MEMOIRS OF THE FACULTY OF SCIENCE, KYOTO UNIVERSITY, SERIES OF GEOL. & MINERAL.
VOL. XXXVII, No.2, pp.163-172, December 20, 1970

Preliminary Report on the Permo-Trias of Kashmir*

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(Received August 24, 1970)

Abstract

A team of Japanese and Indian Geologists carried out detailed studies of the Permo-Triassic sections in the Srinagar region, Kashmir, during 1969. This report embodies certain conclusions arrived at in the light of these studies. The section at Guryul Ravine is described in detail, being the best in the Srinagar region. Lithological and faunistic comparisons with other areas examined are also referred to. The different faunistic zones of the Lower Trias of this area are compared with other important extra-Indian occurrences.

The Zewan Series (Permian) at Guryul Ravine is succeeded by Lower Triassic beds. The arenaceous sediments pass into calcareous through argillaceous sediments. There is neither an intraformational nor interformational unconformity indicative of a hiatus in deposition. Many characteristic Permian elements survived in the lower part of the Lower Trias, constituting a zone of mixed fauna of Permo-Trias. This suggests a rapid faunal change from Permian to Lower Trias but not discontinuous. The lithology however supports a gradual change from Palaeozoic to Mesozoic.

The advent of Lower Trias is marked by the appearance of characteristic species like *Claraia stachei* (BITTNER), SPATH in the dark shales.

The paper also records a number of important Lower Triassic ammonoids (*Otoceras, Glyptophiceras*, etc.), which were so far not known from the Srinagar region. Considering the evolutionary position of some of the species of *Otoceras*, the boundary between the Permian and Trias is tentatively placed just below the advent of *Claraia stachei*.

Introduction

The marked changes in marine faunae at the Palaeozoic-Mesozoic boundary record one of the most conspicuous events in the biological evolution and have been the subject of considerable interest alike among geologists and palaeontologists.

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* The field survey for the present work was supported by the Japanese Ministry of Education (Tokyo) and the Geological Survey of India (Calcutta).

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Several reports on the subject, based on the observations made in the Salt Range (SCHINDEWOLF, 1954 a, b; KUMMEL and TEICHERT, 1966; TEICHERT; 1968), Kashmir (TEICHERT *et al.*, 1970), Armenian Dzhulfa (RUZHENTSEV *et al.*, 1965), Iranian Julfa (STEPANOV *et al.*, 1969), East Greenland (DEFRETIN-LEFRANC *et al.*, 1969), and other regions have been published. No agreement, however, has been arrived at so far on the mode and process of the biological extinctions at the Permo-Triassic boundary. Therefore, in order to come to some conclusion, it was considered necessary to make a detailed study of a region where fossil-bearing Permian and Triassic rocks were widely distributed and which represented a period of continuous deposition, without hiatus.

The authors selected the Srinagar region in Kashmir as a suitable area for the purpose. This fulfils the necessary conditions for execution of the project. A detailed study was accordingly carried out in the region by a team of nine members for nearly a month, from July to August, 1969.

Several reports are available on the Permian and Triassic formations of the Srinagar region (HAYDEN, 1907; MIDDLEMISS, 1909, 1910; DIENER, 1913). Among a number of Permian and Triassic localities, the exposures at Guryul Ravine and a spur 2 miles (3 km) north of Barus in Srinagar region, and Pahlgam area in the North Liddar Valley region were given a special attention.

This is a preliminary report on the foregoing studies. The faunal succession at Guryul Ravine is discussed in detail, as it seems to provide the best example in the region.

A brief study of the problem at Guryul Ravine was attempted by TEICHERT, KUMMEL and KAPOOR in 1968. They have reported their conclusions in a note entitled "Mixed Permian and Lower Triassic Fauna, Guryul Ravine, Kashmir" (TEICHRT *et al.*, 1970).

The present investigation records for the first time certain important Lower Triassic fossils, *viz.*, *Otoceras* and *Glyptophiceras* in Srinagar region. This report also dsecribes briefly the distribution of the marine fauna near the Permo-Triassic boundary.

Geological succession

As shown in Text-fig. 1, the Lower Gondwana beds, the Zewan Series and the Triassic beds lying conformably above the Panjal Trap, are exposed at Guryul Ravine, 10 km southeast of Srinagar, near Khunamuh village. Text-fig. 2 shows the geological column near the Permo-Triassic boundary.

