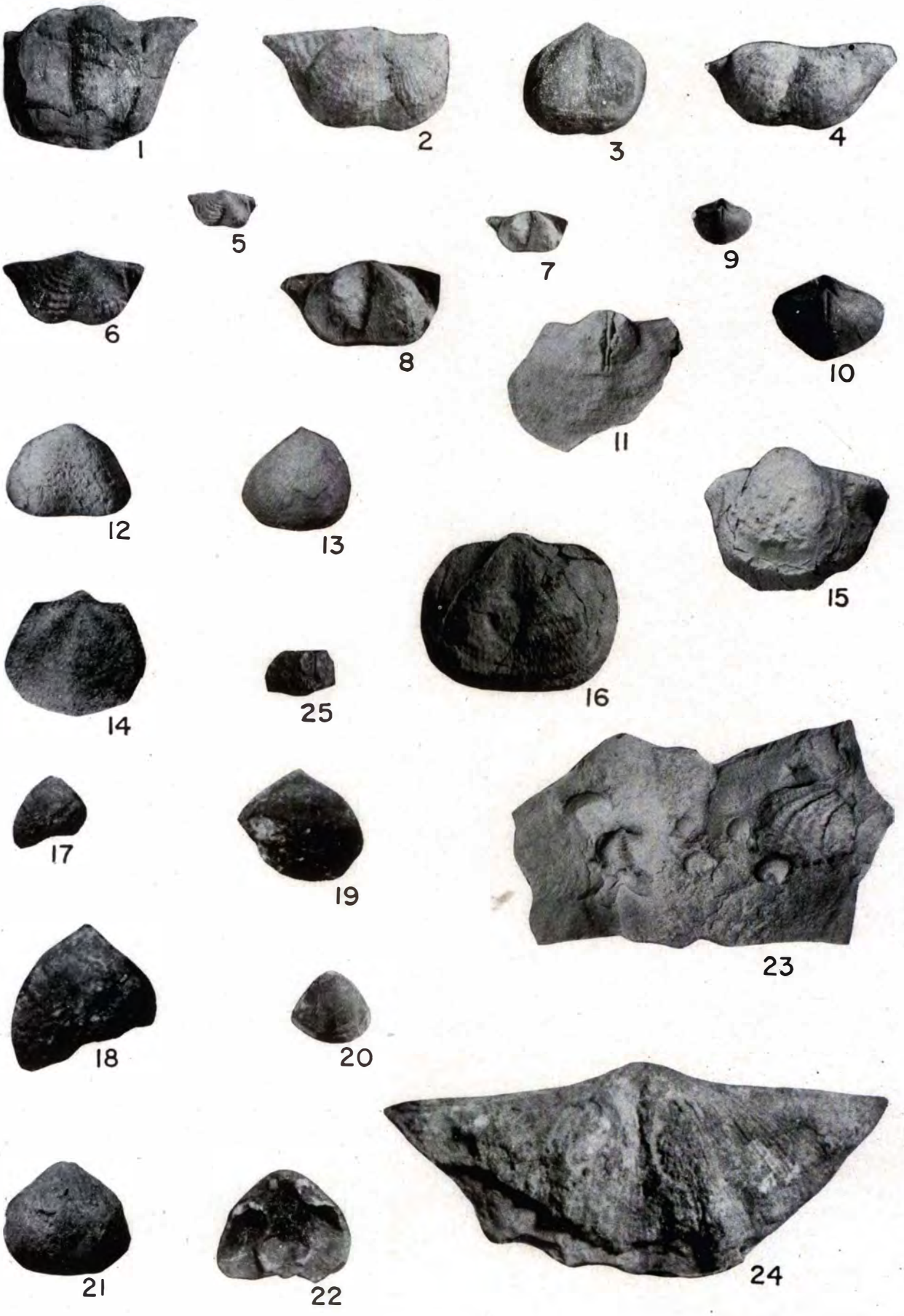
Ventral valve. Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19359.

Fig. 16 *Waagenoconcha abichi* (WAAGEN). x 1.

Internal mould of ventral valve. Bed 19, Unit b_2, Member b at the Spur 3 kilometres north of Barus. GSI. Type No. 19360.

Figs. 17-20 *Dielasma* ? sp.

17. Ventral valve. x 1. 18. Same enlarged. x 2. Bed 43, Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19361. 19. Ventral valve. x 2. Bed 31, Member e, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19362. 20. Ventral valve.x 1. Bed 50, Unit f_1, Member f, Khunamuh Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19363.



SHIMIZU : Upper Premian Brachiopods from Kashmir

PLATE 8 (Continued)

Figs. 21-22 *Spiriferella rajah* (SALTER). x 1.

Ventral view and internal view of ventral valve. Bed 19, Unit b_2, Member b, Zewan Formation at the Spur 3 kilometres north of Barus. GSI. Type No. 19364.

Fig. 23 *Pustula* ? sp. and *Marginifera himalayensis* ? DIENER. x 1.

Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19365.

Fig. 24 *Neospirifer musakheylensis* (DAVIDSON). x 1.

Ventral valve. Bed 18, Unit b_1, Member b, Zewan Formation, at the Spur 3 kilometres north of Barus. GSI. Type No. 19366.

Fig. 25 *Derbyia* sp. x 2.

Incomplete internal mould of ventral valve. Bed 50, Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19367.

BIVALVIA

PERMIAN AND TRIASSIC BIVALVES OF KASHMIR

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PERMIAN AND TRIASSIC BIVALVES FROM KASHMIR

INTRODUCTION

In comparison with rich brachiopods, bivalves are not common in the Permian Zewan Formation, especially in the lower part. However, there are several coquinoid layers rich in bivalves in the upper part of the Zewan Formation (Members C and D), and also in the lowermost part of the Khunamuh Formation of the latest Permian age. In this part bivalves become more predominant than brachiopods. The last one corresponds to Brachiopod and Lamellibranch beds of Middlemiss (1909, 1910) and Lamellibranch zone of Diener (1915).

The succeeding Early Triassic Khunamuh Formation is characterised almost exclusively by ammonoids, bivalves and conodonts.

Diener (1899, 1915) described the following species of the Permian bivalves on examining the collections of R. Lydekker from Eishmakam (Aishmuqam), of H. H. Hayden from Guryul Ravine, and of C. S. Middlemiss from Guryul Ravine, the Spur 3 kilometres north of Barus and all around the Vihi plain near Srinagar. Other localities mentioned by Diener are not important for bivalves.

Aviculopecten (= Streblochondria) sp. ind., Zewan beds of Eishmakam. It is now established that this locality do not have any exposures of the Zewan Formation.

Pecten (= Aviculopecten), locality and bed as mentioned above.

Modiola ? sp. ind., locality and bed as above.

Pseudomonotis (Eumicrotis) sp. ind. aff. *radialis* PHILLIP, *(= Claraia* cf. *bioni* NAKAZAWA*)*, Unit E_1, and upper part of Member D ?, Guryul Ravine.

Aviculopecten (= Etheripecten) cf. *hiemalis* SALTER, Middle part of Member B, Guryul Ravine.

Pseudomonotis nov. sp. ind. *(= Claraia bioni* NAKAZAWA*)*, Unit f_1, the Spur 3 kilometres north of Barus.

Aviculopecten sp. ind. *(= Etheripecten haydeni* NAKAZAWA, n. sp.*)*, horizon and locality as mentioned above.

Schizodus sp. cf. *rotundatus* BROWN, horizon and locality same as above.

Pleurophorus (= Permophorus) sp. ind. aff. *complanatus* WAAGEN, horizon and locality same as above.

Pseudomonotis (Eumicrotis) (= Etheripecten) middlemissi DIENER, comparable to the middle part of Member B, Mandakpal.

Excepting the first four species all have been collected by Middlemiss (1909, 1910) in 1908 and 1909.

Diener (1913) also described from the collections of C. S. Middlemiss, six species from the so-called Ophiceras layer at Pastannah (=Pastun) and one species from the Meekoceras beds of Middlemiss (Member H of the present article) at the Guryul Ravine. These are:

Pseudomonotis griesbachi BITTNER = *Claraia decidens* (BITTNER) of the present article.
Pseudomonotis tenuistriata BITTNER = *Leptochondria minima* (KIPARISOVA),
Pseudomonotis multiformis BITTNER = *Leptochondria bittneri* (KIPARISOVA),
Pseudomonotis (=Claraia) painkhandana BITTNER,
Pseudomonotis sp. ind. aff. *austriaca* BITTNER = *Claraia*? sp.,
Pseudomonotis aurita HAUER = *Claraia* sp. (*Claraia* Group),
Pseudomonotis (=*Claraia*) *decidens* BITTNER.

Only the last species was collected from the Meekoceras beds at the Guryul Ravine. The Ophiceras layer is now generally believed to be Owenitan or Smithian in age (Tozer, 1969; Nakazawa et al, 1975), and is correlated with the upper part of Member G or lowermost part of Member H at the Guryul Ravine section.

From the present study, 16 species could be distinguished in the Upper Permian (Zewan and the lowermost Khunamuh) and 16 species in the Lower Triassic at the Guryul Ravine, among which two species may probably be derived from the underlying Permian beds. Description of *Claraia* also includes the material collected from Pahlgam and Pastun.

FAUANAL CONSIDERATION

PERMIAN

No bivalve has been collected from Member A and B except for a single indeterminable specimen from Unit B_2, presumably belonging to *Etheripecten*. Diener (1915), howeyer, described *Etheripecten* cf. *hiemalis* (SALTER) from the middle part of Member B at Guryul Ravine and *Etheripecten middlemissi* (DIENER) from the similar horizon at Mandakpal, as already mentioned.

Member C has two coquinoid limestones in Bed 27 and Bed 31, respectively. These are composed mainly of bivalve and bellerophonitid gastropod shells. The following species have been identified:

Bed 27—*Nuculopsis*? sp. *b*, *Palaeoneilo* sp. *a*, *Aviculopecten*? n. sp. ind., "*Streblochondria*" sp. and "*Palaeolima*" *middlemissi* n. sp.

Bed 31—*Phestia* sp., "*Palaeolima*" *middlemissi*, *Permophorus* cf. *subovalis* (WAAGEN). This bed also contains *Cyclolobus walkeri* DIENER (Furnish et al., 1973), *Anchygnathodus typicalis*, *Neogondolella subcarinata* and *Neogondolella carinata*.

Bivalves of Member D occur at three horizons, each belonging to Bed 33, 43 and 45, respectively. Bed 43 is a coquinoid limestone accompanied with bellerophons similar to that of Member C. Fossiliferous layers of Beds 33 and 45 consist of sandy limestone or calcareous sandstone having scattered shells. The following forms have been determined:

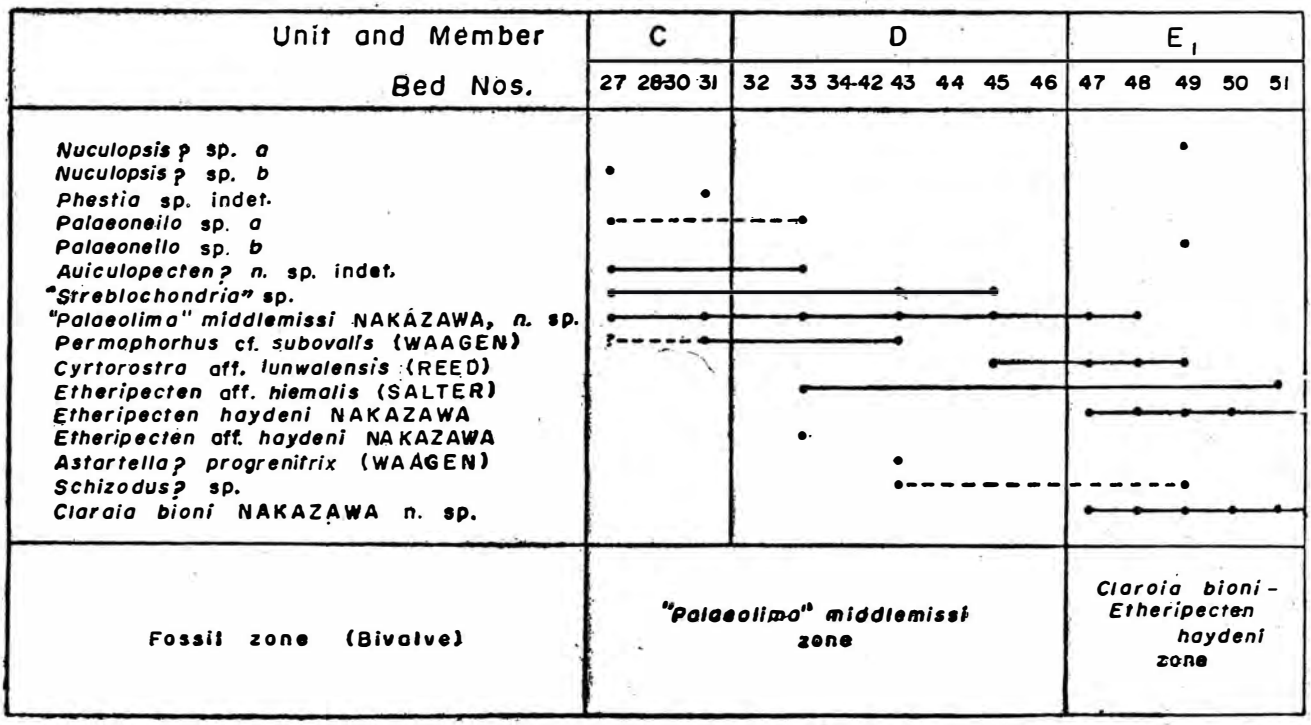
Bed 33—*Palaeoneilo* sp. *a*, *Aviculopecten* n. sp. ind., "*Palaeolima*" *middlemissi*, n. sp., *Etheripecten* aff. *haydeni* n. sp. and *Etheripecten* aff. *hiemalis* (SALTER).

Bed 43—"*Streblochondria*" sp., "*Palaeolima*" *middlemissi*, *Permophorus* cf. *subovalis* (WAAGEN), *Astartella* ? *progrenitrix* WAAGEN and *Schizodus* ? sp.

Bed 45—"*Streblochondria*" sp., "*Palaeolima*" *middlemissi* and *Cyrtorostra* aff. *lunwalensis* (REED).

TABLE 22

RANGE CHART OF THE UPPER PERMIAN BIVALVES IN THE GURYUL RAVINE



Unit E_1, of the Khunamuh Formation is composed mostly of black, sometimes greenish shale intercalating with thin limestone layers at several horizons. Bivalves and brachiopods are common throughout the unit, and usually deposited on a bedding surface of shale, a dark-grey coquinoid limstone (Bed 48a) is also found. Bivalves are more abundant than brachiopods in number of individuals.

This fossiliferous unit has been compared to Brachiopod and Lamellibranch beds of Middlemiss occuring at the Spur 3 kilometres north of Barus (Unit f_1 of this paper). It contains following bivalves, of which the first four are predominant.

Etheripecten haydeni, *Claraia bioni* NAKAZAWA, *Cyrtorostra* aff. *lunwalensis*, "*Palaeolima*" *middlemissi*, *Nuculopsis* ? sp. *a*, *Etheripecten* aff. *hiemalis* ?, and *Schizodus* ? sp.

In addition to these, *Fasciculiconcha* ? sp. is also found from this unit (E_1) of the third Spur at the Guryul Ravine.

As reported earlier (Nakazawa et al., 1975), *Claraia bioni* is generally not associated with other forms. It is found scattered in the matrix, and rarely in a univalved state, while the other shells are mixed together and arranged on a bedding plane. These facts suggest that the former is buried nearly *in situ* and the latter were transported to the present position from presumably a shallower sea bottom.

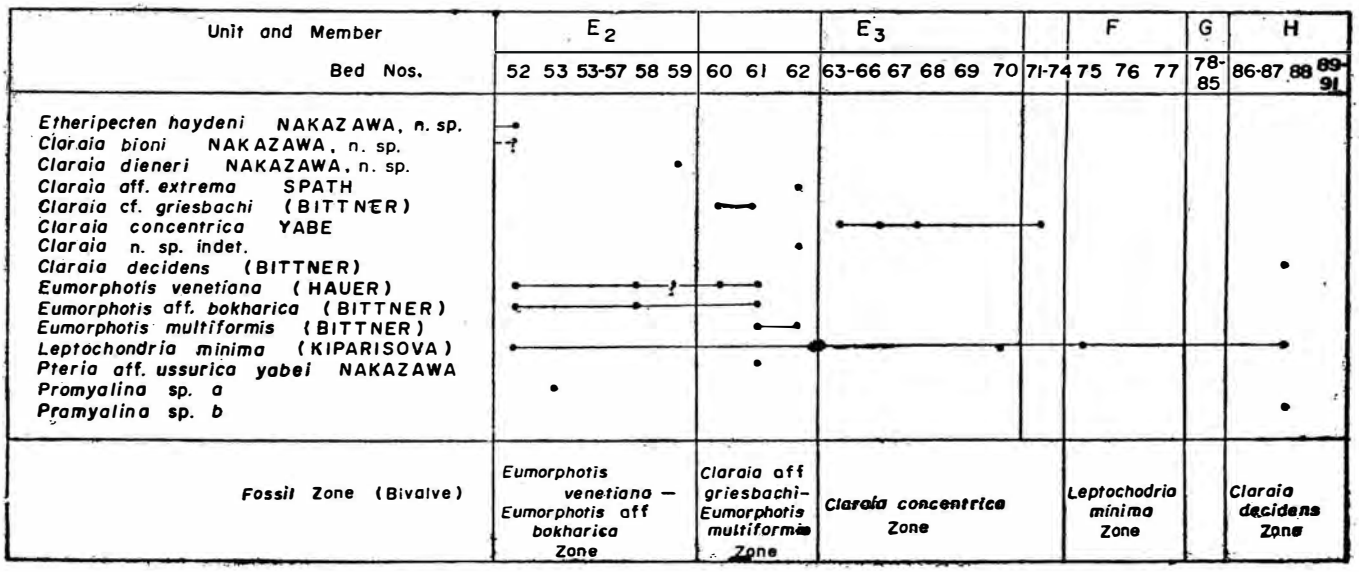
LOWER TRIASSIC

Member E and F of the Khunamuh Formation are rich in ammonoid, bivalve and conodont.

From Member G, only ammonoids have been obtained. They are present in two horizons. Member H, corresponding to the Meekoceras beds of Middlemiss (1909, 1910) has yielded many ammonoids and bivalves along with conodont *Neospathodus waageni* SWEET.

TABLE 23

RANGE CHART OF THE LOWER TRIASSIC BIVALVES IN THE GURYUL RAVINE



The following facts are, however, worth mentioning :—

1. Most species of *Claraia* are confined to shale which alternates with limestone. Only *Claraia decidens* bearing strongly inflated left valve occurs in the limestone of Member G.

2. Other bivalves are mostly found in limestone which shows a turbidite nature, but *Eumorphotis venetiana* and *Eumorphotis* aff. *bokharica* occur in both limestone and shale. In some cases bivalve shell-fragments constitute a graded part of limestone turbidite.

3. *Eumorphotis venetiana*, *E.* aff. *bokharica* and *Leptochondria minima* already appeared at the very base of the Otoceras beds.

4. A fragmentary shell probably identical with *Claraia bioni* is discovered in association with *Otoceras woodwardi* of the lowermost limestone of Unit E_2, and *Etheripecten haydeni* is found in the basal shale of Unit E_3 and at 5 metre above the base. These may, however, be derived fossils.

ZONATION

The lower half of the Zewan Formation yields very few bivalves. *"Palaeolima" middlemissi* is commonly found in the upper half (Member C and D) and *"Streblochondria"* sp. also has a range covering Member C and D, though rare in number. Other species have a limited stratigraphic distribution, but they are too few for zonation. Forcing to make zonation by bivalve, therefore, the upper Zewan has been included in the Zone of *"Palaeolima" middlemissi* though this species survived into the succeeding Unit E_1 of the Khunamuh stage.

Unit E_1 of the Khunamuh Formation is characterised by abundant occurrence of ***Etheripecten haydeni*** and ***Claraia bioni*** and is named as the Zone of ***Etheripecten haydeni—Claraia bioni.***

Zone of *Otoceras-Glyptophiceras* which ranges from Bed 52 to Bed 58 of Unit E_2 is characterised by *Eumorphotis venetiana* and *Eumorphotis* aff. *bokharica* with a few fragments of indeterminable *Claraia.*

The lowermost part of Unit E_3 (Beds 60, 61 and 62) is marked by the association of *Eumorphotis* and *Claraia* cf. *griesbachi*, the middle part by *Claraia concentrica*, and the uppermost part (Bed 70) by *Leptochondria minima. Concentrica*, however, occurs in the basal part of Member F at the neighbouring Spur (Horizon C10 of the third Spur, at the Guryul Ravine, Text Figure 4). The lowermost part of Member H (Bed 8) contains abundant shells of *Claraia decidens* and *Leptochondria minima*.

Based on the occurrences of bivalves, as mentioned above, the following zonation, of the Lower Triassic Khunamuh Formation (excepting Unit E_1) is possible in the ascending order (Table 23).

Zone of *Eumorphotis venetiana— Eumorphotis* aff. *bokharica,*

Zone of *Claraia* cf. *griesbachi—Eumorphotis multiformis,*

Zone of *Claraia concentrica,*

Zone of *Leptochondria minima* and

Zone of *Claraia decidens.*

The correlation of these zones with ammonoid and conodont zones is shown in Text Figure 13.

SYSTEMATIC DESCRIPTION

Subclass	Palaeotaxodonta	KOROBKOV,	1954
Order	Nuculoida	DALL,	1889
Superfamily	Nuculacea	GRAY,	1824
Family	Nuculidae	GRAY,	1824
Genus	*Nucolopsis*	GIRTY,	1911

Nuculopsis sp. ind. *a*

PLATE 9, Fig. 2

Material : Two internal moulds and several fragmental ones.

Description : Shell very small, less than 10 mm in length, sub-trigonal in shape, longer than high ; Taxodont teeth, partly preserved on both sides of the beak.

Dimensions :

Type No.	L	H	L/H	U	U/L	
GSI. 19369	7.8 mm	5.5 mm	1.42	4.7 mm	0.60	Pl. 9, Fig. 2
	4.3 mm	3.6 mm	1.20	2.7 mm	0.63	—

Remarks : Generic identification of the material is difficult due to lack of ligament area and shell-surface. The general configuration of this species differs somewhat from that of usual *Nuculopsis* in its relatively long outline and high position of the maximum length. In these respects it is similar to *Nucula* ? sp. described by Bittner (1899, p. 8, Pl. 1, Fig. 11) from the Otoceras beds of Shalshal cliff in the Himalaya, but the strict comparision is almost impossible.

Horizon and Locality : Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19369

Associated fossils : *"Palaeolima" middlemissi* n. sp., *Palaeoneilo* ? sp. *b* and small gastropods.

Nuculopsis ? sp. *b*

PLATE 9, Fig. 1

Material : Only a left ? external cast.

Description : Shell very small, 6.1 mm high and 6.7 mm long, subtrigonal in shape with subcentral umbo, slightly curved anterior margin, nearly straight posterior one and broadly rounded ventral one. Surface sculptured with regular concentric costae on the umbonal half and ropy, tuberculated ones on the ventral half.

Remarks : As the hinge is not known, the generic position of the specimen is uncertain. Identification is based only on the external shape. No comparable species having such charactersitic ornament could be found.

Horizon and Locality : Bed 27, Member C, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19368

Superfamily	Nuculanacea	ADAMS and ADAMS, 1858
Family	Nuculanidae	ADAMS and ADAMS, 1858
Genus	*Phestia*	CHERNYSHEV, 1951

Phestia sp. ind.

PLATE 9, Fig. 1

Material : Only a single, imperfect right valve.

Description : Right valve, 11.2 mm long and about 5.6 mm high. A part of the umbonal area broken and internal part not clarified. Shell extended laterally as long as twice of the height and tapering posteriorly. Posterodorsal area narrow and depressed, demarcated from the flank of the shell by rounded posteroumbonal ridge. Umbo situated at a little less than one third of shell-length from the anterior end. Surface covered by numerous, round-topped concentric costae intervening furrows of nearly equal strength, which fade away on the posteroumbonal ridge and posterodorsal area.

Remarks : The present species is referred to *Phestia* (including *Polydevcia* CHERNYSHEV) considering the shape and ornamentation. It resembles in the external features with that "*Nuculana*" *subacuta* WAAGEN (1886, p. 248, Pl. 20, Figs. 1 and 2) from the top of the Upper Productus Limestone and "*Leda*" cf. *speruncaria* GEINITZ reported by Diener (1903, p. 126. Pl. 5, Figs. 13 a, b) from the Productus Shales in Nihal. It, however, differs from the former in having more broadly rounded ventral margin, the lower position of the maximum length and more acute umbonal ridge. The species seems to be more allied to the latter, but it slightly differs in less arcuate umbonal ridge.

Horizon and Locality : Bed 31, Member C, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19370

Family Mallettiidae ADAMS AND ADAMS, 1858

Genus *Palaeoneilo* HALL AND WHITE, 1896

Palaeoneilo sp. *a*

PLATE 9, Figs. 4, 5

Material : 2 specimens.

Description : Shell small, elongate-ovate, moderately inflated ; umbo lying a little anterior to two-fifths of shell-length from the anterior end ; posterodorsal margin nearly straight, anterodorsal one slightly arcuate upward and united with the former making umbonal angle of 150 degrees ; posteroumbonal ridge rounded and indistinct ; anterior margin gently rounded, posterior one somewhat truncated and arcuate ; ventral margin broadly curved. Surface covered with numerous, weak, fine growth-lines. Lunule obscure, escutcheon absent. Hinge not observable.

Dimensions :

Type No.	L	H	U	L/H	U/L	
GSI. 19371	1.20 mm	7.0 mm	4.6 mm	1.71	0.38	Pl. 9, Fig. 4.

Remarks : Although the hinge could not be ascertained, the present form is referred to *Palaeoneilo*, since the general outline coincides very well with the type species of the genus, *P. constrica* (CONARD), but the materials are too poor for specific comparison.

Horizon and Locality : Bed 33, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19371, 19372

Associated fossils : *Aviculopecten* ? n. sp., "*Streblochondria*" sp., "*Palaeolima*" *middlemissi* and others.

Palaeoneilo sp. *b*

PLATE 9, Fig.6

Material : Only a left internal mould.

Description : Shell very small, considerably longer than high, being twice as long as the height, moderately inflated, tumid posteriorly ; umbo not prominent, slightly raised above

hinge margin, lying at a little anterior to anterior two-fifths of shell length ; anterodorsal margin slightly arcuate dorsally and posterodorsal one long and straight ; anterior margin well rounded, posterior one acutely rounded and pointed ; ventral margin gently arcuate. Lunule and escutcheon seemingly absent. Outer surface not preserved.

Dimensions :

Type No.	L	H	U	L/H	U/L	
GSI. 19373	6.7 mm	3.5 mm	2.5 mm	1.9	0.37	Pl. 9, Fig. 6.

Remarks : Small taxodont teeth are partly preserved in the anterior portion of the posterodorsal hinge-margin, but the chondrophore is not preserved. Hence, it is not certain whether the present specimen, be placed in *Phestia* or *Palaeoneilo*, but the general feature suggests its belonging to the latter genus.

Horizon and Locality : Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19373

Associated fossils : "*Palaeolima*" *middlemissi*, *Nuculopsis* ? sp. *a*, brachiopods and bryozoa.

Subclass Pteriomorphia BEURELEN, 1944

Order Pterioida NEWELL, 1965

Superfamily Pectinacea RAFINESQUES, 1815

Family Aviculopectinidae MEEK and HAYDEN, 1864

Subfamily Aviculopectininae MEEK and HAYDEN, 1864

Genus *Aviculopecten* GIRTY, 1903

Aviculopecten ? n. sp. ind.

PLATE 9, Figs. 7-8

Material : Two incomplete left valves.

Description : Shell small, moderately inflated, subequilateral, pteriomorph ; maximum convexity lying above midheight of shell ; both ears well developed, anterior one triangular, acutely pointed forward and slightly inflated, sharply defined from main body by sulcus ; posterior ear larger than the anterior one, wing-shaped, a little inflated, marked by shallow depression from main body and acutely projected posteriorly with sinuated posterior margin ; hinge-margin long and straight being as long as shell-length ; anterodorsal margin of disc slightly arcuate with concave side dorsally, posterodorsal one nearly straight ; the rest of shell-margin semi-circular ; umbo moderately inflated, orthogyrate, a little salient above hinge-margin, lying a little anterior to the middle of shell. Surface of disc sculptured with seven, narrow, acutely rounded, primary radial ribs separated by wide, flat interstices. where weak, thread-like secondary radials are inserted alternatingly ; growth-lines very weak, close-set ; anterior ear covered by only growth-lines, while posterior one provided with a few thread-like radial ornaments in addition to growth-lines. Ligament area not exposed.

Remarks : Relatively simple radial ornaments and pointed both ears remind one of those of *Acanthopecten*, but the present specimen is easily distinguised from *Acanthopecten* by the absence of both spinosity of radial ribs and periodic concentric fila characterstic for *Acanthopecten.* Due to the lack of right valve, it is impossible to determine whether this species belong to *Aviculopecten* or *Etheripecten. Etheripecten striatus* WATERHOUSE (1963, p. 195, Figs. 1-5) reported from the Permian of New Zealand is similar to this species in ornamentation, but easily distinguished by smaller ears and less symmetric outline. No other comparable species could be found, and the present species is considered to be a new form, but the materials are too poor to establish a new species.

Horizon and Locality : Bed 27, Member C, and Bed 33, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19374, 19375

Genus *Etheripecten* WATERHOUSE, 1963

Etheripecten haydeni NAKAZAWA, n. sp.

PLATE 9, Figs. 9-15

1915. *Aviculopecten* sp. ind., DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 2, p. 62, Pl. 6, Fig. 9.

Diagnosis : Shell medium, inequivalve with moderately convex left and nearly flat right valves, a little inequilateral, provided with large posterior ear and deep small anterior one, right anterior ear deeply incised below, surface of left valve marked by numerous radial ribs of three or four ranks attaining to more than 80 in total number but not so strongly differentiated, right valve sculptured with numerous, relatively uniform, radial ribs, increasing in number by insertion.

Material : Several specimens.

Description : Shell medium in size, maximum length attaining over 50 mm, inequivalve, a little inequilateral. Left valve moderately inflated, nearly as long as high ; umbo salient above hinge-margin with orthogyrate beak lying a little anterior to the middle of shell hinge-margin, straight, attaining to two-thirds of three-fourths of shell-length ; anterior ear smaller than posterior one, slightly inflated, provided with rounded anterior margin and sinuation below, distinctly marked off from main body ; posterior ear larger, depressed, not sharply defined from main body, extended posterodorsally but not reaching posterior extremity of shell, sinuated posteriorly ; main body subcircular, anterodorsal margin of which is a little arcuate dorsally and shorter than linear posterior dorsal margin ; ventral margin semicircular. Surface covered with numerous radial ribs and concentric ornaments ; radial ones classified into three or four ranks, primary one round-topped, reaching ten to fifteen in number in apical portion ; secondaries starting at very early growth-stage, several to 10 mm apart from beak, alternating with primaries and many of them becoming as strong as primaries in medial growth-stage ; tertiary ribs usually appearing some 20 mm apart from beak and sometimes growing as strong as those of higher ranks ; still weaker ribs inserted at several places near periphery ; wide primary ribs rarely striated by weak furrows, and the total number of radials amounting to 80 to 100 beyond the height of 40 mm ; both ears sculptured with weak radial ribs of similar strength, counting 6 to 10 in the anterior ear and 8-15 in the posterior one ; concentric sculpture consisting of close-set, fine, distinct costae, arching towards hinge-margin in interspaces, growing somewhat stronger in auricular portions.

Right valve nearly flat, provided with deep byssal notch below anterior ear ; main body sculptured with numerous, relatively uniform, radial ribs which increase the number by insertion ; sculpture of both ears being similar to that of left valve, but radial ribs of anterior ear being a little stronger and less in number than those of left valve.

Ligament area very slender ; ligament pit and musculature not observable.

Dimensions : (in mm.)

Type No.	Bed	L	H	L/H	U	U/L	Apical angle	Pl. 9 Fig.
GSI. 19377 (Holotype)	49a	44	45	0.68	20	0.45	115°	10
GSI. 19379	49a	33	36	0.92	17	0.50	110°	12, left
GSI. 19379	49a	43	48	0.90	18	0.42	100°	12, right
GSI. 19376	49a	50	44	1.13	21	0.42	107°	9
GSI. 19380	47b	33	31	1.06	13	0.39	90°	13
—	49a	37	33	1.12	14	0.38	110°	—
—	49a	53	45	1.18	23	0·45	—	—

Discussions : All the specimens were found in shales. These are more or less distorted and flattened by secondary forces. The radial ribs are, although, classified into three or four ranks, but it is not always easy to discriminate them due to rather irregular development of strength, especially in the later growth-stage.

Aviculopecten sp. ind. described by Diener (1915) from horizon (6) 25-10-06 of Hayden at the Guryul Ravine which corresponds to the same horizon as that of present species, belongs to this new species judged from the characterstic ornaments. The new species is undoubtedly closely related to *Aviculopecten hiemalis* reported by Diener (1897, p. 9, Pl. 5. Figs, 10 a-b, 11) from the Upper Permian Productus Shales of Niti area and Maslenikov (1935, p. 55, Pl. 1, Figs. 3-4) and Lutkevich and Lovanova (1960. p. 104, Pl. 15, Figs. 7-15) from the Upper Permian of northern region of U.S.S.R. The Himalayan *hiemalis*, the type of the species, is distinguished from the present species by larger length, fan-shaped outline and regularly differentiated radial ribs. The Russian *hiemalis* is different from the Himalayan species in taller and more circular outline, and the specific identification is questionable. In this respect the Russian species looks more like the present species, but differs in stronger primary ribs and more symmetrical outline. *Aviculopecten* sp. described by Diener (1903, p. 171, Pl. 8, Fig. 3) from the sandstone underlying the Kuling Shales in Spiti area is the other allied species in general outline and ornamentation. Although the species is distinguishable from the Kashmir species in having larger both the ears and weaker development of the second and third radial ribs. In this respect it is closest to the present species.

Distribution : Present sufficiently in Beds 48, 49a in Guryul Ravine and C2 (third Spur) of Guryul Ravine. Very rare in C5 (third Spur) ; a questionable fragment in Bed 52a of Unit E_2. Rare in Beds 48, 49 and 68 of Unit f_2 of the Spur three kilometres north of Barus.

Horizon and Locality : Beds 48, 49 of Unit E_1, Khunamuh Formation at Guryul Ravine. C2 of Unit E_1 at third Spur of the Guryul Ravine. Beds 48, 49 and 68 of Unit f_2, Member f, Khunamuh Formation at the Spur 3 kilometres north of Barus. Fragmental specimens of Bed 52a (Unit E_2) and C5 (Unit E_3) each represented by a single valve, may be derived fossils.

Specimen : GSl. Type Nos, 19376, 19377 (Holotype), 19378, 19379, 19380, 19381, 19382

Etheripecten sp. aff. *Etheripecten haydeni* NAKAZAWA

PLATE 9, Fig. 16

Material : A single left valve.

Description : Shell small, nearly equilateral, suboval in outline, moderately inflated, height slightly exceeding length ; umbo relatively prominent, salient above hinge-margin with orthogyrate beak lying at about anterior one-third of shell-length ; hinge-margin straight, ligament area partly preserved where three transverse grooves are impressed ; anterior ear only partly preserved, marked off from main body by distinct depression ; posterior ear wing-shaped, projected posteriorly but not exceeeding posterior end of shell, depressed and gradually continuing to posterior slope of main body ; posterodorsal margin of disc running linear, anterodorsal one slightly arcuate dorsally ; ventral margin semicircular. Surface covered with numerous radial ribs consisting of three ranks of different strength ; 15 primary ribs acutely rounded, starting from apical part and alternating with secondaries immediately after the appearance, some of the latter becoming as strong as primary ones so as to make somewhat irregular alternation ; tertiary ones very weak, inserted between stronger ribs in medial part near shell-margin ; concentric sculptures consisting of growth lines and wrinkles, the former of which show swinging dorsally in interstices.

Dimensions :

Type No.	L	H	L/H	Apical angle	
GSI. 19383	17.5 mm	18.7 mm	0.94	85°	Pl. 9. Fig. 16

Remarks : The material is represented by semi-internal mould of left valve. The sculptures of both the ears could not be observed, presumably very weak, if present. The species is very similar to *Etheripecten haydeni* n. sp. in general shape and ornamentation, but differs in more numerous primary ribs inspite of the fact that the total number of radials is 40, which are less than that of *haydeni* and attains to more than 50 in similar size. It also differs in smooth posterior wing.

Horizon and Locality : Bed 33, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19383

Etheripecten sp. aff. *Etheripecten hiemalis* (SALTER)

PLATE 9, Fig. 17

?1915. *Aviculopecten* cf. *hiemalis*, DIENER, *Palaeont. Indica*, Vol. 5, Pt. 2, p. 61, Pl. 6, Fig. 8.

Material : Two incomplete left valves from Bed 33 and an incomplete internal left mould from bed 51, which may belong to this species.

Description : Shell small, moderately inflated, nearly equilateral, fan-shaped, height nearly equal to length ; umbo not so prominent, terminating with orthogyrate beak lying at about middle of shell and slightly salient above hinge-margin ; anterior ear relatively large, sub-trigonal, pointed anterodorsally with an acute anterodorsal corner, slightly vaulted and clearly marked off form main body ; posterior ear partly preserved, presumably nearly equal

to anterior ear in size ; anterodorsal and posterodorsal margins of main body slightly arcuate drosally ; the rest shell-margin semicircular ; surface ornamented with radial ribs more or less differentiated into three ranks ; primary ones starting from beak, counting nine in number, slender and acutely round-topped, seperated by flat, wide interspace ; secondary ribs regularly alternating with primaries and in some cases becoming as strong as primaries ; faint tertiary ribs inserting sporadically between higher classes near ventral margin ; several weak concentric folds present ; growth-lines not preserved because of the internal mould. Ligament area and musculature not seen.

