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LATE LOWER TRIASSIC AND EARLY MIDDLE TRIASSIC CONODONT FAUNAS FROM KASHMIR AND KUMAUN SEQUENCES IN HIMALAYA

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ABSTRACT

Conodont assemblages characteristic of Smithian, Spathian, Early and Lower Anisian have been described in the investigated sections of Kashmir and Kumaun Himalaya. An attempt is made to correlate the sections of Kashmir with now well known sections of Salt Range, Pakistan. Conodont fauna from Kumaun, is comparable to that of Lower Anisian assemblages in Europe.

Conodont fauna includes 27 Stratigraphically useful species referable to three genera, *Neospathodus*, *Neogondolella* and *Paragondolella*. Two new species *Neospathodus srivastavai*, n.sp. and *Neospathodus jhelumi*, n.sp. have been proposed from Smithian material in Kashmir.

The age of certain lithologic units devoid of ammonoids and other mega fossils is determined in the light of conodont evidence. In Kashmir, the sequence below Nodular limestone has been included in the Lower Triassic. Conodont fauna is suggestive of Upper Bithynian to Early Pelsonian age for Niti limestone in Kumaun Himalaya.

Associated with conodonts also occur microfossils such as Ostracoda, foraminifera, microvertebrates, micromolluses and echinoid spines.

INTRODUCTION

Marine Triassic sequences are well developed in Kashmir and Kumaun Himalaya. In Kashmir, ammonoids and other mega fossils are not so well known in contrast to Spiti and Kumaun regions where Triassic biostratigraphy is so far based mainly on ammonoid and other mega fossils. In Kashmir, Sweet (1970a) attempted conodont zonation in the Lower part of Lower Triassic (up to Dienerian). Subsequently Nakazawa *et al.* (1975) proposed conodont biozonatin for the Lower Triassic sequence up to Smithian. The objectives of the investigations were ; firstly, to work out conodont biostratigraphy of Smithian and Post- Smithian in the sections of Kashmir ; Secondly, the study of systematic palaeontology of Triassic conodonts ; thirdly, evolutionary lineages in the Tethyan Triassic conodonts ; and lastly, regional correlation with sections of Salt Range, Pakistan (Sweet 1970b) and adjoining areas. Palaeontological samples from the area of study in Kashmir were collected by one of us (NLC) during three field trips in 1972-75. Kumaun samples were collected by Dhoundial and Jangpangi in 1953 from Middle Triassic sequence developed near Niti Pass. Samples were disintegrated by acid extraction method and of the total 225 samples collected, 84 were found to be conodont productive on which this paper is based. Biostratigraphic data collected by authors from the investigated Triassic sections of Kashmir and Kumaun Himalaya have previously been incorporated by Gupta (1978).

Previous investigations on the Triassic Geology of Kashmir by earlier workers have already been discussed Nakazawa *et al.* (1975). In the study area, mention must be made of Srivastava and Mandwal (1966) who reported early Lower Triassic cconodonts from Pastun section, Kashmir which is incidently first report of conodonts from India. Teichert, Kummel and Kapoor (1970) studied the mixed fauna and modified the boundary between Permian and Lower Triassic including the upper most part of Zewan beds into the Lower Triassic. In recent years, significant contribution to the Geology of Upper Permian and Lower Triassic of Kashmir has been by Nakazawa, Kapoor, Ishii, Bando, Okiumura, and Tokuoka (1975) who carried out the detailed investigations in the sections of Guryul Ravine and 3 km north of Barus. These authors proposed Khunamuh Formation which represents the sequence from Latest Permian through Lower Triassic and comprises mainly alternating shales and limestone which is characterized by gradually increasing limestone content. Khunamuh Formation is underlain by Zewan Formation (Upper Permian) with abrupt change in lithology. Their Permian-Triassic boundary is marked by the first appearance of *Otoceras woodwardi*. Nakazawa *et al.* (1975) also attempted biozonation of Khunamuh Formation up to Member H (Smithian) on the basis of conodonts, ammonoids and bivalves. Prior to Nakazawa *et al.* (1975), Sweet (1970a) described conodont fauna from the material collected by Curt Teichert from the Upper most Permian and Lower Triassic sequence up to the base of cliff forming limestone in Guryul Ravine. He proposed four conodont biostratigraphic zones which in the ascending order are : *Anchignathodus typicalis* zone ;

Neogondolella carinata zone ; *Neospathodus dieneri* zone ; and *Neospathodus cristagalli* zone. This investigation is significant ; firstly, because conodont faunas have been described from horizons above those of Sweet (1970a) and Nakazawa *et al.*, (1975) and secondly, most of the conodont elements have been recovered from strata which are almost devoid of mega fossils and precise age determination of these litho-units is now possible. Thust he present work forms a sequel to the work of Sweet (1970a) and Nakazawa *et al.* (1975).

Besides above said reports, Triassic conodonts from India have been described or reported by the following workers : Gupta (1976a), Gupta and Rafek (1976), Joshi and Arora (1976) from Kashmir and Ladakh regions ; Sweet (1973), Goel (1977) and by Bhatt and Joshi (1978) from Spiti ; Gupta (1972), Misra, Sahni and Chhabra (1973), Chhabra, Sahni and Kumar (1973), Sahni and Prakash (1973), Sahni and Chhabra (1974) from Kumaun Himalaya. Fuchs and Mostler (1969), Kozur and Mostler (1973) and Gupta (1976b) have reported Triassic conodonts from Nepal. Huckriede (1958) described some material of Triassic conodonts from Salt Range, Pakistan which represents the first record of conodonts from Indian subcontinent.

STRATIGRAPHY OF THE STUDY AREA

The study area is a part of a very large syncline outcropping in the form of a horse-shoe, opening to the south west through the villages of Mandakpal, Pastun, Lam, Narastan and Khunamuh. The major part of this large syncline is occupied by Triassic sediments.

The investigated sections in Kashmir valley are situated within 15 km of each other (Fig. 1). The sections measured in the present investigation are well known and were earlier studied by Middlemiss (1909, 1910). In these sections a sequence, representing Upper part of Lower Triassic (equivalent to Khunamuh Formation) and Early Middle Triassic has been investigated with special reference to the conodont biostratigraphy and micropalaeontology.

The following is the location and brief lithostratigraphy of the investigated Triassic sections :

GURYUL RAVINE : (lat. 34°4′43″, long. 74°57′30″)

This section is located at a distance of 3 km north of the village of Khunamuh. In this section 129 metres thick sequence of Khunamuh Formation has been investigated (Fig. 2). Middle part of the alternating limestones and shales above the cliff forming limestone is characterized by *Neospathodus waageni* fauna of Smithian age. Two conodont biostratigraphic assemblages referable to *Neogondolella jubata* and *Neospathodus homeri-Neospathodus spathi* are represented in the Uppermost Lower Triassic in this section.