The sequence near the Permo-Triassic junction consists of alternations of microsparitic limestone (originally micritic), calcareous sandstone and black shale. Calcareous sandstone with some black shaly interbands are predominant up to Bed 46b

in the lower part of the section, while Beds 47-51 comprise black sandy shale with discontinuous limestone layers. These are again followed by alternations of dark limestones and black shales varying in thickness from 5.70 to 6.50 metres (Bed 52a to 59b). The black shale tends to break along the bedding plane and weathers into light pale to cream colour. On account of these characters the earlier workers have described the black shale bed as a "fissile, black shale band" (MIDDLEMISS, 1909), "a band of dark shale weathering white" (HAYDEN, 1907) and flaggy shale (H.M. KAPOOR, in unpublished reports of Geological Survey of India). The limestone intercalations in this shale are usually continuous and vary from 10 to 30 cm in thickness, though in Bed 52a, a few discontinuous lenses are present.

The black shale is in turn, overlain by alternate layers of dark grey limestone and shale (from Bed 60 to the foot of cliff); limestones being predominant. The sequence from Bed 47 to the foot of the cliff (Bed 75) corresponds to the "Shale and Thin Bedded Limestone" unit of MIDDLEMISS (1909).

All the strata constitute a conformable sequence, there being no sign of a hiatus. Furthermore, there occurs a mixed fauna of the Palaeozoic and Mesozoic types in the boundary zone (Beds 47-52). The relation between the Permian and Triassic beds in Guryul Ravine is, therefore, undoubtedly conformable. The boundary zone corresponds to the lowermost part of the "Shale and Thin-bedded Limestone" unit of MIDDLEMISS (1909) and "Argillaceous Limestone" of TEICHERT *et al.* (1970).

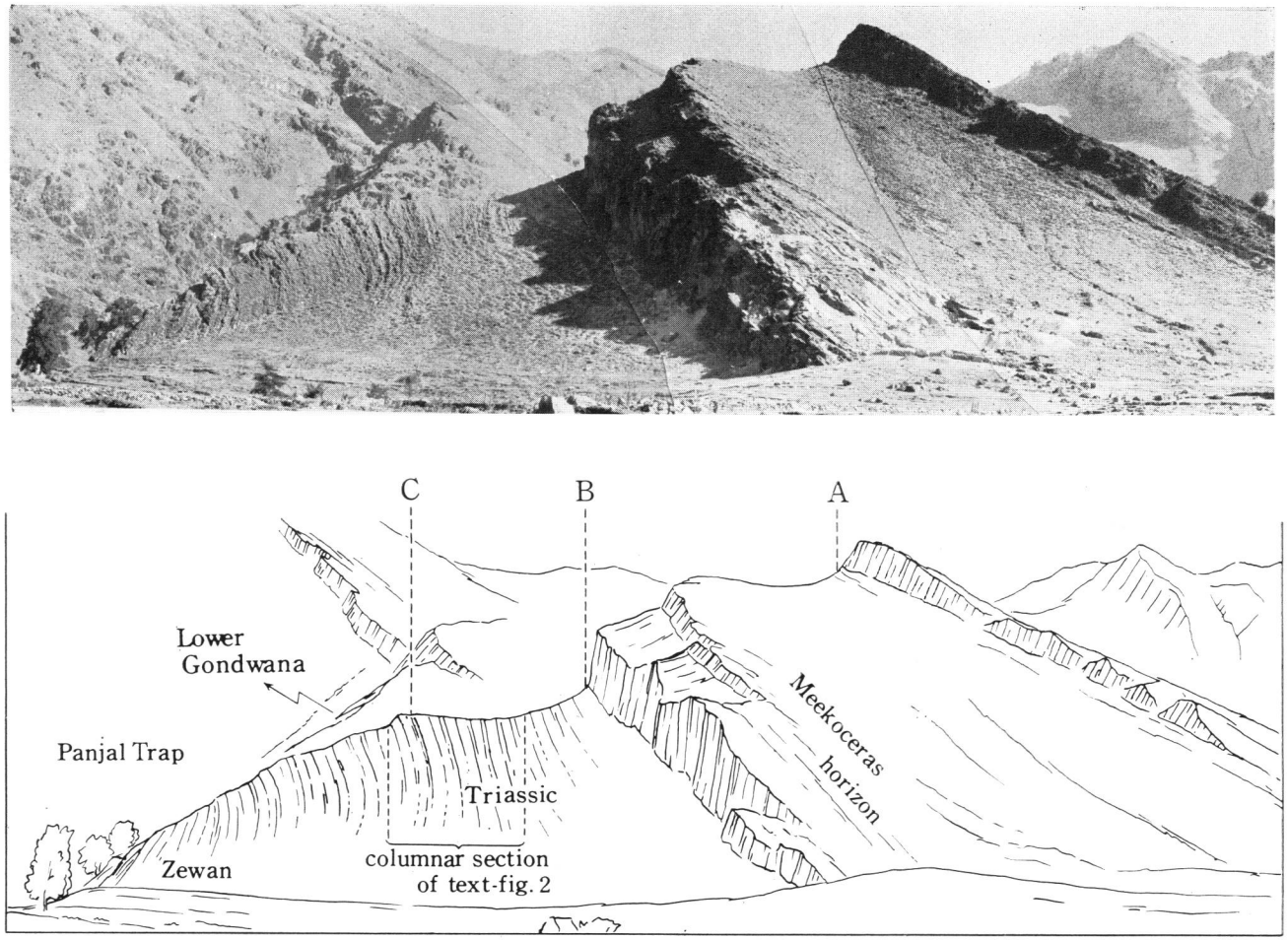
The upper part of the "Sandy Shales" unit of MIDDLEMISS below the "Shale and Thin-bedded Limestone" unit, comprises calcareous sandstones, as pointed out by TEICHERT *et al.* (1970). The "Bivalve Coquina" horizon assigned by TEICHERT *et al.* (1970, fig. 1-B) corresponds to Bed 47a of the present work, and their "Argillaceous Limestones" to 47b-51 (black shale with limestone and calcareous sandstone), which underlies the flaggy shale.