Dimensions :

Type No.	Bed	L	H	L/H	U	U/L	Apical angle	
GSI. 19384	33	12.5 mm	12.5 mm	1.0	6.2 mm	0.5	95°	Pl. 9, Fig. 17
	51	17.0 mm	15.5 mm	1.1	8.5 mm	0.5	95°	

Remarks : *Aviculopecten* cf. *hiemalis* described by Diener (1915) from Middlemiss's horizon (1) 10-10-09 is considered to be conspecific with this species. This horizon of Middlemiss is estimated to be located somewhere between Bed 23 and Bed 25 of Text Figure 2. All these specimens are very similar to *Aviculopecten hiemalis* SALTER from Niti. Judged from a close similarity with *Etheripecten haydeni* described above, *hiemalis* belongs most probably to *Etheripecten*, although its right valve has never been described. The Kashmir specimens seem to be somewhat shorter in outline than the type. Exact comparison is difficult due to poor and small materials.

Horizon and Locality : Bed 33, Member D, Zewan Formation and Bed 51, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19384

Genus *Eumorphotis* BITTNER, 1901

Eumorphotis multiformis (BITTNER)

PLATE 9, Figs. 20-21

1899. *Pseudomonotis multiformis* BITTNER, *Mem. Com. Geol.*, Vol. 7, No. 4, p. 10, Pl. 2, Figs. 12, 15-22 (non Figs. 13-14).

1937. *Pseudomonotis (Eumorphotis) venetiana*, HSU, *Bull. Geol. Soc. China*, Vol. 16, No. 1, p. 313, Pl. 1, Fig. 1.

1838. *Pseudomonotis (Eumorphotis) multiformis*, KIPARISOVA, *Trav. Inst. Geol. Acad. Sci. USSR.*, Vol. 7, p. 224, Pl. 2, Figs. 4, 5, 9-12 ; Pl. 3, Figs. 1-4.

1942. *Eumorphotis multiformis*, NEWELL and KUMMEL, *Bull. Geol. Soc. Amer.*, Vol. 53, p. 957, Pl. 2, Figs. 10-11.

1950. *Eumorphotis multiformis*, CHEN, *Quart. Jour. Taiwan Mus.*, Vol. 3, No. 2, p. 91, Pl. 1, Fig. 10.

1954. *Eumorphotis multiformis*, OZAKI and SHIKAMA, *Bull. Nat. Mus. Sci.* Vol. 1, No. 2, p. 43, Pl. 19, Figs. 1-6.

1955. *Eumorphotis multiformis shionosawensis* ICHIKAWA and YABE, *Trans. Proc. Palaeont. Soc. Japan*, NS, No. 10, p. 5, Pl. 2, Figs. 1-15.

1956. *Pecten* spp. A and B, YABE, *Rep. Tokyo Kyoiku Dagaku*, Sec. C, p. 290, Pl. 17, Figs, 11-12.

1962. *Eumorphotis multiformis*, YIN, *Acta. Geol. Sinica*, Vol. 42, No. 2, Pl. 1, Figs. 3-4.

1963. *Eumorphotis multiformis*, KAMBE, *Rep. Geol. Surv. Japan*, No. 198, p. 38, Pl. 1, Figs. 1-11, Pl. 2, Figs. 1-7.

1963. *Eumorphotis multiformis shionosawensis*, KAMBE, *Rep. Geol. Surv. Japan.*, No. 198, p. 40, Pl. 2, Fig. 8.

1963. *Eumorphotis multiformis*, CIRRIACKS, *Bull. Amer. Mus. Nat. Hist.*, Vol. 125, Art. 1, p. 77, Pl. 15, Figs. 13-15.

1971. *Eumorphotis multiformis*, NAKAZAWA, *Mem. Coll. Sci., Univ. Kyoto*, Ser. B, Vol. 72, No. 2, p. 117, Pl. 23, Figs. 7-12.

non 1913. *Pseudomonotis (Eumorphotis) multiformis*, DIENER, *Palaeont. Indica*, NS, Vol. 15, Pt. 1, p. 44, Pl. 5, Fig. 13.

1935. *Pseudomonotis (Eumorphotis) multiformis*, SPATH, *Medd. om Gronland*, Vol. 98, p. 47, Pl. 22, Fig. 8.

Material : Several specimens. Left incomplete valves.

Description : All the specimens, small, left incomplete valves being less than 20 mm in height. Shell moderately convex, ornamented with numerous radial ribs, consisting of three ranks. Primary ribs 12 to 15 in number alternating with secondary ones which start at about 10 mm apart from the beak. The tertiary riblets usually intercalated between the higher classes, one or two in each interspace.

Remarks : The present species may be identical with *Eumorphotis multiformis* in general shape and ornaments, although the present species slightly differs in smaller size and more numerous primary ribs which are 7 to 11 in typical *multiformis*. On the other hand the present species is somewhat similar to *Eumorphotis multiformis* reported from Greenland by Spath (1935), but the latter has still more numerous primary ribs, and more delicate radial ornaments. The Greenland species however may not be *multiformis*.

Horizon and Locality : Beds 61b, 62b and C5 ? (third Spur) of Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. Beds 61, and 64, Unit f_2, Member f, Khunamuh Formation, the Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19387, 19388

Eumorphotis venetiana (HAUER)

PLATE 9, Figs. 18-19

1850. *Avicula venetiana* VON HAUER, *Aabhand. Haidenger Naturw.*, Vol. 3, p. 2, Pl. 1, Figs. 1-3.

1868. *Avicula venetiana*, BENECKE, p. 11, Pl. 1, Fig. 19.

?1895. *Avicula venetiana*, SALOMON, *Palaeontograph.*, Vol. 42, p. 79., Pl. 4, Fig. 40.

1898. *Pseudomonotis (Avicula) venetiana*, BITTNER, *Jahrb. Geol. Reichs. Anst.*, Vol. 48, p. 712, Pl. 15, Figs. 2-4.

1906. *Pseudomonotis venetiana*, ARTHABER, *Lethaea Geognistica*, Pl. 34, Fig. 6.

1911. *Pseudomonotis venetiana*, WITTENBURG, *Neu Jahreb. f. Miner. usw.*, p. 29, Pl. 3, Fig. 7.

1925. *Pseudomonotis (Eumorphotis) venetiana*, DIENER, *Leitfossilen*, p. 26, Pl. 7, Fig. 2.

1927. *Pseudomonotis (Eumorphotis) venetiana*, OGLIVIE-GORDON, *Abh. Geol. Bundesanst.* Vol. 24, No. 1, p. 19, Pl. 3, Fig. 41.

1935. *Eumorphotis venetiana*, LEONARDI, *Mem. Inst. Geol. R. Univ. Padova*, Vol. 11, p. 59, Pl. 4, Fig. 6.

1965. *Eumorphotis venetiana*, VU KHUC et al., *Direct. Gener. de Geol. de la RDV Hanoi*, p. 25, Pl. 2, Fig. 11.

non 1935. *Pseudomonotis (Eumorphotis) venetiana*, HSU, *Bull. Geol. Soc. China*, Vol. 16, No. 1, p. 313, Pl. 1, Fig. 7 ; *(= Eumorphotis multiformis)*

Material : Several specimens.

Description : Shell rather small, less than 25 mm long, pteriomorph, a little higher than long ; anterior ear small, clearly marked from disc by furrow-like depression ; posterior one larger, not sharply defined, gradually depressed from disc, gently arcuate posteriorly or almost straight. Left valve fairly inflated with incurved, orthogyrate umbo situated between one-third and two-fifths of shell-length from frontalextremity ; maximum convexity lying at dorsal one-third of shell and maximum width being at or slightly below midheight. Surface ornamented with numerous, alternating radial ribs of two ranks attaining 40 to 55 in total number on main body ; very weak radial ribs of third order seen on marginal part ; those of both ears not clearly differentiated. Left valve flat and similary ornamented as in right valve ; deep byssal notch present below anterior ear.

Dimensions : (in mm ; n : number of radial ribs)

Type No.	Bed/Unit	L	H	L/H	U	U/L	n	Plate 9 Fig.
GSI. 19385	52(E_2)	14.2	14.7	0.96	6.0	0.42	40	18
GSI. 19386	52(E_2)	10.5	12.0	0.88	4.0	0.38	37	19
—	C5(E_3)	16.0	17.7	0.90	6.0	0.38	55+	—
—	60(f_2)	13.0	13.0	1.00	5.0	0.38	42	—
—	56(f_2)	7.5	9.3	0.80	2.5	0.33	42	—

Remarks : The present materials are identical with *Eumorphotis vanetiana* in outline and ornamentation. Many specimens have a little broader shape, with H/L ratio of about 10/9, than the type of ***venetiana***, but some are taller like typical specimens of *venetiana.*

Horizon and Locality : Beds 52b, 56, 60a and 61a, 61b of Unit E_3 ; also rarely in Beds 52a, 59b ? and C5 (3rd Spur) of Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. Beds 68, 69, Unit f_2, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19385, 19386

Eumorphotis sp. aff. *Eumorphotis bokharica* (BITTNER)

PLATE 9, Figs. 22-25

Compare :

1898. *Pseudomonotis bokharica* BITTNER, *Jahrb. Geol. Reichs. Anst.* Vol. 48, p. 719, Pl. 15, Fig. 1.

Material : Several specimens.

Description : Similar to *Eumorphotis bokharica* (BITTNER), having wide, gently rounded primary ribs alternating with much weaker secondary ones and relatively strong concentric sculpture. Sometimes the third ribs resulted from splitting of the primaries accompany on both sides of the latter.

Dimensions : (in mm)

Type No.	Bed/Unit	L	H	L/H	U	U/L	Plate 9,Fig.
GSI. 19389	61a(E_3)	13.5	14.9	0.91	5.6	0.41	28
GSI. 19392	68 (f_2)	14.5	17.2	0.84	6.1	0.42	25
GSI. 19390	52a(E_2)	11.2	9.6	1.17	5.0	0.45	23
GSI. 19391	58a(E_2)	13.8	16.7	0.83	6.4	0.46	—

Remarks : In the early growth-stage the species is almost identical with *bokharica*, but in the later stage it is distinguished from the latter in more differentiated radial ribs and presumably taller shape of shell.

Horizon and Locality : Beds 52a and 58a of Unit E_2 and Beds 61a and 64 ? of Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. Bed 68, Unit f_2, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19389, 19390, 19391, 19392

Genus *Leptochondria* BITTNER, 1899

Leptochondria minima (KIPARISOVA)

PLATE 10, Figs. 2-5

1899. *Pecten (Leptochondria ?)* ex aff. *alberti*, BITTNER, *Mem. Com. Geol.*, Vol. 7, No. 4, p. 6, Pl. 2, Figs. 1-2, 4-10, 13?, 14?.

1913. *Pseudomonotis (Eumorphotis) tenuistriata*, DIENER, *Palaeont. Indica*, NS, Vol. 5, No. 2, p. 44, Pl. 5, Fig. 11.

1928. *Pseudomonotis* cf. *iwanowi*, YAHARA, *Japan Geol. Geog.*, Vol. 5, p. 170, Pl. 16, Figs. 13-14.

1935. *Pseudomonotis tenuistriata*, PATTE, *Paleont. Sinica*, Ser. B, Vol. 15, Pt. 2, p. 25, Pl. 3, Figs. 7-8.

1938. *Velopecten minimus* KIPARISOVA, *Trav. Inst. Geol. Akad. USSR*. Vol. 1, Pl. 4, Figs. 10, 12 a-b ; Pl. 5, Figs, 1-6 (incl. var. *laevis* and *reticulatus*).

1954. *Pecten (Velopecten) minimus*, KIPARISOVA, *Field Atlas Triassic fauna and flora*, p. 12, Pl. 3, Figs. 3-7.

1961. *Leptochondria ? minima*, NAKAZAWA, *Mem. Coll. Sci. Univ., Kyoto*. Ser. B, Vol. 27, No. 3, p. 260, Pl. 12, Figs. 16-17.

1963. *Eopecten minimus*, KAMBE, *Rep. Geol. Surv. Japan*, No. 198, p. 47, Pl. 5, Figs. 17-21.

1971. *Leptochondria minima*, NAKAZAWA, *Mem. Fac. Sci., Kyoto Univ. Ser. Geol. Miner.*, Vol. 38, No. 1, Pl. 23, Figs. 13-14.

Material : Many specimens.

Description : Shell small, oval, nearly equilateral, inequivalve with gently inflated left valve and flat right one, height nearly equal to or slightly larger than length ; maximum convexity of left valve lying at about a third of height below the dorsal margin and maximum length between midheight and upper two-thirds of shell ; umbo not prominent, subcentral, only slightly salient above hinge-margin ; both ears of left valve small, obtusely triangular, gradually depressed from main body and not sharply defined ; hinge-margin straight and short being about a half of shell-length. Surface covered with numerous, fine, relatively uniform radial ribs increasing the number by insertion and reaching more than 60 at the full grown stage, some of radial ribs becoming stronger than the others ; concentric growth-lines very weak and closely set.

Dimensions : (in mm)

Type No.	Bed	L	H	L/H	U/L	Plate 10.
GSI. 19394	75(F)	9.0	8.6	1.04	0.38	Fig 5
—	—	9.0	9.0	1.00	0.44	—
—	—	10.3	9.7	1.06	0.39	—
—	—	7.0	6.7	1.04	0.46	—
GSI. 19395	75(F)	8.0	9.0	0.90	0.40	Fig 4
—	—	9.8	10.7	0.92	0.49	—
—	—	10.0	10.3	0.97	0.50	—
—	—	11.2	11.8	0.95	0.43	—
—	Pastun	8.0	9.0	0.90	0.50	—
—	—	8.5	9.3	0.91	0.44	—
—	—	8.5	8.5	1.00	0.47	—

Remarks : The ornamentation of the present species is somewhat variable. In many of the Guryul Ravine specimens, several radial ribs grow a little stronger than the others and look like primary ribs. This form is very similar to the Japanese specimens collected from Meekoceras beds (Nakazawa, 1971). In some specimens ornaments are relatively uniform, but in others irregular in strength ; those collected from the "Ophiceras" beds of Pastun have relatively uniform ornaments. There are many varietal forms in the topotype specimens in Ussuri (Kiparisova, 1938) and minor differences mentioned above are considered to be infraspecific variation.

Horizon and Locality : Bed 52a (rare), Unit E_2, Bed 70 (rare), Unit E_3, Bed 75 (common) of Member F and Bed 88 (abundant) of Member H, C6 (third Spur) of Unit E_3 ; Khunamuh Formation, Guryul Ravine. Common in the so-called "Ophiceras" beds of Pastun.

Specimens : GSI. Type Nos. 19394, 19395

Genus *Fasciculiconcha* NEWELL, 1938

Fasciculiconcha ? sp. ind.

PLATE 10, Fig. 1

Material : A single, incomplete, left internal mould.

Description : Specimen lacking in posterior ear and posteroventral part of the main body. Disc fan-shaped, gently convex ; anterior ear relatively large, subtrigonal and strongly projected anteriorly ; surface covered with nine, flat, broad primary ribs alternating with much slender secondary ones. Judged from the internal mould and the external cast preserved at the periphery, the primary ribs provided with several furrows making 4 to 5 bundled riblets.

Remarks : Fasciculated primary ribs of this species remind one of those of Pennsylvanian *Fasciculiconcha.* However, the details of the ornamentation is uncertain, because most part of the shell is a internal mould, and the generic position is tentative. Similar ornamentation to this species is also observed in the Middle Permian *Etheripecten ? hayasaki* (MURATA) (1964, p. 219, Pl. 34, Figs. 3-9), but it is in the right valve, unlike the Kashmir species.

Horizon and Locality : Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19393

Subfamily Streblochondriinae NEWELL, 1938

Genus *Streblochondria* NEWELL, 1938

"*Streolochondria*" sp. ind.

PLATE 10, Figs. 8-9

Material : Several specimens.

Description : Shell small, ovate in shape, subequilateral, subequivalve, opisthocline in later growth stage, a little extended anteriorly ; height slightly exceeding length ; dorsal margin short and straight, less than a half of shell-length ; anterodorsal margin of disc slightly arcuate with concave side dorsally while posterodorsal one convex dorsally and making apical angle of about 90 degrees with the former. Anterior ear about twice as long as posterior one ; left anterior ear obtusely triangular and right anterior one provided with shallow byssal sinus ; posterior ear of both valves very small, obtusely triangular, obscurely defined from disc ; umbo not prominent, hardly salient above hinge-margin ; surface nearly smooth, only sculptured by fine, close-set growth-lines ; hinge unknown.

Dimensions : (in mm)

Type No.	Bed	L	H	L/H	U	U/L	Apical angle	Plate 10,
GSI. 19398	27	23.5	24.7	0.95	13.0	0.55	87°	Fig. 8
GSI. 19399	27	20.0	20.5	0.98	11.3	0.56	90°	Fig. 9
—	27	10.7	11.5	0.93	5.0	0.47	90°	—
—	27	9.2	8.5	1.08	5.0	0.54	92°	—

Remarks : The genus *Streblochondria* is characterised by reticulate ornaments (Newell, 1938, p. 80) and distinguished from the genus *Streblopteria* M'COY with smooth shell. The present species has a nearly smooth shell, but is considered to be more closely related to *Streblochondria* in more clearly defined posterior ear much smaller than the anterior one, since the type species of *Streblopteria* has a much larger posterior ear than the anterior one. The Kashmir species is very similar to *'Avicula' sericea* VERNUIL and *'Discites' pusillus* SCHLOTHEIM which have variously been identified as *Pecten*, *Pseudamusium*, *Streblopteria* and others. All these forms make a distinct group, which may be included in a new genus in the future (Nakazawa, 1971).

The present species differs from *sericea* in less anteriorly extended outline and less broad shell, and from *pusillus* in larger size and more inequilateral shape. *Entolium aviculatum* (SWALLOW) described by Reed (1944, p. 311, Pl. 54, Fig. 5) from the top of the Upper Productus Limestone belongs most probably to the same genus as this species but distinct from the latter in the more symmetrical shape.

Horizon and Locality : Bed 27, Member C, Bed 33 and 45, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19398, 19399

Genus *Cyrtorostra* BRANSON, 1930

Cyrtorostra sp. aff. *Cyrtorostra lunwalensis* (REED)

PLATE 10, Figs. 6-7

Compare :

1944. *Blanfordinia lunwalensis* REED, *Palaeont. Indica*, NS, Vol. 23, Pt. 2, p. 313, Pl. 55, Figs. 4-7.

Material : Several specimens.

Description : Shell small, ovate in shape, subequilateral, subequiconvex, with a little more inflated left valve than right ; umbo prominent, salient above hinge-margin, orthogyrate, lying a little anterior to midlength ; hinge-line short, about a half of shell-length ; left anterior ear trigonal, depressed, sharply defined from disc ; posterior ear small, obtusely triangular, not so sharply marked from main body ; right anterior ear not well preserved, provided with byssal notch. Surface sculptured with two kinds of radial ribs, that is, broad, gently rounded ribs and alternating riblets, each 11 to 12 in number, of which the former has dorsally curved growth-lamellae and the latter projected ventrally.

Remarks : The present species is most allied to *Blanfordinia lunwalensis* REED of the Middle Products Limestone of the Salt Range. It differs from the latter in its much smaller size (about a half of the latter), presumably more symmetric shape and less prosogyrate umbo. This species might be a dwarfed survival of *lunwalensis*. *Oxytoma laevicostatum* NETSCHAJEW reported by Diener (1903, p. 170, Pl. 8, Fig. 10) from the Kuling Shales and the underlying sandstone in Spiti, *Oxytoma atavum* WAAGEN (1881, p. 287, Pl. 20, Figs. 6-7) of the Middle Productus Limestone, and *Aviculopecten subexoticus* WAAGEN (1881, p. 309, Pl. 23, Figs. 6 a-c) of the Upper Productus Limestone in the Salt Range are all referred to *Cyrtorostra*. The first and third species have broader and more circular outline than the Kashmir species, and the second species has much more strongly projected riblets.

Horizon and Locality : Bed 45 of Member D, Zewan Formation and Beds 47a, 48a and 49a of the Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. Bed 51 of Unit f_1, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19396, 19397

Family Pseudomonotidae NEWELL, 1938

Genus *Claraia* BITTNER, 1901

The species of *Claraia* from Kashmir have already been discussed and described in a separate paper (Nakazawa, 1977) together with those from Iran, and will include only brief remarks in the followings pages.

Claraia sp. aff. *Claraia extrema* SPATH

PLATE 10, Fig. 10

Compare :

1935. *Pseudomonotis (Claraia) extrema* SPATH, *Meddl. om Gronland*, Vol. 83, No. 1, p. 21, Pl. 20, Fig. 10 ; Pl. 21, Fig. 2.

1963. *Claraia extrema*, CIRIACKS, *Bull. Amer. Mus. Nat. Hist.*, Vol. 125, Art. 1, p. 79, Pl. 15, Figs. 5-6.

1969. *Pseudomonotis (Claraia) clarai*, STEPANOV et al , *Rep. Geol. Surv. Iran*, No. 12, Pl. 15, Figs. 1-2.

1977. *Claraia extrema*, NAKAZAWA, *J. Pal. Soc. India, Orlov. Mem.* Vol. 20, p. 198, Pl. 1, Figs. 6-8.

Material : A left valve.

Remarks : This species is represented by single left valve. It is similar to *Claraia extrema* sculptured by concentric wrinkles, reduced radial ribs and obscure posterior ear. *Claraia extrema* described by Ciriacks (1963) from the upper Lower Triassic Thaynes Formation of Nevada differs from the Griesbachian type species of Greenland in developing concentric wrinkles on the umbonal part, more numerous concentric folds, more reduced radial ribs and more elongate shell-form. New subspecific name, *ciriacksi* was proposed for this (Nakazawa, 1977). The Kashmir specimen is more similar to *extrema* s. s. in shell-outline than *ciriacksi*, but distinguished from those two forms in lacking radial ornament excepting several thread-like radial striae.

Horizon and Locality : Bed 62a, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19400

Claraia dieneri NAKAZAWA

PLATE 10, Figs. 11-13

1963. *Claraia stachei*, DICKINS and MCTAVISH, *J. Geol. Soc. Aust.* Vol. 10, p. 132, Pl. 2, Fig. 1.

1977. *Claraia dieneri* NAKAZAWA, *J. Pal. Soc. India., Orlov. Mem.* Vol. 20, Pl. 1., p. 198-199, Fig, 9 ; Pl. 2, Figs. 1-3.

Material : Several specimens.

Remarks : This species is characterised by large size, 50 mm long and 46 mm high in the largest specimen, and development of concentric wrinkles and radial ribs which becomes obsolete in the later growth stage. In the early stage it is allied to *Claraia clarai* (EMMRICH), but differs in not clearly defined posterior ear. *Claraia perthensis* DICKINS and MCTAVISH (1963, p. 131, Pl. 1, Figs, 2-7, non 8-9) from Western Australia is similar to the present species in shell shape and size, but can be distinguished in weaker radial ornament and lack of concentric folds.

Horizon and Locality : Bed 59a, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19004 (Holotype), 19401, 19402

Claraia bioni NAKAZAWA

PLATE 10, Figs. 17-19 ; PLATE 11, Figs. 1-3

1915. *Pseudomonotis* sp., DIENER, *Paleoant. Indica,* NS, Vol. 5, Pt. 2, p. 59, Pl. 6, Fig. 1.

1970. *Claraia stachei,* NAKAZAWA et al., *Mem. Fac. Sci., Kyoto Univ. Ser. Geol. Miner.*, Vol. 37, No. 2, p. 168, Pl. 29, Figs. 4-5.

1977. *Claraia bioni* NAKAZAWA, *J. Pal. Soc. India., Orlov. Mem.*, Vol. 20, p. 200-201, Pl. 2, Fig. 12, Pl. 3, Figs. 1-4.

Material : Several specimens.

Remarks : The present species is closely allied to *Claraia stachei* described by Spath (1930, p. 46, Pl. 9, Figs. 1 a-d ; Pl. 10, Figs. 5 a, b) from Greenland and by VuKhuc et al. (1965, p. 23, Pl. 1, Figs. 1-3) from north Viet-Nam, in shape numerous radial ribs and obscure posterior ear. It was first referred to *stachei* by Nakazawa et al. (1970), but later treated

as a new species *Claraia bioni* by Nakazawa (1977). The species is distinguished from *stachei* in having less inflated left valve, less prominent umbo and minutely waved radial ornament. *Pseudomonotis* sp. of Diener (1915) accompanied with *Xenodiscus* cf. *carbonarius* at the Spur three kilometres north of Barus is identical with *bioni*. This is the earliest and the only so far known Permian *Claraia*, and is considered here to be the ancestral form of *C. stachei* group. The radial ribs are variable in strength and number, which ranges from 28 to more than 50, in total.

Horizon and Locality : Beds 48, 49, 50, 51 of Unit E_1, and Bed 52b ? of Unit E_2, Khunamuh Formation, Guryul Ravine. Beds 49, 50, 51 of Unit f_2, Member f, Khunamuh Formation, the Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19005 (Holotype), 19406, 19407, 19408, 19409, 19410

Claraia concentrica YABE

PLATE 10, Figs. 14-16

1908. *Pseudomonotis (Aviculopecten) griesbachi*, MANSUY, *Pal. Serv. Mines. Hanoi.*, p. 62, Pl. 16, Figs. 4-5.

1928. *Pseudomonotis (Claraia) griesbachi* var. *concentrica* YABE, Jap. J. Geol. Geogr. Vol. 6, Pt. 2, p. 310, Pl. 1, Figs. 4, 4a.

1935. *Pseudomonotis* sp. aff. *griesbachi*, PATTE, *Pal. Sinica*, Ser. B, Vol. 15, Pt. 2, p. 24, Pl. 2, Fig. 6, (non 1-5).

1950. *Pseudomonotis (Claraia) griesbachi concentrica*, CHEN, *Quart. Jour. Taiwan Mus.*, Vol. 3, No. 2, p. 89, Pl. 1, Fig. 1.

1968. *Claraia griesbachi concentrica*, TAMURA, *Geol. Palaeont.* SE Asia, Vol. 5, p. 78, Pl. 11, Figs. 1-14.

1974. *Claraia concentrica*, CHEN et al , *Nanking Inst. Palaeont. Acad. Sinica*, p. 328, Pl. 173, Figs. 12-13.

1974. *Claraia aurita*, CHEN et al., *Nanking Inst. Palaeont. Acad. Sinica*, p. 328, Pl. 174, Figs. 17, 18, 21, 24.

1977. *Claraia concentrica*, NAKAZAWA, *J. Pal. Soc. India, Orlov. Mem.*, Vol. 20, p. 201, Pl. 3, Figs. 9-11.

Material : Several specimens.

Remarks : Claraia concentrica is characterised by regular, close-set concentric costae with no radial ornament. The strength and number of concentric costae are variable ; in some specimens the costae are relatively distantly arranged (Pl. 10, Figs. 14, 15) while in the other ones they are closely set (Pl. 10, Fig. 16) and as strong as interstitial furrows.

Horizon and Locality : Beds 66, 67, 68 of Unit E_3, Member E, Beds 67, 68, 77, 79 of Unit f_2, Member f, Khunamuh Formation at Guryul Ravine and the Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19403, 19404, 19405

Claraia sp. cf. *Claraia griesbachi* (BITTNER)

PLATE 11, Figs. 4-5

Compare :

1899. *Pseudomonotis griesbachi* BITTNER, *Palaeont. Indica*, Ser. 15, Vol. 3, Pt. 2, p. 2, Pl. 1, Figs. 1-4.

1907. *Pseudomonotis griesbachi*, FRECH, *Lethaea Mesozoica*, p. 21, Pl. 6, Fig. 5.

1937. *Pseudomonotis (Claraia) griesbachi*, HSU, *Bull. Geol. Soc. China*, Vol. 16, No. 1, p. 308, Pl. 1, Figs. 2-4.

1977. *Claraia* sp. cf. *griesbachi*, NAKAZAWA, *J. Pal. Soc. India, Orlov. Mem.*, Vol. 20, p. 201, Pl. 3, Figs. 13-14.

non 1913. *Pseudomonotis (Claraia) griesbachi*, DIENER, *Palaeont. Indica.* NS, Vol. 5, Pt. 1, p. 41, Pl. 5, Figs. 8.

Material : Several specimens.

Remarks : Due to secondary deformation of shells, specific determination is difficult, however, this species is comparable with *Claraia griesbachi* in its nearly smooth shell and ovate outline. Original figures of Bittner (1899) are somewhat inaccurate, as such the photographs taken by the writer are shown in Plate 11 (figures 6-8) for the convenience of the workers. Bittner's figure 2 of Plate 1 (1899) has illustrated longer than actual, while in the specimen abyssal notch of the right valve is deeper and more arcuate (Pl. 1, Fig. 4) and is more similar to that of the typical *Claraia.*

Horizon and Locality : Beds 60 and 61, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19411, 19412

Claraia decidens (BITTNER)

PLATE 11, Figs. 9-13

1899. *Pseudomonotis decidens* BITTNER, *Palaeont. Indica*, Ser. 15, Vol. 3, Pt. 2, p. 11, Pl. 1, Figs. 22-24.

1913. *Pseudomonotis (Claraia) decidens*, DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 1, p. 43, Pl. 5, Figs. 14 a-c.

1977. *Claraia decidens*, NAKAZAWA, *J. Pal. Soc. India, Orlov. Mem.*, Vol. 20, p. 201-202, Pl. 3, Figs. 15-19.

Material : Many specimens.

Remarks : As previously discussed (Nakazawa, 1977), the group of *Claraia decidens* consisting of *decidens*, *painkhandana*, *punjabiensis*, and *australasiatica* is an isolated group among *Claraia* in having tall and strongly inflated left valve. *Claraia decidens* collected from Meekoceras beds (Member H) of Kashmir shows a considerable variation of shape of the shell. The tall form (Pl. 11, Fig. 13) is similar to *painkhandana*, while subsymmetric form (Pl. 11, Fig. 9) looks very much like *punjabiensis.* The abberant form of the umbo noticed by Bittner (1899) is also found in this collection (Pl. 11, Fig. 10). All these forms are considered here to be infraspecific variations.

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine. Also from "Ophicras" beds, Pastun.

Specimen : GSI. Type Nos. 19413, 19414, 19415, 19416, 19417

Claraia n. sp. indet.

PLATE 11, Figs. 14-17, 18 ?, 19 ?

Material : Several specimens from Guryul Ravine, a Spur 3 kilometres north of Barus and Pahlgam.

Description : Shell small, subcircular in shape, inequivalve, length nearly equal to height ; hinge-line short, about two-third of shell-length ; left anterior ear small, subtrigonal, depressed, not well defined from disc ; right anterior ear roundly quadrangular, deeply incised below ; posterior ear obscure with rounded posterior margin ; surface sculptured with radial ribs and concentric ornament ; radial ribs weak ; usually limited to medial part of shell, more or less wrinkled and interrupted by concentric ornaments consisting of widely spaced ridge and furrow ; growth-lines very weak.

Dimensions : (in mm ; n_1 : number of radial ribs ; n_2 : number of concentric ridges)

Type No.	L	H	L/H	U	U/L	n_1	n_2	Pl. 11
GSI. 19419	17	16	1.06	5.7	0.33	20	5+	Fig. 15
GSI. 19420	11	12	0.99	2.8	0.25	14	7	Fig. 16
GSI. 19420	21	25	0.84	8.0	0.38	8	13	Fig. 17
GSI. 19418	22	20	1.10	7.6	0.36	0	7	Fig. 14
—	12	12	1.00	4.0	0.33	13	6	—

Remarks : The specimens are all strongly deformed secondarily and wrinkled sculpture may be partly caused by later tectonic forces. The radial ribs are variable in number and strength. Some specimens (Pl. 11, Figs. 18-19) are almost lacking in concentric sculpture and are doubtful to be placed in the same species. The present species is closely allied to *Claraia fukianensis* CHEN et al. (1974, p. 327, Pl. 173, Figs. 8-9) described from the Lower Triassic of South China in its characterstic ornamentation, but the latter has more symmetrical outline, subcentral umbo and stronger concentric ornament.

Horizon and Locality : Bed 62a, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. Bed 68, Unit f_2, Member f, Khunamuh Formation, the Spur 3 kilometres north of Barus. Claraia beds, Pahlgam.

Specimen : GSI. Type Nos. 19418, 19419, 19421, 19422 (Pahlgam) ; 19420, 19423 (Guryul Ravine).

Superfamily Pteriacea GRAY, 1847

Family Pteriidae GRAY, 1837

Genus *Pteria* SCOPOLI, 1777

Pteria sp. aff. *Pteria ussurica yabei* NAKAZAWA

PLATE. 11, Fig. 23

Compare :

1954. *Gervilleia* cf. *exporrecta*, OZAKI and SHIKAMA, *Bull. Nat. Sci. Mus.*, Vol. 1, No. 2, p. 44, Text-Figs. 1-3.

1956. *Bakevellia ussurica* var. *rostrata* YABE, *Japan Sci. Rep. Tokyoto Kyoiku Daigachu*, Sec. C, No. 34, p. 288, Pl. 17, Figs. 1-9 (non Fig. 10).

1959. *Pteria ussurica yabei* NAKAZAWA, *Mem. Coll. Sci., Univ. Kyoto Univ.*, Ser. B, Vol. 26, No. 2, p. 198, Text-Fig. 2, Pl. 3, Figs. 1-3.

1963. *Pteria ussurica yabei*, KAMBE, *Rep. Geol. Surv. Japan*, No. 198, p. 42, Pl. 4, Figs. 17-30 ; Pl. 5, Figs. 1-8.

Material : An incomplete left valve.

Remarks : Single valve is 8 mm in height and has been referred to *Pteria* in general features. The species is allied to *Pteria ussurica yabei* NAKAZAWA commonly found in Owenitan limestone of Japan, but is distinguished in its weaker concentric sculpture.

Horizon and Locality : Bed 61 b, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19427

Superfamily Limacea RAFINESQUE, 1815

Family Limidae RAFINESQUE, 1815

Genus *Palaeolima* HIND, 1903

"*Palaeolima*" *middlemissi* NAKAZAWA n. sp.

PLATE 11, Figs. 25-27

Diagnosis : Shell very small, equivalve, inequilateral, extending anteroventrally triangularly ovate, surface sculptured with weak, uniform, round-topped radial ribs becoming obsolete in umbonal and posterior portions, both ears very small, obtusely triangular, not sharply defined from main body, internal shell-margin being smooth.

Material : Several specimens.

Description : Shell very small, less than 8 mm in height, equivalve, inequilateral, ovate in shape, higher than long, extended anteroventrally, moderately inflated ; anteroumbonal ridge distinct and well rounded, anteromarginal surface making about 90 degrees with main shell surface ; both ears obtusely triangular ; anterior one very small and depressed ; hinge-line short ; umbo moderately inflated, a little prosogyrate ; surface ornamented with weak radial ribs with round top, intervening radial furrows of similar size ; radial ribs becoming obsolete in umbonal and posterior portions of shell, attaining twenty and several in number ; shell relatively thick, without internal crenulation. Both valves presumably closed with no gap.

Discussions : This species is similar to the genus *Palaeolima* but differs in developing umbonal ridge, obscure anterior ear and less oblique outline. It also resembles *Plagiostoma* in ornamentation, but the latter genus is generally much larger, more oblique in shape and usually longer than high. The generic status of this species is, therefore, uncertain and has been tentatively placed with *Palaeolima.* Among the Permian limids, the Lower Permian *Plagiostoma* ? sp. nov. reported by Dickins (1963, p. 93, Pl. 15, Figs. 1-5) from West Australia, is most similar to this species, but it has more numerous, stronger radial ribs, more projected umbo above hinge-margin and the shape is subtrigonal rather than ovate.

Horizon and Locality : Beds 27, 31 (Member C), Beds 33, 43, 45 (Member D) of Zewan Formation, Beds 47b, 48a, 49b (Unit E_1, Member E) of Khunamuh Formation, Guryul Ravine. Bed 31 (Member e), Zewan Formation at the Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19431 (Holotype), 19429, 19430

Superfamily Ambonychiacea MILLER, 1877

Family Myalinidae FRECH, 1891

Genus *Promyalina* KITTLE, 1904

Promyalina sp. indet. *a*

PLATE 11, Figs. 20-21

Material : Two internal moulds represented by a left and a right valve.

Description : Shell small, oblique, mytiliform, posteroventrally extended, strongly inequilateral, subequivalve ; umbo terminal, prosocline ; anterior ear absent, posterior ear ill defined, higher than long ; umbonal ridge demarcating anterior marginal area not sharp, hinge not exposed.

Dimensions : (in mm ; a : angle between hinge-margin and longest axis, l : hinge-length)

Type No.	L	H	L/H	a	l	Plate 11
GSI. 19424	9.3	8.0	1.16	43°	7.0	Fig. 20 left valve
GSI. 19425	9.5	8.5	1.12	45°	5.0	Fig. 21 right valve

Remarks : Angulation of anterior marginal area with the main body is more acute in the right valve than in the left. Because the hinge character could not be confirmed, the generic reference is somewhat uncertain. However, they are externally very similar to *Promyalina* KITTLE and *Selenimyalina* NEWELL. The latter is referred to be an ancestral form of the former. *Promyalina* is here preferred for the Kashmir specimens mainly because the genus flourished in Early Triassic, while *Selenimyalina* is confined to the Carboniferous. The present species is most similar to *Promyalina putiatinensis* (KIPARISOVA) (1938, p. 292, Pl. 6, Fig. 10-12) but can be distinguished in having more oblique outline and smaller size.

Horizon and Locality : Bed 53b, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19424, 19425

Promyalina sp. indet. *b*

PLATE 11, Fig. 22

Material : A small, left valve.

Description : It is distinguished from the preceeding species in the less oblique and taller outline, being 6 mm long and 6 mm high. Anterior marginal area is not sharply marked off from the main body.

Remarks : From the characters referred to above, this is most allied to *Promyalina schamarae* (BITTNER) (1899, p. 19, Pl. 4, Figs. 20-25) of the Ussuri region, but it has a little different outline and much smaller shell. More materials will be required for the specific determination.

Horizon and Locality : Hor. C7, Unit E_2, Member E, Khunamuh Formation at the third Spur, Guryul Ravine.