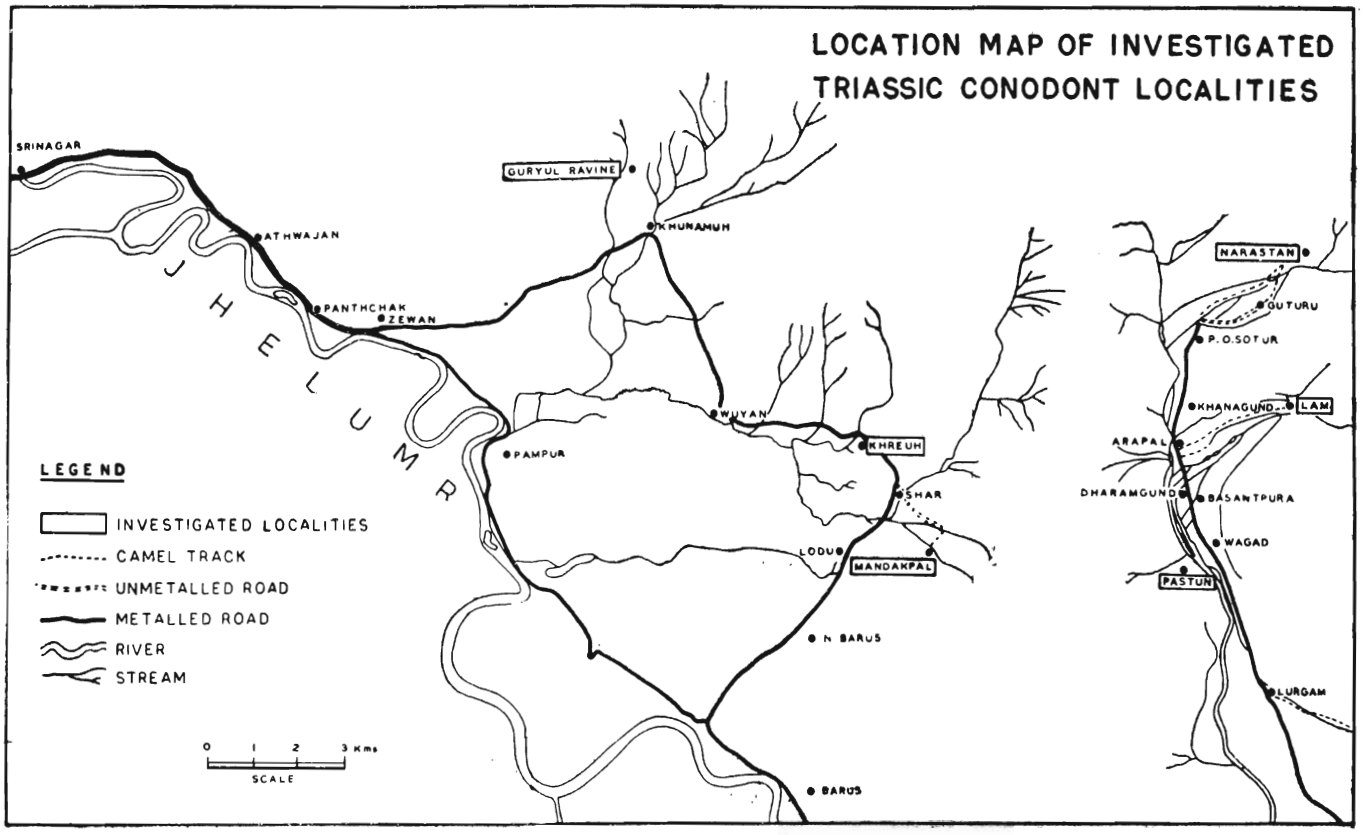

Fig. 1

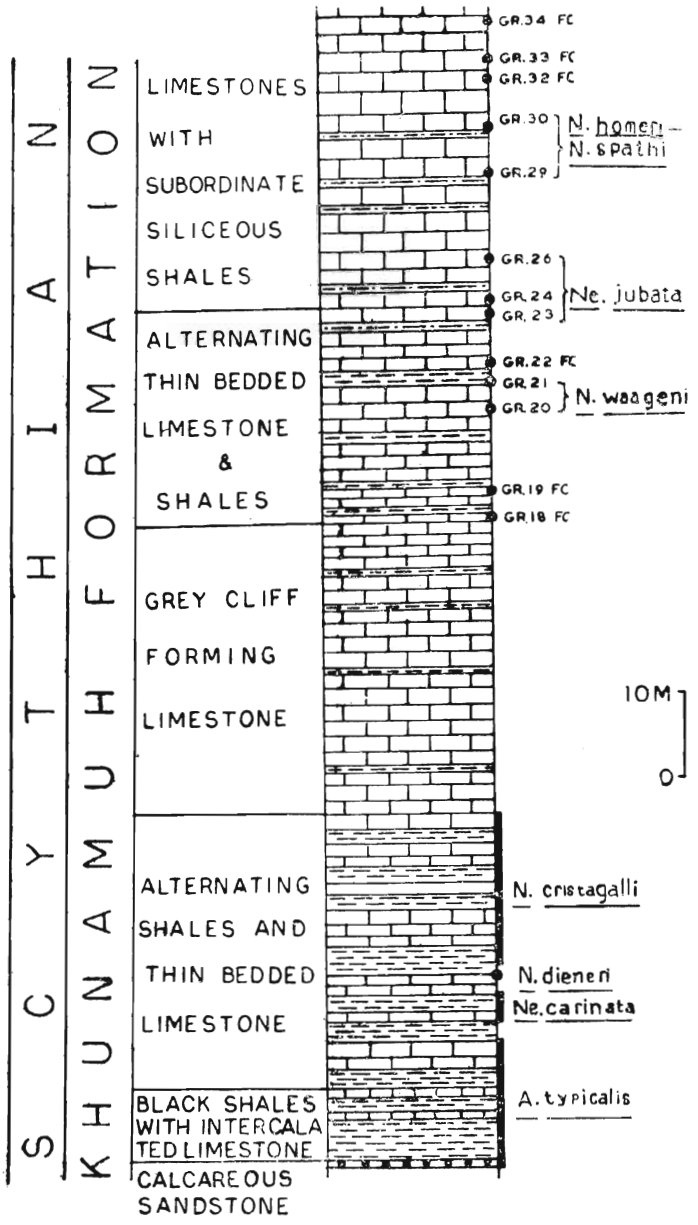

Fig. 2

KHREUH : (lat. 34°1′ ; long. 75°4′)

The investigated section is exposed in Temple Hill above the village of Khreuh situated 20 km east-south-east of Srinagar. In this section 109 metres thick sequence of Uppermost Lower Triassic and Lower part of Middle Triassic comprising of grey coloured thin bedded limestones; alternating limestones and shales; Nodular Limestones and earthy red limestones has been investigated (Fig. 3). Three conodont assemblage zones have been recognised in this section which in the ascending order are referable to *Neogondolella jubata ; Neospathodus homeri-Neospathodus spathi* and *Neospathodus timorensis*. Nodular limestone grades into earthy red limestone (*Gymnites* beds of Middlemiss, 1910) which is characterized by Lower Anisian ammonoid fauna.

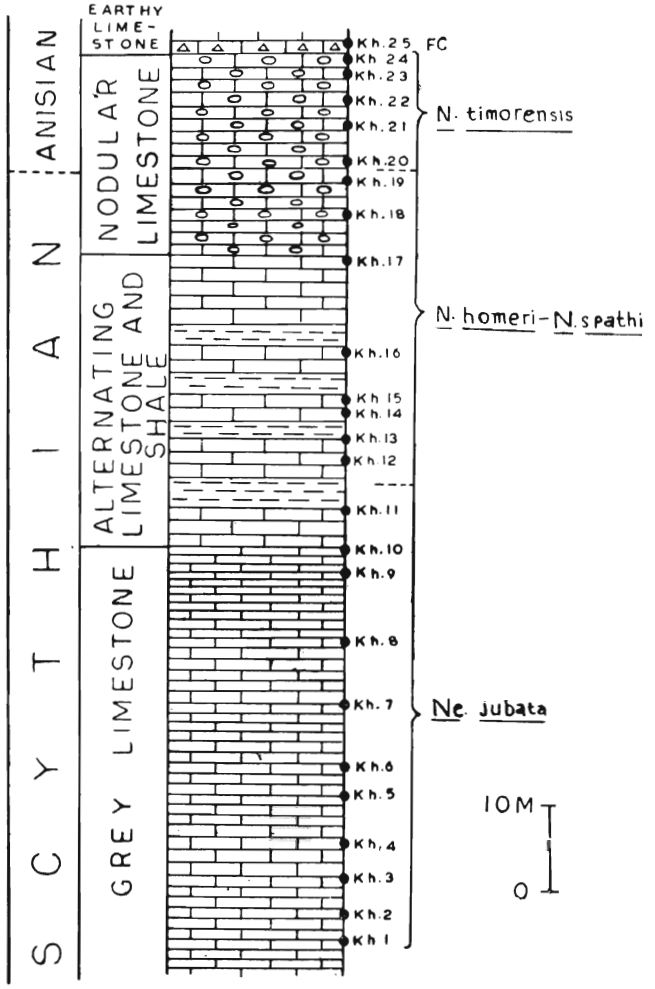

Fig. 3

MANDAKPAL : (lat. 33°59′30″ ; long. 75°6′)

This section is exposed in a hillspur near the Upper Mandakpal village situated 1 km south of Shar village. In this section, 98 metres thick sequence of Lower Triassic has been investigated (Fig. 4). The lower part of the sequence includes alternating sandy shales and thin bedded limestones. The sequence in the upper part becomes more calcareous and is represented by mainly limestones and subordinate shales which are characterized by the presence of conodont fauna referable to *Neogondolella jubata* zone. A sample from the uppermost part of the sequence has yielded conodont fauna referable to *Neospathodus homeri-Neospathodus spathi* zone. A Spathian age has thus been assigned for litho-unit of grey limestones with subordinate shales.

PASTUN : (lat. 33°59′30″ ; long. 75°8′)

The investigated section is located 1 km north-north-west of Pastun village. In this section, a sequence of Lower Triassic and Lower part of Middle Triassic comprising of thin bedded limestone ; alternating lime-