Marine fauna of Permian and Trias near boundary zone

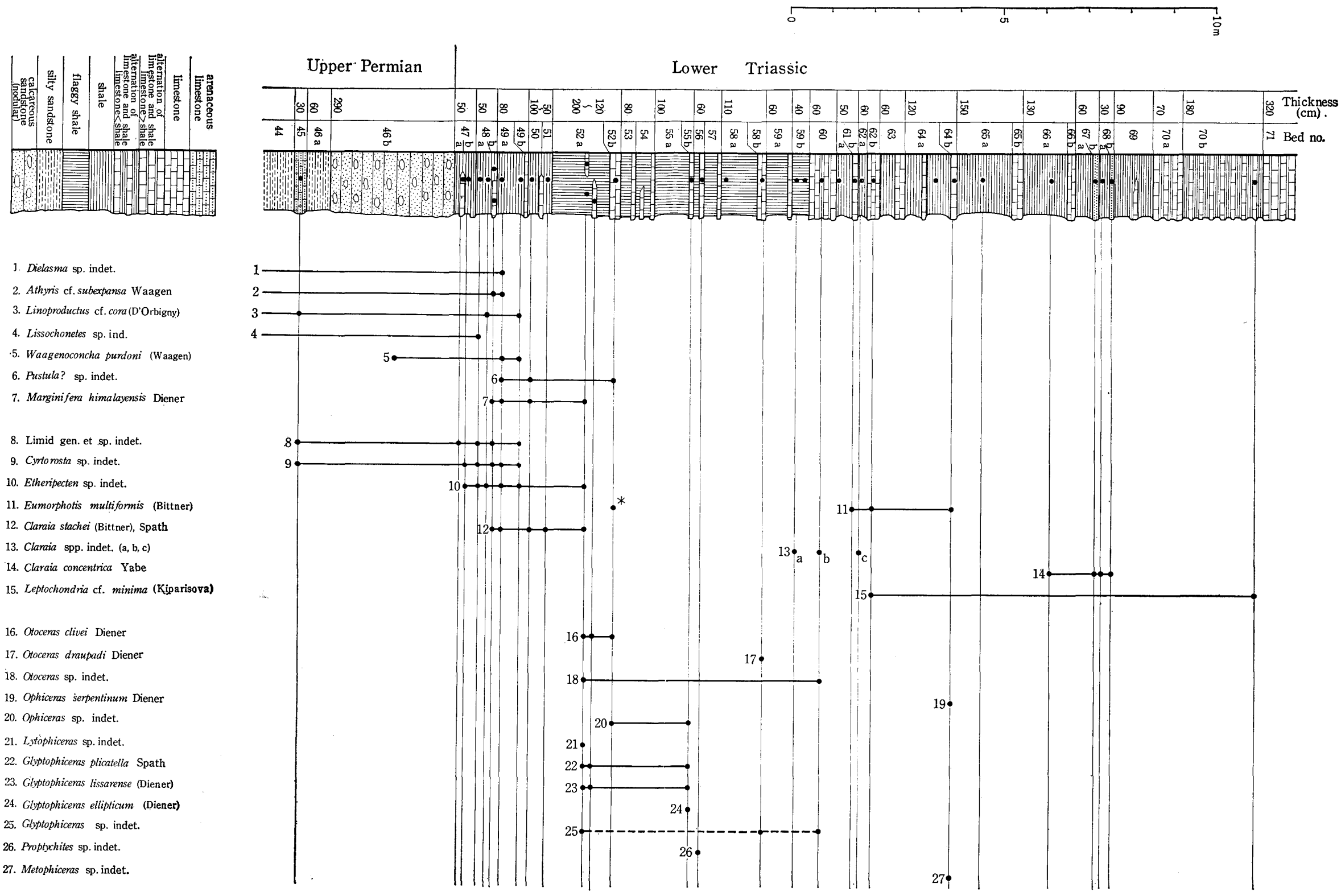
Invertebrate fossils occur profusely in almost all the beds of Zewan Series (Permian) and the Trias. These include mainly brachiopods, bryozoans, ammonoids and bivalves. The brachiopods and bryozoans occur in the lower part of the section, while the bivalves and ammonoids predominate in the upper part. It is noteworthy that corals and foraminifers are exceedingly rare throughout the section.