Specimen : GSI. Type No. 19426

Subclass Palaeoheterodonta NEWELL, 1965

Order Trigonioida DALL, 1889

Superfamily Trigoniacea LAMARCK, 1819

Family Myophoriidae BRONN, 1849

Genus *Schizodus* DE VERNUIL AND MURCHISON, 1844

Schizodus ? sp. indet.

PLATE 11, Fig. 28

Material : A left, external valve.

Remarks : The interior part could not be exposed. The generic position is, however, based solely on the outer features. It is somewhat similar to *Schizodus rotundatus* BROWN reported by Waagen (1881, p. 233, Pl. 19, Figs. 11-12) from the Upper Products Limestone of Salt Range in having subquadrate shape and rounded posterior carina. Specific determination is, however, almost impossible due to poor material.

Horizon and Locality : Bed 43, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19432

Subclass	Heterodonta	NEUMAYR, 1884
Order	Veneroida	ADAMS and ADAMS, 1856
Superfamily	Carditacea	FLEMING, 1820
Family	Permophoriida	POEL, 1959
Genus	*Permophorus*	CHAVAN, 1954

Permophorus sp. cf. *Permophorus subovalis* (WAAGEN)

PLATE 11, Figs. 29-30

Compare :

1881. *Pleurophorus subovalis* WAAGEN, *Palaeont. Indica,* Ser. 13, Vol. 1, Pt. 3, p. 219, Pl. 18, Figs. 2-3.

Material : A left internal mould and several incomplete individuals.

Description : Shell small, elongated transversally, subquadrangular, umbo subdued lying subterminal ; low and rounded ; umbonal ridge running from beak to posteroventral corner. A lateral socket and a less pronounced lateral tooth can be seen along the dorsal margin, and a trace of myophurus buttress behind the anterior muscle scar is also observed ; lunule and escutcheon unknown. Surface covered with fine growth-lines and periodic concentric costae.

Remarks : Although the materials are poor, the present species is considered to belong to *Permophorus* from the above mentioned characters. It is compared to *Permophorus subovalis* (WAAGEN) described from the Upper Productus Limestone with respect to general outline, but the detailed comparision could not be achieved.

Horizon and Locality : Bed 27 ?, Bed 31, Member C, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19433

Superfamily	Crassatellacea	FÉRUSSAC, 1822
Family	Astartidae	D'ORBIGNY, 1844
Genus	*Astartella*	HALL, 1858

Astartella ? progrenitrix (WAAGEN)

PLATE 11, Fig. 24

1880. *Lucina progrenitrix* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 3, p. 264, Pl. 35, Figs. 14 a-d, 15 a-d.

1975. "*Loripes*" *atavus*, NAKAZAWA et al., *Mem. Fac. Sci., Kyoto Univ., Ser. Geol. Miner.*, Vol. 42, Pt. 1, p. 36, Table 8, p. 58.

Material : A single complete left valve and a few fragmentary specimens.

Description : Shell very small, 8 mm long and 8 mm high, subcircular, moderately inflated ; umbo central with pointed prosogyrate beak, lunule and escutcheon sharply excavated ; anterodorsal margin slightly concave dorsally, posterodorsal margin gently arcuate with convex side upward, ventral margin semicircular ; surface ornamented with fine, close-set concentric costae amounting to 17 in total numbers. Internal characters not observable.

Remarks : Nakazawa et al. (1975) listed earlier this specimen as "*Lorpis*" *atavus* WAAGEN based on external similarity, however the slightly truncated shape of the posterior margin of this material suggests its revision to *Lucina progrenitrix* WAAGEN.

Waagen (1881) stressed the presence of internal ligament of the former species, based on the groove behind the posterior cardinal tooth, which was considered to be ligament groove by Waagen. But it is most probably a lateral socket receiving a slender lateral tooth of the opposite valve. The anterior cardinal tooth is seemingly fused with short, anterior lateral tooth. Although, it cannot be decided until the right interior is examined, the known characters, however, indicate that the present species may belong to *Astartella.* Kashmir specimens are identical with the species *progrenitrix* described from the top of the Upper Productus Limestone of the Salt Range.

Horizon and Locality : Bed 43, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19428

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PLATE 9

Fig. 1 *Nuculopsis* ? sp. indet. *b.* × 3.

Left valve. Bed 27, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19368.

Fig. 2 *Nuculopsis* sp. indet. *a.* × 3.

Left internal mould. Bed 49, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19369.

Fig. 3 *Phestia* sp. × 2.5.

Right valve. Bed 31, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19370.

Figs. 4-5 *Palaeoneilo* sp. indet. *a.*

4. Right valve. × 2.0 Bed 33. Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19371. 5. Left valve. × 1.5. Bed 27, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19372.

Fig. 6 *Palaeoneilo* sp. indet. *b.* × 1.

Left internal mould. Bed 49, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19373.

Figs. 7-8 *Aviculopecten* ? n. sp. indet. × 1.5.

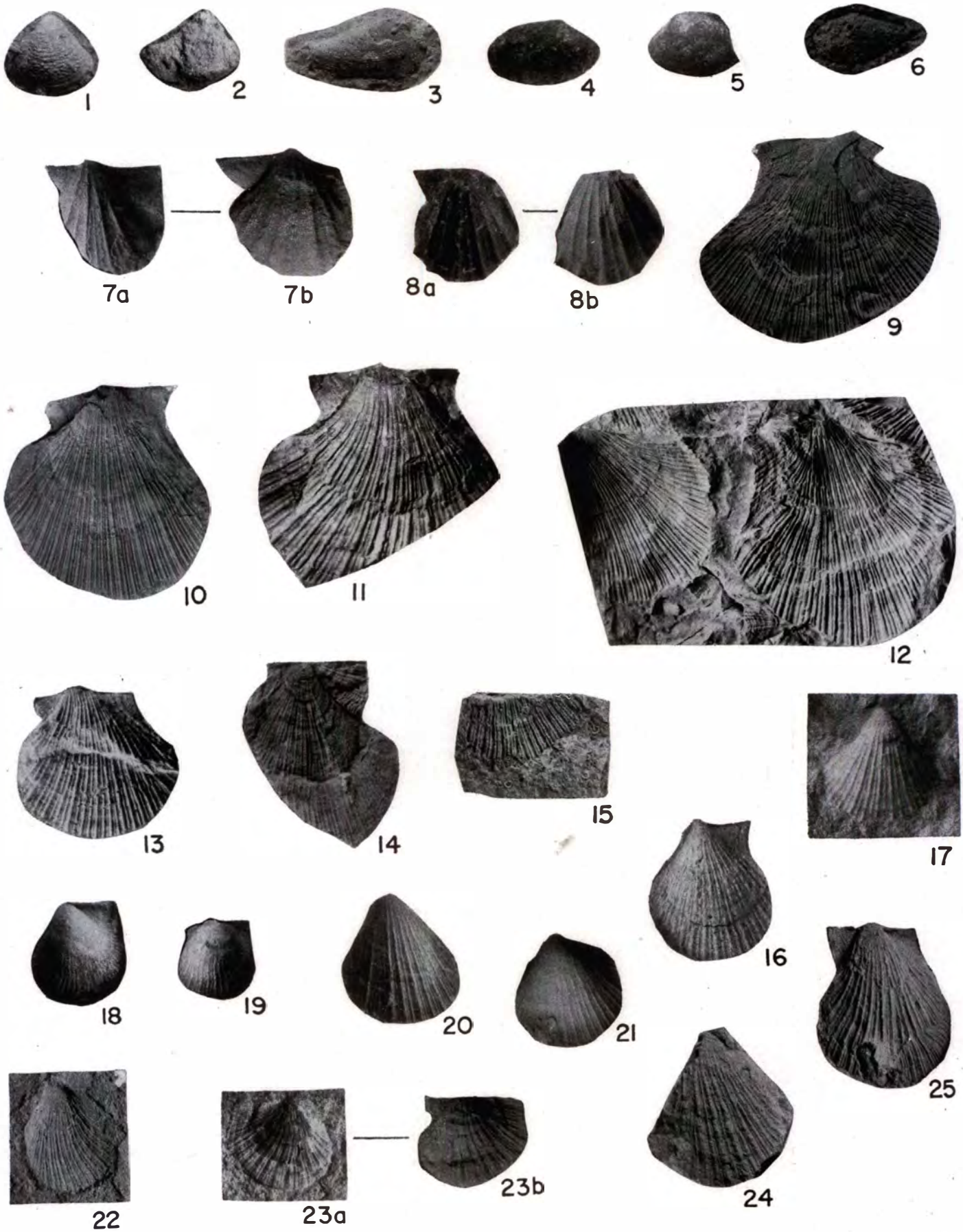
7. a. Left internal mould. b. Gypsum cast of left external mould of the same. Bed 33, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19374. 8. a, b. Left internal mould and gypsum cast. Bed 33, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19375.

Figs. 9-15 *Etheripecten haydeni* NAKAZAWA, n. sp.

9. Left external mould. × 1. Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19376. 10. Left valve. (Holotype). × 1. Bed 48a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19377 (Holotype). 11. Left valve. × 1. Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19378. 12. Left external mould. × 1. Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19379. 13. Gypsum cast of left external mould. × 1. GSI. Type No. 19380. 14. Right valve with attached left anterior ear. × 3. Bed 47b, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19381. 15. Fragmental left external mould with *Spirorbis.* × 1. Horizon C 5, Unit E_2, Member E, Khunamuh Formation, 3rd Spur of the Guryul Ravine. GSI. Type No. 19382.

Fig. 16 *Etheripecten* sp. aff. *haydeni* NAKAZAWA. × 1.

Left semi-internal mould. Bed 33, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19383.



NAKAZAWA : Permian and Triassic Bivalves from Kashmir

PLATE 9 (Continued)

Fig. 17 *Etheripecten* sp. aff. *hiemalis* (SALTER). × 2.

Left semi-internal mould. Bed 33, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19384.

Figs. 18-19 *Eumorphotis venetiana* (HAUER). × 1.5.

Left valves. Bed 52b, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19385, 19386.

Figs. 20-21 *Eumorphotis multiformis* (BITTNER). × 1.5.

20. Left valves. Bed 61b, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19387. 21. Left valve. Bed 64, Unit f_2, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus. GSI. Type No. 19388.

Figs. 22-25 *Eumorphotis* sp. aff. *bokharica* (BITTNER).

22. Left valve. × 1.5. Bed 52a, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19389. 23. Left external mould (a), and gypsum cast (b), × 1.8. Bed 61a, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19390. 24-25. Left valves. 24. × 1.3 ; 25. × 2. Both from Bed 68, Unit f_2, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus. GSI. Type Nos. 19391, 19392.

(All the specimens with whitening except for Figs. 4, 5, 8a, 11. Photo by NAKAZAWA).

PLATE 10

Fig. 1 *Fasciculiconcha* ? sp. indet. × 1.

Left internal mould. Unit E_1, Member E, Khunamuh Formation, Guryu Ravine. GSI. Type No. 19393.

Fig. 2-5 *Leptochondria minima* (KIPARISOVA).

2, 3, 5 in the same sample. × 1. 3. Enlargement of lower left side of the same sample. × 2. GSI. Type No. 19394. 4. Left valve. × 2. GSI. Type No. 19395. 5. Left valve. × 2.5. GSI. Type No. 19394. All the specimens are from Bed 75, Member F, Khunamuh Eormation, Guryul Ravine.

Figs. 6-7 *Cyrtorostra* sp. aff. *lunwalensis* (REED).

6. Left internal mould. × 2. Bed 48b. Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19396. 7. Left gypsum cast. × 2.3. Bed 45, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19397.

Figs. 8-9 "*Streblochondria*" sp. indet.

8. Right valve. × 2.3. Bed 27, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19398. 9. Left valve. × 1.5. Bed 27, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19399.

Fig. 10 *Claraia* sp. aff. *extrema* SPATH. × 1.5.

Left valve. Bed 61, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19400.

Figs. 11-13 *Claraia dieneri* NAKAZAWA. × 1.

11. Left gypsum cast. 12. Right valve. 13. Right external mould. (Holotype). All specimens from bed 59b, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19401, 19402 and 19004 (Holotype).

Figs. 14-16 *Claraia concentrica* YABE. × 1.

14. Right external mould. Claraia bed, Pahlgam. (Khunamuh Formation). GSI. Type No. 19403. 15. Left valve. Bed 67, Unit E_3, Member E, Guryul Ravine. GSI. Type No. 19404. 16. Left gypsum cast. Claraia bed, Pastannah. (Khunamuh Formation). GSI. Type No. 19405.

Figs. 17-19 *Claraia bioni* NAKAZAWA.

17. Left valve. × 1.5. Unit E_1 (loose block), Member E, Khunamuh Formation, 4th Spur at the Guryul Ravine. GSI. Type No. 19406. 18. Right external mould. × 1.5. Unit E_1, (Hor. C 3), Member E, Khunamuh Formation, 3rd Spur at the Guryul Ravine. GSI. Type No. 19407. 19. Left valve. × 1. (Holotype). Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19005. (Holotype).

(All the specimens with whitening photo by NAKAZAWA).


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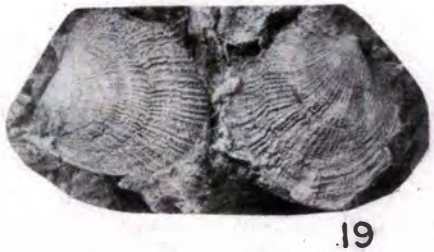

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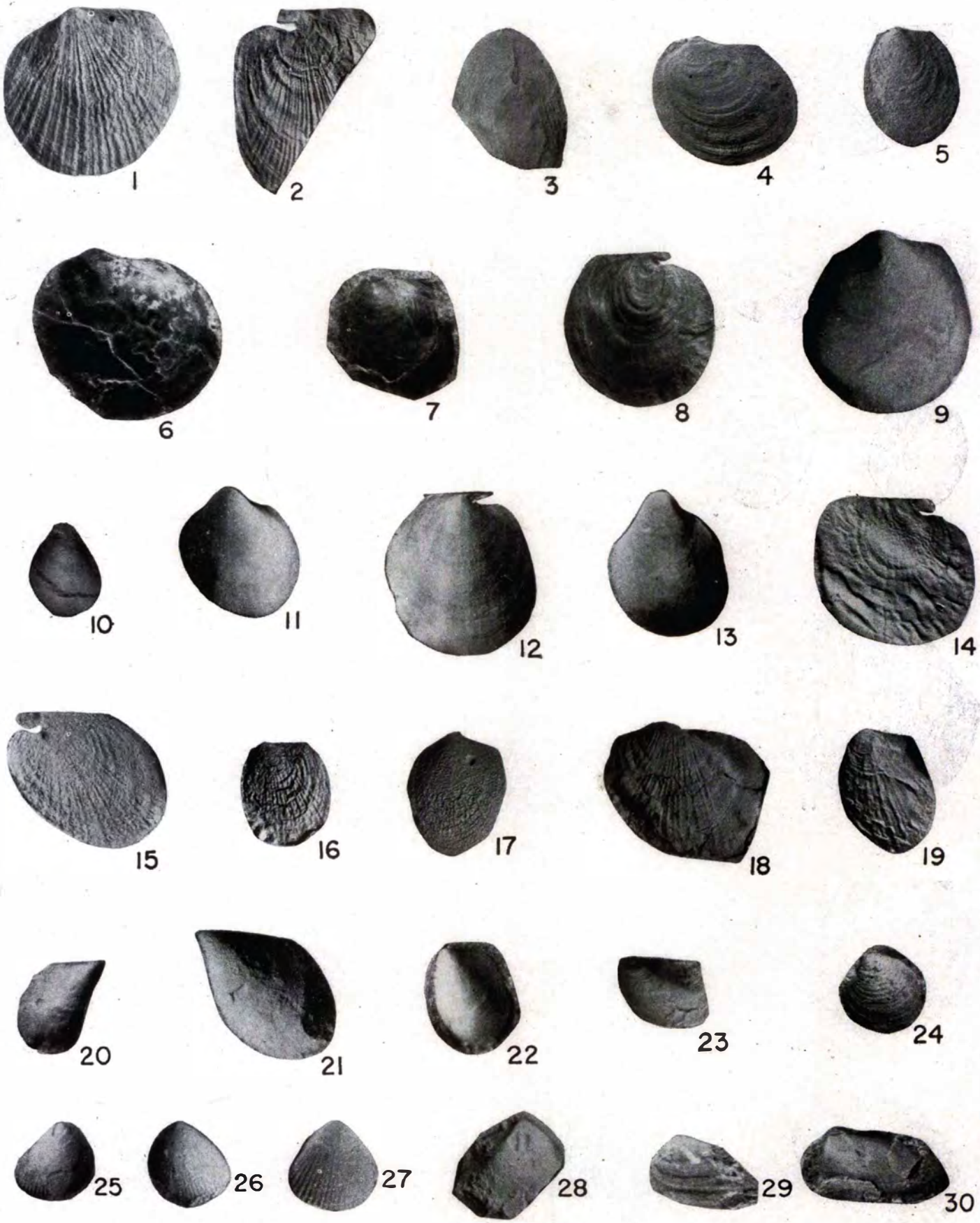

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NAKAZAWA : Permian and Triassic Bivalves from Kashmir



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PLATE 11

Fig. 1-3 *Claraia bioni* NAKAZAWA.

1. Left gypsum cast. × 1.5. Horizon C 3, Unit E_1, Member E, Khunamuh Formation, 3rd Spur of the Guryul Ravine. GSI. Type No. 19408. 2. Right external mould. × 1.5. Bed 49a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19409. 3. Univalved specimen. × 1. Horizon C 3, Unit E_1, Member E, Khunamuh Formation, 3rd Spur of the Guryul Ravine. GSI. Type No. 19410.

Figs. 4-5 *Claraia* sp. cf. *griesbachi* (BITTNER). × 1.5.

Left gypsum casts. Both specimens from Bed 60, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19411, 19412.

Figs. 6-8 *Claraia griesbachi* (BITTNER).

Type specimens of Shalshal Cliff near Rimkin-Priar Bittner's Plate 1-6, Figs. 2, 7 ; Figs. 1, 8 ; Fig. 4.

Figs. 9-13 *Claraia decidens* (BITTNER).

9. Left valve. × 1.5. 10. Left valve. × 2.5. 11. Left valve. × 1. 12. Right valve. × 1.2. All specimens from Bed 88, Member H, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19413, 19414, 19415, 19416, 19417.

Figs. 14-19 *Claraia* n. sp. indet.

14. Right gypsum cast. × 1. Claraia bed, Khunamuh Formation, Pahlgam. GSI. Type No. 19418. 15. Right external mould. × 1.5. Claraia bed, Khunamuh Formation, Pahlgam. GSI. Type No. 19419. 16. Left valve. × 1.5. Bed 62a, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19420. 17. Left valve. × 1. Claraia bed, Khunamuh Formation, Pahlgam. GSI. Type No. 19421. 18. Left valve. × 1.5. Claraia bed, Khunamuh Formation, Pahlgam. GSI. Type No. 19422. 19. Left valve. × 1. Unit E_3, (Exact horizon unknown), Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19423.

Figs. 20-21 *Promyalina* sp. indet. *a.*

20. Right valve. × 2. 21. Left valve. × 3. Bed 52b, Unit E_2, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19424, 19425.

Fig. 22 *Promyalina* sp. indet. *b.* × 1.5.

Left valve. Horizon C 7, Unit E_2, Member E, Khunamuh Formation, 3rd Spur of the Guryul Ravine. GSI. Type No. 19426.

Fig. 23 *Pteria* sp. aff. *ussurica yabei* NAKAZAWA. × 2.

Left valve. Bed 61b, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19427.

PLATE 11 (Continued)

Fig. 24 *Astartella* ? *progenitrix* (WAAGEN). × 2.

Left valve. Bed 43, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19428.

Figs. 25-27 *"Palaeolima" middlemissi* NAKAZAWA n. sp. ×2.5.

25. Left valve. Bed 27, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19429. 26. Right valve. Bed 31, Member C, Zewan Formation, Guryul Ravine. GSI. Type No. 19430. 27. Left valve. (Holotype). Bed 45, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19431 (Holotype).

Fig. 28 *Schizodus* ? sp. indet. ×2.

Right internal mould. Bed 43, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19432.

Figs. 29-30 *Permophorus* sp. cf. *subovalis* (WAAGEN). ×1.5.

29. Left valve. 30. Internal mould. Bed 43, Member D, Zewan Formation, Guryul Ravine. GSI. Type No. 19433.

(All the specimens with whitening except for figs. 6-8, 17, 18, 29. Photo by NAKAZAWA)

GASTROPODA

PERMIAN AND TRIASSIC GASTROPODA FROM GURYUL RAVINE

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PERMIAN AND TRIASSIC GASTROPODA FROM GURYUL RAVINE

INTRODUCTION

Bellerophontacea, a group of representative Palaeozoic gastropods, is an important member of the latest Permian marine fauna, even though some of the species range upto the Middle Triassic. For this reason, the bellerophonetids in the strata close to the Permian and Triassic boundary are considered to be important in paleontology and stratigraphy.

Some species of the Bellerophontacea and Pleurotomariacea from the Zewan and the Khunamuh Formations of the Guryul Ravine are described in this article. They were collected by Prof. K. Nakazawa and his collaborators in 1969 and further additions were made by the author in 1972. The gastropod material in this collection is not much and represented by only a few numbers and they are not well preserved.

The author is indebted to late Dr. Kotora Hatai, Professor Emeritus of the Tohoku University, for his help and advise during the course of the present study. Sincere thanks are also due to Messers Kimiji Kumagai, Shohei Otomo and Mrs. Kimiko Shibuya of the Tohoku University, for their assistance.

STRATIGRAPHICAL POSITION OF THE GASTROPODS

The stratigraphical position of the gastropod fauna collected is as follows :—

ZEWAN FORMATION

Member C

Bed 28. *Bellerophon* (*Bellerophon*) cf. *blanfordianus* WAAGEN and *Bellerophon* (*Bellerophon*) sp. present in the lower part of the bed.

Bed 31. *Bellerophon* (*Bellerophon*) *blanfordianus* WAAGEN present in a limestone layer of the lower part of the bed.

Member D

Bed 38. *Bellerophon* (*Bellerophon*) cf. *blanfordianus* WAAGEN and *Bellerophon* (*Bellerophon*) sp. common but ill-preserved.

Bed 43. *Bellerophon* (*Bellerophon*) *blanfordianus* WAAGEN, *Bellerophon* (*Bellerophon*) sp., *Retispira ornatissima* WAAGEN and *Retispira* cf. *kattensis* (WAAGEN), present in coquinite layer.

Bed 45. *Bellerophon* (*Bellerophon*) cf. *blanfordianus* WAAGEN and (*Bellerophon*) sp. commonly present in sandy limestone (Bed 45-2), but ill-preserved.

KHUNAMUH FORMATION

Member E

Unit E_1

Bed 48. *Pagodina*? sp. associated with many Permian brachiopods and bivalves ; in a limestone of this bed (Bed 48b).

Unit E_2

Bed 52. *Warthia hisakatsui* MURATA, n. sp. associated with typical Triassic bivalves and ammonoids such as *Eumorphotis* and *Otoceras* ; present in lower part of this bed (Bed 52a).

FAUNAL CONSIDERATION

The gastropod fauna at the Guryul Ravine is present in the upper part of the Late Permian Zewan Formation (Members C and D) as well as in the basal part of the latest Permian to Early Triassic of the Khunamuh Formation (Units E_1 and E_2). The present collection is small in number of species and individuals, and moreover, consists mostly of poorly preserved specimens.

Nearly 20 specimens are subgenerically referred to *Bellerophon* (*Bellerophon*) MONTFORT, 1808. They were collected from various horizons between Beds 28 and 45 in the upper part of the Zewan Formation, but their preservation does not satisfy for specific identification. In general, the gastropods from the upper part of the Zewan Formation are closely related to those described by Waagen (1880) from the upper part of the Products Limestone in Salt Range, but are lacking in *Euphemites*. Recently, *Cyclolobus walkeri* (DIENER) was reported by Furnish et al. (1973) from Bed 31 in the top of the Member C. *Cyclolobus* is known to occur from the horizons ranging from 10 to 23 metres below the top of the Chhidru Formation in the Salt Range of Pakistan (Kummel and Teichert, 1970, p. 73). Therefore, the upper part of the Zewan Formation (above Bed 31) is referable to the Chhidruan Stage.

Warthia is one of the representative Permian gastropods and occurs commonly in the eastern Tethys Province. However, according to Nakazawa et al. (1975), Bed 52a yielded typical Early Triassic bivalves and ammonoids, such as *Eumorphotis multiformis* (BITTNER), *Otoceras woodwardi* GRIESBACH and *Glyptophiceras lissarenum* (DIENER). Therefore, *Warthia hisakatsui* MURATA n. sp. from Bed 52a is considered to be a relict species survived into the Triassic, like the "Permian type" brachiopods and bivalves (*Marginifera himalayensis* DIENER, *Pustula* ? sp., *Etheripecten haydeni* NAKAZAWA etc.). *Warthia*, as a straggler in the Triassic has already been mentioned by Bittner (1889) from Himalaya.

SYSTEMATIC DESCRIPTION

Superfamily Bellerophontacea M'COY, 1851

Family Sinuitidae, DALL, in ZITTEL-EASTMAN, 1913

Subfamily Euphemitinae KNIGHT, 1956

Genus *Warthia* WAAGEN, 1880

Warthia hisakatsui MURATA, n. sp.

PLATE 12, Figs. 1-3

Diagnosis : Shell small, slit exceedingly short, shallow sinus uniformly curved, lip one-fourth of a whorl aperture, lateral lips joining anterior lip by about 100 degrees, outer lip long, curved, surface ornamentation and growth lines lacking.

Material : 7 specimens.

Description : Shell small, rounded globose, smooth Euphemitinae, slit exceedingly short, sinus shallow, uniformly curved ; outer lip extending over one-fourth of a whorl from aperture, about halfway flattened, curving distinctly to sickle-shape with growth ; lateral lips joining anterior lip at about 100 degrees ; anterior lip produced slightly, curving inward near dosum to form a shallow sinus culminating in a short slit ; selenizone obscure ; anomphalous ; shell moderately thin, structure unknown due to replacement.

Dimensions : (in mm)

Type No.	Length	Thickness	Width of aperture	Heigh of aperture	Axial width
GSI. 18691 (Holotype)	12.0	10.5	12.6	4.6	8.8
GSI. 19479 (Paratype)	11.6	10.8	13.2	?	8.9
GSI. 19480 (Paratype)	11.6	10.0	12.0	4.3	7.1
(Unfigured Paratype)	12.2	9.8	12.3+	?	8.1

Discussions : The present new species is based on seven specimens, including three nearly perfect ones. *Warthia vaceki* (BITTNER), 1889, from the Lower Werfen Slate in south Tyrol, and *Warthia* cf. *vaceki* from the Otoceras Bed in the northwest Kiunglung in the Himalaya seem to be closely related to this new species in their horizon and general form. But the present form lacks surface ornamentations, even growth lines. *Warthia polita* WAAGEN, 1880, from the topmost bed of the Productus Limestone of Chhidru, is also related to the present form, but the latter species has larger shell, wider aperture, more advanced outer lip and shallow sinus. This new species is also similar to many species described as *Warthia*, however, the long curved outer lip serves to distinguish it from the known species of this genus.

Etymology : This species is named in honour of the late Dr. Hisakatsu Yabe, Professor Emeritus of the Tohoku University in recognition of his palaeontological work in Asia.

Associated fossils : This species is abundant in the lowermost limestone layer (52 a) of Khunamuh Formation. Bando identified *Otoceras woodwardi* GRIESBACH, *Glyptophiceras lissarenum* (DIENER) and *Glyptophiceras himalayanus* (GRIESBACH) from the same limestone layer.

Horizon and Locality : Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 18691 (Holotype), 19479, 19480 (Paratypes).

Family Bellerophontidae M'COY, 1851

Subfamily Bellerophontinae M'COY, 1851

Genus *Bellerophon* MONTFORT, 1808

Subgenus *Bellerophon* MONTFORT, 1808

Bellerophon (*Bellerophon*) *blanfordianus* WAAGEN

PLATE 13, Figs. 1-3

1880. *Bellerophon blanfordianus* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 2, p. 142, Pl. 14. Figs. 1-2.

Material : Several specimens.

Description : Some specimens in the present collection have small shell, which are characterised by angulated sub-cardiform apertural opening, high prominent median crest and very closely arranged growth lines forming into bundles towards the end of last whorl.

Dimensions : (in mm)

Type No.	Length	Thickness	Width of aperture	Height of aperture	Axial
GSI. 19484	15.5	11.1	12.8+	7.4	7.6
GSI. 19485	24.5+	17.2+	25.0	8.2+	14.7
GSI. 19486	16.6	12.2	16.5+	11.8	10.3

Remarks : The specimens resemble closely with *Bellerophon* (*Bellerophon*) *blanfordianus* described from the upper part of the Productus Limestone in the Salt Range by Waagen (1880). *Bellerophon* (*Bellerophon*) *yabei* described by Murata (1969) from Kitakami Massif, Northeast Japan, is also more or less similar to this species in outline of the shell, but the Japanese species shows different pattern of growth line.

Associated fossils : This species is common in the lower part of Bed 31 (Member C), of the Zewan Formation from where Furnish et al. (1973) reported *Cyclolobus walkeri* (DIENER).

Horizon and Locality : Bed 31, Member C and Bed 43, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19484, 19485, 19486

Bellerophon (*Bellerophon*) sp. cf. *Bellerophon* (*Bellerophon*) *blanfordianus* WAAGEN

PLATE 13, Fig. 4

Material : Four fragmentary specimens.

Description : Specimens with distinct prominent median crest and angulated sub-cardiform in cross section of the whorl. Ventral part of shell covered with closely arranged growth lines of various strength forming into bundles towards the dorsal side.

Remarks : Specimens have some similarity with *Bellerophon* (*Bellerophon*) *blanfordianus* WAAGEN, but could not be identified precisely because of poor preservation.

Horizon and Locality : Bed 28, Member C ; Beds 38, 43, and 45, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19487

Bellerophon (*Bellerophon*) sp.

PLATE 13, Fig. 5

Material : Nearly 20 specimens.

Description : Globose, rather rounded sub-cardiform cross section of whorl, slightly prominent median crest and numerous growth lines on the shell surface.

Remarks : Specimens can be referred to *Bellerophon* (*Bellerophon*) subgenerically, but being so poorly preserved and absence of the last whorl, specific identification has been reserved. Among them, a single fragmental specimen (Pl. 13, Figs. 5 a-c) is similar to *Bellerophon* (*Bellerophon*) *triangularis* WAAGEN (1880) which has been described from the upper part of the Productus Limestone of Salt Range. This is also similar to the younger stage of *Bellerophon* (*Bellerophon*) *affinis* WAAGEN, described from the same horizon as *Bellerophon* (*Bellerophon*) *triangularis*.

Horizon and Locality : Bed 28, Member C ; Beds 38, 43, and 45, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19488

Genus *Retispira* KNIGHT, 1945

Type Species : *Retispira bellireticulata* KNIGHT.

1945. *Retispira bellireticulata* KNIGHT, *Jour. Paleont.*, Vol. 19, Pt. 4, p. 335, Pl. 49, Figs. 1 a-c.

Knight (1945) distinguished this Late Paleozoic genus from *Bucanopsis* ULRICH by its simple inductural inner lip and lack of sharp ridge on the floor of interior of the whorl. However, several authors have discussed about the taxonomic position and rank of this genus. Yochelson (1960) and Knight et al. (1960) treated this genus as a subgenus of the genus *Knightites* MOORE, 1941, because of the spiral ornamentation and intergrading of forms of "*Retispira*" *eximia* YOCHELSON. But Dickins (1963), Wilson (1967), Rollins et al. (1971) and Batten (1972) asserted that *Retispira*, should be accepted as a separate genus. Except in *Retispira eximia* and a few other species of Yochelson (1960), most species of *Retispira*, as well as the type species show a relatively unexpanded aperture, smooth, thin parietal inductra and a well-marked, more or less raised median crest with selenizone. Knight (1956) expressed on the importance of the depressed selenizone in the subfamily Knightitinae. Therefore, *Retispira* can not be included in the genus *Knightites* or even in the subfamily Knightitinae, when the raised selenizone is taken into consideration. In the present paper, *Retispira* is raised provisionally to a generic rank, and has been placed in the subfamily Bellerophonitinae.

Retispira ornatissima (WAAGEN)

PLATE 12, Fig. 4

1880. *Bucania ornatissima* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 2, p. 155, Pl. 14, Figs. 7 a-e.

Material : Only a single incomplete specimen.

Description : Shell small, slightly compressed globular ; whorl well rounded, with slight transverse undulation in profile ; selenizone narrow, convex on raised median crest ; aperture unknown ; last whorl expanding rather rapidly, but not flaring ; ornamented with spiral lirae of two orders, rather thick coarsely arranged one about 14 in number, and finer lirae of second order intercalated alternately on lateral slope of last whorl ; numerous growth lines of various strength forming bundles along transverse undulation of whorl.

Dimensions : (in mm)

Type No. GSI. 19481 : Length +11.0 ; Thickness 8.5 ; Width of aperture 12.2 ; Axial width 6.6.

Remarks : This specimen lacks apertural part and can be identified as *Retispira ornatissima* (WAAGEN) from the topmost bed of upper part of the Productus Limestone at Amb, Salt Range. The latter has, however, a more distinct undulated shell.

Horizon and Locality : Bed 43, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19481

Retispira sp. cf. *Retispira kattaensis* (WAAGEN)

PLATE 12, Fig. 5

1880. *Bucania kattaensis* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 1, Pt. 2, p. 151, Pl. 14, Figs. 6 a-e.

Material : Only a single fragmentary specimen.

Description : Shell rather broad, flattened ; rather broad selenizone on raised median crest, about 1.4 mm in width ; ornamented with very closely arranged numerous fine spiral lirae of various strength, and marked by fine but distinct growth lines.

Remarks : The specimen may be a fragment of *Retispira kattaensis* (WAAGEN) which has been described from the lower part of Productus Limestone at Katta in the Salt Range.

Horizon and Locality : Bed 43, Member D, Zewan Formation, Guryul Ravine.

Specimen : GSI. Type No. 19482

Suborder Pleurotomarina COX AND KNIGHT, 1960

Superfamily Pleurotomariacea SWAINSON, 1840

Family Eotomaridae WENZ, 1938

Subfamily Agnesiinae KNIGHT, 1956

Genus *Pagodina* WANNER, 1942

Pagodina ? sp.

PLATE 12, Figs. 6-7

Material : Four fragmentary specimens ; more or less deformed. Three of them are incomplete inner moulds of more or less deformed whorls and the other is a fragment of an external mould.

Description : Shell of medium size, rather high-spired tubiniform with somewhat step-like whorl profile. The selenizone rather broad, just above the periphery, 1.2 mm in later whorl, and marked by distinct spiral cords. In later whorls a spiral cord located at about the middle of the slightly concaved upper whorl face. Base rounded, spiral ornamentation not observed, anomphalos.

Remarks : The fragmentary specimens are referred to *Pagodina* with question.

Horizon and Locality : Upper part of Bed 48 (48a), Unit E_1, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19483

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PLATE 12

Figs. 1-3 *Warthia hisakatsui* MURATA, n.sp. × 3.

1. a-d. Adapertural, oblique apertural, posterior and left side views. (Holotype). Bed 52a, Unit E_2, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 18691 (Holotype).

2. a-c. Adapertural, anterior and left side views (Paratype). Bed 52a, Unit E_2, Member E, Khunamuh Formation, at the Guryul Ravine. GSI. Type No. 19479 (Paratype).

3. a-c. Adapertural, apertural and right side views (Paratype). Bed 52a, Unit E_2, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19480 (Paratype).

Fig. 4 *Retispira ornatissima* (WAAGEN).

a-b. Adapertural and oblique right side views. × 3. c. Enlarged view of the same specimen to show details of surface ornamentation. × 5. Bed 43, Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19481.

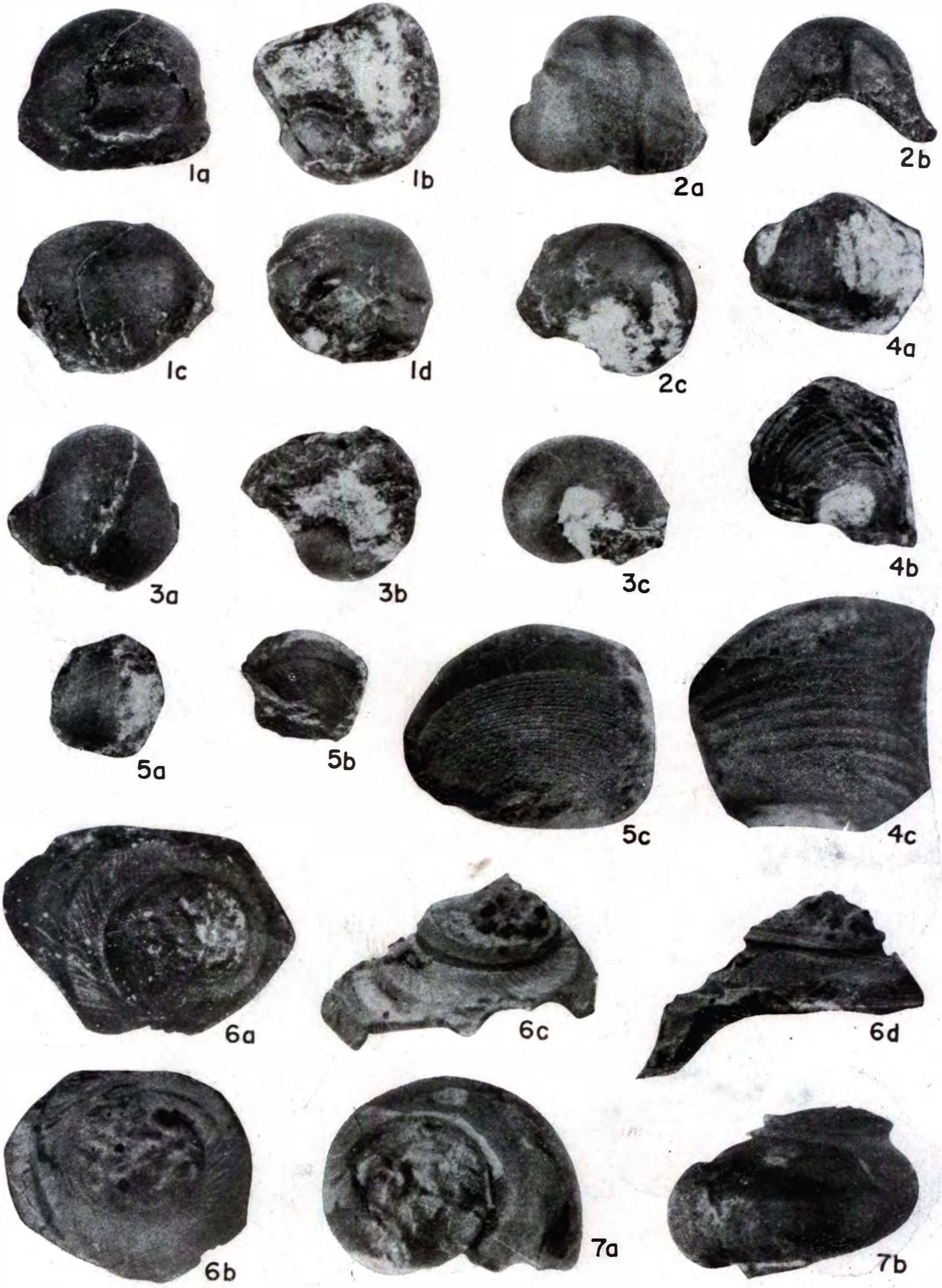
Fig. 5 *Retispira* cf. *kattaensis* (WAAGEN).

a-b. Adapertural and right side views. × 2. c. Enlarged view of the same specimen to show the details of surface ornamentation. × 5. Bed 43, Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19482.