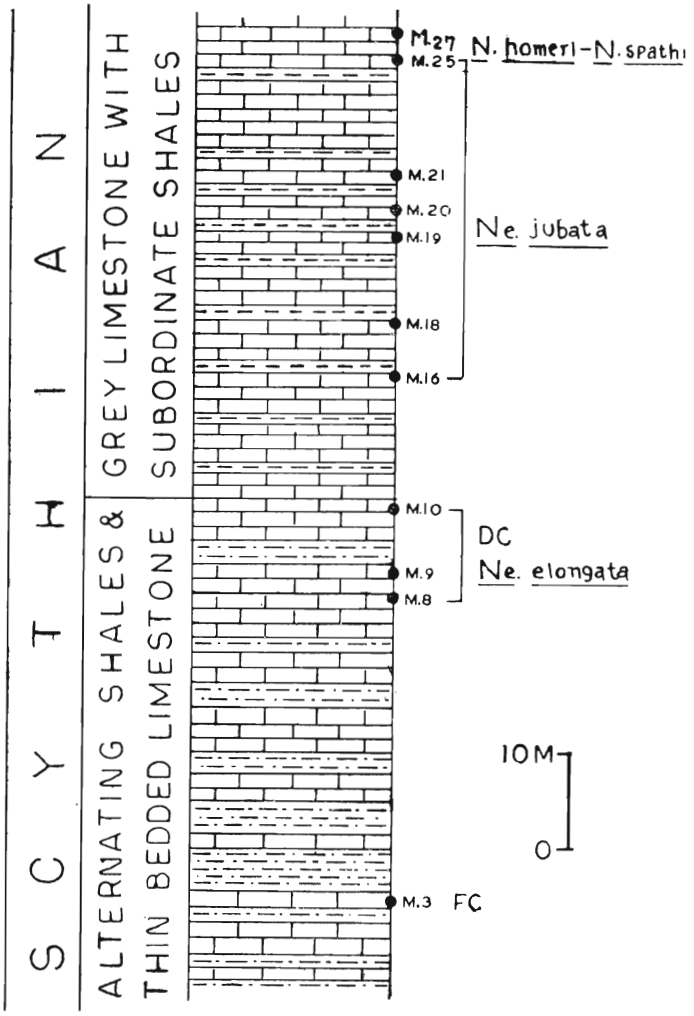

Fig. 4

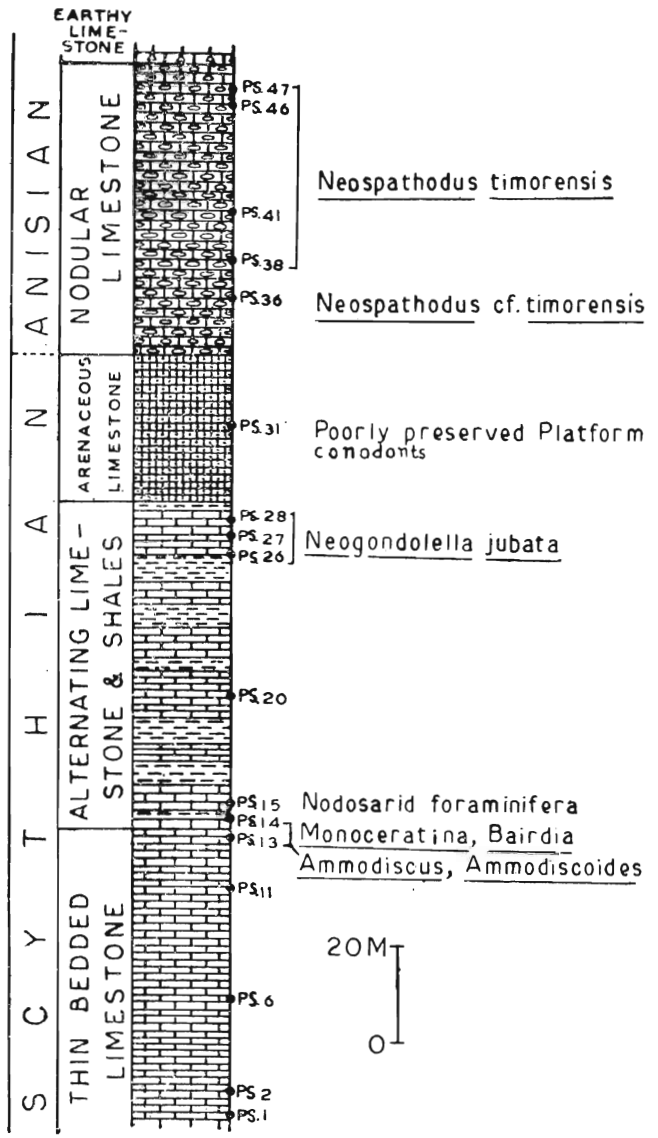

Fig. 5

stones and shales ; arenaceous limestone ; Nodular limestone and earthy red limestone (*Gymnites* beds of Middlemiss, 1910) has been investigated (Fig. 5). It was observed that in the Lower part of the investigated sequence, conodont fauna recovered is fragmentary and includes mostly denticle conodonts and a few platform conodonts. Four samples from Nodular limestone have yielded *Neospathodus timorensis* assemblage. A few poorly preserved platform conodonts referable to genus *Neogondolella* were recovered from one sample of earthy red limestone.

LAM : (lat. 34°2′ ; long. 75°10′)

This section is located in a hillspur north of village Lam which is situated at 2.5 km north-east of Arapal. The measured sequence includes 110 metres thick gray coloured thin bedded limestone and 100 metres thick sequence of sandy shales with intercalatedli mestone of Scythian age (Fig. 6). Smithian age has been assigned to the lower 53 metres of thin bedded limestones on the basis of conodont fauna. Lower part of sandy shales with intercalated limestone unit has been assigned Spathian age on the basis of *Neospathodus homeri-Neospathodus spathi* assemblage.

NARASTAN : (lat. 34°4′ ; long. 75°10′)

The investigated section of Narastan is exposed in a hill above the ancient temple near the village of Narastan which is situated east of Srinagar at a distance of about 28 km. In this section, samples from 65 metres thick sequence of thin bedded limestones were studied. *Neospathodus timorensis* fauna is known from two samples in the uppermost part of this lithologic unit. 5 samples revealed fragmentary conodonts material represented by denticle conodonts and a few incomplete specimens of *Neogondolella*.

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In the investigated Middle Triassic sequence near

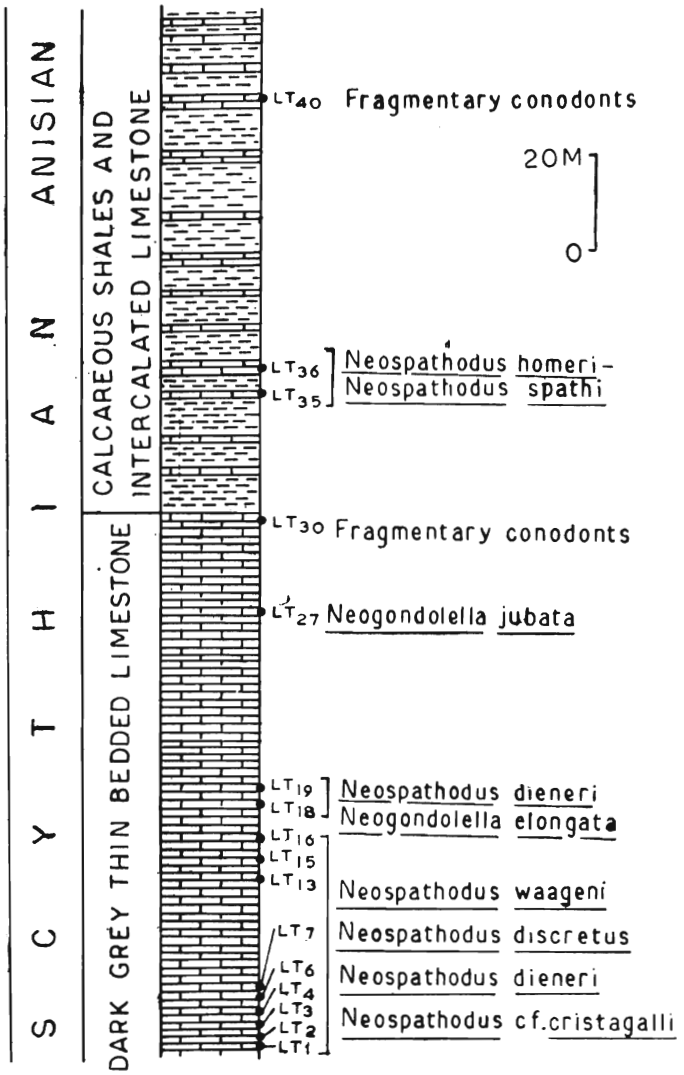

Fig. 6

Niti Pass, conodont fauna is characterized by the dominance of *Neogondolella constricta* and *Neogondolella nitiensis*.

CONODONT BIOSTRATIGRAPHY

Conodont biostratigraphic zones which characterize Griesbachian and Dienerian are already known (Sweet 1970a). During this investigation, conodont faunas characteristic of Smithian, Spathian, Early and Lower Anisian have been recorded from the area of study. All the conodont faunas known so far from the investigated sections are shown in Fig. 7.

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Smithian :

Neospathodus waageni zone : Biostratigraphic zone referable to *Neospathodus waageni* has been recognised in the Triassic section at Lam and is known from 9 samples from the lower 44 metres of the sequence of grey thin bedded Limestone. In the two samples ($LT._1$ & $LT._2$) from the basal part of this unit, *Neospathodus dieneri* is fairly abundant and is associated with *Neospathodus waageni* and *Neospathodus jhelumi*, n. sp. In the other 7 samples ($LT._3$, $LT._4$, $LT._6$, $LT._7$, $LT._{13}$, $LT._{15}$ and $LT._{16}$), the yield of conodonts is poor and specimens recovered are also not well preserved. The fauna includes the following biostratigraphically significant species : *Neospathodus waageni*, *Neospathodus discretus*, *Neospathodus* cf. *cristagalli*, *Neospathodus dieneri* and *Neogondolella elongata*. In twos amples ($LT._{18}$ & $LT._{19}$) collected 50 and 53 metres above the base of thin bedded limestone, conodont fauna is fragmentary and includes mostly denticle conodonts and few specimens of *Neospathodus dieneri* and *Neogondolella elongata*. On the basis of conodont evidence, Smithian age has been assigned to the Lower 53 metres of the sequence of thin bedded limestone in the Lam section.