Brachiopods are rather abundant from the base of the Zewans (Bed 14, not shown in Text-fig.) to the bottom of Bed 50, but are extremely rare thereafter. The representative genera are *Linoproductus, Waagenoconcha, Dictyoclostus, Pustula*?, *Marginifera, Lissochonetes, Athyris, Dielasma* and *Derbyia.*

Among the species listed in Text-fig. 2, those of *Linoproductus* (pl. 29, fig. 10) are



Text-figure 1. A distant view of the Guryul Ravine section. A, B and C: Permo-Trissic boundary proposed by WADIA (1953), MIDDLEMISS (1909), and TEICHERT *et al.* (1970) (which coincides with the view expressed in this paper), respectively.



Text-figure 2. Geological column and stratigraphical distribution of important fossils near the Permo-Triassic boundary at the Guryul Ravine section.
* *Eumophotis* cf. *venetiana* (HAUER). Read *Cyrtorostra* for *Cyrtorosta* in the columm of fossil names.

intimately related to *L. cora* (D'ORBIGNY)—a cosmopolitan Permian form. *Waagenoconcha purdoni* (WAAGEN) (pl. 29, figs, 12, 13) is known from the Upper Productus Limestone of the Salt Range, and *Marginifera himalayensis* DIENER (pl. 29, fig. 14a) from the Permian of the Himalayas. The genus *Lissochonetes* is characteristic of the Middle to Upper Permian of Asia. *Derbyia* sp. (pl. 29 fig, 11) is almost identical with an unnamed species described by SHIMIZU (1961) from the Upper Permian of Japan.

No Permian ammonoid species were found, though a number of specimens were collected from the Trias (Beds 52a-100). These include *Otoceras, Glyptophiceras, Ophiceras, Metophiceras, Vishnuites, Proptychites, Kashmirites, Owenites* and others which occur successively from Bed 52a to Bed 100. These genera are important being zone markers of the Eo-Trias (from Otoceratan to Owenitan).

Otoceras clivei DIENER and *O.* sp. are found in thin coquinoid limestone layers in Bed 52. The specimens of *O. clivei* (pl. 28, figs. 1a-c) have convex flanks and tricarinated venter, and are almost identical with the originals from the Spiti Himalaya. Such a form, with concave sides (as *O. concavum* TOZER) has never been obtained from Guryul Ravine section. According to DIENER (1897), *O. clivei* is associated in Spiti with *O. woodwardi* GRIESBACH. The Himalayan form *O. woodwardi* and the Arctic form *O. boreale* SPATH closely resemble each other in shell characters; also they occur at an identical stratigraphic horizon. Judging from its shell features and suture line, *O. concavum* is, however, considered to be a transition between the Permian *Araxoceras* and the Triassic *Otoceras*. It is consequently believed that *Otoceras clivei* appears at a somewhat higher level than *O. concavum*, and at a nearly equivalent level to *O. boreale* or *O. woodwardi*.