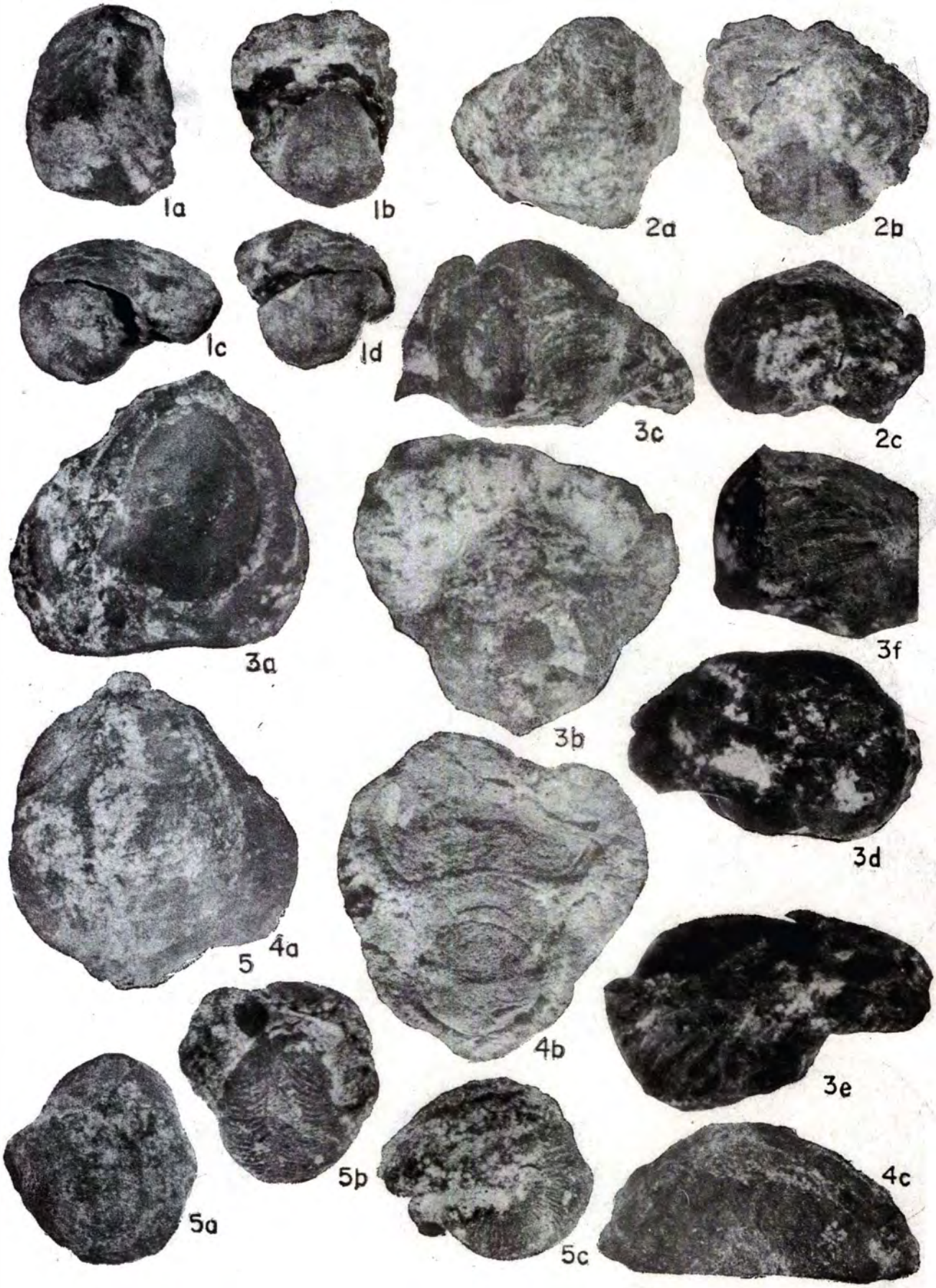
Figs. 6-7 *Pagodina*? sp. × 3.

6. a. External mould of a fragmental specimen. 6. b-d. Apical, oblique lateral and lateral views of gumtype of the same specimen. Bed 48a, Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19483.

7. a-b. Apical and lateral views of a fragmental steinkern. Bed 48a, Unit E_1, Member E, Khunamuh Formation at the Guryul Ravine. GSI. Type No. 19483.



MURATA : Permian and Triassic Gastropods from Kashmir



MURATA : Permian and Triassic Gastropods from Kashmir

PLATE 13

Figs. 1-3 *Bellerophon* (*Bellerophon*) *blanfordianus* WAAGEN.

1. a-d. Adapertural, apertural, right side and posterior views of a small specimen. × 3. Bed 43, Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19484.

2. a-c. Adapertural, apertural and right side views of a poorly preserved specimen. × 3. Bed 43, Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19485.

3. a-e. Adapertural, apertural, posterior, left and right side views of a slightly deformed specimen. × 2.5. f. Enlarged view of the same specimen to show growth lines. × 3. Bed 31, Member C, Zewan Formation at the Guryul Ravine. GSI. Type No. 19486.

Fig. 4 *Bellerophon* (*Bellerophon*) cf. *blanfordianus* WAAGEN. × 2.

a-c. Adapertural, apertural and left side views of a fragmental specimen. Bed 43, Member D, Zewan Formation, at the Guryul Ravine. GSI. Type No. 19487.

Fig. 5 *Bellerophon* (*Bellerophon*) sp. × 3.

a-c. Adapertural, apertural and left side views of a poorly preserved specimen. Bed 45 (Horizon 45-2), Member D, Zewan Formation at the Guryul Ravine. GSI. Type No. 19488.

CEPHALOPODA

LOWER TRIASSIC AMMONOIDS FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

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LOWER TRIASSIC AMMONOIDS FROM GURYUL RAVINE AND THE SPUR THREE KILOMETRES NORTH OF BARUS

INTRODUCTION

Cephalopods are scarce in the Permian Zewan Formation of the Guryul Ravine, so far only *Cyclolobus walkeri* DIENER of the Dzhulfian stage is recorded by Furnish et al. (1973). The Lower Triassic, Khunamuh Formation, on the other hand has abundant cephalopods, represented by about 17 genera.

The lower division of the Lower Triassic of the Guryul Ravine is divisible into four ammonoid zones viz. the *Otoceras-Glyptophiceras* Zone ; the *Ophiceras* Zone, the *Paranorites-Vishnuites* Zone and the *Prionites-Koninckites* Zone.

The detail work on the upper division of the Lower Triassic was not carried out, however, its begining was noticed by distinguishing *Owenites-Kashmirites* Zone of Olenekian or Smithian stage in the Meekoceras bed of Middlemiss (1909, 1910) (Member H of the present work).

Otoceras and many other ammonoids were collected by Nakazawa and his collaborators from the Guryul Ravine as well as from the Spur three kilometres north of Barus in the years 1969 and 1972, many of which are new to Kashmir and important to bio-stratigraphy. In addition, Kapoor and Bando (1974) also reported the presence of Lower Triassic fauna in the Pir Panjal by recognising *Lytophiceras* aff. *ptychodes* DIENER, *Hypophiceras* ? sp., *Ophiceras* s. str. and *Glyptophiceras* ? sp. from a collection of H. M. Kapoor from Khowurwat Gali and Malidar Gali.

FAUNAL CONSIDERATION

The species of *Otoceras* from the Guryul Ravine and the Spur three kilometres north of Barus are characterised by shells with gently convex sides and tricarinate keeled venter. They are identical with the specimens of the *Otoceras* Zone of Spiti described by Diener (1895). Other specimens of *Otoceras* from different Himalayan sections have also the convex side but it differs from *Otoceras concavum* TOZER of the Blind Fiord Formation of Arctic Canada (Tozer, 1967, p. 86, Pl. 1, Figs, 1-3).

The *Otoceras woodwardi* of the Himalayan type and the *Otaceros boreale* SPATH of the Arctic type occur almost at the same horizon in association with *Claraia* and morphologically may essentially be a homeomorph. *Otoceras concavum* TOZER of Arctic Canada (Tozer, 1967), however, is considered to be an intermediate form by Bando (1973) and has been placed between the Permian *Araxoceras* (*Vedioceras*) and Triassic *Otoceras woodwardi.* This view has the support by the presence of *Claraia stachei* which occurs at a higher horizon than the bed bearing *Otoceras concavum.*

In Beds 51-60 of the Guryul Ravine, among Ophiceratidae, the species of *Glyptophiceras* predominate over typical *Ophiceras.* The main species of *Ophiceras* fauna include :

Ophiceras tibeticum GRIESBACH, *Lytophiceras sakuntala* (DIENER), *"Metophiceras" subdemissum* (SPATH), *Glyptophiceras himalayanum* (GRIESBACH), *Glyptophiceras lissarenum* (GRIESBACH) and *Vishnuites* cf. *pralambha* DIENER.

These ammonoids are present in a horizon between Bed 51 and Bed 76 (approximately 35 meters) ; *Vishnuites* is presnt in Bed 76.

On the basis of the vertical distribution of the above mentioned ammonoids, the horizon between Beds 51 and 60 favours Otoceratan age of the earliest Lower Triassic and is correlatable to the *Otoceras woodwardi* and *Ophiceras commune* Zones in the proposed scheme of Kummel (1957). It also corresponds to the Otoceras bed of Arctic Canada and Siberia (Tozer, 1965 ; Kiparisova and Popov, 1964).

Trümpy (1969) recognised three ammonoid beds in the Early Triassic of Jameson Land in East Greenland, i.e. Hypophiceras bed, Ophiceras bed and Vishnuites bed. According to the present author, the Hypophiceras bed is correlatable to the *Otoceras woodwardi* Zone of the Himalaya ; Ophiceras bed to the *Ophiceras tibeticum* (or *Ophiceras serpentinum* Zone) and *Vishnuites* (?) *decipens* Zone to *Vishnuites pralambha* Zone of Himalayas and Abadeh region of Iran (Bando, 1978). In Abadeh *Vishnuites pralambha* occurs about 8 to 9 metres above the base of the Lower Triassic, in Unit a or Unit 8 of Taraz, (1971, 1974) called Claraia bed. It is associated with *Lytophiceras dubium* and *Acanthophiceras golshani* (Bando, 1978).

In the review of *Otoceras* and *Ophiceras* faunas of the world, Kummel (1972) suggested a revised classification of the Otoceratidae and Ophiceratidae. The former family includes :

Otoceras undatum (GRIESBACH), *O. parbati* DIENER, *O. clivei* DIENER, *O. fissisellatum* DIENER, *O. draupadi* DIENER and *O.* (*Tetotoceras*) *dieneri* (SPATH). To these, Kummel groups under the group of *Otoceras woodwardi woodwardi* GRIESBACH.

Otoceras indigirense POPOV has been included by him into the group of *Otoceras boreale* SPATH. Thus the genus *Otoceras* GRIESBACH is divisible into group of *Otoceras woodwardi woodwardi* GRIESBACH and *Otoceras woodwardi boreale* SPATH (Kummel, 1972). The author also supports Kummel in including *woodwardi* and *boreale* into a single common species, as it is rather extremely difficult to separate specifically the two species described from two different regions ; the slight differences seen in them are only morphological variability and be given only subspecific rank.

Bando (1971, 1973) pointed out that the family Otoceratidae includes various forms, many of which show transition between Araxoceratidae and Otoceratidae. The Araxoceratidae showing rectangular whorl-section gradually pass into Otoceratidae having tricarinate keel through *Avushoceras*, *Julfotoceras* and *Pseudotoceras*. This morphological change has important bearing on palaentology, stratigraphy and palaeoecology of Late Permian and Early Triassic.

Ophiceratidae from Pastannah (Pastun) described by Diener (1913) and revised by Spath (1934) needs further attention. *Ophiceras* (*Lytophiceras*) *ptychodes* (DIENER), (1897, p. 120, Pl. 11, Figs. 5 a-c, (lectotype), 3, 6 ; 1913, p. 16, Pl, 1, Fig. 6 ; 1915, p. 212 ; Spath, 1930, p. 21 ; 1934, p. 78, Pl. 1, Figs. 1 a-b), according to the author, is the genus *Xenoceltites*. The specimen described by Spath (1934, No. C 28531) which is stored in the British Museum of Natural History was pointed out by Tozer (1969, p. 354) to be Smithian "*Xenodiscus*" *comptoni* DIENER by its characterstic peripheral constrictions of the Smithian genus *Xenoceltites*. This view has the strong stratigraphic support from Kapoor's observations, who proved that the so-called *Ophiceras* bed of Pastannah is Smithian *Meekoceras* bed, (Kapoor, 1977). It is, therefore, suggested that *Glyptophiceras kashmiricum* SPATH from Pastannah (Spath, 1930, p. 37 ; 1934, p. 83, Pl. 1, Figs. 3 a-b, No. C 28540, Holotype) of the British Museum be absorbed in the genus *Xenoceltites*.

The subgenus *Metophiceras* (Spath, 1935, p. 34 ; type species : *Ophiceras* (*Metophiceras*) *subdemissum* SPATH ; Spath, 1930, p. 14, Pl. 11, Fig. 1, as *Ophiceras demissum* ; Spath, 1935, Pl. 13, Fig. 3 ; Pl. 17, Figs. 3 a-b ; Pl. 18, Figs. 3 a-b ; Pl. 19, Fig. 2) with its characterstic ornamentation of the shell (Bando, 1973, p. 346), unlike this genus also needs inclusion in the genus *Glyptophiceras.*

Teichert, Kummel and Sweet (1973, p. 384) consider that the earliest Triassic Ophiceratids had an extremely plastic stock, which reflected wide adaptive radiations. The genus *Ophiceras* (*Metophiceras*), can, therefore, be better understood as a part of the Ophiceratid radiation rather than that of the surviving *Xenodiscus.* Kummel (1970, p. 182) noticed that the wide morphological variations of the early Scythian Glyptophiceratids characterised by radial, or nearly radial ribs, are remarkably similar to the Middle and Late Permian ribbed *Xenodiscus.*

Schindewolf (1954) described the earliest *Ophiceras* i.e. *Ophiceras connectens* from the Kathwai Member of the Salt Range (Kummel and Teichert, 1970). He pointed out that the Ophiceratid of East Greenland (from Ophiceras bed), which was considered by Spath (1935) as an earliest form, *Ophiceras* (*Metophiceras*), is most likely a *Xenodiscus.*

A new Ophiceratid ammonoid, *Durvilleoceras woodmani* WATERHOUSE, is reported by Waterhouse (1973) from the Gerville Formation of New Zealand. It occurs in association with *Episageceras* aff. *noetlingi* HANIEL. He considers the formation to be late Middle Permian and correlates the horizon of New Zealand with the bed of *Ophiceras connectens* SCHINDEWOLF of Salt Range i. e. Kathwai Dolomite. Waterhouse is of the opinion that Ophiceratidae is not suited as an index of early Triassic and therefore believes in the revision of the Griesbachian stage of Tozer (1967) as a part of the Late Permian.

Kozur (1972), on the other hand, proposed the revision of the boundary between the Permian and Triassic at the base of the horizon of *Ophiceras commune*, and does not agree to be placed at the base of *Otoceras boreale* or *Otoceras woodwardi.* He is of the view that the horizon of *Otoceras concavum* and *Otoceras boreale* are the highest horizon of the Late Permian representing "Dorasham" stage.

The author, however, feels that it will be appropriate to draw for the present the beginning of the Early Triassic, just at the base of the horizon of *Otoceras concavum,* where associate elements of *Claraia* and *Ophiceras* are present. The *Otoceras concavum* is a primitive form of *Otoceras* s. str. (*Otoceras woodwardi*). This genus, as indicated earlier, exhibits a good amount of variation in the whorl shape, cross section of the whorl and umbilical sutures. Moreover, same size specimens of *Otoceras concavum* and *Otoceras woodwardi* show differences in shape of the whorl sections, which undoubtedly place them to the rank of two distinct species and suggests an evolution from *concavum* to *woodwardi.* It is however, unfortunate that *Otoceras concavum* is not known from other areas except only from Blind Fiord Formation of Arctic Canada, therefore, it is difficult to make exact correlation (Tozer, 1967, p. 15) with other regions. Still, Tozer is of the view that the zone of *Otoceras concavum* has the same position as that of the Glyptophiceras bed of Greenland. The Glyptophiceras bed occupies the position between the Foldvik Creek Formation (Upper Permian) and Lower Ophiceras bed (Spath, 1935 ; Trümpy, 1961, p. 249).

In the Guryul Ravine section, Unit E_2 is considered to represent *Otoceras-Glyptophiceras* Zone and includes species of *Claraia, Otoceras woodwardi, Glyptophiceras himalayanum* and *Glyptophiceras lissarenum* etc. The succeeding *Ophiceras* Zone is present in Unit E_3. The biostratigraphy of the Lower Triassic of the Guryul Ravine, based on ammonoids, suggests that

the Otoceratidae actually started in the Permian and *Otoceras woodwardi* is likely to be a straggler into the Triassic from the Permian *Julfotoceras*, *Avushoceras*, *Pseudotoceras*.

The *Glyptophiceras*, on the other hand, is an intermediate form between the Permian Xenodiscidae and the Triassic Ophiceratidae. It had a short range and restricted distribution, like Otoceratidae. In the Section of the Guryul Ravine ammonoids of the Araxoceratidae could not be found and is likely to be present between the *Cyclolobus walkeri* Zone and the *Otoceras woodwardi* Zone, because there does not appear to have any stratigraphic hiatus.

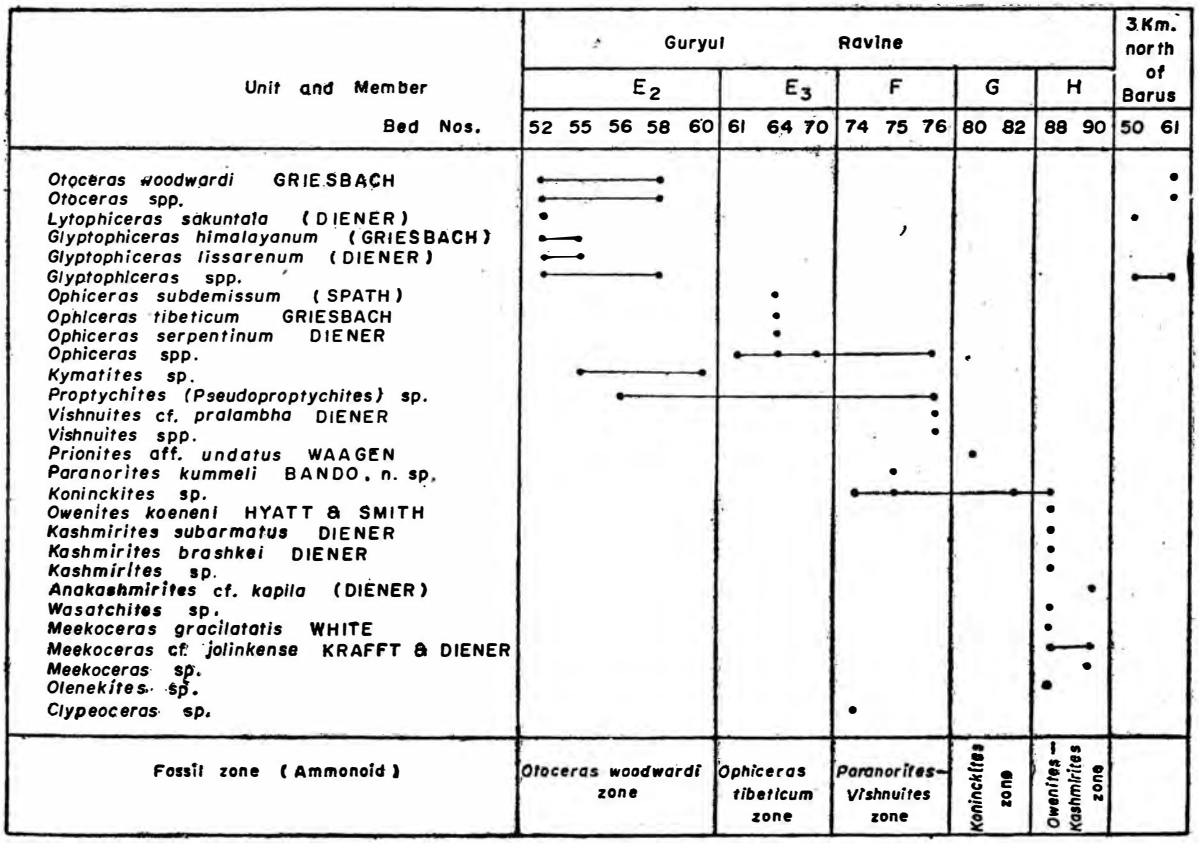
The *Ophiceras* Zone of the Guryul Ravine corresponds to the Ophiceras bed of the Himalaya in respect to its faunal contents. Based on the analysis of the Lower Triassic of the Guryul Ravine as suggested by Kapoor (1977), the fauna and the position of the Himalayan Lower Triassic beds need to be reviewed.

A recent discovery of *Ophiceras* (*Lytophiceras*) and *Vishnuites* by the author (Bando, 1978,) from the Lower Triassic of Kuh-e-Hambast in the Abadeh region of Iran has indicated that the *Ophiceras* Zone and *Paranorites-Vishnuites* Zones of the Guryul Ravine are present in Iran at Unit 8 (Taraz, 1971) = Unit a (Taraz, 1974). Equivalent of *Otoceras-Glyptophiceras* Zone, is yet to be found in Abadeh. It is interesting to note that Otoceras bed s. str. has not so far been found in the Salt Range and westward in the Tethys. It is actually not discovered or might be missing or will be proved by future researches.

Twenty nine species belonging to sixteen genera of the Lower Triassic ammonoids are recognised in the Guryul Ravine and the Spur three kilometres north of Barus. Their distribution is given in Table 24.

TABLE 24

RANGE CHART OF THE LOWER TRIASSIC AMMONOIDS IN THE GURYUL RAVINE AND THE SPUR TRHEE KILOMETRES NORTH OF BARUS



SYSTEMATIC DESCRIPTIONS

Superfamily Otoceratacea HYATT, 1900

Family Otoceratidae HYATT, 1900

Genus *Otoceras* GRIESBACH, 1880

Subgenus *Otoceras* SPATH, 1934

Type species : 1880. *Otoceras woodwardi* GRIESBACH, *Rec. Geol. Surv. India*, Vol. 13, Pt. 2, p. 106, Pl. 1, Fig. 4.

The genus *Otoceras* was first described from Himalaya by Griesbach (1880) and Diener (1897) and is now also known from Siberia, China and from North America. Five specimens of the genus *Otoceras*, were collected from the basal part of the Khunamuh Formation in Kashmir in 1969 (Nakazawa et al., 1970, 1975).

Diener (1897) recognised seven species of *Otoceras* in his collection from the Himalaya, but recently most of them were included in one species, *Otoceras woodwardi* GRIESBACH by Kummel (1972). Kummel (1972) considered that the Arctic *Otoceras boreale* SPATH also belongs to a subspecies of the Himalayan *Otoceras woodwardi.* Another species of the genus, *Otoceras concavum* TOZER is also known from the basal zone of the Lower Triassic Blind Fiord Formation (Tozer, 1967) at Griesbach Creek on Axel Heiberg Island. Tozer, proposed Griesbachian stage for this horizon. . *Otoceras concavum* has concave flanks similar to *Julfotoceras tarazi* BANDO (1973, p. 349, Pl. 38, Figs. 1 a-b ; Pl. 39, Figs. 1 a-d) from the Dzhulfian beds of Iran ; difference in the two genus lies in sutures (especially in the umbilical series). Kummel (1972, p. 388) considers *concavum* to be an intraspecific variant of the *Otoceras woodwardi boreale.* The present author however, believes that *concavum* differs from *woodwardi* or *boreale* in the whorl shape in the specimens of the same size.

According to the author, two groups of *Otoceras*, proposed by Kummel (1972 ; mentioned in faunal consideration of this article), can not be separated even subspecifically. The genus *Otoceras* is a direct descendant of the latest Permian *Julfotoceras* of the family Otoceratidae.

The genus *Otoceras* is confined to the Zone of *Otoceras woodwardi*, Otoceratan of Early Induan Stage (or Early Griesbachian), in Himalaya (Kashmir, Spiti, Central Himalaya), Siberia, China and Arctic North Canada.

Otoceras woodwardi GRIESBACH

PLATE 14, Figs. 1-3 ; PLATE 16, Fig. 6 ; PLATE 18, Fig. 3

1880. *Otoceras woodwardi* GRIESBACH, *Rec. Geol. Surv. India*, Vol. 13, Pt. 2, p. 106, Pl. 1, Figs, 4-5 ; Pl. 2, Figs. 1-6. (1901. FRECH, p. 575, Figs. 4 a-d ; 1902. FRECH, p. 628, 629 ; 1909. KRAFFT and DIENER, p. 116 ; 1915. DIENER, p. 213 ; 1925. DIENER, p. 34, Pl. 22, Fig. 1 ; 1930. SPATH, p. 9-11 ; 1934. SPATH, p. 66, Fig. 10 ; 1935. SPATH, p. 11 ; 1957. KUMMEL in ARKELL et al., p. L 132, Fig. 162, 10 ; 1972. KUMMEL, p. 391, Pl. 1, Figs. 1-12.)

1897. *Hungarites (Otoceras) woodwardi*, DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 156-160, Pl. 2, Fig. 1, Pl. 3, Fig. 1, Pl. 4, Figs. 2-5, Pl. 5, Figs. 1, 3, 5, Pl. 6, Fig. 16.

1897. *Hungarites (Otoceras) undatum*, DIENER, *ibid.* p. 162, Pl. 4, Fig. 6.

1897. *Hungarites (Otoceras) parbati*, DIENER, *ibid.* p. 160, Pl. 4, Fig. 1.

1897. *Hungarites (Otoceras) fissisellatum*, DIENER, *ibid.* p. 163, Pl. 3, Fig. 3, Pl. 5, Fig. 6, Pl. 6, Fig. 15.

1897. *Hungarites* sp. indet., DIENER, *ibid.* p. 150, Pl. 23, Fig. 5.

1880. *Otoceras woodwardi* var. *undatum*, GRIESBACH, *Rec. Geol. Surv. India*, Vol. 13, Pt. 2, p. 107. Pl. 1, Fig. 5.

1915. *Otoceras uudatum* DIENER, *Fossil Catalog.* I, Pt. 8, p. 213.

1934. *Otoceras undatum*, SPATH, *Catalog. Fossil* 4, p. 69.

1909. *Otoceras cf. undatum*, KRAFFT and DIENER, *Palaeont. Indica*, Ser. 15, Vol. 6, p. 116.

1915. *Otoceras parbati*, DIENER, *Fossil. Catalog.* I, Pt. 8, p. 213.

1897. *Otoceras clivei*, DIENER, *Palaeont, Indica*, Ser. 15, Vol. 2, Pt. 1 p. 161, Pl. 3, Figs. 2, 4, Pl, 5, Fig. 4, Pl. 7, Fig. 17. (KRAFFT and DIENER, 1909. p. 116 ; 1915, DIENER, p. 213, 1970. NAKAZAWA et al., Pl. 28, Fig. 1 a-c.).

1915. *Otoceras fissisellatum*, DIENER, *Fossil Catalog.* I. Pt. 8, p. 213. (1934. SPATH, *Catalog. Fossil* 4., p. 68.)

1915. *Otoceras draupadi*, DIENER, *Fossil. Catalog.* I, Pt. 8, p. 213. (1970. NAKAZAWA et al., *Mem. Fac. Sci., Kyoto Univ. Ser. Geol. Miner.* Vol. 37, Pt. 2, Pl. 28, Figs. 3 a-b).

1930. *Otoceras* (*Metotoceras*) *dieneri*, SPATH, *Meddl. om. Grönland* Vol. 83, Pt. 1, p. 8. (1934. SPATH, p. 69 ; 1957. KUMMEL in ARKELL et al., p. L 132).

1935. *Otoceras, boreale* SPATH, *Medd. om Gronland*, Vol. 98, Pt. 2, p, 9-11, Pl. 1, Figs. 1 a-b, 6 ; Pl. 2, Figs. 2-3, Pl. 3, Figs. 1-3, Pl. 4, Fig. 1, Pl. 5, Fig. 1, Pl. 6, Fig. 1. (1957. KUMMEL in REESIDE et al. p. 1501 ; 1958. POPOV, p. 107, Text Figs. 1-2 ; 1935. POPOV, p. 20-22, Pl. 3, Fig. 4-5 ; 1961. TOZER, p. 45-47, Pl. 6, Figs. 1 a-3 ; Pl. 7, Figs. 1-3b ; Pl. 8, Figs 1-4b ; 1961. KELLER et al., p. 187 ; 1961, TRÜMPY, p. 249 : 1964. VOZIN and TIKHOMIROVA, p. 47, Pl. 25, Figs. 1 a-b ; 1969. TRÜMPY, p. 83).

1972. *Otoceras woodwardi boreale*, KUMMEL, *Bull. Mus. Comp. Zool.* Vol. 143, No. 6, p. 391.

1958. *Otoceras indigirense.* POPOV, *Izv. Akad. Nauk. USSR., Geol. Ser.* No. 12, p. 109 ; Text Figs. 1a, 2 a-b ; (1969. POPOV, p. 22, Pl. 1. Fig. 3)

Material : 5 specimens.

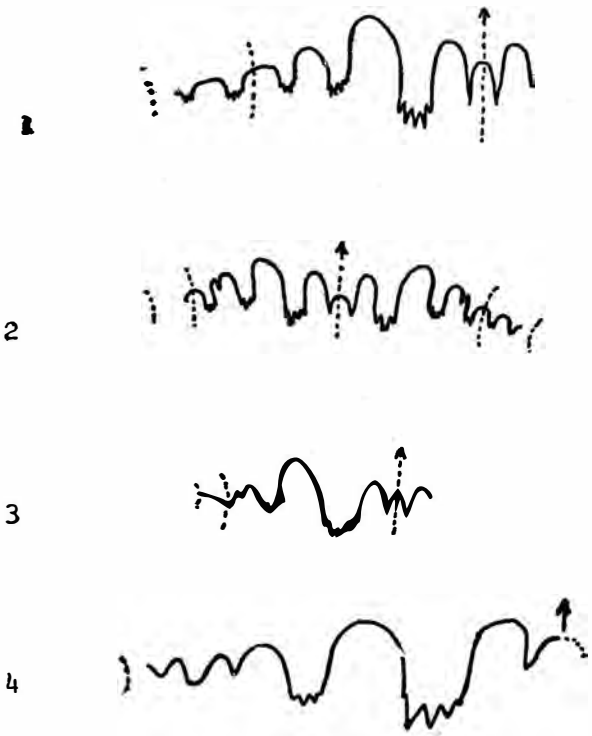
Description : Shell involute, laterally compressed, discoidal, with tricarinate venter and small, deep umbilicus. Umbilical wall cone shaped. Umbilical shoulders sharply acute, forming ear-shaped umbilical edge in adult. Sides flattened with falciradiate, and faint radial ribs or folds extending from umbilical margin to ventral margin.

Widest at umbilical shoulders. Sutures ceratitic, consist of entirely rounded lateral saddles and serrated lateral lobes. External lobe widest and deeper than other lateral lobes ; first lateral saddle entirely rounded and higher than others ; umbilical lobe variable, from simple form to narrowly serrated form ; ventral saddle divided into two shallow and narrow lobes at ventral shoulders.

Dimension : (in mm).

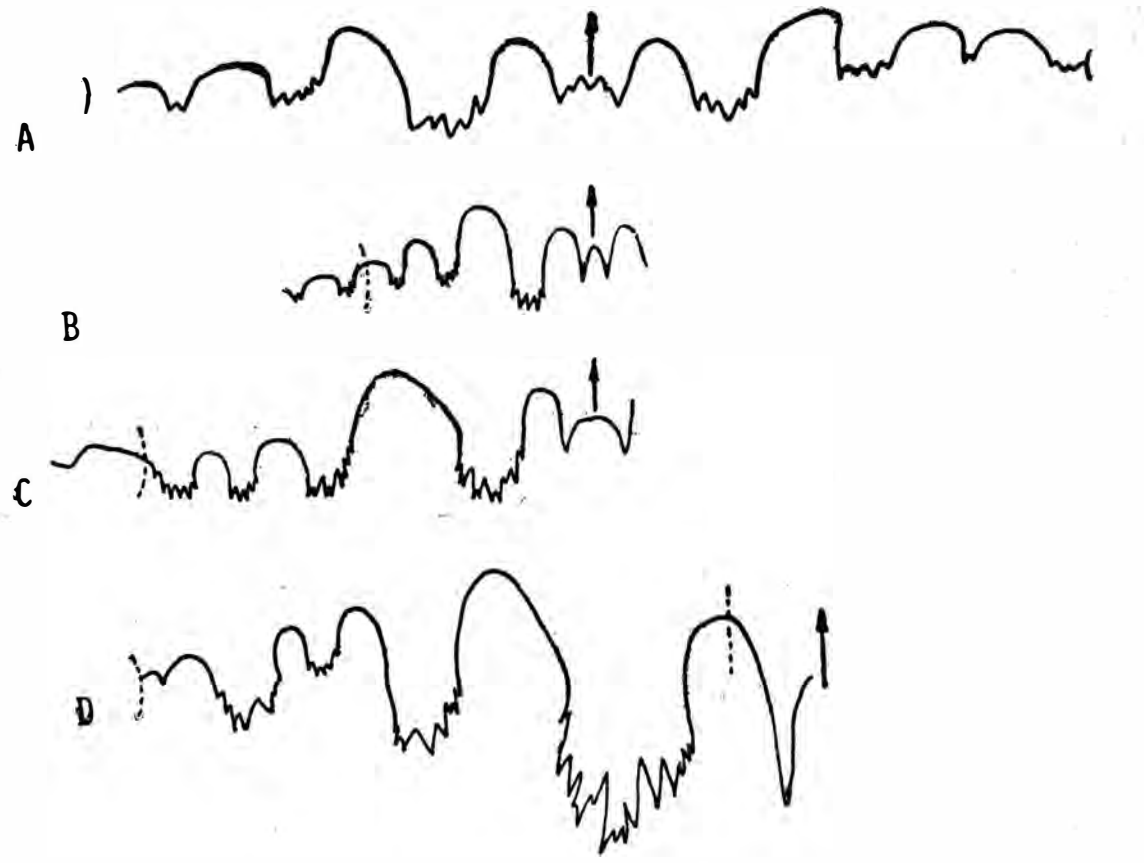
Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19434	111.9	52.8	—	26.5	0.47	—	0.25
GSI. 19435	36.2	18.1	11.0	9.2	0.50	0.61	0.25
GSI. 19436	61.0 ?	31.9	91.8	11.6	0.52 ?	0.68	0.19 ?

Remarks : The specimens of this collection are well preserved. On the basis of the diagnostic characters, they can safely be determined as *Otoceras woodwardi* GRIESBACH. *Otoceras* aff. *fissisellatum* DIENER (GSI. Type No. 19434) referred earlier in Nakazawa et al. (1970) was further examined in more detail. It was noticed that Diener's species and Griesbach's species show slight diffrences, that are only of the suture in the umbilical lobes.



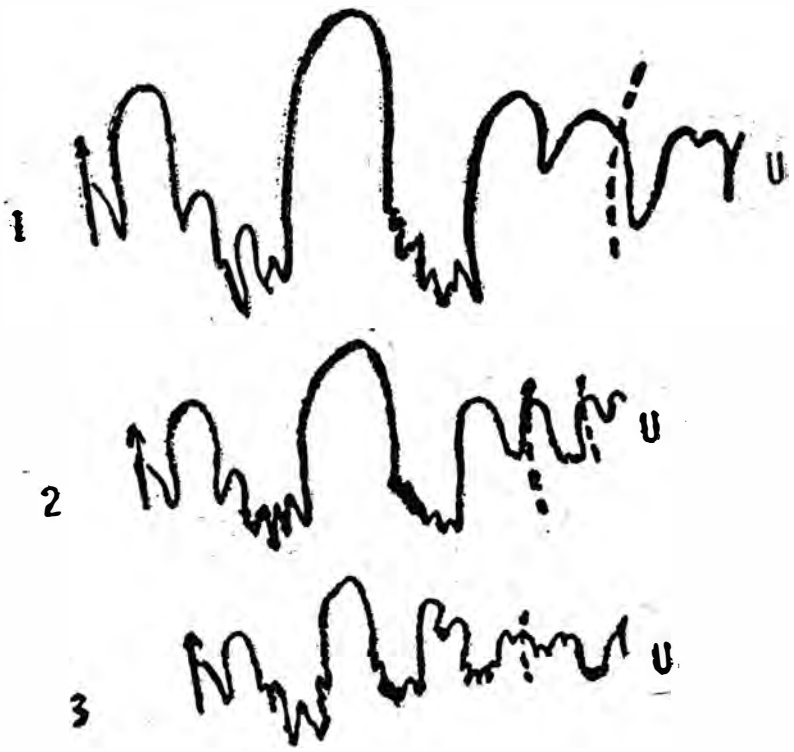
Text Figure 6. Suture lines of *Otoceras woodwardi* GRIESBACH.