Neospathodus waageni zone was also recognised by Nakazawa *et al.* (1975) from their Member H (*Meekoceras* beds of Middlemiss, 1909) of Khunamuh Formation in Guryul Ravine. During this investigation, this fauna is known from two samples (GR. 20 and GR. 21) from the middle part of alternating limestone and shale sequence above cliff forming limestone. In the *Neospathodus waageni* assemblage at Guryul Ravine, *Neospathodus dieneri* is fairly common. The following species are represented in the assemblage besides *Neospathodus waageni* and *Neospathodus dieneri : Neogondolella elongata*, *Neospathodus discretus*, *Neospathodus pakistanensis* and *Neospathodus srivastavai*, n. sp. Samples from cliff forming limestone in Guryul Ravine were searched for the presence of *Neospathodus pakistanensis* zone but none of the sample was found conodont productive. However, a few specimens referable ot *Neospathodus pakistanensis* were found in the *Neospathodus waageni* assemblage.

Sweet *et al.* (1971) established three zones within the temporal range of Smithian but these zones could not be recognised in the section of Lam and Guryul Ravine. In Lam Section some fragmentary material recovered in the present collection has been assigned to *Neospathodus* cf. *N. cristagalli*. It differs from the type material described by Sweet (1970b) from Salt Range and Kashmir (1970a) by its shorter length. It appears that *Neospathodus cristagalli* gives rise to *Neospathodus waageni* in overlying strata after shortening in length. Figured specimen (Pl. 1, fig. 9) may be transitional between *Neospathodus cristagalli* and *Neospathodus waageni*.

McTavish (1973) has also shown the presence of similar fauna from West Australian material. At present, Goel (1977) also reported *Neospathodus waageni* assemblage from the Khar Section in Spiti region.

The Microfauna of *Neospathodus waageni* yielding strata in Guryul Ravine, besides conodonts, also includes foraminifera, ostracoda, micro-fish remains and micro-

		LOCALITIES / CONODONT ZONATION	KASHMIR HIMALAYA						KUMAUN HIMALAYA
			GURYUL RAVINE	KHREUH	MANDAKPAL	PASTUN	LAM	NARASTAN	NITI PASS
ANISIAN	Bt	NE. NITIENSIS NE. CONSTRICTA							+
	Ag	NEOSPATHODUS TIMORENSIS		+		+		+	
SCYTHIAN	SPATHIAN	N.HOMERI–N.SPATHI	+	+	+		+		
		NEOGONDOLELLA JUBATA	+	+	+	+	+		
	SMITHIAN	NEOSPATHODUS WAAGENI	+				+		
	DIENERIAN	NEOSPATHODUS CRISTAGALLI	+						
		NEOSPATHODUS DIENERI	+						
	GRIESBACHIAN	NEOGONDOLELLA CARINATA	+						
		ANCHIGNATHODUS TYPICALIS	+						

Fig. 7

gastropods. Foraminifera and ostracoda are poorly preserved. Two genera namely *Ammodiscus* and *Nodosaria* represent foraminifera and ostracodes are referable to genera such as *Bairdia*, *Monoceratina*, and *Hungarella*.

Spathian

Neogondolella jubata zone : *Neogondolella jubata* zone which characterizes all but uppermost part of Narmia Member of Mianwali Formation in Pakistan is known from the localities of Guryul Ravine, Khreuh, Mandakpal, Pastun and Lam. It has been observed during this study that frequency of conodonts is maximum (500 per kg) in strata yielding *Neogondolella jubata* fauna. The presence of this assemblage in the section of Khreuh and adjoining areas was stated by Sahni and Chhabra (1976) in a paper on microfish remains from the Triassic sections of Kashmir and Kumaun Himalaya.

Neogondolella jubata zone in Khreuh is known from eleven samples (Kh. 1-Kh. 11) and characterizes 55 metres thick sequence of gray coloured thin bedded limestones. In the assemblage 60 per cent of the total conodont elements are referable to *Neogondolella jubata* and *Neogondolella elongata*. Middlemiss (1910) named this lithologic unit as 'Barren limestone' and included it in Muschelkalk. On the basis of *Neogondolella jubata* assemblage, Spathian age has now been assigned to this unit.

In Mandakpal, *Neogondolella jubata* zone is known from 6 samples (M.16, M.18, M.19, M.20, M.21 & M.25) representing gray limestones with subordinate shales, the uppermost part of which is characterised by *Neospathodus homeri-Neospathodus spathi* assemblage. In Guryul Ravine, *Neogondolella jubata* zone is known from three samples (GR. 23, GR. 24 and GR. 26) of which the lowest sample was collected from the uppermost part of alternating limestones and shales. Other two samples represent basal 5 metres of limestones with subordinate siliceous shales. In Lam, *Neogondolella jubata* fauna is known from only one sample (LT. 27), 20 metres below the top of grey coloured thin bedded limestone. In the investigated section of Pastun, three samples (PS. 26, PS. 27 and PS. 28) from the uppermost part of the litho-unit of alternating limestone and shale have yielded *Neogondolella jubata* zone fauna.

In *Neogondolella jubata* assemblage in Kashmir, the following species are represented besides *Neogondolella jubata* : *Neogondolella elongata*, *Neogondolella* sp. A. *Neogondolella* sp. B, *Neogondolella* sp. C., *Neospathodus homeri*, *Neospathodus triangularis*, *Neospathodus spathi*, *Neospathodus* sp. A, *Neospathodus* sp. B, and denticle conodonts referable to genera such as *Cypridodella*, *Enantiognathus*, *Diplododella*, *Hindeodella*, *Prioniodina* and *Ozarkodina*. It has been observed that *Neogondolella elongata* is morphologically close to *Neogondolella jubata* in this assemblage, the latter is represented by different growth as well as adult stages. *Neogondolella* sp. C is transitional form between *Neogondolella jubata* and *Neogondolella nitiensis*.

Neogondolella jubata yielding strata have also yielded

ostracodes, microgastropods and microfish remains in great abundance of which the last mentioned group of microfossils is well preserved and shows diversity. Ostracoda are poorly preserved and are represented by genera such as *Bairdia*, *Monoceratina*, *Hungarella*, *Microcheilinella*, *Bairdiacypris* and *Judahella*. Microgastropods in the Spathian assemblage are referable to *Pleurotomaria*, and *Euomphalus*. Some specimens have been assigned to Lophospirinae. The frequency of foraminiferal specimens is extremely low and are represented by *Ammodiscus*, *Glomospira* and *Nodosaria*.

Neospathodus homeri-Neospathodus spathi assemblage *zone* : This study has revealed that in four sections of Guryul Ravine, Khreuh, Mandakpal and Lam, the strata above *Neogondolella jubata* zone are characterized by conodont fauna in which *Neospathodus homeri* and *Neospathodus spathi* are dominant and are associated with *Neospathodus triangularis*, but *Neospathodus timorensis* and platform conodonts are unrepresented. About 60 per cent conodont elements are referable to *Neospathodus homeri*, *Neospathodus triangularis* and *Neospathodus spathi*. Rest of the material is represented by denticle conodonts. According to Chhabra (1977), this fauna may correspond to "Lower *homeri* Zone" of Bender (1968) from Late Scythian in Chios, Greece.

In the section of Khreuh, *Neospathodus homeri-Neospathodus spathi* zone is underlain by *Neogondolella jubata* zone and strata above the *Neospathodus homeri-Neospathodus spathi* zone are characterized by *Neospathodus timorensis* zone. It is known from eight samples (Kh. 12—Kh. 19) representing all but the lowest part of the sequence of alternating limestones and shales.

In the section of Guryul Ravine, two samples (GR. 29 and GR. 30) collected from 15 and 20 metres above the base of limestone with subordinate siliceous shales have yielded *Neospathodus homeri-Neospathodus spathi* fauna. A sample from the basal part of this unit has yielded *Neogondolella jubata* assemblage. In this section, the elements of *Neospathodus homeri* and *Neospathodus triangularis* are large in size in comparison to those in Khreuh.

In Mandakpal, this assemblage is known from one sample (M. 27) from the uppermost part of grey limestone with subordinate shales. In Lam, two samples (LT. 35 and LT. 36) from the lower 31 metres of sandy shales with intercalated limestone have revealed the presence of *Neospathodus homeri-Neospathodus spathi* assemblage. In both the sections at Mandakpal and Lam, *Neospathodus spathi* dominates in the fauna and is associated with *Neospathodus homeri* and large number of denticle conodonts. *Neospathodus homeri* is common in both the sections but none of the specimen referable to *Neospathodus triangularis* could be observed in the assemblage. In Lam, conodont fauna has revealed the presence of some material referable to *Neospathodus kedahensis* and *Hadrodontina-Pachycladina* group. It is worthy of mention that *Hadrodontina-Pachycladina* group characterizes the strata lying below the Scythian-Anisian boundary. On the basis of conodont fauna, the lower part of sandy shales with intercalated limestone in Lam Section has been assigned Spathian age. Earlier, Middlemiss (1910) included this litho-unit in Middle Triassic.

In Lam, conodont fauna is associated with Ostracoda, foraminifera, microfish remains and microgastropods. Ostracoda are represented by *Monoceratina* and *Bairdia*. *oraminifera* are represented by *Nodosaria*.