Species of *Glyptophiceras, viz., G. plicatella* SPATH, *G. lissarense* (DIENER) (pl. 29, fig. 2), and *G. ellipticum* (DIENER) are more common than those of the typical *Ophiceras* in Beds 52-60, and fairly abundant in Beds 52a-55b. Typical ophiceratids (*Ophiceras serpentinum* DIENER, pl. 29. figs, 1a, b) occur from Bed 64b. *Proptychites* sp. (pl. 28, figs, 4a, b), *Otoceras draupadi* DIENER (pl. 28, figs, 3a. b) and *Metophiceras* sp. are found in Bed 56, Bed 58b, and Bed 64b, respectively.

These ammonoids suggest a correlation with the lower Scythian or the Otoceratan established by SPATH (1930, 1934). Beds 51-60 have almost the same geological position as the *Otoceras woodwardi* and *Ophiceras commune* zone recognized by KUMMEL (1957); as *Otoceras boreale* and *Ophiceras commune* zones (TOZER, 1965, 1967) in Arctic Canada and as the *Otoceras* zone of Induan (KIPARISOVA and POPOV, 1964) in northeastern Siberia.

Bivalves are scarce in the lower part (Zewans) (Text-fig. 2); only limid gen. et sp. indet. and *Cyrtorostra* sp. have been obtained from Bed 45 near the boundary zone. Bivalves are dominant in horizons higher than Bed 47. *Etheripecten* sp. (pl. 29, figs.

6, 7), *Cyrtorostra* sp. (pl. 29, fig. 8), and *Claraia stachei* (BITTNER), SPATH (pl. 29, figs. 4, 5) are represented in Beds 47-52. *Eumorphotis* cf. *venetiana* (HAUER), *Eumorphotis multiformis* (BITTNER), *Leptochondria* cf. *minima* (KIPARISOVA) and *Claraia concentrica* YABE occur successively at higher levels.

The genus *Etheripecten* is considered to be intermediate between *Limipecten* and *Aviculopecten* and is known from the upper Permian of Australia (WATERHOUSE, 1963). *Eumorphotis venetiana* is a common species of the Lower Trias in the Tethys province. *Cyrtorostra* is a cosmopolitan genus from the Permian (CIRIACKS, 1963), and *Leptochondria* appears first in the Permian and becomes prolific in the Trias (NAKAZAWA and NEWELL, 1968). A species of *Leptochondria* obtained in Bed 62b and higher level is closely allied to *L. minima* which is confined to the Eo-Trias.

The genus *Claraia* is considered to be indicative of the Eo-Trias. According to TOZER (1967), the cosmopolitan species *C. stachei* occurs in the *Ophiceras* and *Proptychites* beds of Greenland and Arctic Canada, no specimen having been found in the *Otoceras* beds. Accordingly, its occurrence is believed to be limited to the upper Griesbachian. *C. stachei* has, however, been recently reported by DEFRETIN-LEFRANC *et al.* (1969) from the lower Griesbachian *Glyptophiceras martini* zone in Greenland, and, furthermore, by DICKINS (1963) from a drill core from an Australian horizon obtained about 100 feet below a bed with *Ophiceras* cf. *subkyoticum* (SPATH).

At the Guryul Ravine section, *Claraia stachei* is the dominant species in Beds 48-51, and is also found in Bed 52 yielding *Otoceras clivei*. A number of species of *Claraia*, which are still under study, are found in Beds 59-62. *C. concentrica* (pl. 29, fig. 3) predominates at a higher horizon, and is confined to Beds 65-68. Further studies are required to establish the correct evolutionary trend in these species.

Gastropods are represented by bellerophonids. They are found abundantly along with Permian brachiopods (in Bed 43) and with *Otoceras clivei* (in Bed 52a). Conodonts are present in limestones of the *Otoceras* zone (Beds 51-52). This gruop is represented by *Neogondolella nevadensis* (CLARK) and *Neospathodus cristagalli* (HUCKRIEDE), which are identical with those reported by HUCKRIEDE (1958) from the *Ophiceras* horizon in the Salt Range and by CLARK (1959) from the pre-*Meekoceras* horizon in Nevada. A few foraminifers also occur in Bed 45. Some of the specimens appear to be comparable with the Upper Permian *Colaniella*.