1. *Otoceras clivei* DIENER, (1897, Pl. 3, Fig. 4b). 2. *Otoceras fissiselatum* DIENER, (1897, Pl. 3, Fig. 3c).
3. *Otoceras fissiselatum* DIENER, (1897, Pl. 5, Fig. 2b). 4. *Otoceras woodwardi* GRIESBACH (Present Specimen).



Text Figure 7. Suture lines of some species of *Otoceras*.

A. *Otoceras woodwardi* GRIESBACH, Bed 52 a of Guryul Ravine. B. *Otoceras woodwardi* GRIESBACH, Otoceras bed in Central Himalaya, (Diener, 1895, Pl. 3) C. *Otoceras woodwardi* GRIESBACH, Otoceras bed in Spiti (Diener, 1897, Pl. 2, Fig. 1c). D. *Otoceras concavum* TOZER, Blind Fiord Formation, Arctic Canada (Tozer, 1967, p. 87, Fig. 20).



Text Figure 8. Suture lines of *Otoceras boreale* SPATH.
1. Spath (1935, p. 9, Pl. 3, Figs. 1a-b). 2. Spath (1935, Pl. 1, Fig. 6). 3. Tozer (1961, p. 45, Fig. 7)

On the basis of the slight differences in lateral and umbilical sutures, Diener (1897) proposed two groups of *Otoceras*, viz. Group of *Otoceras woodwardi* GRIESBACH (*O. woodwardi* GRISESBACH, *O. parbati* DIENER, *O. clivei* DIENER, *O. undatum* GRIESBACH) and Group of *Otoceras fissisellatum* DIENER (*O. fissisellatum* DIENER and *O. draupadi* DIENER). Kummel (1972) as well as the author consider both the species to be the same. Kummel's subdivisions and author's views have already been discussed earlier.

Horizon and Locality : Beds 52 and 58, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. Bed 61, Unit f_2, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus.

Specimen : GSI. Type Nos. 19434, 19435, 19436, 19453, 19467

Superfamily Xenodiscaceae FRECH, 1902
Family Ophiceratidae ARTHABER, 1911
Genus *Ophiceras* GRIESBACH, 1880
Subgenus *Ophiceras* SPATH, 1934

Ophiceras (Ophiceras) tibeticum GRIESBACH

PLATE 15, Fig. 1

1888. *Ophiceras tibeticum* GRIESBACH, *Rec. Geol. Surv. India*, Vol. 13, Pt. 2, p. 109, Pl. 3, Fig. 4.

1897. *Ophiceras tibeticum*, DIENER, *Palaeont. Indica* Ser. 15, Vol. 2, Pt. 1, p. 105, Pl. 8, Figs. 1-7.

1915. *Ophiceras tibeticum*, DIENER, *Fossil Catalog.* I, Pt. 8, p. 212.

1934. *Ophiceras tibeticum*, SPATH, *Catalog. Fossil Cephal*, Pt. 4, p. 73, 75, Figs. 13 d-e.

1957. *Ophiceras tibeticum*, KUMMEL, in ARKELL '*Treatise on Invertebrate Paleontology*', p. L 132-133 ; Fig. 5a-c.

1972. *Ophiceras tibeticum*, KUMMEL, *Bull. Mus. Comp. Zool.*, Vol. 143, No. 6, p. 384, Pl. 5, Figs. 1-10.

Material : One specimen.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19440	46.9	16.7	14.1	17.5	0.35	0.48	0.31

Remarks : This specimen is similar to *Ophiceras tibeticum* GRIESBACH originally described from the Otoceras bed of the Shalshal cliff, near Rimkin Paiar, Kiunlung in Central Himalaya, and Kuling in Spiti. According to Diener (1897, p. 108) *Ophiceras tibeticum* occurs, about 25 feet above the main layer of *Otoceras woodwardi* in Otoceras bed. At the Guryul Ravine, the horizon of *Ophiceras tibeticum* is about 8.5 meters above the lowest layer of *Otoceras.* Therefore stratigraphic position of this species in these areas appear to be identical.

Ophiceras serpentinum DIENER (1897, p. 110, Pl. 13, Figs. 2 a-b, lectotype ; Figs. 1, 3-7 ; Spath, 1934, p. 74) resembles *Ophiceras tibeticum* GRIESBACH in the shape of the whorl and umbilicus but differs in shape of the whorl section. Spath (1934, p. 74) has already stated the difference of the two species. In the former it has more rounded venter than that in the latter.

Horizon and Locality : Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19440

Ophiceras (Ophiceras) serpentinum DIENER

PLATE 16, Fig. 10

1897. *Ophiceras serpentinum* DIENER, *Palaeont. Indica,* Ser. 15, Vol. 2, Pt. 1, p. 110, Pl. 13, Figs. 1, 3-7, Figs. 2 a-b, (lectotype). (1915. DIENER, p. 212 ; 1934. SPATH, p. 74).

Material : one specimen.

Description : Specimen in hand lacks half of the outer whorl, as such, sutures of outer whorl not observed. Shell and umbilicus features and sutures on inner whorls, well preserved. Lateral lobes slightly denticulated, but not prominent and the lateral saddles roundly arched without serrations. Umbilical lobe smooth, with no denticulations.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19456	—	22.9	22.0 ?	25.8 ?	—	0.96	—
A	67	22	15	30	0.32	0.68	0.45
B	86	28	23	40	0.32	0.82	0.47

A. Diener's specimen. 1897, Pl. 13, Fig. 5. B. Diener's specimen. 1897, Pl. 13, Fig. 2.

Remarks : The sutures of the specimen resemble those of *Ophiceras serpentinum* Diener. Spath (1934, p. 74) differentiates *serpentinum* from *tibeticum* on the basis of elliptical coiling ; however, author feels that the elliptical coiling may not be the primary character but a secondary deformation.

The shape of the specimen can be deduced from the outline of the outer whorl. The shell ornamentation is similar to *Lytophiceras*, however differs in whorl section. The subgenus *Lytophiceras* has more compressed whorl than *tibeticum* or *serpentinum.*

Horizon and Locality : Bed 64 (associated with *Ophiceras tibeticum*), Unit E_3, Member E, Khunamuh Formation, Guryul Ravine (age Otoceratan of Early Induan).

Specimen : GSI. Type No. 19456

Ophiceras (*Ophiceras*) sp. indet.

PLATE 15, Fig. 8

Material : One specimen.

Description : Shell evolute, rather laterally compressed, with arched venter, gently convex sides and rounded umbilical shoulders. Surface ornamented with irregularly spaced, indistinct radial folds. Whorl cross-section of outer volution trapezoidal. Suture ceratitic, consists of roundly arched lateral saddles and slightly denticulated lateral lobes. Ventral lobe shallow and divided by small median siphonal saddle into narrow, non-denticulated lobes. Umbilical lobe shallow and simple. Height of last whorl 18.6 mm and width about 17 mm. Inner whorls unknown.

Remarks : The specimen lacks in the inner volution and half of the outer volution. The whorl section, ornamentation, ventral features and sutures resemble those of *Ophiceras demissum* (OPPEL) (1865, p. 290, Pl. 36, Figs. 1 a-c, holotype ; Diener, 1897, p. 121, pl. 14, Figs. 1-7 ; Diener, 1915, p. 211, Spath, 1934, p. 74), still it is difficult to determine exact species due to poor preservation of the material.

Horizon and Locality : Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine, (Late Otoceratan of Early Induan).

Specimen : GSI. Type No. 19447

Subgenus *Lytophiceras* SPATH, 1930

Type species : 1897. *Ophiceras chamunda* DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 123, Pl. 12, Figs. 3a-b.

Diagnosis : Ophiceratidae, which are compressed, more or less involute, discoidal development of *Ophiceras*, without high umbilical rim (Spath, 1934, p. 75).

Remarks : Three species, viz. *Ophiceras chamunda* DIENER, *Ophiceras sakuntala* DIENER and *Ophiceras ptychodes* DIENER were included in the Subgenus *Lytophiceras* by Spath (1934). The subgenus is more intimately related to *Ophiceras* s. str. than to *Glyptophiceras* in respect to the shell ornamentation, umbilicus and sutures. *Lytophiceras ptychodes* (DIENER) has more distinct sculpture than the other species of *Lytophiceras.*

Distribution : Late Otoceratan or Early Induan. Himalaya, East Greenland, Primorye in Far East Russia and North America.

Ophiceras (*Lytophiceras*) *sakuntala* (DIENER)

PLATE 16, Fig. 5 ; PLATE 17, Fig. 1 ; PLATE 18, Fig. 2

1897. *Ophiceras sakuntala* DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 114, Pl. 10, Figs. 1-8 ; Pl. 11, Figs. 1, 2, 4.

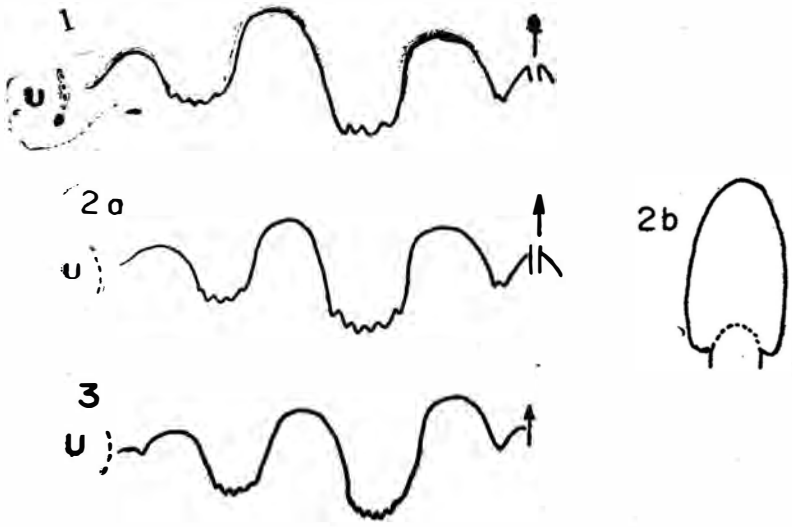
1913. *Ophiceras sakuntala*, DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 1, p. 15, Pl. 1, Figs. 1-2.

1932. *Ophiceras sakuntala*, SMITH, *U. S. Geol. Surv. Prof. Paper* No. 167, p. 50, Pl. 54, Figs. 1-17 ; Pl. 56, Figs. 13-18.

1934. *Ophiceras* (*Lytophiceras*) *sakuntala*, SPATH, *Catalog. Fossil Cephal.* 4, p. 76, Pl. 1, Fig. 2.

1954. *Ophiceras* (*Lytophiceras*) cf. *sakuntala*, KIPARISOVA, *Comp. Rend.*, Vol. 49, Pt. 6, p. 16, Pl. 6, Fig. 2.

1961. *Lytophiceras sakuntala*, KIPARISOVA, *Trudy. Bses. Nauts. Isred.*, Vol. 48, p. 37, Pl. 7, Figs. 2, 6.



Text Figure 9. Suture lines and whorl section of *Ophiceras* (*Lytophiceras*) *sakuntala* DIENER (1-2) and *Ophiceras* (*Ophiceras*) sp. indet. (3).

1. GSI. Type No. 19457, Bed 51-52, Guryul Ravine. 2. GSI. Type No. 19452, Bed 55, the Spur 3 kilometres north of Barus. 3. GSI. Type No. 19447, Bed 64, Guryul Ravine.

Material : Two specimens.

Description : Whorls rather involute, laterally compressed, discoidal shell with rounded venter and convex sides. Diameter of the umbilicus about one third diameter of shell, and their shoulders abruptly rounded from umbilical margin to umbilicus. Umbilicus exposes three inner volutions. Sides gently convex from umbilical margin about one third height from umbilical rim. Shell surface sculptured with falciradiate folds, variable in strength and increasing gradually in breadth towards ventral margin where they diminish. Sutures of primitive ceratite form consist of narrow and elongate saddles and lobes. Second lateral lobe comparatively broad, but siphonal lobe divided by two narrowly denticulated terminal into lateral branch on ventral shoulders. Umbilical series or auxiliary lobes missing in present specimen.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19457	49.7	19.2 (14, 6)	– (9.9)	16.2	0.39	0.67	0.32
GSI. 19452	54.7 ?	22.0	12.8	18.3	0.40	0.58	0.33
Diener's specimens							
1.	—	—	—	—	0.43	0.67	0.30
2.	—	—	—	—	0.32	0.68	0.29
3.	—	—	—	—	0.39	0.73	0.32
4.	—	—	—	—	0.40	0.55	0.34

Remarks : The specimens of the Guryul Ravine and the Spur three kilometres north of Barus are identical with those of *Ophiceras* (*Lytophiceras*) *sakuntala* originally described by Griesbach and Diener from the Otoceras bed of Shalshal Cliff and Niti pass (Diener, 1897, p. 118).

Kummel (1972) pointed out that most of the described specimens of *Ophiceras* (*Lytophiceras*) *sakuntala* DIENER bolong to *Ophiceras medium* GRIESBACH. The general characters of both of the shells are similar. Shell surface however, in the latter species is smooth with no distinct fold when compared with *sakuntala.* Falciradiate fold ornamentation of shell surface of *O. sakuntala* is however, variable.

This species is also known from Primorye region (Kiparisova, 1954, 1961). *Ophiceras* (*Lytophiceras*) *spathi* TRÜMPY (1969, p. 97, Pl. 2, Figs. 6-7) reported from Jameson Land of East Greenland has close relation with *Lytophiceras sakuntala* of Himalaya in respect to the general characters of shell.

The Guryul Ravine specimen of the present material is found in association with *Otoceras woodwardi*, which represents the lowest horizon of the Lower Triassic.

Horizon and Locality : Bed 52b, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. Bed 55, Unit f_2, Member f, Khunamuh Formation, a Spur 3 kilometres north of Barus. (Otoceras bed, Early Otoceratan or Early Induan).

Specimen : GSI. Type Nos. 19452, 19457, 19466

Ophiceras (*Lytophiceras*) *subdemissum* SPATH

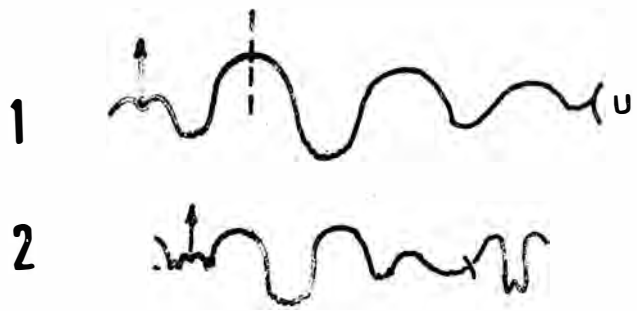
PLATE 17, Figs. 2, 4

1930. *Ophiceras* aff. *demissum* (OPPEL), SPATH, *Meddl. om. Grönland.* Vol. 83, Pt. 1, p. 14, Pl. 2, Figs. 1-7.

1934. *Ophiceras* cf. *demissum* (OPPEL), SPATH, *Catalog. Fossil Ceph.* 4, p. 74, Text Figs. 34 d.

1935. *Ophiceras* (*Metophiceras*) *subdemissum* SPATH. *Medd. om. Grönland* Vol. 98, Pt. 2, p. 35, Pl. 13, Fig, 3, Pl. 17, Figs. 3a-b, Pl. 18, Figs. 3 a-b, Pl. 19, Fig. 2.

1969. *Metophiceras subdemissum* (SPATH), TRÜMPY, *Medd. om Grönland.* Vol. 168, No. 2, p. 94.



Text Figure 10. Sutures of *Lytophiceras subdemissum* (SPATH).

1. *Ophiceras tibetium* Zone, Bed 64, Guryul Ravine. 2. Lower Ophiceras beds, Clavering Island, Nathorst Fjord, Greenland (Spath, 1935, p. 35, Pl. 13, Fig. 3).

Material : A single fragmentary specimen.

Remarks : Preservation of the specimen is not good but only the sutures and surface ornamentation assist in identifying the specimen with the species. Sutures are primitive ceratitic type and consist of slightly serrated lateral lobes and roundly arched saddles. External saddle is situated on ventral shoulder. The species is associated with *Ophiceras tibeticum* GRIESBACH in the Guryul Ravine section (Text Fig. 10).

Horizon and Locality : Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. Late Otoceratan or Early Induan.

Specimen : GSI. Type No. 19458

Ophiceras (*Lytophiceras*) sp. indet.

PLATE 17, Fig. 3

Material : A single specimen.

Description : Whorl evolute, laterally compressed, discoidal, with rounded venter and wide umbilicus. Shell surface ornamented with adventitious and radial folds, slightly sigmoidal and faint inner whorl. Width of shell maximum at one third height of whorl. Sutures ophiceratid.

Dimensions : (in mm)

Type No.	U	H	W	U	H/D	W/H	U/D
GSI. 19459	37.0	12.0	10.4 ?	18.0	0.32	0.86	0.48

Remarks : The present specimen resembles "*Metophiceras*" *prescursor* (SPATH) (Spath, 1935, p. 37, Pl. 1, Figs. 7 a-b ; Pl. 6, Figs. 3 a-b) of the lower Ophiceras bed of Clavering Island, Nathorst Fjord, Greenland, in respect to the general characters of shell, but due to poor preservation of the umbilicus, specific identification is not possible. "*Metophiceras*" *wageneri* TRÜMPY (Trümpy, 1969, p. 94, Pl. 1, Figs. 4-6), on the other hand has similar ornamentation like that of the present specimen but differs from it in having more compressed whorls in the ventral part and also has helmet-shaped whorl section.

Horizon and Locality : Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. (Late Otoceratan or Early Induan).

Specimen : GSI. Type No. 19459

Genus *Glyptophiceras* SPATH, 1930

Type species :

1913. *Xenodiscus aequicostatus* DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 1, p. 6, Pl. 2, Figs. 10a-b.

Diagnosis : Whorls rather evolute, with oval or rounded cross section, shallow and rounded umbilical wall, with prominent radial ribs tending to degenerate into striation. Sutures are like *Ophiceras* but have weak lateral denticulations.

Remarks : The type species of the genus *Glyptophiceras* was erected by Spath (1930, p. 33) by revising *Xenodiscus aequicostatus* DIENER from the collection of the *Ophiceras* layer, Pastannah, Kashmir (Diener, 1913, p. 6, Pl. 2, Figs. 10 a-b). Tozer (1969, 1971) insisted that

Pastannah fauna should be of Smithian in age because it includes fossils such as "*Xenodiscus*" (=*Xenoceltites*) *comptoni* DIENER, and ammonoids assigned to the genus *Ophiceras* as well, be assigned to a Smithian genus *Dieneroceras*. The author had the opportunity to examine specimens of Pastannah stored in British Museum by courtesy of Dr. M. K. Howarth and came to the same conclusion as mentioned earlier (in Nakazawa et al., 1975, p. 73). The Otoceratan species referred to as *Glyptophiceras* by Spath (1930, 1935) are different from the Owenitan type species, and their generic position should be reexamined, although they are tentatively placed in *Glyptophiceras* in this paper.

Glyptophiceras himalayanum (GRIESBACH)

PLATE 16, Figs. 1, 3 ; PLATE 18, Fig. 4

1886. *Ceratites himalayanus* MOJSISOVICS, *Mem. Acad. Imp. Sci. Nat. St. Petersb.*, Vol. 33, No. 7, p. 20.

1880. *Ophiceras himalayanus* GRIESBACH, *Rec. Geol. Surv. India.*, Vol. 13, Pt. 2, p. 111, Pl. 3, Fig. 8.

1897. *Danubites hiamalayanus*, DIENER, *Palaeont. Indica*, Ser. 15, Vo. 2, Pt. 1, p. 41, Pl. 14, Figs. 14 a-c.

1897. *Danubites ellipticus*, DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2., Pt. 1, p. 32, Pl. 14, Figs. 12-13.

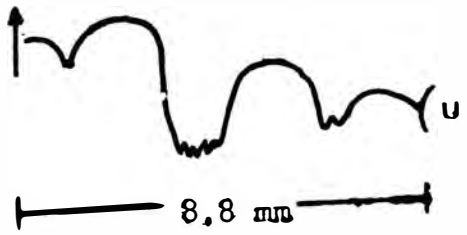
1913. *Ophiceras himalayanum*, DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 1, p. 5.

1934. *Glyptophiceras himalayanum* SPATH, *Catalog. Fossil Cephal.* 4, p. 81 and p. 120.

Material : Four specimens.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19468	31.2	10.0	7.6	14.4	0.32	0.76	0.46
GSI. 19450	28.9	9.5	6.5	12.4	0.32	0.68	0.42
GSI. 19448	31.8	10.2	7.4	14.4	0.32	0.73	0.45



Text Figure 11. Suture line of *Glyptophiceras himalayanum* (GRIESBACH), Bed with *Otoceras woodwardi* (Bed 52, arenaceous grey coquinoid limestone), Guryul Ravine.

Remarks : Glyptophiceras himalayanum was first described as *Ophiceras* by Griesbach in 1880. Diener (1897) described the same species as *Danubites* from the Otoceras bed of Shalshal Cliff. Present material of the Guryul Ravine comes from the arenaceous limestone of the Otoceras bed. The similarity of shell sculpture and sutural elements suggests that the *Glyptophiceras ellipticum* (DIENER) may also be merged with this species.

Horizon and Locality : Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. It occurs in dark grey coquinoid limestone with many shell fragments. (Early Induan or Otoceratan ; in *Otoceras woodwardi* layer).

Specimen : GSI. Type Nos. 19448, 19450, 19468

Glyptophiceras lissarenum (DIENER)

PLALE 15, Fig. 6 ; PLATE 16, Fig. 4

1897. *Danubites lissarensis* DIENER, *Palaeont. Indica* , Ser. 15, Vol. 2, Pt. 1, p. 45, Pl. 14, Figs. 8, 9, 11 a-c.

1934. *"Danubites" lissarensis*, SPATH, *Catalog. Fossil. Cephal.*, 4, p. 83.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19451	39.05	11.5	11.0	18.6	0.29	0.96	0.48

Remarks : The species *Danubites lissarensis* DIENER from the Otoceras beds of the Lissar valley was originally described by Diener (1897). Ornamentation of the present material is similar to this species. The species needs its merger with genus *Glyptophiceras*, based on the characters of the shell.

Horizon and Locality : Bed 52, Unit E_2, (Coquinoid limestone with *Otoceras woodwardi*) Member E, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type Nos. 19445, 19451

Glyptophiceras ellipticum (DIENER)

PLATE 16, Fig. 2

1897. *Danubites ellipticus* DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 32, Pl. 14, Figs. 12.

Material : One specimen.

Remarks : Diener (1897, Pl. 14, Figs. 12, 13) illustrated two specimens, one with obliquely elliptical shape and the another circular in form (Fig. 12). Present species is distinguished by its strongly developed lateral sculpture from other species of *Glyptophiceras.*

The material has strong sculpture on shell surface, rather more strong than *Glyptophiceras himalayanum* (GRIESBACH) or *Glyptophiceras lissarenum* (DIENER). Since Diener's type species was collected from the Otoceras beds ? at hills above Kuling, and the present material also comes from the *Otoceras woodwardi* layer of the Guryul Ravine, therefore, there is every likelihood of its being a characterstic fossil of the *Otoceras woodwardi* Zone.

Horizon and Locality : Bed 52, Unit E_2, Member E, (Coquinoid limestone with *Otoceras woodwardi*), Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19449

Genus *Vishnuites* DIENER, 1897

Type species :

1897. *Vishnuites pralambha* DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 88, Pl. 7, Figs. 4 a-d.

Diagnosis : Laterally compressed, evolute, with acute knife-edged venter and smooth surface. Ornamentation rather delicate, consists of irregular wrinkles or narrow folds as in *Ophiceras.* Sutures are *Ophiceras* type, but show a slight progress in auxillary elements.

Remarks : The genus *Vishnuites* is the most advanced form of Ophiceratidae and keeps pace with the genus *Subinyoites* (Spath, 1930). The form of the venter shows transitional

variations between *Ophiceras* and *Vishnuites*. *Ophiceras* has a broadly rounded venter, and *Vishnuites* compressed acute venter. These progressive transformation of shell is compared to that observed in Otoceratidae.

The horizon that yielded *Vishnuites* is about 22 metres above the horizon of *Ophiceras tibeticum*.

Distribution : Early Triassic Gyronitan or Late Induan. Greenland, South China, Himalaya, Primorye in Far East Russia and Iran.

Vishnuites sp. cf. *Vishnuites pralambha* DIENER

PLATE 15, Fig. 2

Compare :

1897. *Vishnuites Pralambha* DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 88, Pl. 7, Figs. 4-5.

1913. *Vishnuites pralambha*, DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 1, p. 21, Pl. 3, Figs. 4 a-b.

1934. *Vishnuites* aff. *pralambha*, SPATH, *Catalog. Fossil. Cephal.*, 4b, p. 85, Fig. 16.

1979. *Vishnuites pralambha*, BANDO, *Mem. Fac. Educ. Kagawa Univ.*, II, Vol. 29, No. 2, p. 109, Pl. 11, Fig. 1.

Material : Two specimens.

Description : Shell very flat and discoidal, laterally compressed, with acute venter and wide umbilicus as in flemingitid ammonoids. Maximum thickness of shell at about half height of whorl. Surface ornamented with irregular, faint falcoid striations on body whorl. Venter sharply acute like knife-edge. Inner whorls indented about half height of outer whorl and outer whorl overlapping inner whorls about two third height of inner whorls.

Sutures well preserved and consist of ceratitic forms, represented by entirely rounded lateral saddles and denticulated lateral lobes ; siphonal lobe obscure because of poor preservation, but first, second and third lateral lobes denticulated at their bottom. Second lateral lobe deeper and broader than others ; second lateral saddle broader and higher than other saddles. Umbilical lobes consist of linear, small, irregularly denticulated form extending from umbilical margin to umbilical shoulders.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19441	92.6	39.9	—	24.8	0.42	—	0.26
Holotype	57	23	8	19	0.42	0.35	0.33

(Holotype : Diener, 1897, p. 88, Pl. 7, Figs. 4-5)

Remarks : Both the specimens lack their umbilical structure. One of them has well preserved outer whorls and their sutures while the other is not so well preserved. The specimens are almost identical with *Vishnuites pralambha* DIENER described first time from the Otoceras beds at Shalshal Cliff near Rimkin Paiar. Originally this genus was separated by Diener (1897, p. 83) as a Subgenus of *Xenaspis* WAAGEN (1895) and later included in the Ophiceratidae by Spath (1934, p. 84).

This species was later described by Diener (1913) from the "Ophiceras" beds at Pastannah in Kashmir. In the Guryul Ravine *Vishnuites* horizon occurs between Ophiceras and Meekoceras beds, and is found in a hard compact cliff forming limestone. Other species of

Genus *Vishnuites* are *Vishnuites wordiei* SPATH and *Vishnuites decipiens* SPATH, described from Greenland by Spath (1935, p. 41-42). *Vishnuites decipiens* is very similar to *Vishnuites pralambha* in its general characters of shell form but differs in the suture of umbilical series, which is simpler than *pralambha*. In general, no significant difference is observed in Himalayan and Greenland species, and may safely be included in *Vishnuites pralambha* in a wider sense.

Kiparisova (1961, p. 44) described *Vishnuites* sp. and *Paravishnuites* ? sp. from the Induan stage of the Primorye region of Siberia. In South China, *Vishnuites marginalis* CHAO, was described by Chao (1959, p. 35) from the Eotriassic shale of Lolou (Linglo district, Kwangsi). Chinese species is too small for comparision with the present species. Recently author found this species in the collection of Claraia bed, at Kuh-e-Hambast, Abadeh region, Iran (Unit 8 or a of Taraz, 1971, 1974) which occurs in association with *Ophiceras* (*Lytophiceras*) and *Ophiceras* (*Acanthophiceras*) (Bando, 1979, 1981, in press).

Horizon and Locality : Bed 76, Member F, Khunamuh Formation, Guryul Ravine, (Gyronitan or Late Induan).

Specimen : GSI. Type No. 19441

Superfamily Meekoceratidae WAAGEN, 1895

Family Paranoritidae SPATH, 1930

Subfamily Paranoritinae SPATH, 1930

Genus *Koninckites* WAAGEN, 1895

Koninckites kraffti SPATH

PLATE 16, Fig. 9

1909. *Meekoceras varaha* DIENER, (in Krafft A. v. and Diener, C.), *Palaeont. Indica*, Ser. 15, Vol 6, Pt. 1, p. 17, Pl. 11, Figs. 4 a-d (lectotype), 2-3, 5-6 ; Pl. 14, Figs. 7-8.

1915. *Meekoceras varaha*, DIENER, *Fossil. Catalog.*, I, Pt. 8, p. 195.

1930. *Meekoceras varaha*, SPATH, *Meddl. om Grönland*, Vol. 83, Pt. 1, p. 28.

1934. *Koninckites kraffti*, SPATH, *Catalog. Fossil. Cephal.*, Pt. 4, p. 155, Fig. 43 c (p. 152).

Material : One specimen.

Description : Whorl involute, discoidal, laterally compressed, with narrowly tabulated or arched venter ; small umbilicus with abruptly rounded umbilical wall. Sides gently convex and widest at one third height of whorl. Surface smooth. Suture ceratitic, consists of first and lateral rounded saddles and slightly denticulated lateral lobes, and of denticulated umbilical lobe. Umbilical lobe considerably wide and shallow and ventral lobe also shallow and narrow divided by median siphonal small saddle.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19455	37.6	17.4	9.0	5.0	0.46	0.51	0.13

Remarks : The material fully resembles *Koninckites kraffti* SPATH known from the "Meekoceras" bed which is exposed one mile north of Lilang, Spiti (Diener, 1909 ; Spath 1934). Original description (Diener, 1909 in Krafft and Diener) referred the species to be of the species of genus *Meekoceras* and its horizon to be Meekoceras bed. Spath (1934) pointed

out that this species entirely differs from *Meekoceras* in respect to the forms of venter as well as ventral and umbilical sutures.

Horizon and Locality : Bed 80, Member G, Khunamuh Formation, Guryul Ravine, (*Prionites-Koninckites* Zone).

Specimen : GSI. Type No. 19455 *Collection :* H. M. KAPOOR, 1972.

Koninckites sp.

PLATE 20, Figs. 1, 2

Material : One specimen.

Description : Whorls discoidal, involute, laterally compressed, with narrowly arched venter. Umbilicus small with funnel shaped umbilical wall. Sides flattened and gently convex from umbilical margin to ventral shoulders. Maximum thickness at umbilical margin of flanks. Outer whorl indented, height of inner whorl about half height of outer whorl. Suture consists of rounded arched-shape lateral saddles and weakly denticulated lobes at bottom. Umbilical and ventral lobes not observed because of poor preservation.

Demensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19478	—	32.4	15.8	6.5	—	0.48	—

Remarks : The present material is broken at about one-third of the outer whorl and the preservation of the sutures is poor. Though the whorl section, umbilicus and surface of the shell are well preserved but helps only identification upto its generic rank.

Koninckites generally occurs universally from the beds with *Meekoceras*, *Owenites* and *Kashmirites* of Olenekian stage (Late Scythian). In Guryul Ravine, it was found in association with *Kashmirities subarmatus* (DIENER).

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine, (*Owenites-Kashmirites* Zone, Olenekian).

Specimen : GSI. Type No. 19478

Genus *Paranorites* WAAGEN, 1895

Type species :

1895. *Paranorites ambiensis* WAAGEN, *Palaeont. Indica*, Ser. 13, Pt. 2, p. 158, Pl. 22 Fig. 1.

Diagnosis : More or less evolute, discoidal, with narrowly rounded periphery and slightly convex sides, highly rounded umbilical wall, and ceratitic suture-line, with external saddles and lobes more differentiated than in *Ophiceras* or *Prionolobus* (Spath, 1934, p. 141).

Remarks : The genus *Paranorities* was established by Waagen in 1895 (p. 157) for a single species *Paranorities ambiensis* WAAGEN, obtained from the Ceratite Formation of the Salt Range. Waagen comments on this species "it is only a single species for which I must create this new genera and therefore it is very difficult to distinguish between specific and generic characters. That which I consider as essential for the genus is the sutural line." Diener

(1915) regarded this genus to be synonym of *Meekoceras* but Spath (1934, p. 140) later on stressed that Meekoceratidae is distinguished from Paranoritid by variable proportions of the sutural elements as well as different stages of development and without any tendency to involution or sharpening of the periphery.

The author, however, considers that *Paranorites* is a representative form showing the evolutionary stages between *Ophiceras—Gyronites—Prionolobus* and *Proptychites* and *Koninckites*. This analysis is based mainly on the characterstic features of the sutures.

The type species of genus *Paranorites*, *i.e.*, *Paranorites ambiensis* WAAGEN, was formerly considered by Frech (in Noetling, 1905) to be identical with "*Prionolobus*" *volutus*. Spath (1934) included *Koninckites vercheri* WAAGEN (1895, p. 265, pl. 30, Figs. 1 a-d), *Koninckites volutus* WAAGEN (1895, p. 268, Pl. 28, Figs. 1-2), *Koninckites gigas* WAAGEN (1895, p. 266, Pl. 31, Fig. 2) and *Meekoceras pulchrum* WAAGEN (1895, p. 249, Pl. 29, Figs. 1 a-c ; non Pl. 27, Figs. 2-3) into the genus *Paranorites*. He also described some species of *Paranorites*, viz., *P. hydaspis*, *P. praestans*, *P. aequilis* and *P. inflatus* from a collection of Koken obtained from the Ceratite Marls of Salt Range.

Meekoceras tuberculatum SMITH (1932, p. 62, Pl. 50, Figs. 1-4) was placed with the genus *Paranorites* by Kiparisova (1961) who described a new species *Paranorites subhydaspis* KIPARISOVA from the Lower Triassic of Ussuri region. In addition, Popov (1961) described *Paranorites* fauna (*Paranorites* Zone) from Induan Bed of Northeast Siberia containing several species of the genus, viz., *Paranorites vercheri* WAAGEN, *P. tzeregradski* POPOV, *P. kolymensis* POPOV, *P. kolymensis costata* POPOV, *P.* cf. *inflatus* SPATH, *P. olenekensis* (KIPARISOVA) and *P.* cf. *gigas* WAAGEN.

Distribution : Gyronitan or Late Induan (Early Eo-Trias). Salt Range, Kashmir, Ussuri, Northeast Siberia and North America.

Paranorites kummeli BANDO sp. nov.

PLATE 18, Fig. 1 (a-b)

Diagnosis : Shell rather evolute, discoidal, with narrowly rounded or indistinctly tabulated venter. Sides convex on umbilical whorl and rather flattened on ventral sides. Umbilical sides highly rounded at greatest whorl thickness at umbilical margin. Suture ceratitic and consists of highly arched-shape entire saddles, and of denticulated lateral and umbilical lobes. Umbilical lobes considerably long.

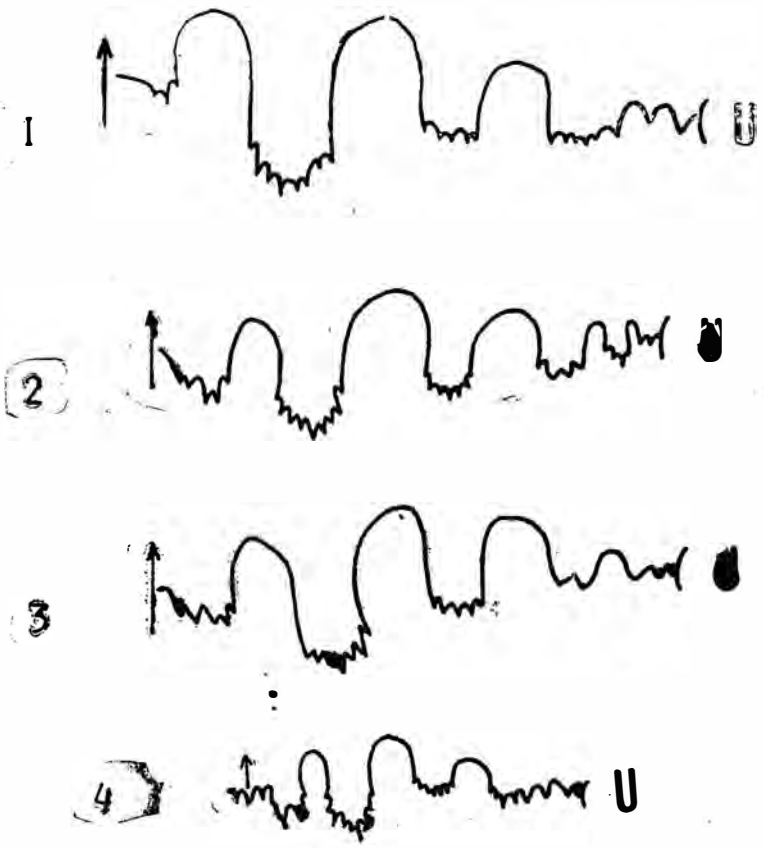
Material : A single specimen.

Description : Whorl rather evolute, discoidal, laterally compressed, with narrowly rounded of slightly tabulated venter and steeply sloped umbilical wall. Surface ornamented with node-like ridges near umbilical shoulders and generally convex sides ; width maximum at umbilical margin. Diameter of umbilicus about one fourth of diameter of shell and width of whorl about half of height. Venter narrowly rounded or slightly tabulated and their shoulders abruptly rounded. Sutures typically ceratitic, consist of high arch-shaped saddles and denticulated deep lobes. Umbilical lobes considerably long and projected, as like, as small saddle near umbilical edge. Ventral lobe shallow and denticulated, and divided by tricarinated saddle into two shallow lobes on ventral margin.