Anisian :

Neospathodus timorensis zone : *Neospathodus timorensis* zone is known from three sections of Khreuh, Pastun and Narastan. At Khreuh, *Neospathodus timorensis* fauna is known from five samples (Kh. 20—Kh. 24) representing all but lower 11 metres of Nodular limestone. *Neospathodus timorensis* first appears in sample Kh. 20 obtained 11 metres above the base of Nodular limestone. In three samples (Kh. 20-Kh. 22), *Neospathodus timorensis* is associated with *Neospathodus triangularis*, *Neospathodus spathi*, *Neospathodus homeri* and denticle conodonts. *Neospathodus timorensis* is represented by growth stages as well as adult stages. In two samples (Kh. 23 and Kh. 24) from the upper part of Nodular limestone, *Neospathodus homeri* is the only other species of genus *Neospathodus* represented in the assemblage. Some specimens are transitional between *Neospathodus timorensis* and *Neospathodus homeri* (Pl. 1, fig. 43). All through the *Neospathodus timorensis* zone in Khreuh, *Ozarkodina tortilis* is nearly abundant.

In Pastun section, *Neospathodus timorensis* fauna is known from four samples (PS. 41, PS. 46, PS. 47, PS. 38) from Nodular Limestone. In these samples *Neospathodus homeri* is represented in the assemblage and most of the material referable to *Neospathodus timorensis* represents the adult stages of growth with well developed mid-lateral ribs. In the microfauna besides conodonts, large number of ostracodes, fish teeth and placoid scales are also present. In one sample (PS. 36), the material of *Neospathodus* is fragmentary but resembles *Neospathodus timorensis* and has been assigned to *Neospathodus* cf. *timorensis*. In Narastan section, *Neospathodus timorensis* fauna is known from two samples (N. 16 & N. 17) that represent the top of thin bedded limestone.

Neospathodus timorensis was erected by Nogami (1968) from the Late Scythian material of Portuguese Timor, Malaysia. He considered it to characteristic of Late Scythian or it may extend in to Early Anisian. The material closely resembling *Neospathodus timorensis* has been described by Bender (1968) as *Spathognathodus gondolelloides* from the Upper part of Lower Anisian in Chios, Greece. The problem of priority between *Neo-*

spathodus timorensis (Nogami) and *Neospathodus gondolelloides* (Bender) has been discussed by Sweet (1970 b), McTavish (1973) and Nicora (1977). They accept the priority of *Neospathodus timorensis* (Nogami) and consider *Neospathodus gondolelloides* (Bender) as junior synonym.

Regarding the temporal range of *Neospathodus timorensis* Sweet *et al.*, (1971), McTavish (1973) and Kozur and Mostler (1972) favour Spathian age. Nicora (1977) and Budurov (Pers. Com.) consider *Neospathodus timorensis* as characteristic of Aegean Substage.

In Kashmir material, the age of the *Neospathodus timorensis* fauna is Early Anisian for the reason that *Neospathodus timorensis* yielding Nodular limestone in its uppermost part grades into earthy red limestone (*Gymnites* beds of Middlemiss, 1910) which yields Lower Anisian ammonoid fauna. Authors are of opinion that all the sequence below *Neospathodus timorensis* zone is certainly Scythian in age. The Scythian-Anisian boundary is suggested at the base of *Neospathodus timorensis* zone. This is in agreement with the opinion of Nicora (1977) who studied *Neospathodus timorensis* fauna from Chios and Nevada. According to him, *Neospathodus timorensis* makes its appearance at the base of Anisian and characterizes the lower part of the Aegean Substage of Assereto (1974).

KUMAUN HIMALAYA :

Recently authors examined some additional and earlier described material by Misra *et al.*, (1973) from the Middle Triassic sequence near Niti Pass. It has been observed that in the conodont fauna from Niti limestone, two taxa referable to *Neogondolella constricta* and *Neogondolella nitiensis* predominate over other platform conodonts. The following taxa are represented in the assemblage besides above mentioned two species :

Neogondolella jangpangii, *Neogondolella* cf. *Neogondolella mombergensis*, *Neogondolella* cf. *Neogondolella cornuta*, *Neogondolella* sp., *Paragondolella excelsa*, and *Paragondolella* cf. *Paragondolella bulgarica*. Recently Budurov has examined the Niti material and favours Upper Bithynian to Early Pelsonian age for Niti limestone which yields this fauna.

Recently two species *Neogondolella nitiensis* and *Neogondolella jangpangii* proposed by Misra *et al.* (1973) were discussed in the Workshop meeting of Triassic conodont Specialists (IGCP, Project no. 4, "The Triassic of the Tethys Realm") in November, 1979 at Budapest, Hungary. Present authors are of opinion that these two forms are different from *Neogondolella regale* which was founded by Mosher (1970) from the Lower Anisian material of British Columbia and Nevada.

Sahni and Chhabra (1974) described conodont fauna from Kalapani Limestone of Sumna area, Malla Johar region and suggested Upper Anisian age. Additional material has revealed that *Neogondolella constricta* is dominant form in assemblage. According to authors of this paper, conodont fauna includes following forms besides *Neogondolella constricta : Neogondolella nitiensis*, *Neogondolella* cf. *Neogondolella mombergensis*, *Neogondolella* sp., *Paragondolella bulgarica*, *Paragondolella excelsa*, *Paragondolella navicula navicula*. Conodont fauna indicates Bithynian to Early Palsonian age for Kalapani limestone developed in Sumna area in Malla Johar.

In the microfauna of Niti material, conodonts are associated with ostracoda, foraminifera, microfish remains, microgastropods, microbryozoans and echinoid spines. Foraminifera are moderate to poorly preserved and are represented by *Ammodiscus*, *Ammodiscoides*, *Spirillina*, *Lituotuba*, *Glomospira* and *Glomospirella*. Ostracodes in the Niti material are referable to genera such as *Bairdia*, *Monoceratina*, *Hungarella* and *Judahella*. A few specimens representing bryozoans in the microfauna have been assigned to genus *Archimedes*.

The following is the list of stratigraphically useful conodont species in the Triassic material of Kashmir and Kumaun Himalaya :

Blade-like Conodonts

1. *Neospathodus dieneri* Sweet
2. *Neospathodus waageni* Sweet
3. *Neospathodus discretus* (Müller)
4. *Neospathodus* cf. *N. cristagalli* (Huckriede)
5. *Neospathodus triangularis* (Bender)
6. *Neospathodus homeri* (Bender)
7. *Neospathodus spathi* Sweet
8. *Neospathodus timorensis* (Nogami)
9. *Neospathodus Srivastavai*, n. sp.
10. *Neospathodus jhelumi*, n. sp.
11. *Neospathodus kedahensis* Koike
12. *Neospathodus* sp. *A*
13. *Neospathodus* sp. *B*

Platform Conodonts

1. *Neogondolella elongata* Sweet
2. *Neogondolella jubata* Sweet
3. *Neogondolella constricta* (Mosher & Clark)
4. *Neogondolella nitiensis* (Misra, Sahni & Chhabra)
5. *Neogondolella* cf. *N. mombergensis* (Tatge)
6. *Neogondolella* cf. *N. cornuta* Budurov & Stefanov
7. *Neogondolella jangpangii* (Misra, Sahni and Chhabra)
8. *Neogondolella* sp. A.
9. *Neogondolella* sp. B.
10. *Neogondolella* sp. C.
11. *Neogondolella* sp. transitional to *Paragondolella bulgarica* Budurov & Stefanov.
12. *Neogondolella* sp.
13. *Paragondolella excelsa* Mosher
14. *Paragondolella* cf. *Paragondolella bulgarica* Budurov & Stefanov

SYSTEMATIC PALAEONTOLOGY

Platform Conodonts

Genus *Neogondolella* BENDER & STOPPEL, 1965

Type species *Gondolella mombergensis* TATGE

Neogondolella sp. A

(Pl. II—9 A, B)

There are three incomplete specimens which are morphologically far removed from other contemporary specimens of *Neogondolella*. These have been here designated as *Neogondolella* sp. A. The specimens are characterized by an extremely robust platform with stout platform laterals. The width of the platform is relatively greater than other known species of *Neogondolella*. In lateral view, a low carina composed of about seven to eight denticles can be made out. There is no apparent tendency for increase in the height of the denticles either anteriorly or posteriorly. The cusp is well separated from the other denticles of the carina and is conical and triangular in shape. Another unique characteristic is the rather wide basal keel which occupies most of the aboral surface.

All the three specimens have been recovered from *Neogondolella jubata* assemblage at Mandakpal. At present no specific taxonomic identification can be made because of the inadequate nature of the material.

Repository : Figured specimens LUGD 21225, Geology Department Lucknow Univeristy, Lucknow.

Neogondolella sp. B

(Pl. II—6A, B)

The figured specimen LUGD 21226 is a rather large, broad specimen possessing a rather low carina. In these features it resembles *Neogondolella* sp. A but differs from other species in having a platform with broad elevations and depressions, giving a rather uneven or "lumpy" appearance. It is possible that these swellings on the platform reflect an abarrent type of growth. This species is represented in *Neogondolella jubata* assemblage known froms sample (Kh. 4) in the section of Khreuh.

Repository : Figured specimen LUGD 21226 Geology Department, Lucknow University.