Mixed fauna at the Permo-Triassic boundary

Claraia stachei (BITTNER), SPATH, which is one of the most useful index-fossils of the Eo-Trias, is fairly common in Beds 48-51. It occurs together with brachiopods and bivalves referable to such "Permian" genera as *Linoproductus, Marginifera, Cyrtorostra* and *Etheripecten*. Moreover, in Bed 52b *Eumorphotis* cf. *venetiana* (HAUER) and the

definite indicator *Otoceras clivei* DIENER are found with some forms of *Marginifera, Pustula*?, and *Etheripecten*. It must, therefore, be emphasized that both the "Permian" and characteristic Triassic fossils are associated with each other to constitute a mixed fauna in Beds 48-52 at Guryul Ravine section.

As already stated, *Otoceras clivei* is considered to be morphologically more advanced and appears at a somewhat higher stratigraphical level than *O. concavum* TOZER, characteristic of the lowest Trias of Arctic Canada (TOZER, 1967). A more primitive form of *Otoceras* than *clivei* may be expected in the lower horizon, where *Claraia stachei* predominates.

The Permo-Triassic boundary, in the present paper, is tentatively placed between Bed 46 and 47. It is based upon the first appearance of *C. stachei,* which, taken together with the concurrent lithological changes regarded as important evidence, is in favour of a Lower Triassic age, as accepted by TEICHERT *et al.* (1970). The "Permian" brachiopods and bivalves in Beds 47-52 are consequently considered as relict survivors into the Trias.

Furthermore, the Permo-Triassic mixed fauna is found at a spur 2 miles north of Barus, about 11 km southeast of Guryul Ravine. In this section, the lithological and palaeontological sequences are almost identical to those at the Guryul Ravine section. *Otoceras* (pl. 28, figs, 2a, b) and some ophiceratid genera occur in the lower part of the "Brachiopod and Lamellibranch beds" of MIDDLEMISS (1909); and *Claraia* is found in association with *Etheripecten* and some productids in the lowest horizon. Productids are further reported by BION (in HAYDEN, 1914) from the basal portion of the *Otoceras* beds at Pahlgam, about 32 km east of Guryul Ravine. It is highly probable that the Permo-Triassic mixed fauna is distributed rather widely in the Kashmir region.

The Permo-Triassic mixed fauna is reported from other extra-Indian regions besides Kashmir, e.g., Armenian Dzhulfa (RUZHENTSEV *et al.,* 1965), Iranian Julfa or Dzhulfa (STEPANOV *et al.,* 1969), Salt Range (KUMMEL and TEICHERT, 1966; TEICHERT, 1968; TEICHERT *et al,* 1970), and Greenland (TRÜMPY, 1960; DEFRETIN-LEFRANC *et al.,* 1969). In Kashmir, however, the fauna contains several species of cosmopolitan genera *Otoceras* and *Glyptophiceras* as important elements in addition to *Claraia stachei* already reported by TEICHERT *et al.* (1970).

The strata characterized by the Permo-Triassic mixed fauna are only a few metres thick both at the Guryul Ravine and a spur 2 miles north of Barus. In both the sections there is gradual lithological change from Permian (Zewans) to Trias. The lower arenaceous facies passes into the upper calcareous through middle argillaceous facies. No evidence suggesting a hiatus could be seen anywhere in the Permian or the Lower Trias. On the basis of these facts, it can, therefore, be safely concluded that the faunal changes between the Palaeozoic and Mesozoic in Kashmir have occurred rather rapidly, even if not so suddenly as SCHINDEWOLF (1954a, b) presumed, but not

discontinuously.

Acknowledgements

The authors wish to express their sincere gratitude to the Geological Survey of India for their kind support and collaboration throughout the work. Without their cooperation this work would undoubtedly have been less fruitful. The authors also wish to record their thanks to the Ministry of External Affairs, Government of India, for giving them permission so promptly for carrying out the field survey in the Srinagar region, Kashmir.

Finally, the authors would like to put on record that the funds necessary for the field survey were given mostly by the Ministry of Education, Government of Japan.