Dimensions : (in mm)

	D	H	W	U	H/D	W/H	U/D
A	211.4	86.0	51.9	61.0	0.40	0.60	0.28
B	240.0	93.0	53.0	90.0	0.38	0.56	0.37
C	185.0	93.0	52.0	37·0	0.50	0.55	0.20
D	102.0	45.0	22.0	27.0	0.44	0.48	0.26
E	120.0	45.0	21.5?	40.0	0.37	0.47?	0.33

A. Present species GSI. Type No. 19465 (Holotype). B. *Paranorites gigas* (WAAGEN), 1895. p. 266, Pl. 31, Figs. 2 a-c, as *Koninckites*. C. *P. kingianus* (WAAGEN), 1895. p. 225, Pl. 32, Fig. 1 ; Pl. 33, Figs. 1 a-b, as *Aspidites*. D. *P. ambiensis* WAAGEN, 1895. p. 158, Pl, 22, Fig. 1 (holotype). E. *P. hydaspis* SPATH, 1934. p. 145, Pl, 9, Figs. 3 a-b (holotype).



Text Figure 12. Comparision of sutures of some species of *Paranorites*

1. *Paranorites kummeli* BANDO (D=211.4 mm) ; 2. *Paranorites kingianus* (WAAGEN) (D=93.0 mm) ;
3. *Paranorites ambiensis* WAAGEN (D=45.0 mm) ; 4. *Paranorities hydaspis* SPATH (D=120·0 mm).

Discussions : The present new species is erected on a single specimen collected from Member F of the Khunamuh Formation at the Guryul Ravine. The preservation of the specimen is good and it can be distinguished from other species of the *Paranorites*. It has distinct differences in the sutures of umbilical series and ventral part. The present specimen is the largest ammonoid in the collection of the Guryul Ravine.

The new species is similar to *Paranorites gigas* (WAAGEN) and *P. ambiensis* WAAGEN having identical form of shell and lateral sutures, but the umbilicus of *P. gigas* is larger than that of the present species. The sculpture of the shell of *P. ambiensis* differs from the present

species. *Paranorites hydaspis* SPATH is also similar to the present species in the sutures and the cross section of the outer whorl, but it is slightly different in the umbilical sutures.

"*Aspidites*" *kingianus* WAAGEN was provisionally included in the genus *Paranorites* by Spath (1934, p. 142). The author also includes *kingianus* in the genus *Paranorites*. It resembles the present species, but the umbilicus of the present specimen is wider than that of Waagen's species known from the Salt Range (vide, Dimensions above).

Etimology : The species is named in the honour of the Late Prof. Bernhard Kummel, Museum of Comparative Zoology, Harvard University.

Horizon and Locality : Bed 75-76, Member F, Khunamuh Formation, Guryul Ravine, (Gyronitan).

Specimen : GSI. Type No. 19465 (Holotype) *Collection :* H. M. Kapoor, 1972.

Family	Proptychitidae	WAAGEN, 1895
Subfamily	Proptychitinae	SPATH, 1930
Genus	*Proptychites*	WAAGEN, 1892
Subgenus	*Pseudoproptychites*	BANDO, nov.

Type species :

1863. *Ceratites laarencianus* DE KONINCK.

1897. *Proptychites sheibleri* DIENER, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 79, Pl. 6, Fig. 3.

Diagnosis : Shell strongly inflated, with rapidly increasing whorls and comparatively large umbilicus, last volution overlapping preceding one rather less than two-third of its height. Whorl section cordiform and surface of shell perfectly smooth. Suture ceratitic, narrowly elongated saddles and broadly denticulated lobes. Ventral lobe divided by high, slender siphonal prominence.

Discussions : Pseudoproptychites scheibleri (DIENER), has been selected as holotype (Pl. 6, Fig. 3) for this new subgenus *Pseudoproptychites*. This species was originally described by Diener (1897) from the horizon above the bed with *Otoceras woodwardi* GRIESBACH at Shalshal Cliff near Rimkin Paiar. In original description Diener already mentioned that *Proptychites scheibleri* could not be compared with any other species of *Proptychites* (Diener, 1897, p. 80). The author is of the view that *Proptychites scheibleri* may represent a new subgenus, for which the name *Pseudoproptychites* is here proposed.

Distribution : Gyronitan or Late Induan. Central Himalaya and Kashmir.

Proptychites (*Pseudoproptychites*) sp.

PLATE 15, Fig. 3

Material : One specimen.

Description : Shell rather involute, slightly laterally compressed, discoidal, with broadly rounded venter and deep umbilicus. Sides broadly convex from umbilical margin to ventral margin. Widest portion at about one fifth height of whorl. Height of outer whorl about 3/7

of total diameter of shell. Umbilical wall abruptly rounded. Suture ceratitic, consists of entirety rounded external and lateral saddles and slightly serrated first lateral lobe. Umbilical series missing. External saddles considerably narrower than those of the first lateral saddle.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19442	42.0	18.3	15.3	8.9	0.42	0.85	0.21

Remarks : A half of the outer volution is missing in the present material. It is most allied to *Proptychites* (*Pseudoproptychites*) *scheibleri* DIENER (1897, p. 79, Pl. 6, Fig. 3) in the form of whorls, umbilical features, whorl section and suture.

Specific identification of the specimen is however withheld for the present, because of the shell's immaturity.

Horizon and Locality : Bed 56, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. It occured about 2 to 2.5 metres above the Otoceras bed.

Specimen : GSI. Type No. 19442

Subfamily Owenitinae SPATH, 1934

Genus *Owenites* HYATT and SMITH, 1905

Type Species :

1905. *Owenites koeneni* HYATT and SMITH, *U. S. Geol. Surv. Prof. Papers*, No. 40, p. 83, Pl. 10, Figs. 1-22.

Diagnosis : Involute, laterally compressed, lenticular, with acute venter and narrow umbilicus. Sides convex and surface smooth at maturity. Sutures ceratitic, with numerous serrated lobes and rounded saddles (after Hyatt and Smith, 1905, p. 83 ; Smith, 1932, p. 100-101).

Distribution : Owenitan or Early Olenekian. North America, Timor, Eastern Siberia, Caucasus, Japan, Afghanistan, South China and Kashmir.

Owenites koeneni HYATT and SMITH

PLATE 17, Fig. 7

1905. *Owenites koeneni* HYATT and SMITH, *U. S. Geol. Surv. Prof. Papers*, No. 40, p. 83. Pl. 10, Figs. 1-22. (1914. DIENER, p. 214 ; 1922. WELTER, p. 152 ; 1932. SMITH, p. 100, Pl. 10, Figs. 1-23 ; 1934. SMITH, p. 185, Figs. 57 a-c ; 1957. KUMMEL in Arkell et al., p. 138, Figs. 171-8 a-b ; 1962. KUMMEL and STEELE, p. 674, Pl. 101, Figs. 3-7 ; 1962. POPOV, p 44, Pl. 6, Fig. 6 ; 1965. KUENZI, p. 374, Pl. 53, Figs. 1-6, Text Figs. 3D, 6 ; KUMMEL and ERBEN, p. 121, Pl. 19, Figs. 10-15 ; 1968. ZAKHAROV, p. 94, Pl. 18, Figs. 1-3.).

1932. *Owenites egrediens* SMITH (non WELTER), *U. S. Geol. Surv. Prof. Papers*, No. 167, p. 100, Pl. 52. Figs. 6-8. (1962. KUMMEL and STEELE, p. 674).

1932. *Owenites zitteli* SMITH, *U. S. Geol. Surv. Prof. Paper*, No. 167, Pl. 52, Figs. 1-5. (1962. KUMMEL and STEELE, p. 674).

1947. *Owenites* aff. *egrediens*, KIPARISOVA, *All. Sov. Geol. Instt. VSEGEI, USSR*, p. 139, Pl. 32, Figs. 1-3.

1955. *Owenites shimizui*, SAKAGAMI, *Tokyo Kyoiku Daigaku Sci. Rep., Sec. Geol. Geog.*, Vol. 4, No. 30, p. 138, Pl. 3, Figs. 2 a-c.

1959. *Owenites shimizui*, KUMMEL, *N. Z. J. Geol. Geog.*, Vol. 2, No. 3, p. 430 ; (1960. KUMMEL and SAKAGAMI, p. 6, Pl 2, Figs. 5-6.).

1959. *Owenites pakungensis* CHAO, *Pal. Sinica*, NS, Vol. 9, p. 83, 248, Pl. 21, Figs 6-8. (1962. KUMMEL and STEELE, p. 645).

1959. *Owenites pakungensis* var. *compressa* CHAO, *Pal. Sinica*, NS, p. 86, 252, Pl. 23, Figs. 1-16 ; Text Figs. 27 a-d. (1962. KUMMEL and STEELE, p. 645).

Material : One specimen.

Description : Whorl involute, discoidal, with closed umbilicus and funnel-shaped umbilical wall as in Ptychitids. Sides convex, widest part on umbilical shoulders. Venter sharply acute, without keel. Sutures ceratitic, consist of rounded and entire saddles and serrated lateral lobes on external half but on umbilical sides rather goniatitic. First lateral saddles largest, gradually becoming smaller towards umbilical shoulders. Ventral lobe divided by a siphonal saddle into two short branches as in the type species described by Hyatt and Smith. Shell ornamentation not observed.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19462	47.7	22.0	15.5?	6.9	0.46	0.70	0.14
	46.4?	20.0	19.6	9.6	0.43?	0.98	0.20
	30.0	?	10.4	?	—	—	—

Remarks : The Genus *Owenites* has been well known from Inyo Country, California. Four species were recognised by Smith (1932) in the *Meekoceras gracilitatis* Zone of the Upper Scythian. Later, Kummel (1957), discovered a new locality in Western United States. Kuenzi (1965) also described the same species from Kelly Hill in Stevens Country, Washington. The present species was recorded from the Olenekian beds of Northern Caucasus (Popov, 1962, p. 44-45), Timor (Welter, 1922) and from the Owenites bed at Kotal-e-Tera Pass (near Gardez, in Afghanistan) (Kummel and Erben, 1968). It was also described from the Lower Triassic Olenekian beds in southern Primorye (Zakharov, 1968, p. 94-96, p. 18, Figs. 1-3). The present specimen was collected from Bed 88 of the Guryul Ravine in association with the species of *Anasibirites* and *Kashmirites* of the Late Scythian. The forms of sutures, venter, whorl shape and the type of umbilicus agree fully with those of *Owenites koeneni* known from North America.

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine. (*Owenites-Kashmirites* Zone ; Owenitan or Early Olenekian).

Specimen : GSI. Type No. 19462

Family Hedenstroemiidae WAAGEN, 1895

Subfamily Hedenstroemiinae WAAGEN, 1895

Genus *Anahedenstroemia* HYATT, 1900

Type species :

1934. *Anahedenstroemia himalayica* SPATH (=*Hedenstroemia mojsisovicsi* DIENER, 1897, *Palaeont. Indica*, Ser. 15, Vol. 2, Pt. 1, p. 63, Pl. 20, Fig. 1).

Diagnosis : Involute, discoidal, greatly compressed Hedenstroemiinae, with tabulated venter and smooth, flat sides. Suture-line ceratitic, with slender saddles and numerous generally well-individualized auxiliaries (Spath, 1934, p. 217).

Distribution : Late Induan or Late Eo-Triassic. Spiti, Central Himalaya, Salt Range, Kashmir, Primorye (Siberia), Madagascar, Timor, California (North America).

Anahedenstroemia sp.

PLATE 17, Fig. 5 ; PLATE 20, Fig. 7

Material : One specimen.

Description : Shell involute, discoidal, laterally compressed, with gently convex sides and high whorls. Umbilicus comparatively small and umbilical margin gently rounded. Shell surface almost smooth. Venter narrowly rounded in outer whorl, but rather narrowly tabulated in inner whorl. Suture characteristic like Hedenstroemid, consists of ceratitic, with slender, entire lateral saddles and numerous well denticulated lateral and umbilical lobes. Ventral lobe comparatively wide and shallow, with sharply carinated median saddle in siphonal edge.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19460	81.0 ?	43.0	—	8.0	0.53	—	0.1

Remarks : The half side of the present specimen is missing, but the other half is well preserved. Umbilical and lateral sutures are nearly similar to *Anahedenstroemia himalayica* SPATH (1934, p. 217, Fig. 68 – *Hedenstroemia mojsisovicsi* DIENER, partim, 1897, p. 63, Pl. 20, Fig. 1), but the siphonal lobe is more highly denticulated than *himalayica.* The present specimen also shows its resemblance with the Siberian species *A. bosphorense* ZAKHAROV (1968, p. 55-56, Pl. 4, Fig 4, Text Fig. 8-a) as regards to the general shape of shell, but differs in the nature of the ventral suture.

Horizon and Locality : Bed 64 ?, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. Late Induan or Late Griesbachian.

Specimen : GSI. Type No. 19460 *Collection :* H. M. KAPOOR, 1972.

Family Kashmiritidae SPATH, 1934

Genus *Anakashmirites* SPATH, 1930

Type species :

1897. *Anakashmirites nivalis* (DIENER), *Palaeont. Indica,* Ser. 15, Vol. 2, Pt. 1, p. 51, Pl. 15. ; Figs. 17-19, as *Danubites nivalis.*

Diagnosis : Evolute, serpenticone Kashmiritidae, with ribs tending thicken towards ventro-lateral borders, and widely arched peripheries. Sutures with low external lobe and large external saddle (Spath, 1934, p. 236).

Distribution : Owenitan or Olenekian ; Late Eo-Trias. Himalaya, Timor, Afghanistan, Primorye and Arctic Canada.

Anakashmirites sp. cf. *Anakashmirtes kapila* (DIENER)

PLATE 15, Fig. 7

Compare :

1897. *Danubites kapila,* DIENER, *Palaeont. Indica,* Ser. 15, Vol. 2, Pt. 1, p. 50, Pl. 15, Figs. 16 a-c.

1909. *Xenodiscus kapila,* KRAFFT and DIENER, *Palaeont. Indica,* Ser. 15, Vol. 6, Pt. 1, p. 99, Pl. 27, Figs. 2-3.

1934. *Anakashmirites kapila* SPATH, *Catalog. Fossil. Cephal.* 4, p. 238.

Material : One specimen.

Description : Whorls evolute, slightly compressed, with arched venter and shallow umbilicus. Ribs tending to thicken towards ventral shoulders from umbilical shoulders, but diminish on venter and each ribs prorsiradiate. Sutures unknown.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19446	26.2	9.0	6.5	8.5	0.34	0.72	0.32

Remarks : The present material lacks half volution, still the shell sculpture and ventral part of the whorl are well preserved and help in identification. Considering the characters of the shell, the present specimen can be identified with *Anakashmirites.* It is similar to *Anakashmirites kapila* (DIENER) described as *Danubites* from the *Kashmirites subrobustus* Beds of Himalaya (Diener, 1897). The type species *Anakashmirites nivalis* (DIENER) (1897, as *Danubites*) has coarser ribs on the shell surface than the present specimen. *Anakashmirites nivalis* has about 6-7 coarse and broad ribs on the half outer volution, but *Anakashmirites kapila* has about 12 to 17 ribs.

Horizon and Locality : Bed 90, Member H, Khunamuh Formation, Guryul Ravine. (*Owenites-Kashmirites* Zone, Owenitan or Early Olenekian).

Specimen : GSI. Type No. 19446

Genus *Kashmirites* DIENER, 1913

Type species :

1895. *Ceratites armatus* WAAGEN, *Palaeont. Indica.* Ser. 13, Vol. 2, p. 75, Pl. 7, Fig. 1, 7.

Diagnosis : More or less evolute, quadrate-whorled Kashmiritidae, with strong, often almost tuberculate ribbing on inner, but degenerating into striation on the outer whorls. Venter subtabulate and wide, often with the costation continuous across them. Sutures simple, ceratitic, generally with only two lateral lobes (Spath, 1934, p. 240).

Remarks : The genus *Kashmirites* has been recorded from Kashmir, Salt Range, Timor and South China, but no species are known from other areas in spite of the fact that the *Owenites-Meekoceras* fauna has the widest distribution in the world. Thus it may be possible that the genus *Kashmirites* is limited in distribution. Spath (1934, p. 241) noticed that no true *Kashmirites* is known in the *Owenites* Beds of California. The shell ornamentation of *Kashmirites* may be variable from coarse ribbing as seen in *Kashmirites subarmatus* to fine ribbing as seen in *Kashmirites blashkei* DIENER, *Kashmirites densistriatus* WELTER, and *Kashmirites subrobustus* WELTER. The author considers that *Kashmirites subrobustus* may be conspecific with *Kashmirites subarmatus* and that *K. blashkei* conspecific with *K. densistriatus*

on the basis of the general characters of the shell. *Kashmirites evolutus* WELTER may be a form intermediate between *K. subrobustus* and *K. blashkei* as indicated in the shell ornamentation.

Distribution : *Meekoceras gracilitatus* Zone, Owenitan or Early Olenekian. Kashmir, Salt Range, Timor and China.

Kashmirites subarmatus DIENER

Plate 19, Figs. 1, 3, 5, 6(S)

1895. *Celtites multiplicatus* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 2, p. 78, Pl. 7, Figs. 2 a-c.

1895. *Celtites dimorphus*, WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 2, p. 80, Pl. 7, Figs. 5 a-c.

1913. *Kashmirites subarmatus* DIENER, *Palaeont. Indica*, NS, Vol. 5, Pt. 1, p. 36, Pl. 3, Figs. a-b. ; Pl. 5, Figs. 2 a-c, 3 a-b, 5 a-c. (1959. CHAO, p. 277, Pl. 37, Figs. 16-17, 20, 21).

1922. *Kashmirites subrobustus*, WELTER, *Palaeont. von Timor*, Vol. 11, p. 121, Pl. 163(9), Figs. 7-8. (1934. SPATH, p. 241).

1922. *Kashmirites evolutus* WELTER, *Palaeont. von Timor*, Vol. 11, p. 124, Pl. 164, Figs. 1-3 (holotype), 4-5 (var. *bihatiensis* WELTER). (1934. SPATH, p. 242).

1922. *Kashmirites* cf. *subarmatus* DIENER, WELTER. *Palaeont. von Timor*, Vol. 11, p. 121. Pl. 10, Figs. 6-8. (1933. TIEN, p. 31, Pl. 4, Figs. 3 a-c).

Material : Several specimens.

Remarks : The genus *Kashmirites* includes many variable forms in the shell ornamentation. Many species have been established by previous workers, but subsequent studies show that many of them belong to two or three species only.

The present species probably includes *Kashmirites subrectangularis* (WAAGEN) and *Kashmirites dimorphus* (WAAGEN) with regards to the shell characters. The ribbing system is coarser and stronger in the immature forms. *Kashmirites varians* CHAO (1959, p. 108, Pl. 37, Figs. 26-28) in the nature of its sculpture of the shell, is a form, intermediate between *Kashmirites subarmatus* and *Kashmirites blashkei*, but present worker believes that *Kashmirites varians* belongs to *Kashmirites blashkei* in respect to the characters of the outer volutions and the sculpture of the inner whorls.

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine. (Owenitan or Olenekian).

Specimen : GSI. Type Nos. 19471, 19472, 19473, 19476

Kashmirites blashkei DIENER

PLATE 19, Figs. 2, 4, 6B

1913. *Kashmirites blashkei* DIENER, *Palaeont. Indica*, NS, Vol. 5, No. 1, p. 33, Pl. 3, Figs. 11 a-c, 12 a-c. (1934. SPATH, p. 241, Fig. 81).

1922. *Kashmirites densistriatus* WELTER, *Palaeont. von Timor*, Vol. 11, p. 123, Pl. 10, Figs. 9-16. (1934. SPATH, p. 242, Fig. 81).

1959. *Kashmirites varians* CHAO, *Palaeont. Sinica*, NS, Vol. 9, p. 108, Pl. 37, Figs. 26-28.

Material : Three specimens.

Description : Shell evolute, deeply embracing inner whorls, depressed and broadly tabulated venter and flattened sides. Umbilicus deep, with steep funnel-shaped umbilical wall. Surface ornamented with fine radial striae without ribs or nodes on surface

and these extend from umbilical margin to venter. Suture simple and ceratitic in mature forms, but goniatitic in immature forms.

Remarks : The present species has the shell sculpture consisting of numerous, fine striations on the flattened sides and each striation crosses the tabulated venter.

The present species is closely allied to *Kashmirites densistriatus* WELTER (1922, p. 123) described from Timor, in regards to the shell sculpture. On the otherhand, *K. densistriatus* is similar to *Kashmirites evolutus* WELTER as pointed out by Spath (1934), but slightly differs in the embracement of the outer whorl and ornamentation of the shell. The author, however, believes that both the species from Timor are intermediate between *K. blashkei* and *K. subarmatus.*

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine. (Kashmirites bed, Owenitan or Olenekian).

Specimen : GSI. Type Nos. 19474, 19475, 19476

Family	Meekoceratidae	WAAGEN,	1895
Subfamily	Meekoceratinae	SPATH,	1934
Genus	*Meekoceras*	HYATT,	1879

Type Species :

1880. *Meekoceras gracilitatis,* WHITE, (1878), *12th Ann. Rep. U. S. Geol. Surv. Terr.*, Pt. 1, p. 115, Pl. 31, Fig. 2a.

Meekoceras gracilitatis WHITE

PLATE 18, Fig. 5

1879. *Meekoceras gracilitatis* WHITE, p. 114, (1880. WHITE, p. 115, Pl. 31, Fig. 2 a-d ; 1904. SMITH, p. 370, Pl. 42, Figs. 1-4, Pl. 43, Figs. 3-4 ; 1905. HYATT and SMITH, p. 143, Pl. 12, Figs. 1-13, Pl. 13, Figs. 1-18, Pl. 14, Figs. 1-8, Pl. 70, Figs. 4-7 ; 1955. DIENER, p. 191 ; 1925. DIENER, p. 82, Pl. 24, Fig. 1 ; 1932. SMITH, p. 57, Pl. 12, Figs. 1-13, Pl. 13, Figs. 1-18, Pl. 14, Figs. 1-8, Pl. 36, Figs. 19-28, Pl. 37, Figs. 1-7, Pl. 38, Figs. 1-6, Pl. 70, Figs. 4-7 ; 1934. SPATH, p. 244, 246-248, 253, 336, Figs. 83 ; 1954. KUMMEL, p. 185 ; 1957. KUMMEL in ARKELL et al. p. L142, Figs. 175-8 ; 1961. TOZER, 1961, p. 65, Pl. 15, Fig. 6, Pl. 17, Figs. 1a-3, Pl. 18, Figs. 4-6 ; 1962. KUMMEL and STEELE, p. 693, Pl. 103, Figs. 1-6 ; 1968. KUMMEL and ERBEN, p. 129, Pl. 20, Figs. 1-3, 8-13).

1902. *Prionolobus gracilitatis* FRECH, *Lethaea Geognistica*, p. 631, Fig. 2.

1908. *Aspidites gracilitatis*, FRECH, *Lethaea Geognistica*, Pl. 61, Fig. 6.

1932. *Meekoceras arthaberi* SMITH, *U. S. Geol. Surv. Prof. Paper* 167, p. 56, Pl. 32, Figs. 26-33.

1932. *Meekoceras elkoense* SMITH, *U. S. Geol. Surv. Prof. Paper* 167, p. 56, Pl. 55, Figs. 14-16.

1932. *Meekoceras radiosum* SMITH, *U. S. Geol. Surv. Prof. Paper* 167, p. 59, Pl. 59, Figs. 1-4.

Material : One specimen.

Description : Whorls involute, discoidal, with narrow umbilicus and narrowly tabulated venter. Sides gently convex and umbilical shoulders abruptly rounded. Surface smooth. Sutures ceratitic, consist of entirely rounded lateral saddles and denticulated lateral lobes. Umbilical series also denticulated and considerably long.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19469	54.0	28.0	14.6	9.9	0.52	0.52	0.18

Remarks : The present species is the most famous Lower Triassic ammonoid in western North America (Kummel and Steele, 1962, p. 693). Recently, Kummel and Erben (1968) described the same species from Central Afghanistan (Kabul-Gardez road, Kotal-e-Tera). The material from Kashmir is clearly identifiable with *Meekoceras gracilitatis* described from North America including Arctic Canada (Tozer, 1961).

At the Guryul Ravine, this species is associated with *Kashmirites subarmatus* DIENER, *Owenites koeneni* HYATT and SMITH and *Wasatchites* sp. etc. Kummel and Steele (1962, p. 694) pointed out that it is of particular interest to recognise the presence of diamorphism reflected in the degree of inflation of the outer whorl and nature of umbilical region in North American species. This feature is not clear in the present material, as the delicate inflation on the shell surface is missing.

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine.

Specimen : GSI. Type No. 19469

Meekoceras sp. cf. *Meekoceras jolinkense* KRAFFT and DIENER

PLATE 17, Fig. 9 ; PLATE 20, Fig. 4

Material : One specimen.

Description : Shell discoidal evolute, laterally compressed, with gently convex sides and narrowly tabulated venter, ventral shoulders sharply edged. Umbilicus small and their shoulders abruptly rounded. Maximum thickness at one third height of flank. Suture ceratitic, consists of broad ventral lobe, roundly arched external saddle, deeply denticulated lateral lobe, very high and wide lateral saddle, and rounded second lateral saddle. Umbilical lobe coarsely denticulated and broad U-shaped, extending from umbilical shoulders. Sides smooth with no sculpture on surface.

Dimensions : (in mm)

Typ	No.	D	H	W	U	H/D	W/H	U/D
GSI.	19464	—	20.0	9.55	7.2	—	0.47	—

Remarks : Only one poorly preserved specimen is present in the collection and it belongs to the genus *Meekoceras*. The shell character and sutures are of typical *Meekoceras*. The specimen can only be compared specifically with *Meekoceras jolinkense* KRAFFT and DIENER (1909) described from Chocolate Limestone of Byans.

Horizon and Locality : Bed 88-90, Member H, Khunamuh Formation, Guryul Ravine. (*Kashmirites subarmatus* Zone, Owenitan or Olenekian).

Specimen : GSI. Type No. 19464

Superfamily	Dinaritaceae	MOJSISOVICS,	1889
Family	Prionitidae	HYATT,	1900
Genus	*Prionites*	WAAGEN,	1895

Type species :

1895. *Prionites tuberculatus* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol. 2, p. 58, Pl. 5, Fig. 2.

Prionites sp. aff. *Prionites undatus* WAAGEN

PLATE 17, Fig. 6

1895. *Prionites undatus* WAAGEN, *Palaeont. Indica*, Ser. 13, Vol, 2, Pl. 5, Figs. 1-a-b.

Material : A single specimen.

Description : Shell rather involute, with broadly rounded or subtabulated venter and gently rounded umbilical shoulders. Umbilicus rather shallow and slightly expose inner whorls at bottom. Sides smooth and gently convex, maximum width at one third height from umbilical margin. Whorl section more or less trapezoidal and considerably higher than wide. Surface of shell ornamented with distinct nodes near umbilical margin, which are irregularly spaced and most prominent on body whorl. Sutures ceratitic, consist of narrow ventral lobe ; serrated lobe ; entirely rounded saddle and considerably long and small serrated umbilical lobe. Width of lateral lobe little narrower than lateral saddle. External lobe on ventral shoulder and lateral saddle equally high to external saddle. Umbilical lobe begins from umbilical shoulder.

Dimensions : (in mm)

Type No.	D	H	W	U	H/D	W/H	U/D
GSI. 19461	75.9	34.2	24.9	16.5	0.45	0.72	0.21

Remarks : The material resembles closely *Prionites undatus* WAAGEN, described from Upper Ceratite Limestone of the Salt Range (Waagen, 1895, p. 61). Unfortunately sutures of Waagen's species were not illustrated. According to Waagen the septa of *Prionites undatus* are very similar to those of *Prionites lingnatus* WAAGEN, especially in the second lateral lobe. In the transverse section the whorls of *Prionites undatus* and *Prionites lingnatus* are similar to each other. The present specimen differs in the features of the septa from *Prionites lingnatus* WAAGEN (1895, p. 61, Pl. 6, Figs. 3 a-b, Fig. 5), especially in the lateral lobe. The lateral lobe of *Prionites lingnatus* is much narrower and more acute than that of the present specimen. The present specimen is most allied to *Prionites undatus*, judging from its whorl section, nodes and ventral shape and umbilical elements.

Horizon and Locality : Bed 80, Member G, Khunamuh Formation, Guryul Ravine. (*Owenites-Kashmirites* Zone, Owenitan or Early Olenekian).

Specimen : GSI. Type No. 19461

Family Sibiritidae MOJSISOVICS, 1896

Genus *Wasatchites* MATHEWS, 1929

Type species :

1929. *Wasatchites perrini* MATHEWS, *Walker Mus. Mem.*, Paper 28-45, p. 40, Pl. 9, Figs. 1-3 (4-9).

Wasatchites sp. indet.

PLATE 17, Fig. 8 ; PLATE 20, Fig. 5

Material : A single fragmentary specimen.

Description : Shell evolute, with tabulated venter and trapezoidal whorl section. Sculpture highly ornamented with radial ribs which are most projected on ventral shoulders like spines and inclined towards body whorl. Each rib swells at ventro-lateral, shoulders rounded. Secondary ribs occassionally present between prominent ribs and variable length. About 6-7 primary ribs on a half outer volution.

Remarks : The fragmentary specimen has half of its outer whorl missing, and poorly preserved but the characteristic shell sculpture is retained and resembles *Wasatchites tridentinus* SPATH (1934, p. 352, Pl. 15, Figs. 2 a-c, Pl. 16, Figs. 2 a-b, 4). *Wasatchites meeki* MATHEWS, (1929, p. 41, Pl. 7, Figs. 1-3 ; Pl. 8, Figs. 11-14 ; Smith, 1932, Pl. 81, Figs. 1, 2 (*Kashmirites*) is allied to the present material, but Mathew's specimen has umbilicus smaller than the present material. *Wasatchites tardus* (McLearn, 1945, p. 5, Pl. 2, Figs. 1-2 ; Tozer, 1961, p. 71, Pl. 19, Figs. 1a-3c) has more feeble ribs on the lateral sides than those of the present specimen. *Wasatchites* occurs in the Upper Scythian beds of Timor, North America (Utah, British Columbia), Spitsbergen, Ellesmere Island and Axel Heiberg Island outside the Himalaya. In the Guryul Ravine *Wasatchites* is associated with *Kashmirites subarmatus* DIENER, *Meekoceras* sp. (cf. *M. jolinkense* KRAFFT and DIENER) and *Koninckites* sp.

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine. (*Owenites-Kashmirites* Zone, *Kashmirites subarmatus* Zone).

Specimen : GSI. Type No. 19463

Family Dinaritidae MOJSISOVICS, 1882

Genus *Olenekites* HYATT, 1900

Type species :

1886. *Dinarites spinipricatus* MOJSISOVICS, *Mem. Acad. Wiss. Wien*, Vol. 63.

Olenekites sp.

PLATE 19, Fig. 7

Material : One specimen.

Description : Shell involute ?, with rounded venter and rounded umbilical wall with distinct nodes. Surface ornamented with distinct node-like ribs that tend to disappear near half height of whorl, and about 4 nodes are observed on outer half whorl. Umbilicus and sutures are not observed.

Remarks : The specimen is incomplete and poor in preservation. The form of venter and surface ornamentation of the specimen may suggest it to be *Olenekites*, but it is difficult to identify its specific rank.

Horizon and Locality : Bed 88, Member H, Khunamuh Formation, Guryul Ravine (Owenitan or Early Olenekian).

Specimen : GSI. Type No. 19477

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PLATE 14

Figs. 1-3 *Otoceras woodwardi* GRIESBACH.

1. a-b. ×1. Coquinoid Limestone (Unit f_2, Member f, Khunamuh Formation, at the Spur three kilometres north of Barus. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19434.

2. a. ×1.3. b. ×0.9. Bed 58b, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19435.

3. a. ×1.6. b. ×1.5. c. ×1.65. d. ×1.3. Bed 52a, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators., 1969. GSI. Type No. 19436.

Figs. 4-6 *Glyptophiceras* sp.

4. ×1.4. Bed 55 ?, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19437.

5. ×1.25. Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19438.

6. ×1.5. Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19439.

PLATE 15

Fig. 1 *Ophiceras tibeticum* GRIESBACH. a-c. × 1.52.

Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. *Ophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19440.

Fig. 2 *Vishnuites* cf. *pralambha* DIENER. × 1.

Bed 76, Member F, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19441.

Fig. 3 *Pseudoproptychites* sp. a-c. × 1.3.

Bed 56, (dark gray arenaceous limestone), Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19442.

Fig. 4 *Otoceras* sp. × 1.9.

Bed 52a, Unit E_1, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19443.

Fig. 5 *Otoceras* aff. *woodwardi* GRIESBACH. × 1.8.

Bed 61a, Unit f_2, Member f, Khunamuh Formation at the Spur three kilometres north of Barus. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19444.

Fig. 6 *Glyptophiceras lissarenum* (DIENER). × 1.5.

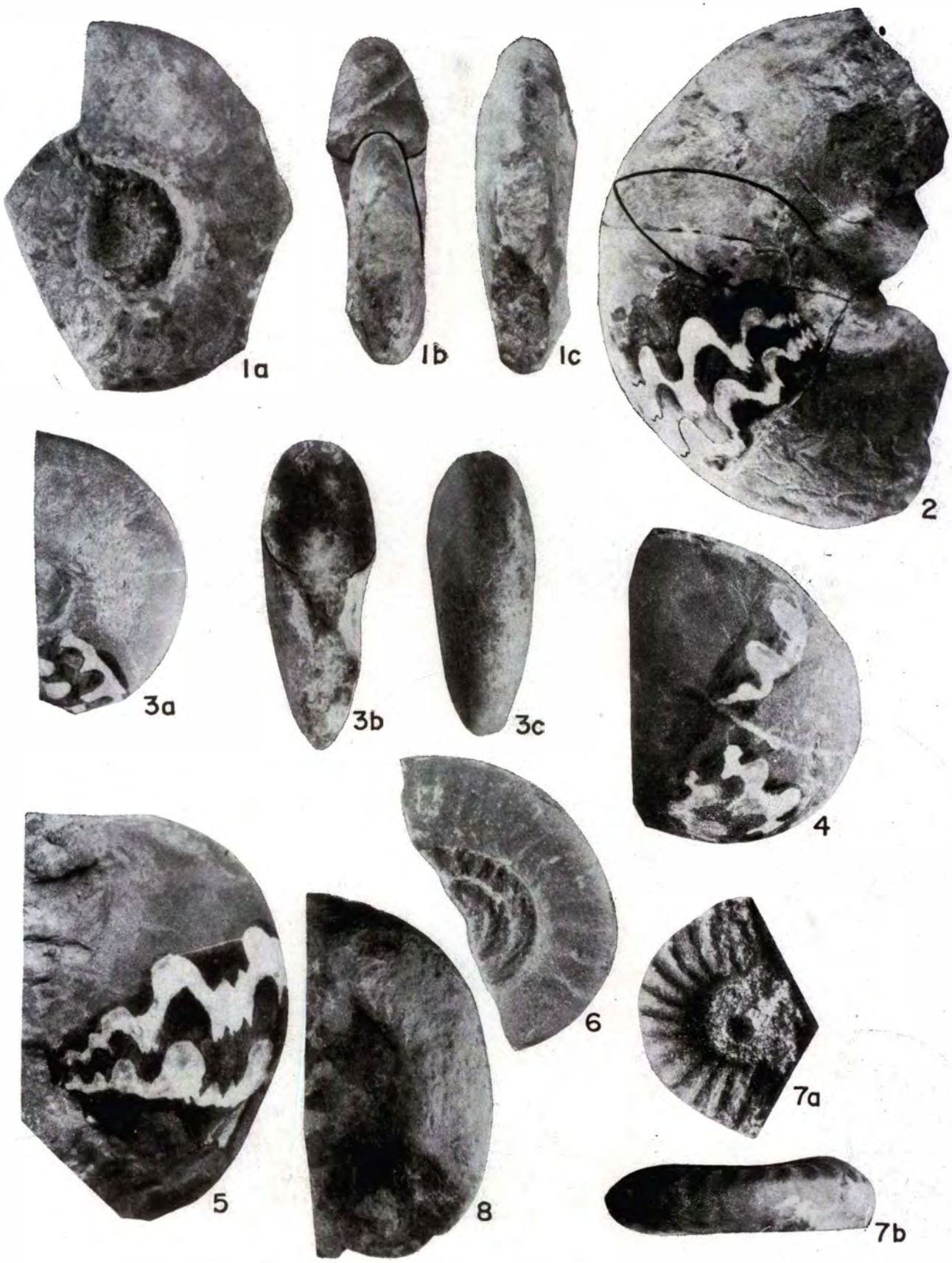
Bed 52a, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19445.

Fig. 7 *Anakashmirites* cf. *kapila* DIENER. a. × 1.8. b. × 2.