Neogondolella sp. C

(Pl. II—2, 3)

In sharp contrast to other forms in the *Neogondolella jubata* assemblage which have a relatively low carina, the specimen LUGD 21227, the soler epresentative in the present collection has a high carina. The carina is relatively higher anteriorly, decreasing only slightly in height posteriorly. The cusp is separated from the anterior denticles and constitutes the lowest denticle in the carina. In this trait, it resembles *Neogondolella nitiensis* which is a Middle Triassic form. However, the character of platform and carina at anterior and central part bear a close resemblance to *Neogondolella jubata*. This form may be transitional between *Neogondolella jubata*. and *Neogondolella nitiensis*.

Occurrence : This species occurs in a sample (M.21) in the *Neogondolella jubata* assemblage at Mandakpal.

Repository : Figured specimen LUGD 21227, Geology Department, Lucknow University.

Genus *Neospathodus* MOSHER, 1968

Type species *Neospathodus cristagalli* (HUCKRIEDE)

Neospathodus sp. A

(Pl. I—21A, B)

In the *Neogondolella jubata* assemblage at Khreuh, there are a few large sized specimens in which width to height to length ratio is close to that of *Neospathodus homeri*. Representative of these is LUGD 22026, which differs from the adult stages of *Neospathodus homeri* by possessing a terminal position of the cusp and by the character of the anterior denticles that do not show progressive decrease in size anteriorly. In the figured specimen (LUGD 22026), the basal edge is straight in the anterior two third part but is downcurved in the posterior third. Twelve laterally compressed, reclined and high denticles are present on the upper edge. These denticles are not uniform in thickness but are discrete in the upper one third of their height. The shortest denticle is located at the anterior end. The cusp is terminal with a rounded apex and is slightly thicker than the second posterior denticle. A prominent mid-lateral rib is developed parallel to the basal edge, but it does not develop into a true platform. A flaring pit is located in the posterior half of the specimen. The basal pit joins a narrow groove at a point below the sixth denticle.

Occurrence : *Neospathodus* sp. A occurs in a sample (Kh. 4) in the lower part of the grey limestone exposed in a cliff at Khreuh.

Repository : Figureds pecimen LUGD 22026 and three unnumbered specimens, Geology Department, Lucknow University.

Neospathodus sp. B

(Pl. I—22 A, B)

This species is represented by only three specimens in the *Neogondolella jubata* assemblage at Mandakpal. This species is close to *Neospathodus triangularis* in dimensional ratios, character of cusp and anterior denticles. However, *Neospathodus* sp. B differs from *Neospathodus triangularis* by the nature of basal pit which in the present species is characterized by a prominent constriction laterally and slightly anterior to the cusp. The anterior extremity of the basal pit gives a 'V' shaped appearance.

Neospathodus sp. B is associated with *Neospathodus triangularis*, *Neospathodus spathi*, *Neospathodus homeri*, *Neogondolella jubata* and *Neogondolella elongata*.

Neospathodus srivastavai, sp. nov.
(Pl. I—30)

Derivation of Name : This species is named after Sri J. P. Srivastava, Director, Geological Survey of India and discoverer of conodonts from India.

Holotype : LUGD 22029

Diagnosis and description : This species is characterized by blade-like skeletal elements with 5-8 moderately high and discrete denticles, the apices of which are broken. The holotype (LUGD 22029) shows nearly straight basal margin up to the anterior two third and is slightly upcurved just below the second posterior denticle and again becomes straight. Specimen (LUGD 22029) shows six discrete, slightly reclined denticles of which the cusp is terminal, stout, expanding towards the base. The apical portion of the cusp is broken. Second and third denticle from posterior are longer than cusp and are directed posteriorly. Fourth denticle from posterior is highest in the specimen and is posteriorly erect. Anterior to this denticle, the size of two denticles decreases and are nearly erect. The ratio of width to height to length in the holotype is 1 : 2 : 3.4. In holotype and other specimens (Paratype LUGD 22029/A and LUGD 22029/B) terminal, moderately flaring basal pit is present in the posterior one third.

Discussion : *Neospathodus srivastavai* somewhat resembles *Neospathodus cristagalli* in general appearance but can be distinguished from it by dimensional ratios, less robust cusp and discrete nature of denticles throughout their length. In comparison to the material of *Neospathodus cristagalli* described by Sweet (1970a, b) from Kashmir and Pakistan, the length and height is reduced in *Neospathodus srivastavai*. This species is associated with *Neospathodus waageni* in Smithian in Kashmir. It might have evolved from *Neospathodus cristagalli* which characterizes the strata underlying *Neospathodus waageni* zone.

Occurrence : This species occurs in a sample GR. 21 in Guryul Ravine section where it is associated with *Neospathodus waageni*, *Neospathodus dieneri*, *Neospathodus discretus* and *Neogondolella elongata*.

Repository : Specimen LUGD 22029, holotype, L.U.G.D. 22029/A, LUGD 22029/B, Paratypes and four unnumbered specimens, Museum, Geology Department, Lucknow University.

Neospathodus jhelumi, sp. nov.
(Pl. I—5, 6)

Derivation of the name: This species is named after river Jhelum in Kashmir.

Holotype : LUGD 22003/A.

Diagnosis and description : This species is characterized by blade-like skeletal elements with 6-9 short, slender and discrete denticles. The holotype specimen LUGD 22003/A shows basal margin which is nearly straight in the anterior half and strongly flaring and down curved in the posterior half of the specimen. In LUGD 22003/A, 8 short, slender denticles are present which are discrete in upper part. Cusp is terminal, posteriorly directed, slightly higher and thicker than other denticles and it expands towards the base. Anterior to the cusp, three denticles are directed posteriorly and four anterior denticles are posteriorly erect. In holotype, the basal margin at the posterior extremity is projected beyond the cusp and forms a concave outline at the posterior extremity. In paratype, LUGD 22003, the basal margin is straight in the anterior two third and it slightly upcurves from the point just below the second posterior denticle. In paratype, LUGD 22003 also, the cusp is terminal, slightly stout and higher than other denticles. Anterior to the cusp, six partly discrete, posteriorly directed denticles are present which decrease in height slightly towards the anterior. In specimen LUGD 22003, moderately flaring basal pit is present in the posterior one third. A prominent mid lateral rib and groove is present in holotype and other specimens.

Discussions : *Neospathodus jhelumi* can be distinguished from *Neospathodus dieneri* by dimensional ratios. The specimens referable to *Neospathodus jhelumi* are more elongated and reduced in height in comparison to those of *Neospathodus dieneri*. The species of *Neosopathodus jhelumi* differs significantly from *Neospathodus bransoni* described by Müller (1956) from Upper Scythian in Nevada, U.S.A. by the character of cusp which is smaller and less robust in the present material.

Occurrence : *Neospathodus jhelumi* occurs in samples $LT._1$ and $LT._2$ in the basal part of Lam Section where it is associated with *Neospathodus dieneri* and *Neospathodus waageni*.

Repository : The figured specimen LUGD 22003/A, holotype, LUGD 22003, Paratype and seven unnumbered specimens, Museum, Geology Department, Lucknow University.

SUMMARY AND CONCLUSION

Present study reveals that conodont biostratigraphic zonation proposed by Sweet (1970b) and Sweet *et al.*, (1971) is broadly applicable and useful in regional and inter-continental correlation. But zone referable to *Neospathodus pakistanensis* could not be recognised in section of Guryul Ravine or any other section in Kashmir. An assemblage of *Neospathodus homeri-Neospathodus spathi* has been recognised in between the zones of *Neogondolella jubata* and *Neospathodus timorensis*. It may correspond to 'Lower *homeri* zone' of Bender (1968) from the Upper Scythian material of Chios, Greece.

The assemblage of *Neospathodus waageni* which characterizes Smithian is represented in the Triassic sections at Lam and Guryul Ravine. *Neospathodus waageni* yielding

strata in Kashmir may be biostratigraphically equivalent to upper part of Mittiwali Member of Mianwali Formation in Salt Range, Pakistan. Spathian assemblage referable to *Neogondolella jubata* is known from Guryul Ravine, Khreuh, Mandakpal, Pastun and Lam. A correlation with all but the topmost part of Narmia Member of Mianwali Formation, has been suggested for *Neogondolella jubata* yielding strata in Kashmir.

Neospathodus timorensis fauna has been recognised from Khreuh, Pastun and Narastan sections. The strata yielding this fauna have been included into Anisian as the uppermost part of Nodular limestone grades into earthy red limestone (*Gymnites* beds of Middlemiss, 1910) which is characterized by Lower Anisian ammonoid fauna. In Kashmir, the boundary between Lower and Middle Triassic has been suggested at the base of *Neospathodus timorensis* assemblage.

In Kashmir material, *Neospathodus spathi*, *Neospathodus homeri*, *Neospathodus triangularis* range from the base of Spathian to Early Anisian. These three species are represented in assemblages of *Neogondolella jubata*, *Neospathodus-homeri-Neospathodus spathi* and *Neospathodus timorensis* in Kashmir. The upper range of *Neospathodus, pakistanensis* may be into Smithian.

In the conodont fauna at Niti Pass, two species referable to *Neogondolella constricta* and *Neogondolella nitiensis* predominate over other platform conodonts in the fauna. Upper Bithynian to Early Pelsonian age is suggested for Niti limestone.

Biostratigraphic significance of recovered ostracoda and foraminifera could not be worked out as the material is poorly preserved, inadequate and at present identification is possible only up to genus level.