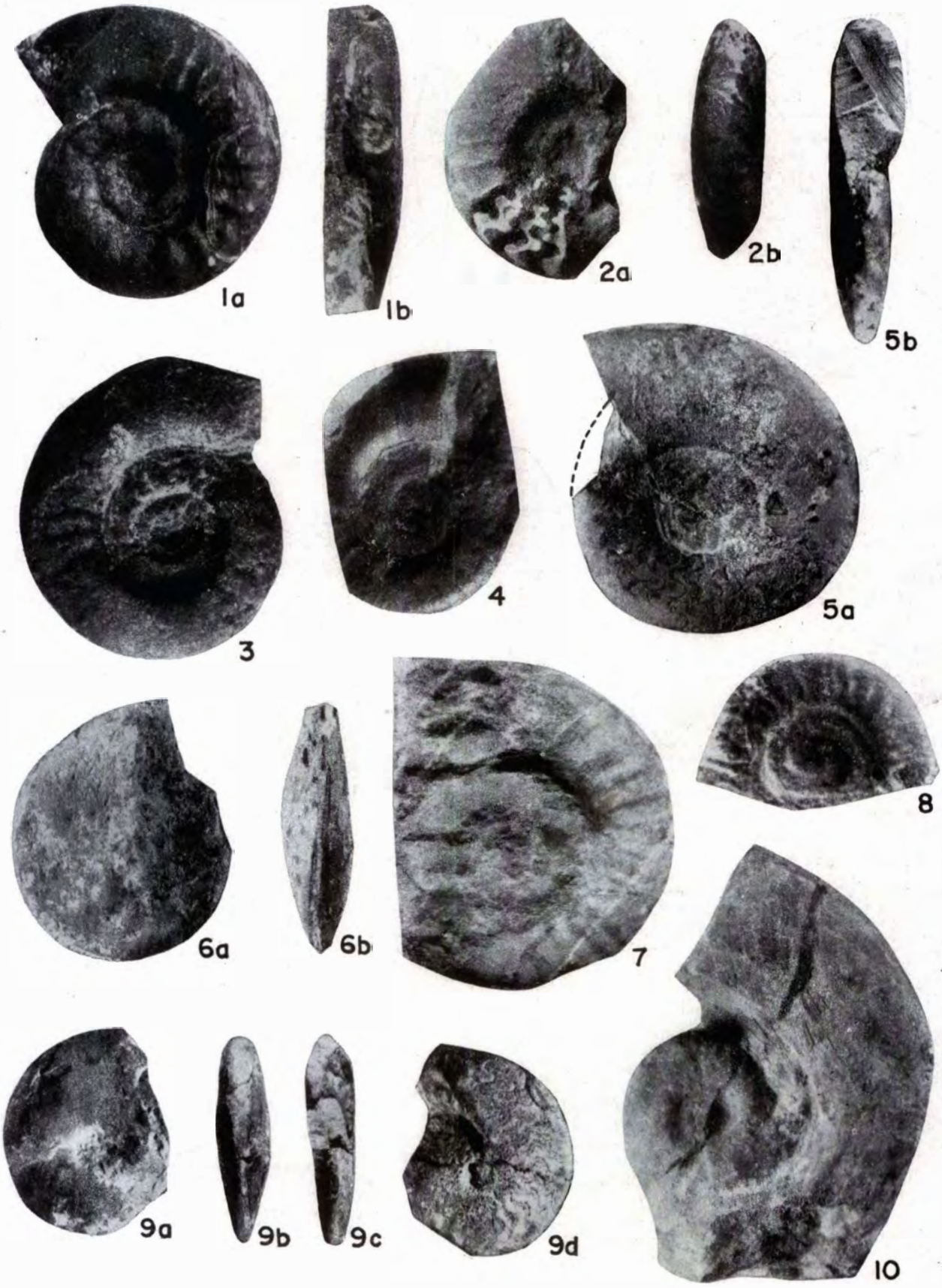
Bed 90, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19446.

Fig. 8 *Ophiceras* (*Ophiceras*) sp. indet. × 1.

Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. *Ophiceras tibeticum* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19447.



BANDO : Lower Triassic Ammonoids from Kashmir



BANDO : Lower Triassic Ammonoids from Kashmir

PLATE 16

Figs. 1, 3 and 7 *Glyptophiceras himalayanum* (GRIESBACH)

1. a-b. × 1.8. Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19448.

3. × 1.76. Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19450.

7. × 1.8. Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19448.

Fig. 2 *Glyptophiceras ellipticum* (DIENER). a-b. × 1.7.

Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19449.

Fig. 4 *Glyptophiceras lissarenum* (DIENER). × 1.8.

Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19451.

Fig. 5 *Ophiceras* (*Lytophiceras*) *sakuntala* (DIENER). a-b. × 1.

Bed 55, Unit f_2, Member f, Khunamuh Formation at the Spur three kilometres north of Barus. *Otoceras-Glyptophiceras* Zone. *Coll.* H. M. Kapoor, 1972. GSI Type No. 19452.

Fig. 6 *Otoceras woodwardi* GRIESBACH. a-b. × 1.38.

Bed 55, (thin limestone layer), Unit f_2, Member f, Khunamuh Formation at the Spur three kilometres north of Barus. *Otoceras-Glyptophiceras* Zone. *Coll.* H. M. Kapoor, 1972. GSI. Type No. 19453.

Fig. 8 *Glyptophiceras* sp. × 1.25.

Bed 55 ?, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19454.

Fig. 9 *Koninckites kraffti* SPATH. a-d. × 1.

Bed 80 ?, Member G, Khunamuh Formation, Guryul Ravine. *Prionites-Koninckites* Zone. *Coll.* H. M. Kapoor, 1972. GSI. Type No. 19455.

Fig. 10 *Ophiceras serpentinum* DIENER. × 1.3.

Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and his collaborators, 1969. GSI. Type No. 19456.

PLATE 17

Fig. 1 *Ophiceras (Lytophiceras) sakuntala* DIENER. a-b. × 1.5.

Beds 51-52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19457.

Figs. 2, 4 *Ophiceras* (*Lytophiceras*) *subdemissum* (SPATH). × 1.64.

Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. *Ophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19458.

Fig. 3 *Ophiceras* (*Lytophiceras*) sp. × 1.

Bed 64, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19459.

Fig. 5 *Anahedenstroemia* sp. × 1.

Bed 64, Unit E_3 (*Ophiceras* Zone ?), Member E, Khunamuh Formation, Guryul Ravine. *Coll.* H. M. Kapoor, 1972. GSI. Type No. 19460.

Fig. 6 *Prionites* sp. aff. *Prionites undatus* WAAGEN. × 1.22.

Bed 80, Member G (arenaceous limestone), Khunamuh Formation, Guryul Ravine. *Prionites-Koninckites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19461.

Fig. 7 *Owenites koeneni* HYATT and SMITH. a-b. × 1.36.

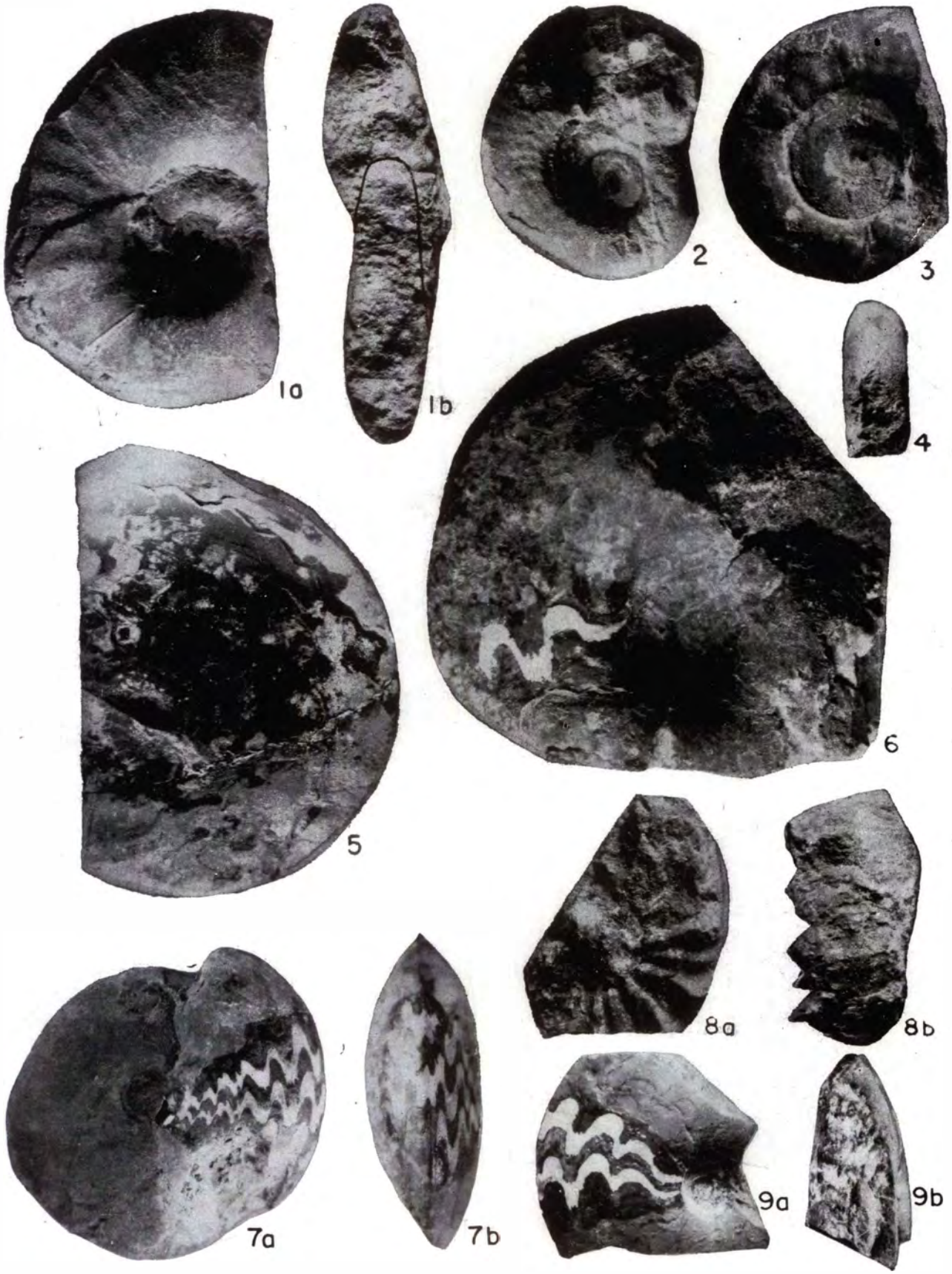
Bed 88, Member H, Khunamuh Formation, at the Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19462.

Fig. 8 *Wasatchites* sp. a-b. × 1.4.

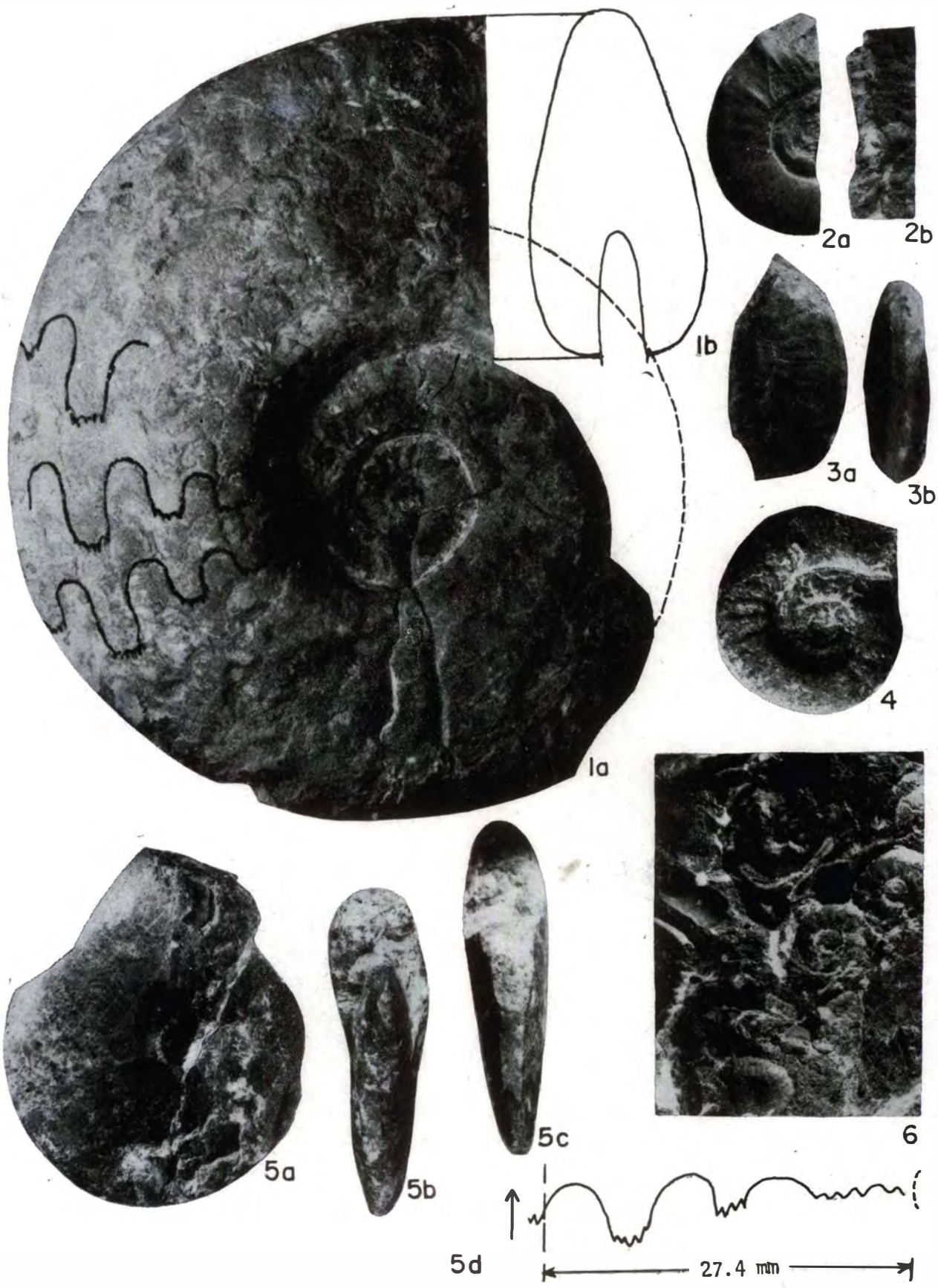
Bed 88, Member H, Khunamuh Formation, at the Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19463.

Fig. 9 *Meekoceras* sp. cf. *M. jolinkense* KRAFFT and DIENER. a-b. × 1.58.

Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19464.



BANDO : Lower Triassic Ammonoids from Kashmir



BANDO : Lower Triassic Ammonoids from Kashmir

PLATE 18

Fig. 1 *Paranorites kummeli* BANDO sp. nov. a-b. ×0.7.

Bed 75-76, Member F, Khunamuh Formation, Guryul Ravine. *Paranorites-Vishnuites* Zone. *Coll.* H. M Kapoor, 1972. GSI. Type No. 19465 (holotype).

Fig. 2 *Ophiceras* (*Lytophiceras*) *sakuntala* (DIENER). a-b. ×1.3.

Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19466.

Fig. 3 *Otoceras woodwardi* GRIESBACH. a-b. ×1.6.

Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19467.

Fig. 4 *Glyptophiceras himalayanum* (GRIESBACH). ×1.25.

Bed 52, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. *Otoceras-Glyptophiceras* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19468.

Fig. 5 *Meekoceras gracilitatis* WHITE. a-d. ×1.06.

Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19469.

Fig. 6 *Proptychites* ? limestone. ×1.

Sandy limestone with *Vishnuites* and *Claraia decidens*. Many small specimens are probably immature forms of *Proptychites*. Member F, Khunamuh Formation, Guryul Ravine. *Paranorites-Vishnuites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19470.

PLATE 19

Figs. 1, 3, 5 *Kashmirites subarmatus* DIENER.

1. × 1.25. Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19471.

3. × 1. Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No 19472.

5. × 1.25. Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19473.

Figs. 2, 4 *Kashmirites blashkei* DIENER. × 1.25.

2. Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19474.

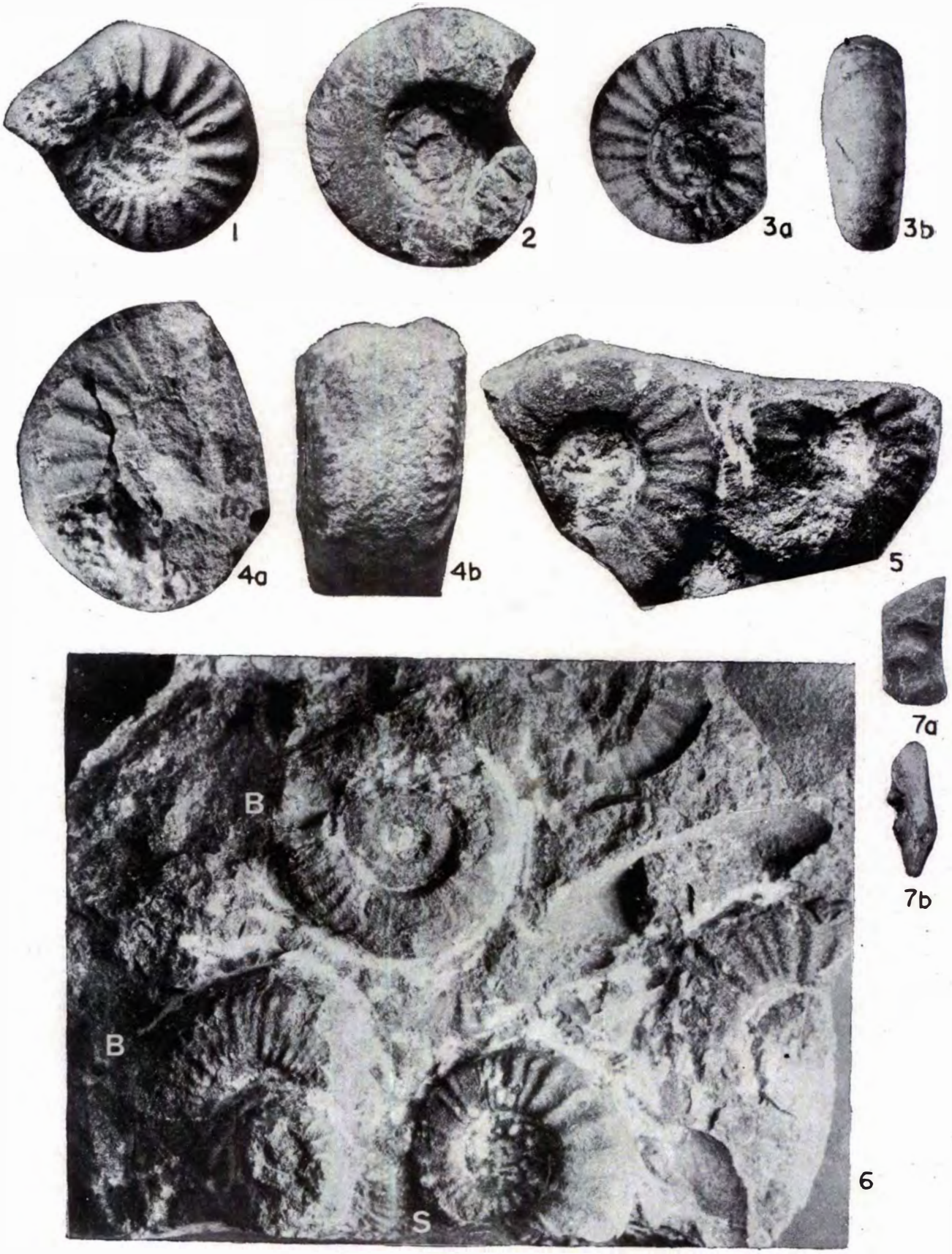
4. Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19475.

Fig. 6 *Kashmirites blashkei* DIENER (B) and *Kashmirites subarmatus* DIENER (S). × 1.25.

Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Owenites-Kashmirites* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19476.

Fig. 7 *Olenekites* ? sp. a-b. × 1.

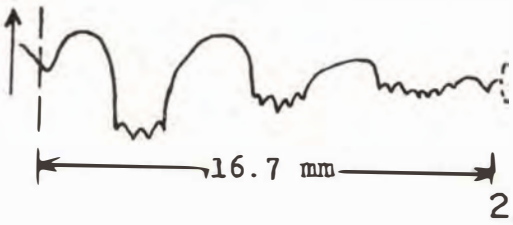
Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19477.



BANDO : Lower Triassic Ammonoids from Kashmir

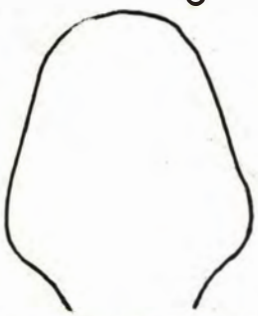
PALAEONT. INDICA, N. S., VOL. XLVI **PLATE 20**


1

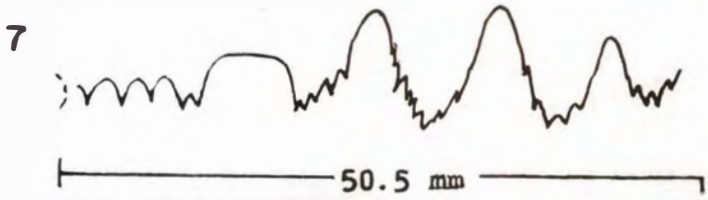


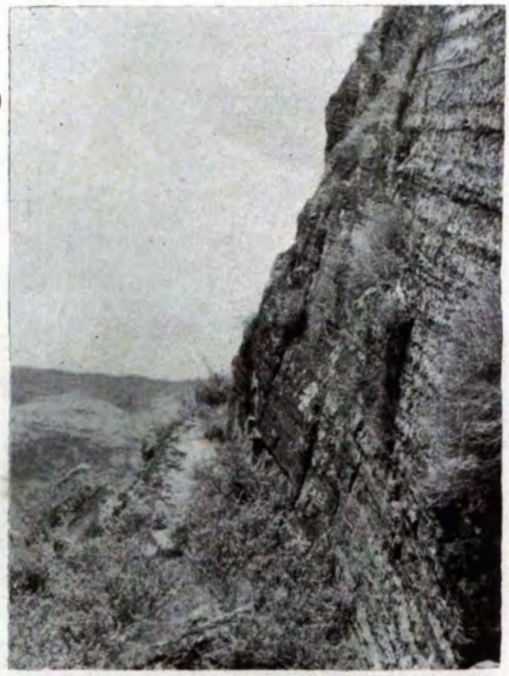

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BANDO : Lower Triassic Ammonoids from Kashmir

PLATE 20

Figs. 1, 2 *Koninckites* sp.

1. ×1. 2. Suture line. Bed 88, Member H, Khunamuh Formation, Guryul Ravine. *Kashmirites subarmatus* Zone. *Coll.* K. Nakazawa and collaborators, 1969. GSI. Type No. 19478.

Fig. 3 *Koninckites kraffti* SPATH.

Suture line. (refer to Plate 16, Fig. 9).

Fig. 4 *Meekoceras* sp. cf. *Meekoceras jolinkense* KRAFFT and DIENER.

Suture line. (refer to Plate 17, Fig. 9).

Fig. 5 *Wasatchites* sp.

Whorl section. (refer to Plate 17, Fig. 8).

Fig. 6 *Prionites* sp. aff. *Prionites undatus* WAAGEN.

Whorl section. (refer to Plate 17, Fig. 6).

Fig. 7 *Anahedenstroemia* sp.

Suture line. (refer to Plate 17, Fig. 5).

Fig. 8 Exposure of the beds of Members F and G. Member G forms cliff, while Member F is exposed down the cliff, forming slope (Guryul Ravine).

Fig. 9 Ridge exposure of the Guryul Ravine section showing upper part of Member F and the lower part of Member G.

Fig. 10 An exposure of limestone of Member H, Khunamuh Formation, Guryul Ravine. Showing ammonoids of *Owenites-Kashmirites* fauna on the limestone surface.

Fig. 11 *Otoceras woodwardi* GRIESBACH (×3000). An Electronic microscopic view of the shell. (Specimen from Otoceras bed, Member E_2, Guryul Ravine).

CONODONTOPHORA

LATE PERMIAN AND EARLY TRIASSIC CONODONTS FROM GURYUL RAVINE

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AND

APPENDIX TO CONDONTS OF GURYUL RAVINE

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LATE PERMIAN AND EARLY TRIASSIC CONODONTS FROM GURYUL RAVINE

INTRODUCTION

As pointed out by Sweet (1970 a, 1970 b, 1973) and Sweet et al. (1971), conodonts form a biostratigraphically important group among the Late Permian and Triassic marine faunas. Conodonts, fairly abundant but not so well-preserved, were obtained by Nakazawa and his co-workers in 1969 from various horizons of the Upper Permian and Lower Triassic formations exposed in the Guryul Ravine section. The conodont fauna from the same section was previously described by Sweet (1970 a), from the collection of Kummel and Teichert in the year 1968. The present work, however, is an attempt to clarify the biostratigraphical relationship of conodonts with ammonoids from the same stratigraphic section.

The author deeply acknowledges the appreciation of Dr. Yasuo Nogami of Kyoto University, for his kind help and discussion.

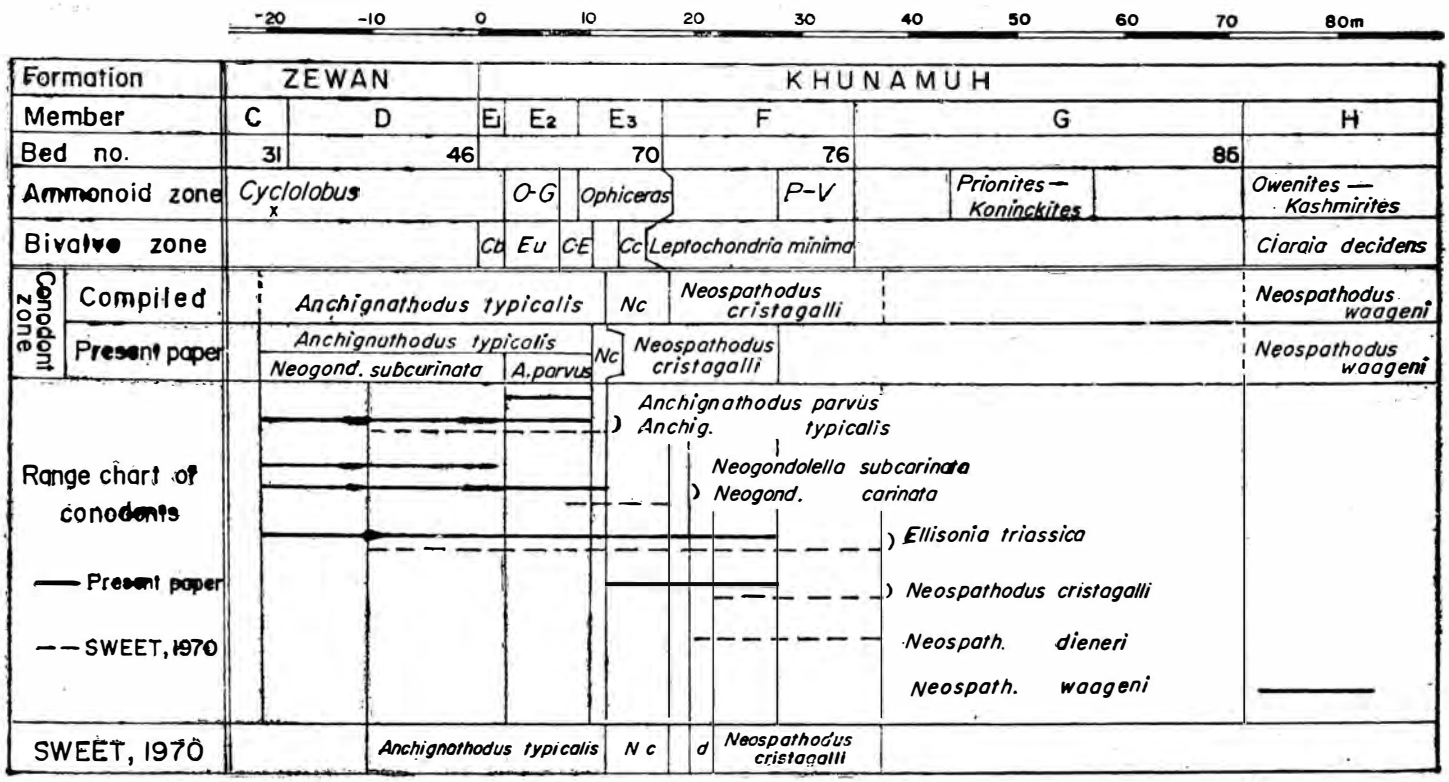
FAUNAL CONSIDERATION

The conodonts were isolated from the present materials from sixteen horizons, namely, Beds 31, 43, 47, 52, 55, 56, 58, 60, 61, 62, 64, 73, 75, 88, 89 and 90 which are mentioned in the ascending order. Among them, the lower two beds (Bed 31 of Member C and Bed 43 of Member D) are in the upper part of the Zewan Formation, and the other beds are in the Khunamuh Formation (Text Fig. 13).

Four conodont zones and two subzones are distinguished in the Permian and Triassic sequence at the Guryul Ravine. They are the *Anchignathodus typicalis* Zone, subdivided into the *Neogondolella subcarinata* Subzone (Beds 31 to 47) and the *Anchignathodus parvus* Subzone (Beds 52 to 61), *Neogondolella carinata* Zone (Beds 62 to 64), *Neospathodus cristagalli* Zone (Beds 64 to 75) and the *Neospathodus waageni* Zone (Beds 88 to 90).

The *Anchignathodus typicalis* Zone (Beds 31 to 61) is defined by the coexistence of *Anchignathodus typicalis* SWEET (Pl. 21, Fig. 1) and *Neogondolella carinata* (CLARK) (Pl. 21, Figs. 6 a-c, 7 a-c). A few elements rather of long stratigraphical range, such as *Ellisonia triassica* MÜLLER and *Ellisonia teicherti* SWEET, are always accompanied with them. This conodont zone can be subdivided into the *Neogondolella subcarinata* Subzone in the lower (Beds 31 to 47) and the *Anchignathodus parvus* Subzone in the upper (Beds 52 to 61) by the respective existence of *Neogondolella subcarinata* SWEET (Pl. 21, Figs. 4 a-c, 5 a-c) and *Anchignathodus parvus* KOZUR and PJATAKOVA (Pl. 21, Figs. 2 and 3). Sweet (1970 a) distinguished *Anchignathodus typicalis* from the Pennsylvanian *Anchignathodus minutus* (ELLISON) by their characterstic differences in length and width and also characters of denticles. However, Kozur (1975) and Kozur and Pjatakova (1976), who considered the difference of height between main cusp and denticles and the number of denticles as the important character, referred *Anchignathodus typicalis* SWEET to a junior synonym of *Anchignathodus minutus* (ELLISON). A long stratigraphical range of *Anchignathodus minutus* (ELLISON) however shows, much variation in shape and size, and also differs, rather distinctly with that of *Anchignathodus typicalis* SWEET. In the present article, *Anchignathodus minutus* (ELLISON) and *Anchignathodus typicalis* SWEET as well as *Anchignathodus parvus* KOZUR and PJATAKOVA are treated to be independent

species. *Neogondolella subcarinata* SWEET and *Neogondolella carinata* (CLARK) are extremely variable in shape and size, but as a whole, they well coincide with the type specimens, described and illustrated by Sweet (1973a) from the latest Permian Ali Bashi Formation of the northwest Iran, and also from those described by Clark (1959) from the pre-*Meekoceras* beds of the western United States. The stratigraphical range of *Neogondolella subcarinata* SWEET is limited in the Guryul Ravine from Bed 31 (in the top of the Member C, situated at 18.5 meters below the upper limit of the Zewan Formation), to Bed 47, (the lowermost bed of the Khunamuh Formation). *Cyclolobus walkeri* (DIENER) was reported by Furnish et al. (1973) from the Bed 31. *Anchignathodus parvus* KOZUR and PJATAKOVA occurs from Bed 52, (the lowermost bed of the Unit E_2), to the Bed 61 (in the lower part of the Unit E_3 of the Khunamuh Formation) along with *Anchignathodus typicalis* SWEET. The stratigraphical range of *Otoceras woodwardi* (DIENER) (Beds 52 to 56), *Ophiceras* (*Lytophiceras*) *sakuntala* (DIENER), *Glyptophiceras himalayanum* (GRIESBACH) and *Glyptophiceras lissarenum* (DIENER) are included within the range of the *Anchignathodus parvus* Subzone.



Text Figure 13. Ammonoid, bivalve and conodont zones of Late Permian and Early Triassic in Guryul Ravine section. *O-G* ; *Otoceras—Glyptophiceras* Zone ; *P-V* : *Paranorites—Vishnuites* Zone ; *Cb* : *Claraia bioni* Zone ; *Eu* : *Eumorphotis venetiana—Eumorphotis* aff. *bokharica* Zone ; *C-E* : *Claraia* cf. *griesbachi-Eumorphotis multiformis* Zone ; *Cc* : *Claraia concentrica* Zone ; *Nc* : *Neogondolella carinata* Zone ; *d* : *Neospathodus dieneri* Zone.

The *Neogondolella carinata* Zone is characterised by a more or less abundance of the named species, but it lacks *Anchignathodus typicalis* SWEET, *Anchignathodus parvus* KOZUR and PJATAKOVA and *Ellisonia teicherti* SWEET. The stratigraphical distribution of this fauna is limited within about 2.5 meters from the Bed 62 to the Bed 64 in the lower part of the Unit E_3 of the Khunamuh Formation. *Ophiceras* (*Ophiceras*) *tibeticum* GRIESBACH, *Ophiceras* (*Ophiceras*) *serpentinum* DIENER, *Ophiceras* (*Lytophiceras*) *demissum* DIENER and *Glyptophiceras subdemissum* (SPATH) are associated with this conodont fauna.

The conodont fauna of the *Neospathodus cristagalli* Zone is composed mainly of the named species, and subordinately of a few stratigraphically unimportant elements. No species

of gondolellid conodonts occurs in the association. *Neospathodus cristagalli* (HUCKRIEDE) (Pl. 21, Figs. 10-12) in the present materials, is generally small in size, and closely allied to *Neospathodus dieneri* SWEET (1970 b) from the Kathwai Member of Pakistan, which is referred to be a synonym of *Neospathodus cristagalli* (HUCKRIEDE) in this article. *Neospathodus cristagalli* (HUCKRIEDE) occurs from Bed 64, and also from the Beds 73 to 75, nearly 35 metres above the base of the Khunamuh Formation.

The *Neospathodus waageni* Zone is characterised by the presence of the named species, accompanied by a few elements having a rather long stratigraphical range, but no gondolellid in association. *Neospathodus waageni* SWEET (Pl. 21, Figs. 8-9) is quite similar to the type specimen described by Sweet (1970 b) from the Mittiwali Member of Pakistan. This conodont zone has limited stratigraphical range from Beds 88 to 90 in H Member, ranging from about 75 m to 80 m above the base of the Khunamuh Formation. It is associated with *Owenites*, *Kashmirites* and *Meekoceras*.

Four conodont zones, namely the *Anchignathodus typicalis*, the *Neogondolella carinata*, the *Neospathodus dieneri* and the *Neospathodus cristagalli* in ascending order, were distinguished by Sweet (1970 a) in the same section at the Guryul Ravine, from a collection made by Kummel, Teichert and Kapoor in 1968 (Teichert et al., 1970). He (1973 b) plotted the sample horizons on the columnar section of Nakazawa et al. (1970). Although each zone differs in the lower and upper limits by a few to ten metres which are higher than that discussed in the present work. The *Anchignathodus typicalis* Zone, the *Neogondolella carinata* Zone, the *Neospathodus dieneri* and the *Neospathodus cristagalli* Zones of Sweet (1970 a) correspond to the *Anchignathodus typicalis*, the *Neogondolella carinata* and the *Neospathodus cristagalli* Zones of the present work. The *Anchignathodus typicalis* Zone of Sweet (1970 a) is defined as the stratigraphical range of the named species, and is accompanied by *Neogondolella carinata* in its higher horizons (K 40 and K 41). However, the Bed 31 situated at about ten meters lower than the lowest horizon of the *Anchignathodus typicalis* Zone of Sweet (K 28), yielded abundant *Neogondolella carinata* (CLARK) as well as *Anchignathodus typicalis* SWEET and *Neogondolella subcarinata* SWEET. Therefore, the stratigraphical range of these species extends downwards to a certain horizon lower than that estimated by Sweet. In fact, the frequency of conodonts vary in different horizon and in different samples in the Guryul Ravine. *Anchignathodus typicalis* SWEET was reported recently by Behnken (1975) from the Guadalupian of West Texas.

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1


2


3


4a


4b


4c


5a


5b


5c


6a


6b


6c


7a


8a


9a


7b


7c


8b


9b


10


11


12

MURATA : Permian and Triassic Conodonts from Kashmir

PLATE 21

Fig. 1 *Anchignathodus typicalis* SWEET. × 60.

Lateral side view. Bed 56, Unit E_2, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type No. 19489.

Figs. 2-3 *Anchignathodus parvus* KOZUR and PJATAKOVA. × 60.

2-3. Lateral side views. 2. from Bed 52, Unit E_2 and 3 from Bed 61, Unit E_3 of Member E, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19490, 19491.

Figs. 4-5 *Neogondolella subcarinata* SWEET. × 60.

4-5. Views of upper, lateral and under sides. 4. from Bed 31, Member C. 5. from Bed 43, Member D, Zewan Formation, Guryul Ravine. GSI. Type Nos. 19492, 19493.

Figs. 6-7 *Neogondolella carinata* (CLARK). × 60.

6-7. Views of upper, lateral and under sides. 6. from Bed 31, Member C, Zewan Formation. 7. from Bed 62, Unit E_3, Member E, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19494, 19495.

Figs. 8-9 *Neospathodus waageni* SWEET. × 60.

8-9. Views of lateral and upper sides. Both from Bed 90, Member H, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19496, 19497.

Figs. 10-12 *Neospathodus cristagalli* (HUCKRIEDE). × 80.

10-12. Lateral side views. 10. from Bed 64, 11 from Bed 73 and 12 from Bed 75, Member F, Khunamuh Formation, Guryul Ravine. GSI. Type Nos. 19498, 19499, 19500.

APPENDIX TO CONODONTS OF GURYUL RAVINE

(Received by T. Matsuda after submission of the manuscript of this memoir)

After presenting this manuscript by editors, for publication, the author made further detailed sampling of the limestones for conodont in Kashmir in co-operation with H. M. Kapoor in August, 1977. On preliminary examination, nine conodont zones have been distinguished in the Khunamuh Formation. The comparison between the zonation by Murata in this Memoir and that of the author, is shown in the TABLE 25.

TABLE 25

COMPARISON OF CONODONT ZONES OF THIS VOLUME WITH THAT REVISED BY MATSUDA

<table>
<tr><th>this volume</th><th>new zonation by Matsuda</th></tr>
<tr><td>Neospathodus waageni</td><td>Neospathodus waageni</td></tr>
<tr><td rowspan="2">?</td><td>?</td></tr>
<tr><td>Neospathodus pakistanensis – N. labiatus</td></tr>
<tr><td rowspan="2">Neospathodus cristagalli</td><td>Neospathodus cristagalli</td></tr>
<tr><td>Neospathodus dieneri</td></tr>
<tr><td rowspan="3">Neogondolella carinata</td><td>Neospathodus kummeli</td></tr>
<tr><td>Gondolella carinata</td></tr>
<tr><td>Anchignathodus isarcicus</td></tr>
<tr><td rowspan="2">Anchignathodus parvus</td><td>Anchignathodus parvus</td></tr>
<tr><td>Anchignathodus typicalis</td></tr>
</table>

The zonation is quite identical with that of the Salt Range established by Sweet (1970), and which are referred to as standard for the lower Eo-Triassic conodont zones by Sweet et al. (1971). It also includes *Anchignathodus parvus* Zone and *A. isarcicus* Zone, considered by Sweet earlier. The latter two zones, though reverse in succession were first distinguished by Kozur (1974), and were correlated with the *Ophiceras commune* Zone (Upper Griesbachian).

A little difference in age assignment to the *Neospathodus kummeli* Zone between Kashmir and Pakistan is a future problem to be resolved.

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Additional Comments : While memoir was in press, Matsuda made further progress. The results of additional work have already been published in the following papers :—

NAKAZAWA, K., BANDO, Y. AND MATSUDA, T. 1980. The *Otoceras woodwardi* Zone and the time-gap at the Permian-Triassic Boundary in East Asia. *Geology and Paleontology of Southeast Asia—Symposium Tsukuba* 1978. Vol. 21, p. 75-90.

MATSUDA, T. 1981. Early Triasic conodonts from Kashmir, India. Part 1. *Hindeodus* and *Isarcicella*. *J. Geosciences, Osaka City Univ.*, Vol. 24, Art. 3, pp. 75-100.

Anchignathodus typicalis Zone of Sweet has been divided into three zones viz., *Hindeodus minutus* Assemblage Zone, *H. Parvus* Assemblage Zone and *Isarcicella isarcica* Zone. The first and second assemblage zones correspond to the lower and upper part of the *Otoceras woodwardi* Zone, respectively, and the last zone is assigned to the lower part of the *Ophiceras tibeticum* Subzone. *I. isarcica* does not occur in association with *Otoceras woodwardi*. Both *H. minutus* and *H. parvus* range up to the *I. isarcica* Zone.

Matsuda (1981) has critically reviewed the conodonts *Anchignathodus typicalis* SWEET, *Anchignathodus minutus* (ELLISON) and *Anchignathodus isarcicus* (HUCKRIEDE) in his paper.

—Editors

PART III

CONCLUSION

ANALYSIS OF LATE PERMIAN AND EARLY TRIASSIC FAUNAS OF KASHMIR

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ANALYSIS OF LATE PERMIAN AND EARLY TRIASSIC FAUNAS OF KASHMIR

INTRODUCTION

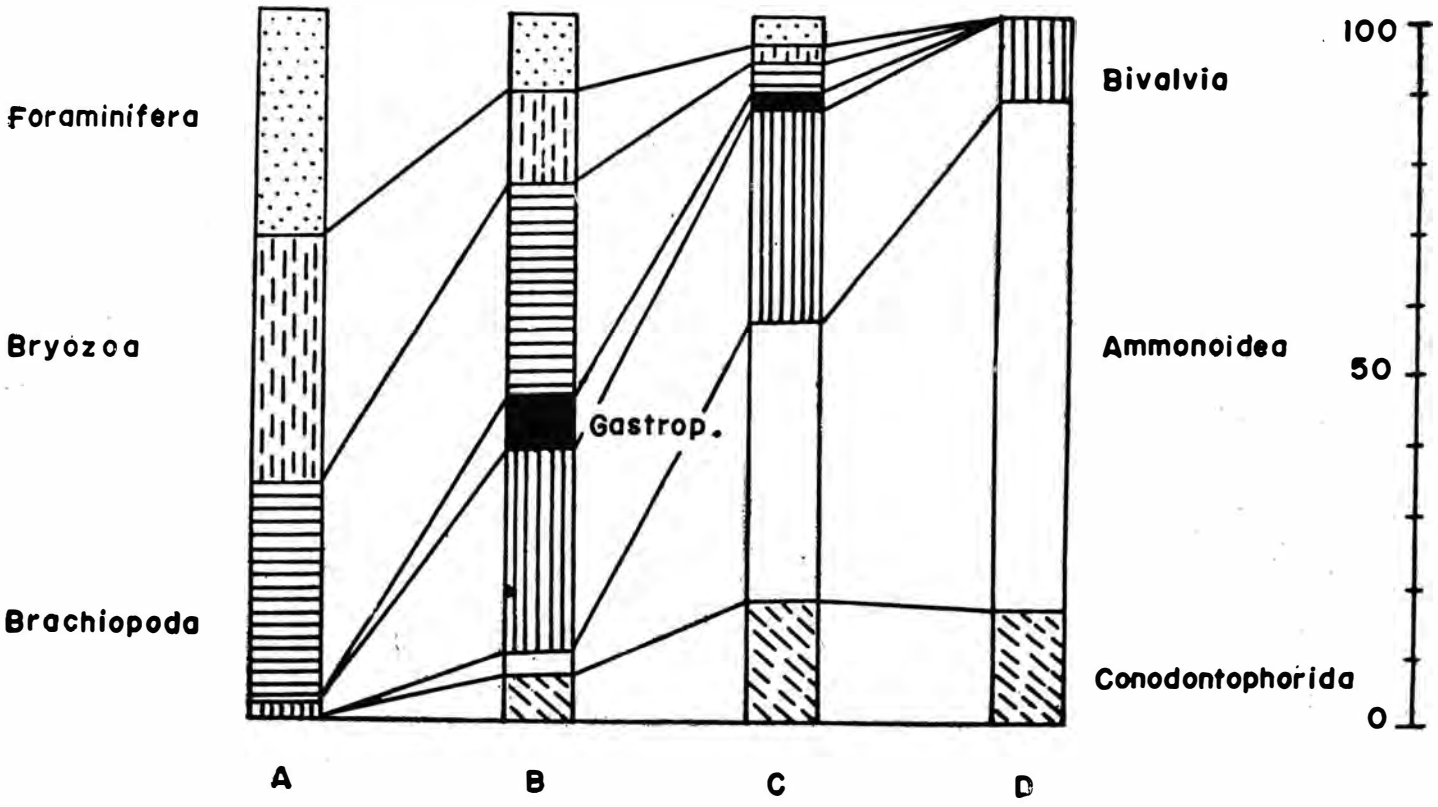
The most remarkable faunal change that took place at the junction of Unit E_1 and Unit E_2 of the Guryul Ravine (Text Figs. 2 and 3) and also at Unit f_1 and f_2 at the Spur three kilometres north of Barus (Text Fig. 5), is clearly understood from the range charts. The evidence of the faunal change is present within the lowermost part of the Khunamuh Formation. Almost all the organisms of the Zewan Formation as well as that of the lowermost unit of the Khunamuh Formation (E_1 and f_1) did not survive into the overlying beds excepting *Pustula*? sp., *Marginifera himalayensis*, *Claraia bioni*, and *Etheripecten haydeni*. While in the basal part of the Khunamuh Formation, elements from the Zewan Formation continue and are represented by typical Palaeozoic genera. Furthermore, the first three species crossing the boundary of the two units mentioned above are represented each by a single shell of incomplete preservation and were found in the basal *Otoceras*-bearing limestone. Only an incomplete valve of *Etheripecten haydeni* has also been collected from a horizon five meter above the base of the Khunamuh Formation located at the third Spur of the Guryul Ravine. Accordingly it is not certain whether these species are real survivor or reworked ones. Only exception is conodonts that are identified as *Neogondolella carinata carinata*, *Neogondolella carinata subcarinata* and *Anchignathodus typicalis*. All of them had appeared in the uppermost part of Member C of the Zewan Formation and became more common in Unit E_2 of the Khunamuh Formation. But in this case, some problems in regard to identification and classification still remain and will be discussed later. (See also p. 187-188).

Based on the faunal change, the Permian-Triassic boundary should therefore, be placed at the base of the Units E_2, or Unit f_2, that is, at the base of the *Otoceras woodwardi* Zone as commonly used (Griesbach, 1891 ; Spath, 1934 ; Diener, 1912 ; Kummel, 1957 ; Tozer, 1967), although, several scientists have opined that the *Otoceras* Zone should be included in the Permian, as the Genus *Otoceras* is a last survivor of the essentially Permian, Superfamily Otoceratacea and the associating genus *Glyptophiceras* is referred to *Xenodiscus* which flourished in the Permian (Newell, 1973 ; Kozur : 1972 ; Waterhouse, 1973). In this connection, however, the incoming of the Mesozoic type bivalves, such as *Eumorphotis venetiana*, *Eumorphotis* aff. *bokharica* and *Leptochondria minima* at the basal *Otoceras* limestone of Unit E_2 is also stressed.

FAUNAL CHARACTERISTICS

Characteristics of the Permian Faunas

The numbers of genera and species belonging to various taxa in our collection and those described by Diener (1915) from the Guryul Ravine and the Spur three kilometres north of Barus is shown in Table 26. As already discussed by Nakazawa et al. (1975) and deduced from the tables and range-charts included in the Member (Text Figures 2-5 and 14), the Permian strata have been divided into four divisions, I to IV, based on the faunal assemblages, which primarily depend on the lithofacies.



Text Figure 14. Apparent changes of faunal composition throughout the Late Permian and the Early Triassic in terms of numbers of species. Adapted from Table 26.

A : Divisions I and II. B : Divisions III and IV.
C : Units E_2-Member G. D : Member H of the Khunamuh Formation.

Division I corresponding to Member A of the Guryul Ravine and Member a at the Spur three kilometres north of Barus is represented by limestone and characterised by the association of Foraminifera, Bryozoa and Brachiopoda. The benthic organisms of this division are almost exclusively occupied by these three taxa excepting calcareous algae and ostracods that have not yet been studied.

Division II corresponding to Member B or b, which is composed mostly of terrigenous clastic sediments, is represented mostly by brachiopods and is marked by a rapid decline of foraminifers and bryozoans in accordance with the poor development of carbonate rocks.

Division III includes Member C and D or c to e, and consists of alternating carbonate rocks and terrigenous clastic rocks. The appearance of gastropods and diverse bivalves is a characterstic of this division. Foraminifers and bryozoans have slightly increased though much less than the Division I.

The main constituents of the Division IV (Unit E_1 and f_1) are brachiopod and bivalve like that of Division III, but bivalves have become more superior to brachiopods in number of individuals. Foraminifera and Bryozoa were almost extinct.

But for a single record of *Pseudomonotis* (=*Aviculopecten*?) *middlemissi* by Diener (1915) from Mandakpal, no other mollusc has so far, been reported from the lower

half of the Zewan Formation. Corals are almost absent; only one solitary coral *Euryphyllum cainodon* was found from Member b at the Spur three kilometres north of Barus.

A general tendency of the faunal change during the late Permian in this region has been shown in the Text Figure 14 and Table 27 by combining Divisions I and II, and III and IV respectively. The upper Zewan and the basal Khunamuh Formation are faunistically distinguished from the lower Zewan Formation by a decline of Foraminifera and Bryozoa and subsequent development of Bivalvia. Brachiopods are common throughout the Permian, but tend to decrease towards the end of the Permian.

TABLE 26

	I	II	III	IV
Foraminifera	16/14	1/1	6/4	1/1
Bryozoa	20/15	0/0	8/7	0/0
Brachiopoda	4/4 14/12*	6/5 9/6*	8/7 10/9*	11/11 16/13*
Bivalvia	0/0	1/1*	12/11	7/7 9/8*
Gastropoda	0/0	0/0	5/2	1/1
Ammonoidea	0/0	0/0	2/2	1/1*
Conodontophorida	0/0	0/0	4/4	2/2

Numbers of genera (denominator) and species (numerator) of each division of the Permian (Zewan Formation and Unit E_1 of the Khunamuh Formation) at Guryul Ravine and the Spur three kilomitres north of Barus. Those with asterik include the ones described by Diener (1915).

CHARACTERSTICS OF THE LOWER TRIASSIC FAUNAS

There is a great contrast of the faunal assemblage between the Permian and the Triassic. Brachiopods that were most flourishing among the Permian life, completely disappeared in the Triassic of Kashmir, excepting a few questionable shells of *Pustula*? sp. and *Marginifera himalayensis*, and an undescribed record of productids from the *Otoceras* beds in Pahlgam (Bion, 1914).

Foraminifera and Bryozoa, both main elements of the Permian fauna are very scarcely represented by only one or two species in the lowermost part of the Triassic. The Early Triassic seas were inhabited almost exclusively by ammonoids, bivalves and conodonts. In the later stage of the Early Triassic, ammonoids became more prosperous in this area (Table 27, Text Figs. 3, 4, 5 and 14). This faunal change is mainly due to a change in environment, related to more off-shore or deeper sedimentary conditions.

TABLE 27

	Late Permian		Early Triassic	
	I and II	III and IV	E_2 to G	H
Foraminifera	18/14	7/5	2/2	0/0
Bryozoa	20/15	8/7	1/1	0/0
Brachiopoda	18/14	19/15	2/2	0/0
Gastropoda	0/0	5/2	1/1	0/0
Bivalvia	1/1	18/12	14/7	3/3
Ammonoidea	0/0	2/2	18/9	18/13
Conodontophorida	0/0	4/4	8/5*	4/4*
Total	57/44	63/47	46/27	25/20

Numbers of genera (denominator) and species (numerator) throughout the Late Permian and Early Triassic at Guryul Ravine and the Spur three kilometres north of Barus, based on the present Memoir, Diener (1913, 1915) and Sweet (1970 a with asterik).

FAUNAL AFFINITIES WITH OTHER REGIONS

LATE PERMIAN

Table 28 shows aerial and vertical distributions of species common or intimately related to those of Kashmir region. Most of the identified species of Foraminifera of the Zewan Formation are found in the Tethys realm (Table 28) and there is no known record of these organisms outside the Tethys. Okimura and Ishii (this volume) pointed out that the faunal assemblage of the Zewan Formation differs from that of Trans-Caucasia and suggested different faunal provinces for the two regions. According to their preliminary investigation, the foraminiferal assemblage of the Salt Range region is quite similar to that of Kashmir. The same phenomenon is also recognized in respect to Bryozoa. Most of the identical species are found in the Salt Range and some intimate species occur in USSR, South China, Timor and Japan. Brachiopod fauna is most allied to that of the Salt Range and the Central Himalaya, although a few species are also commonly found in other regions of the Tethys, such as South China, Southeast Asia, Japan and the West Tethys. Bivalves contain many endemic forms, but common or intimately related species are confined mostly to the Salt Range and Central Himalaya.

Thus, the general faunal affinities support the proposal of Nakazawa and Kapoor (1977) that the Salt Range, Kashmir and the Central Himalaya have properly been referred to as Peri-Gondwana Tethys, in prefernce to the Middle Tethys which also includes Pamir region. Kashmir region, is however, a little different faunistically from that of the Salt Range region by the fact that there has been no record of colonial corals and fusulines are extremely rare. On the contrary, these organisms are relatively common in the Salt Range as exemplified by *Waagenophyllum* and *Wentzelella* of colonial corals and *Codonofusiella* and *Reichelina* of smaller fusulines. In this respect, Kashmir is closer to the Central Himalaya and the Salt Range is more intimate to the northern Tethys during the Late Permian time. This fact implies that Kashmir and Himalaya were located at a higher latitudes than that of the Salt Range or influenced by cooler current.

TABLE 28

VERTICAL AND AERIAL DISTRIBUTION OF ALLIED OR IDENTICAL SPECIES OF THE PERMIAN OUTSIDE KASHMIR

Species	Division	Horizon and Area
	FORAMINIFERA	
Nodosinella cf. *grandis*	I	Lower to Middle Permian of USSR (Donetz basin, Bashkir).
Lunucammina postcarbonica	I	Allied to that of Bellerophon Limestone in Turkey and *Lepidolina multiseptata* Zone to *Palaeofusulina* aff. *sinensis* Zone in Japan.
Colaniella cf. *minima*	I	*Lepidolina multiseptata* Zone to *Palaeofusulina* aff. *sinensis* Zone in Japan and Sichote-Alin; lower Wuchiaping in China, Kalabagh-lower Chhidru in Pakistan.
Colaniella cylindrica	I	*Lepidolina kumaensis* Zone to *Palaeofusulina* aff. *sinensis* Zone in Japan; Wuchiapingian and Changhsingian in China; Upper Permian in Transcaucasia and Greece; Kalabagh-Chhidru, Salt Range.
Abadehella coniformis	I	*Lepidolina kumaensis* Zone in Japan; *Palaeofusulina sinensis* Zone in Malaysia; Abadehian in Iran.
Endothyra miassica	I	Upper Permian in USSR, *Lepidolina kumaensis* Zone in Japan.
Globivalvulina cf. *cyprica*	III	Upper Permian in Greece and Cyprus, *Lepidolina kumaensis* or *Palaeofusulina simplex* Zone in Japan; Wargal and Chhidru Formations in Pakistan.
Nodosinella longissima	IV	Kazanian in Russian platform.
	BRYOZOA	
Stenopora ? kashmirensis n. sp.	I	Allied to *Stenopora parvulipora* of Amarassi in Timor.
Streblascopora cf. *fasciculata*	I	Basleo in Timor, Kazanian in Russian platform, Gnishik in Transcaucasia.
Dyscritella sparsigemmata	I	Middle and Upper Productus Limestone in Salt Range.
Dyscritella cf. *iwaizakiensis*	I	*Lepidolina multiseptata* Zone in Japan.
Polypora transiense	I	Middle Productus Limestone in Salt Range.
Acanthocladia anceps	I	Permian in Europe; Middle Productus Limestone in Salt Range.
Dyscritella tenuirama	I & III	Upper Artinskian to Guadalupian in Australia; Upper Sakmarian to Guadalupian in Thailand.
Stenodiscus cf. *chaetetiformis*	III	Upper Productus Limestone in Salt Range.
Stenopora sp.	III	Allied to *Stenopora ovata* of Middle and Upper Productus Limestone in Salt Range.
Septopora sp.	III	Allied to *Septopora neopavlowi* of Changhsingian in China.
	CORAL	
Euryphyllum cainodon	II	Basleo of Timor; *Yabeina* Zone of Cambodia.
	BRACHIOPODA	
Spirigerella sp.	I	Allied to *Spirigerella grandis* of Middle and Upper Productus Limestone in Salt Range; Maokouan to Lopingian in China.
Cleiothyridina cf. *subexpansa*	II	Lower to Upper Productus Limestone in Salt Range; Upper Permian in Nepal.
Neospirifer musakheylensis	II	Middle to Upper Productus Limestone in Salt Range.
Spriferella rajah	II	Productus Shales in Central Himalaya; Amarassi in Timor.

TABLE 28 (*Contd.*)

Species	Division	Horizon and Area
Leptodus nobilis	II	Upper Permian, cosmopolitan.
Chonetina ? sp.	I & III	Allied to *Chonetina strophomenoides* of Middle Productus Limestone in Salt Range ; *Chonetina substrophomenoids* of Changhsingian in China.
Waagenoconcha abichi	II	Middle to Upper Productus Limestone in Salt Range ; Amarassi in Timor ; Lopingian in China ; *Pseudoschwagerina* Zone in Japan.
Waagenoconcha purdoni	III & IV	Middle to Upper Productus Limestone in Salt Range ; Upper Permian in Nepal ; *Neoschwagerina* Zone in Japan.
Lissochonetes bipartita	III	Midd'e to Upper Productus Limestone in Salt Range ; *Lepidolina kumaensis* Zone in Japan.
Lissochonetes cf. *morahensis*	I to IV	Middle to Upper Productus Limestone in Salt Range ; *Lepidolina kumaensis* Zone in Japan.
Linoproductus lineatus	I to IV	Lower to Upper Productus Limestone in Salt Range ; Upper Permian in Nepal ; *Neoschwagerina* Zone in Japan.
Marginifera himalayensis	I & IV	Productus Shales of Central Himalaya ; Amarsassi in Timor ; *Neoschwagaerina* to *Lepidolina multiseptata* Zone in Japan.
Costiferina indica	II	Middle to Upper Productus Limestone in Salt Range.
	BIVALVIA	
Phestia sp.	III	Allied to *Phestia subacuta* of Productus Shales in Central Himalaya.
Schizodus ? sp.	III	Allied to *Schizodus rotundatus* of Upper Productus Limestone in Salt Range.
Permophorus cf. *subovalis*	III	Upper Productus Limestone in Salt Range.
Astartella progrenitrix	III	Top of the Upper Productus Limestone in Salt Range.
Etheripecten aff. *hiemalis*	III & IV	Upper Permian of northern USSR ; Productus Shales in Central Himalaya.
Cyrtorostra aff. *lunwalensis*	III & IV	Middle and Upper Productus Limestone in Salt Range.
Claraia bioni	IV	Allied to *Claraia stachei* of Early Triassic in Viet-Nam ; China and Greenland.
	GASTROPODA	
Bellerophon (Bellerophon) blanfordianus	III	Upper Productus Limestone in Salt Range.
Retispira ornatissima	III	Top of Upper Productus Limestone in Salt Range.
Retispira cf. *kattaensis*	III	Lower Productus Limestone.
	AMMONOIDEA	
Xenaspis cf. *carbonarius*	III & IV	Kalabagh to Chhidru in Salt Range.
Cyclolobus walkeri	III	Upper Chhidru in Salt Range ; Kuling Shales and Chtichum Limestone in Central Himalaya ; Ankitohazo Formation of Madagascar.

EARLY TRIASSIC

The Early Triassic Period was biologically more uniform than the Late Permain throughout the world having many cosmopolitan genera. But, if examined at species level, it becomes clear that the Early Triassic fauna of Kashmir is most intimate to that of the Salt Range and Central Himalaya, as shown in Table 29, as in the case of Permian. It is interesting to note that the bivalve assemblage is more allied to East Tethys rather than the West (Nakazawa, 1977).

TABLE 29

VERTICAL AND AERIAL DISTRIBUTION OF IDENTICAL OR ALLIED SPECIES OF THE LOWER TRIASSIC FOSSILS

Species	Unit or Member	Horizon and Area
	FORAMINIFERA	
Glomospirella shengi	E_3	Middle to Upper Triassic in China.
	GASTROPODA	
Warthia hisakatsui, n. sp.	E_2	Allied to Lower Eo-Triassic *Warthia vaceki* in Southern Alps and China.
	BIVALVIA	
Claraia dieneri	E_2	Allied to *Claraia stachei* of Dickins & McTavish, *Ophiceras* beds in Australia.
Claraia aff. *extrema extrema*	E_3	*Ophiceras* and *Vishnuites* beds in Greenland ; *Ophiceras* and *Gyronites* beds in Iran.
Claraia cf. *griesbachi*	E_3	*Otoceras-Ophiceras* beds in Central Himalaya ; basal part of the Lower Triassic in China.
Claraia concentrica	E_3	Otoceratan and Gyronitan in China and Malaysia.
Eumorphotis venetiana	E_2, E_3	Werfen Formation in Alps ; lower Eo-Triassic in China.
Eumorphotis aff. *bokharica*	E_2, E_3	Lower Eo-Triassic in Bokhara.
Eumorphotis multiformis	E_3	Otoceratan to Gyronitan in China ; Gyronitan to Owenitan in Japan ; Sichote-Alin ; *Ophiceras* beds in USA.
Leptochondria minima	E_2 to H	Gyronitan to Owenitan in Sichote-Alin ; Owenitan in Japan.
Pteria aff. *ussurica yabei*	E_3	Owenitan in Japan.
	AMMONOIDEA	
Otoceras woodwardi	E_2	*Otoceras* Zone in Central Himalaya ; China ; Verchoyan ; Alaska ; Greenland and Canada.
Glyptophiceras himalayanum	E_2	*Otoceras* Zone in Central Himalaya and Salt Range.
Glyptophiceras lissarenum	E_2	*Otoceras* Zone in Central Himalaya.
Lytophiceras sakuntala	E_2	*Otoceras* Zone in Central Himalaya ; *Proptychites* Zone in Sichote-Alin and Gyronitan in Trans-Caucasia.
Proptychites (*Pseudoproptychites*) sp.	E_2 to G	Allied to *Pseudoproptychites scheibleri* of upper *Otoceras* beds in Central Himalaya.
Lytophiceras subdemissum	E_3	Lower *Ophiceras* beds in Greenland.
Ophiceras tibeticum	E_3	Top of *Otoceras-Ophiceras* beds in Central Himalaya.
Ophiceras serpentinum	E_3	*Otoceras-Ophiceras* beds in Central Himalaya.
Vishnuites aff. *pralambha*	F	*Otoceras-Ophiceras* beds in Central Himalaya ; '*Ophiceras*' beds (Owenitan) at Pastun.
Koninckites krafft i	G	'*Meekoceras*' beds (Gyronitan) in Central Himalaya.
Owenites koeneni	H	Owenitan in Northern Caucasus ; Afghanistan ; Japan ; Sichote-Alin and USA.
Anakashmirites cf. *kapila*	H	Owenitan in Central Himalaya.
Kashmirites subarmatus	H	Owenitan in Salt Range and Timor.
Meekoceras gracilitatus	H	Owenitan, cosmopolitan.
Prionites aff. *undatum*	H	Upper Ceratite Limestone (Owenitan) in Salt Range.

CORRELATION

LATE PERMIAN

Zonation and correlation were discussed in detail in the previous paper (Nakazawa et al., 1975) and the conclusion was endorsed by the later examination (Nakazawa and Kapoor, 1977).

The correlation of the lower part of the Zewan Formation (Members A and a) with the Kalabagh Member of the Wargal Formation (upper Middle Productus Limestone) is unquestionable because both have many species in common, belonging to Foraminifera, Bryozoa and Brachiopoda. This is further confirmed by the discovery of the group of *Colaniella minima* from Kalabagh Member and from the lower part of the Chhidru Formation.

The foraminiferal assemblage of Member A and Member a consists of various shell forms, while that of Members C and D (Division III) is represented by a few, long-ranging genera having uniserial arrangements of chambers. The similar faunal change of Foraminifera is recognised between the lower and the upper parts of the Chhidru Formation (pers. comm. of Dr. Okimura). Accordingly, the lower half of the Zewan Formation (Divisions I and II) can be equated with that of the Kalabagh and lower Chhidru in Pakistan, the Abadeh Formation in Iran, the Khachik beds in Transcaucasia, the lower Wuchiapingian in South China, the Kuman Series (the *Lepidolina kumaensis* Zone or the *Palaeofusulina simplex-Colaniella minima* Zone) in Japan, and also with the lower part of the Ochoan (post-Guadalupian) in the United States.

The upper part of the Zewan Formation is compared with the upper Chhidru Formation in respect to the similar bivalve and gastropod fauna ; common occurrence of *Cyclolobus walkeri* and associating conodonts, such as *Anchignathodus typicalis*, *Neogondolella carinata* and *Ellisonia triassica*. *Cyclolobus* in the Salt Range is limited to the uppermost beds 36 to 60, possibly 77 feet of the Chhidru Formation (Kummel and Teichert, 1970). *A. typicalis* assemblage is also confined to the uppermost 14 feet of the Chhidru Formation and the lowermost 3 to 9 feet of the overlying Kathwai Member (Sweet, 1970 b). However, there is some discrepancy and confusion regarding the conodont zonation and classification. According to Kozur (1974, 1975) and Kozur and Pjatakova (1976), *Neogondolella* (=*Gondolella* of their classification) *carinata* is in reality a superspecies comprising the Capitanian-Abadehian *bitteri* KOZUR, the lower Baisalian *leveni* KOZUR et al., the upper Baisalian-Dorashamian *subcarinata* (SWEET) and also the Lower Triassic *carinata* s.s. He referred *Anchignathodus typicalis* as a junior synonym of *A. minutus* which ranges from the Missourian up to the end of the *Otoceras woodwardi* Zone, and seperated *typicalis* of the *Ophiceras commune* Zone as a distinct species and named *A. parvus* (Kozur and Pjatakova, 1976). Therefore, further examination is needed for conodont zonation and correlation. (See also Appendix on p. 187-188 ; editors).

Unit E_1 is difficult to be correlated with sections of other regions. The brachiopod fauna does not essentially differ from that of the Zewan Formation, but this unit is characterised by unique bivalves, *Claraia bioni* and *Etheripecten haydeni*. The former is quite similar to the Lower Triassic *C. stachei*, which has a world wide distribution, such as North Viet-Nam, South China, East Siberia and North America including Greenland.

Conodonts are rare in this unit, a few of them has been identified as *Anchignathodus typicalis* and *Ellisonia triassica*. The correlation of this unit with the highest Permian (Dorashamian) is mainly based on its stratigraphic position, as there is no other common species of any group except for conodonts of the stratotype in the Dorasham region. The equivalent strata are most probably absent in the Salt Range.

EARLY TRIASSIC

Each of the five ammonoid and bivalve zones and four conodont zones were distinguished in the investigated part of the Lower Triassic by Bando, Nakazawa and Murata, respectively (this Memoir). Their mutual relation is given in Table 30 and the range chart (Text Fig. 3).

TABLE 30

MUTUAL RELATION OF AMMONOID, BIVALVE AND CONODONT ZONES AT GURYUL RAVINE

I	II	Ammonoid	Bivalve	Conodont
Smithian	Owenitan	*Owenites – Kashmirites*	*Claraia decidens*	*Neospathodus waageni*
Dienerian	Flamingitan	*Prionites – Keninckites*	?	?
	Gyronitan	*Paranorites – Vishnuites*	*Leptochondria minima*	*Neospathodus cristagalli*
U. Griesbachian		*Ophiceras*	*Claraia concentrica*	*Neogondolella carinata carinata*
			Claraia cf. *griesb.* *Eumorphotis multiformis*	
L. Griesbachian	Otoceratan	*Otoceras – Glyptophiceras*	*Eumorphotis venetiana – Eumorphotis* aff. *bokhorica*	*Anchignathodus parvus*

I: Tozer, 1967, II: Spath, 1934

Anchignathodus typicalis referred in the earlier paper (Nakazawa et al., 1975) has now been revised and splitted into two species, *typicalis* and *parvus* in this Memoir, following Kozur and Pjatakova, 1976. The compiled zonation of conodonts derived from our own data and that of Sweet (1970 a) is adopted here. (See also Appendix on p. 187-188 ; editors).

The successive ammonoid zones coincide well with those of the Salt Range (Waagen, 1895 ; Noetling, 1905 ; Diener, 1912), the Central Himalaya (Griesbach, 1891 ; Neotling, 1905 ;

Diener, 1912), Canada (Tozer, 1967) and Greenland (Spath, 1935; Trümpy, 1969). The *Otoceras-Glyptophiceras* Zone is correlated with the *Otoceras woodwardi* Zone of the Himalaya, the *Otoceras concavum* Zone? and *O. 'boreale'* Zone of Canada, the *Glyptophiceras* beds and also the lower *Ophiceras* beds of Greenland. The bivalve zone *Eumorphotis venetiana-E.* aff. *bokharica* corresponds to this ammonoid zone. *Anchignathodus parvus* is limited to the *Otoceras* Zone in our collection. But Sweet (1970 a) described this species, as *typicalis*, from the *Ophiceras* Zone, and Kozur (1975) designated it as a type species of the upper part of the *Ophiceras commune* Zone based on species from the *Ophiceras* Zone of Trans-Caucasia. Considering the Kashmir collection, *Anchignathodus parvus* most probably ranges from the *Otoceras woodwardi* Zone to the *Ophiceras commune* Zone.

Most of the species of *Ophiceras* are found in the lower half of the named zone and this zone has been compared to the *O. tibeticum* Zone of the Himalaya, *O. Commune* Zone of Canada and the upper *Ophiceras* beds of East Greenland, and is referred to upper Otoceratan of Spath or lower Upper Griesbachian of Tozer. The upper half of this zone coincides with the *Claraia concentrica* Zone. On the basis of the stratigraphic distribution of *Claraia aurita* in the West Tethys, which is very intimate to *concentrica*, this part of the Khunamuh Formation may be referred to as early Gyronitan rather than Otoceratan.

The genus *Paranorites* is characteristic of the Ceratite Marls and Ceratite Sandstone of the Salt Range and also occurs in the upper Dienerian *P. sverdrupi* Zone of Arctic Canada. *Vishnuites* is known in the *Otoceras-Ophiceras* beds of Himalaya and is also common in the *Vishunites* beds of Greenland and Canada. The *Paranorites-Vishnuites* Zone of Kashmir is assignable to late Gyronitan or early Dienerian.

The correlation and the age *Prionites-Koninckites* Zone is somewhat dubious. *P. undatus* is an Upper Ceratite Limestone species of the Salt Range which has been referred to Owenitan. On the other hand, *Koninckites kraffti* has been originally described from '*Meekoceras*' beds of the Himalaya which is considered to be Gyronitan. This zone is tentatively correlated to Flemingitan or Upper Dienerian.

The *Owenites-Kashmirites* Zone is safely referred to Owenitan of Spath or Smithian of Tozer in having many characterstic species of this stage.

The stratigraphic succession of conodont zones *Anchignathodus parvus*, *Neogondolella carinata carinata*, *Neospathodus cristagalli* and *Neospathodus waageni* is concordant with that of other regions (Sweet, 1970b, 1973; Kozur, 1974), though boundary of each zone does not always coincide with each other. The group of *Claraia decidens* is also characterstic of the late Eo-Triassic (Nakazawa, 1977). (See modifications in Appendix on p. 187-188; editors).

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ERRATA

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Page	Line	Written	Please read
23.	above first line please add :		FORAMINIFERA
51.	Table 12, Title	{WAAGEN AND WENTZEL}	(WAAGEN AND WENTZEL)
53.	Table 14, Title	*Dyscritella iwaizakiensis*	*Dyscritella* cf. *iwaizakiensis*
54.	Table 14,8 lin.	,canthoeciumn	acanthoecium
55.	Table 15,7 line	aconthoecium	acanthoecium
56.	Table 16, Title	Cf.	cf.
56.	Table 16,5 line	long	longitudinal
57.	14	Kray	area
58.	27	witn that of	with those of
59.	3	(SCHLOTHEIM)	SCHLOTHEIM
61.	14	msnanok	mshanok
63.	15	(SAKAGAMI)	SAKAGAMI
64.	13	(SCHLOTHEIM)	SCHLOTHEIM
64.	14	Meekellinae	Meekillidae
69.	24	value	valve
71.	8	(HUANG 1932, 1933)	(HUANG)(1932, 1933)
72.	3	Pt. 1, p. 62,	Pt. 4, p. 620,
72.	7	towords	towards
73.	3	extremeties	extremities
73.	19	as that of	as those of
74.	21	resemble with the	resemble the
74.	23	smoothely	Smoothly
76.	10	valve-dendritic	valve dendritic
76.	19	with that of	with of
77.	33	drosal	dorsal
77.	35	weak	weaker
78.	34	resembles with	resembles
79.	6	longitudinal,	longitudinal
79.	15	resembles with	resembles
79.	19	Salt Sange	Salt Range
79.	21	cf. *subexpansa*	cf *Cleithyridina subexpansa*
80.	11	*B. A.*, p. 33,	*B.A. Sonderbd*, Vol. 12, p. 33
80.	19	extremeties	extremities
80.	20	extends	extends to
80.	31	recognised to	recognised
81.	21	hardly comparable	comparable
82.	3	Product.	Producti.
82.	4	p. 1.	Pt. 1.
82.	5	PURDON	PURDONI
90.	9	(*Claraia* Group)	(*clarai* Group)
90.	21	from Member	from Members
90.	26	bellerophonitid	bellorophonid
91.	Table 23, FOSSIL ZONE, Col. 3	*Claraia* aff. *griesbachi*	*Claraia* cf. *griesbachi*

Page	Line	Written	Please read
93.	11	(Bed 8)	(Bed 88)
93.	20	*Nucolopsis*	*Nuculopsis*
93.	21	ind. *a*	indet. *a*
95.	25 (2 column)	1.20 mm	12.0 mm
95.	28	*constrica*	*constricta*
97.	24	Several specimens	Many left valves and two right valves
97.	27	Shell hinge—	Shell ; hinge-
98.	34-35	radial ribs. In this respect it is.. ...	radial ribs, it is.....
100.	36	*Dagaku*	*Daigaku*
100.	27	*Reich. Anst.*	*Reichsanst.*
101.	28	*Geognistica*	*Geognostica*
102.	9	similary	similarly
102.	28	*Reichs. Anst.*	*Reichesanst.*
103.	14	YAHARA, *Japan Geol.*	YEHARA, *Japan Journ. Geol.*
104.	37	a internal	an internal
110.	25	*Daigachu*	*Daigaku*
115.	4	Muschelkalkbla-gerungen	Muschelkalka-blarengen
115.	6	zentralasatischer.	zentralasiatischer
115.	7	p. 681	p. 1-681.
115.	10	p. 76	p. 1-76.
115.	16	p. 100	p. 1-100.
115.	18	p. 202	p. 1-202.
116.	2	in Russian	(in Russian)
117.	14	Berückischtigung	Berücksichtigung
117.	19	Schinosawa	Shinosawa
117.	21	Nomura Iyo Province	Numura, Iyo Province
119.	9	20. Left valves	20. Left valve
121.	15	Rimkin-Priar	Rimkin-Paiar
121.	13	Plate 1-6,	Plate 1,
125.	5	bellorophonetids	bellorophontids
128.	11	closely with	closely
129.	27	Bellorlphonitinae	Bellorophontinae
130.	30	concaved	concave
130.	31	anomphalos	anamphalous
137.	11	detail work	detailed work
138.	15	*golshani*	*golshanii*
141.	19	two genus	two genera
142.	34 (last column)	0.25	0.23
142.	36 (4th column)	91.8	21.8
152.	13	4b,	4
158.	34	KIP.RISOVA	KIPARISOVA
161.	1	cf. *Anakashmirtes*	cf. *Anakashmirites*