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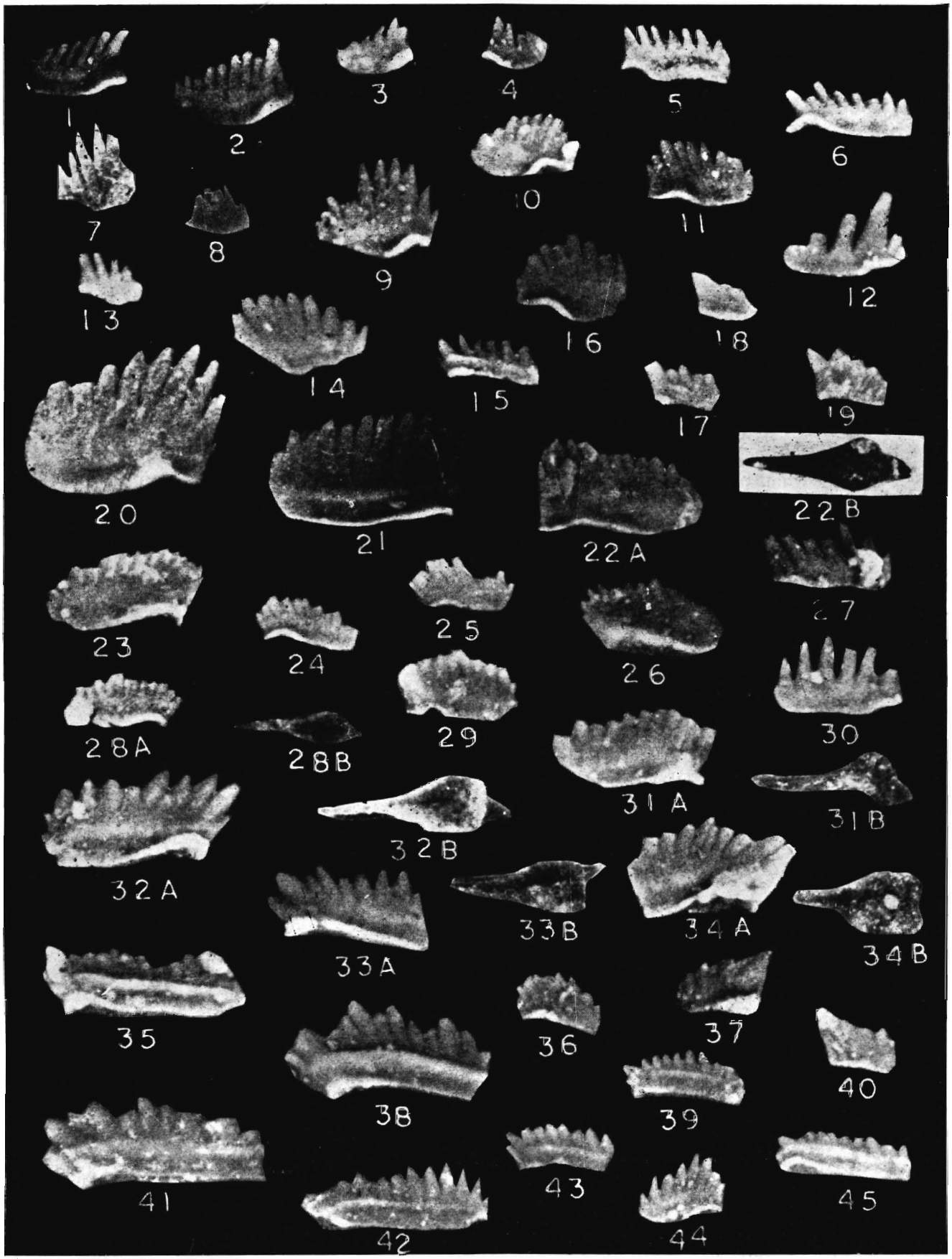
EXPLANATION OF PLATES

PLATE I

(All figures ×60)

1-4 & 13.	*Neospathodus dieneri* Sweet, 1. LUGD 220001, 2. LUGD 22002, 3. LUGD 22005, 4. LUGD 22004 & 13. LUGD 22006
5& 6	*Neospathodus jhelumi* sp. nov., 6. LUGD 22003/A, Holotype, 5. LUGD 22003, Paratype.
7 & 8.	*Neospathodus* cf. *N. cristagalli* (Huckriede), 7. LUGD 22008, 8. LUGD 22007.
9,10,14, 16 & 20.	*Neospathodus waageni* Sweet, 9. LUGD 22001, 10. LUGD 22014, 14. LUGD 22010, 16. LUGD 22013, 20. LUGD 22009.
11	*Neospathodus pakistanensis* Sweet, LUGD 22011.
12	*Neospathodus discretus* (Müller), LUGD 22015
15 & 17	*Neospathodus spathi* Sweet, 15. LUGD 220245, 17. LUGD 22030, adult stages.
18, 19, 37 & 40	*Neospathodus spathi* Sweet, 18. LUGD 22033, 19. LUGD 22032, & 37. LUGD 22042, growth stages, 40. LUGD 22031.
21	*Neospathodus* sp. A, LUGD 22026.
22 A, B.	*Neospathodus* sp. B., A. Side view, B. basal view, LUGD 22027.
23	*Neospathodus triangularis* (Bender), LUGD 22018
24,25	*Neospathodus homeri* (Bender), 24. LUGD 22024, 25. LUGD 22023
26	*Neospathodus triangularis* (Bender), LUGD 22017
27, 30	*Neospathodus srivastavai* sp. nov., 27. LUGD 22029, Holotype, 30. LUGD 22028, Paratype.
28A,B.	*Neospathodus homeri* (Bender), A. Side view, B. basal view, LUGD 22021.
29.	*Neospathodus triangularis* (Bender), LUGD 22020/A.
31A, B.	*Neospathodus triangularis* (Bender), A. Side view, B. basal view, LUGD 22020.
32A, B.	*Neospathodus triangularis* (Bender), A. side view, B. basal view, LUGD 22022.
33 A, B.	*Neospathodus homeri* (Bender), A. side view, B. basal view, LUGD 22016.
34 A, B.	*Neospathodus triangularis* (Bender), A. Side xiew, B. basal view, LUGD 22016.
35, 38	*Neospathodus timorensis* (Nogami), 35. LUGD 22034, 38. Platform developed as in *Neogondolella*. LUGD 22037,
36	*Ozarkodina* sp. LUGD 22043
39	*Neospathodus timorensis* (Nogami), LUGD 22039, growth stage
41	*Neospathodus timorensis* (Nogami), LUGD 22035, adult stage
42, 43	*Neospathodus timorensis* (Nogami), 42. LUGD 22036, 43. LUGD 22040, leary growth stages.
44	*Neospathodus kedahensis* Koike, LUGD 22046
46	*Neospathodus timorensis* (Nogami), 45. LUGD 22041, intermediate growth stage.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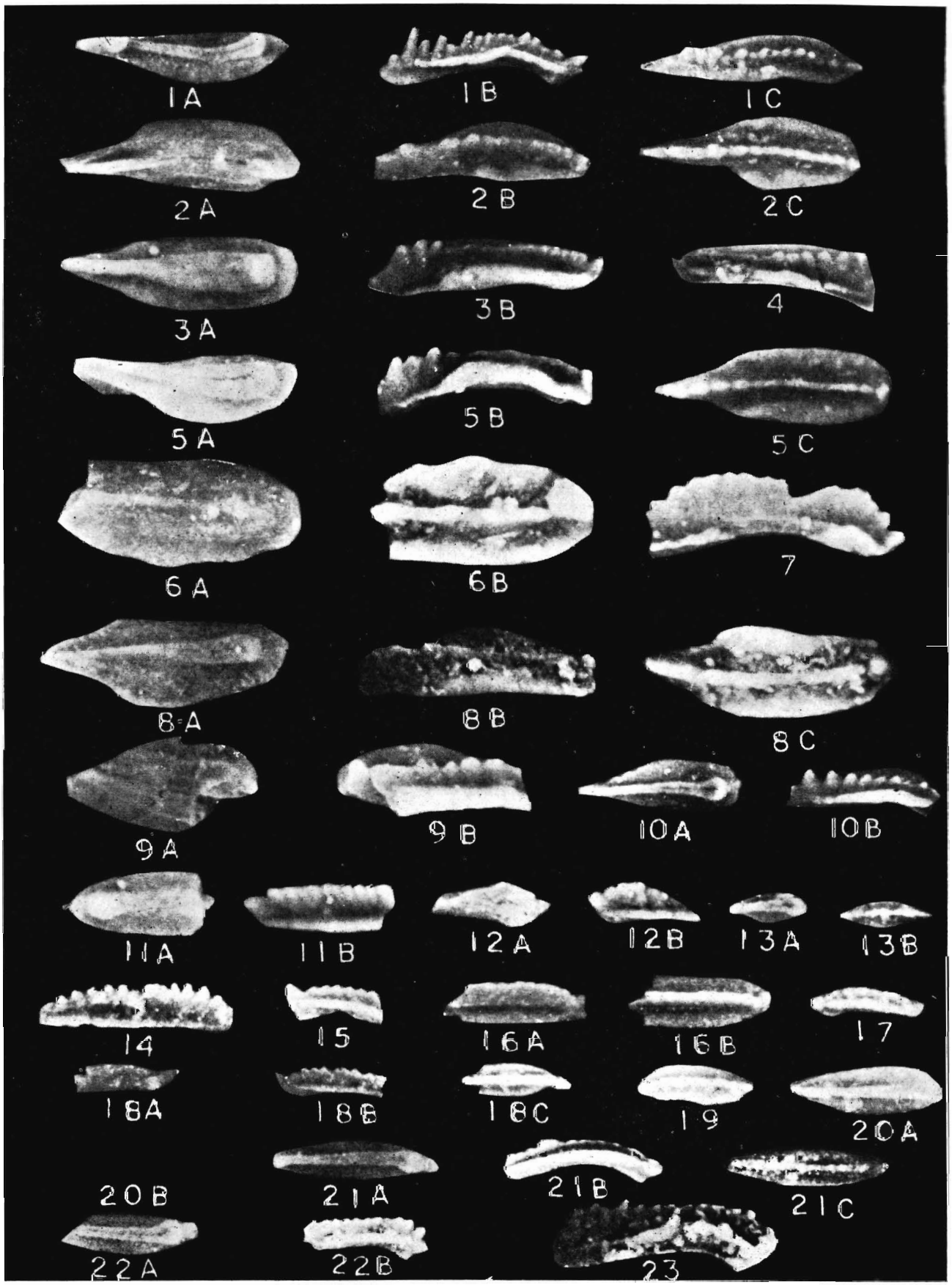
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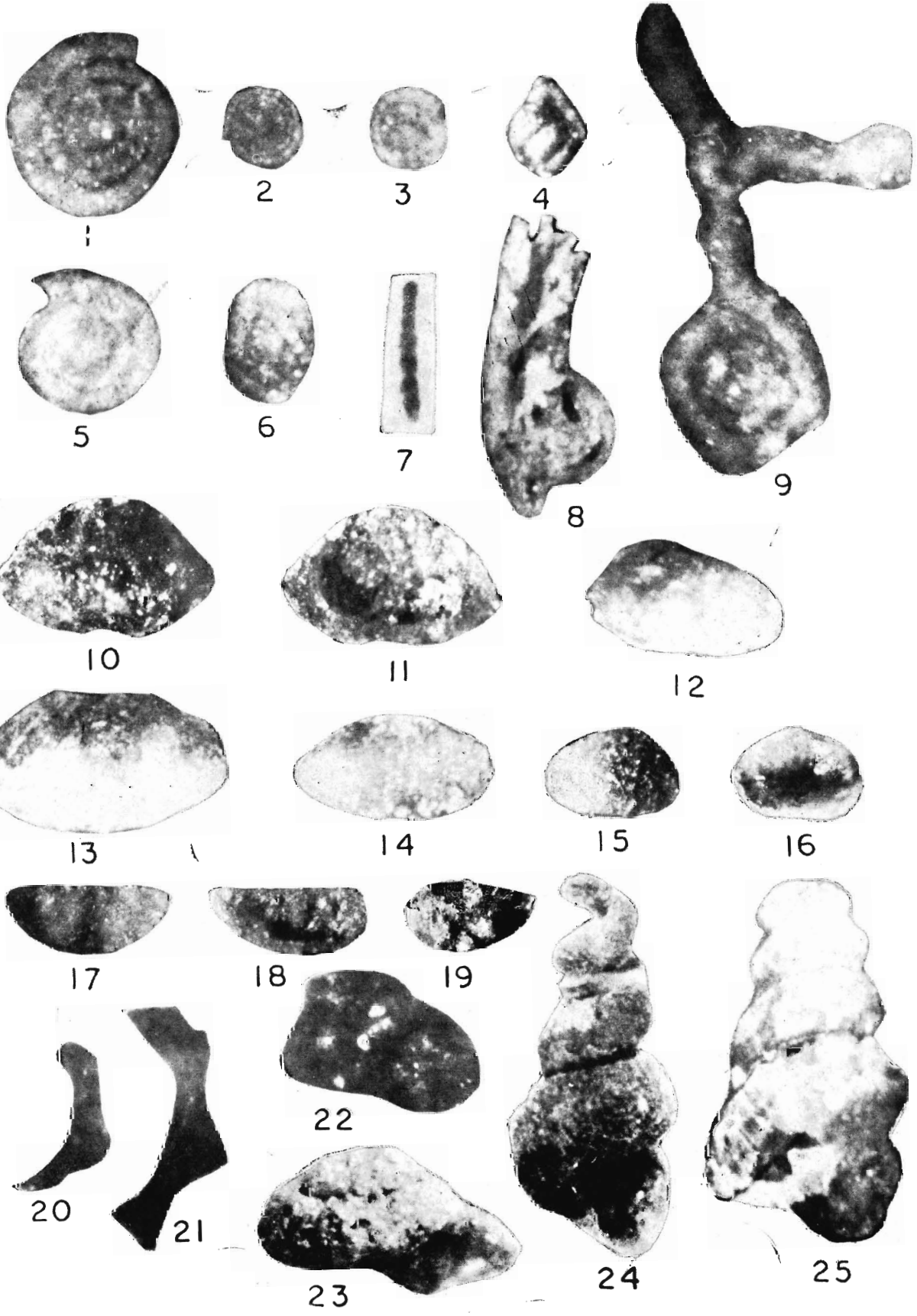
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PLATE II

(All figures ×60)

1 A,B,C. *Neogondolella elongata* Sweet, A. basal view, B. lateral view, C. oral view, LUGD 21215.
2 A, B, C. *Neogondolella elongata* Sweet, A. basal view, B. Lateral view, C. oral view, LUGD 21216
3 A, B. *Neogondolella jubata* Sweet, A. basal view, B. Oblique oral view, LUGD 21220.
4 *Neogondolella jubata* Sweet, Oblique oral view, LUGD 21221.
5 A,B,C. *Neogondolella elongata* Sweet, A. basal view, B. lateral view, C. oral view, LUGD 21217.
6 A, B. *Neogondolella* sp. B., A. basal view, B. Oral view, LUGD 21226.
7. *Neogondolella* sp. C., lateral view, LUGD 21227.
8A, B, C. *Neogondolella jubata* Sweet, A. basal view, B. oblique oral view, C. oral view, LUGD 21223.
9 A,B. *Neogondolella* sp. A., A. basal view, B. oblique oral view, LUGD 21221.
10, A, B. *Neogondolella jubata* Sweet, A. basal view, B. oblique oral view, LUGD 21219
11 A, B. *Neogondolella* cf. *N. cornuta* Budurov & Stefanov, A. basal view, B. lateral view, LUGD 21201.
12, A, B. *Neogondolella* sp., A. basal view, B. lateral view, LUGD 21202.
13 A, B. *Neogondolella jubata* Sweet, A. basal view, B. Oral view, growth stage, LUGD 21222
14. *Paragondolella excelsa* Mosher, lateral view, LUGD 21101/B.
15 *Neogondolella nitiensis* Misra, Sahni & Chhabra, lateral view, LUGD 21095/C
16, A, B. *Neogondolella* sp., A. Lateral view, B. oral view, LUGD 21120.
17 *Neogondolella* cf. *N. constricta* (Mosher & Clark), lateral view LUGD 21205.
18 A, B, C. *Neogondolella constricta* (Mosher & Clark), A. basal view, B. lateral view, C. oral view, LUGD 21206
19 *Neogondolella constricta* (Mosher & Clark), Oral view, LUGD 21206
20 *Neogondolella jangpangii* Misra, Sahni and Chhabra A. basal view. B. oblique oral vew, LUGD, 21100/C
21A,B,C, *Neogondollella constricta* (Mosher & Clark), A. basal view. B. lateral view, C. Oral view, LUGD 21097
22A, B. *Neogondolella constricta* (Mosher & Clark), A. basal view, B. lateral view, LUGD 21207.
23 Transitional to *Paragondolella bulgarica* Budurov & Stefanov, lateral view, LUGD 21209.

PLATE III

(Figs 1-9 ×90, Figs. 10-25 ×60)

1. *Ammodiscus*, Side view, LUGD 25001
2. *Ammodiscus*, side view, LUGD 25002.
3. *Ammodiscus*, side view, LUGD 25003.
4. *Glomospira*, side view, LUGD 25005
5. *Ammodiscus*, side view, LUGD 25004
6. *Glomospira*, side view, LUGD 25006.
7. *Nodosaria*, side view, LUGD 25007.
8. *Lituotuba*, side view, LUGD 25008.
9. *Lituotuba*, side view, LUGD 25009
10,11 *Bairdia*, 10. external view, 11. internal view, LUGD 26001.
12. *Bairdia*, external view, LUGD 26002
13 *Hungarella*, external view, LUGD 26003
14 *Hungarella*, external view, LUGD 26004.
15, 16 *Hungarella*, 15. external view, 16. internal view, LUGD 26005.
17, 18 *Monoceratina*, 17. external view, 18. internal view, LUGD 26006.
19. *Judahella*, external view, LUGD, 26607.
20,21 *Archimedes*, microbryozoan remain, 20. LUGD 27050, 21. LUGD 27051
22,23 *Pleurotomaria*, 22.. LUGD 28001, 23. LUGD 28002.
24, 25 Lophospirinae, 24. LUGD 28003, 25. LUGD 28004.