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Explanation of Plate 28

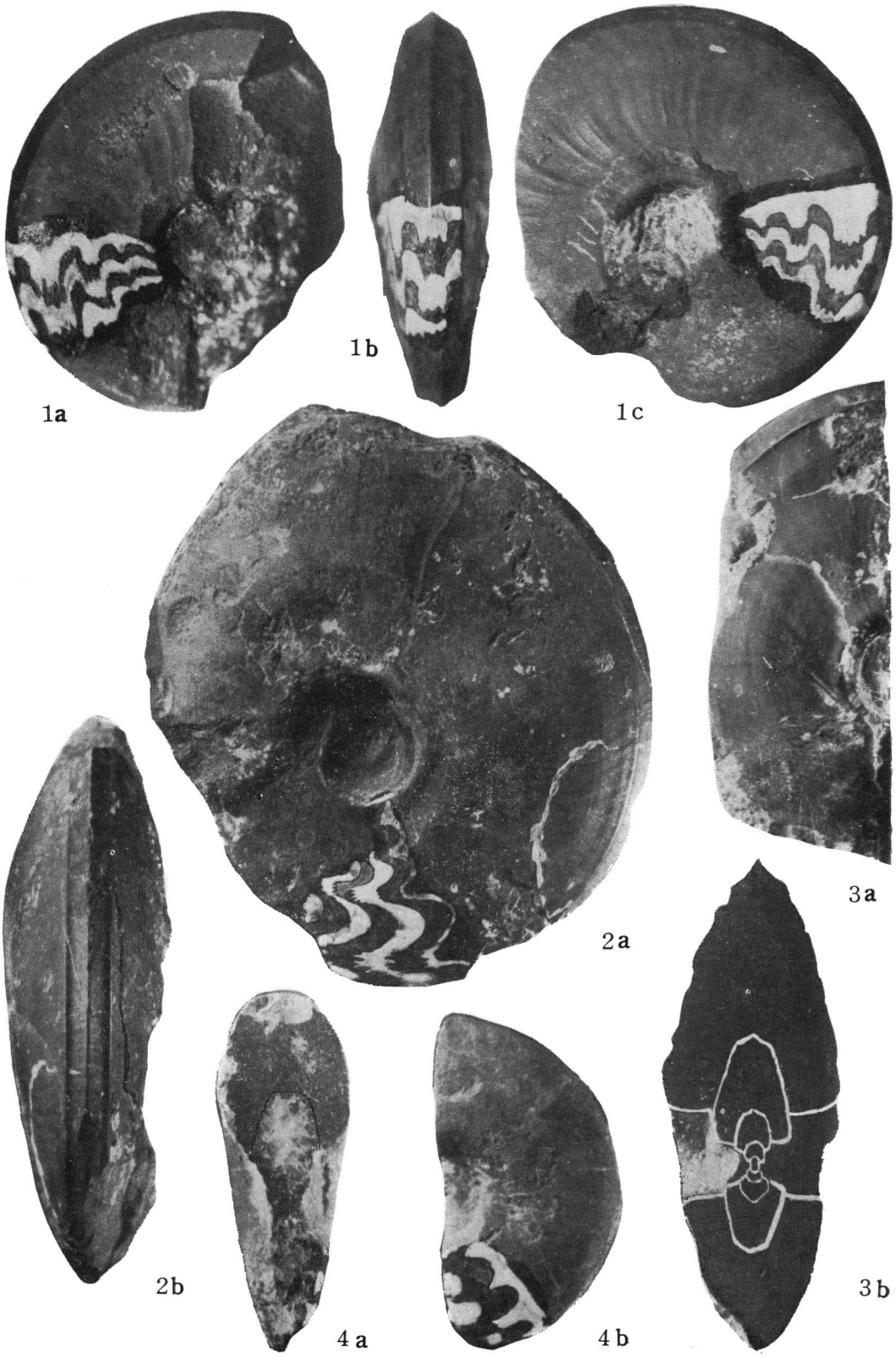
(All figures natural size)

Figures 1a-c. *Otoceras clivei* DIENER, Guryul Ravine, Bed 52a.

Figures 2a,b. *Otoceras* sp. indet., spur two miles north of Barus, Bed 61.

Figures 3a,b. *Otoceras draupadi* DIENER, Guryul Ravine, Bed 58b.

Figures 4a,b. *Proptychites* sp. indet., Guryul Ravine, Bed 56.



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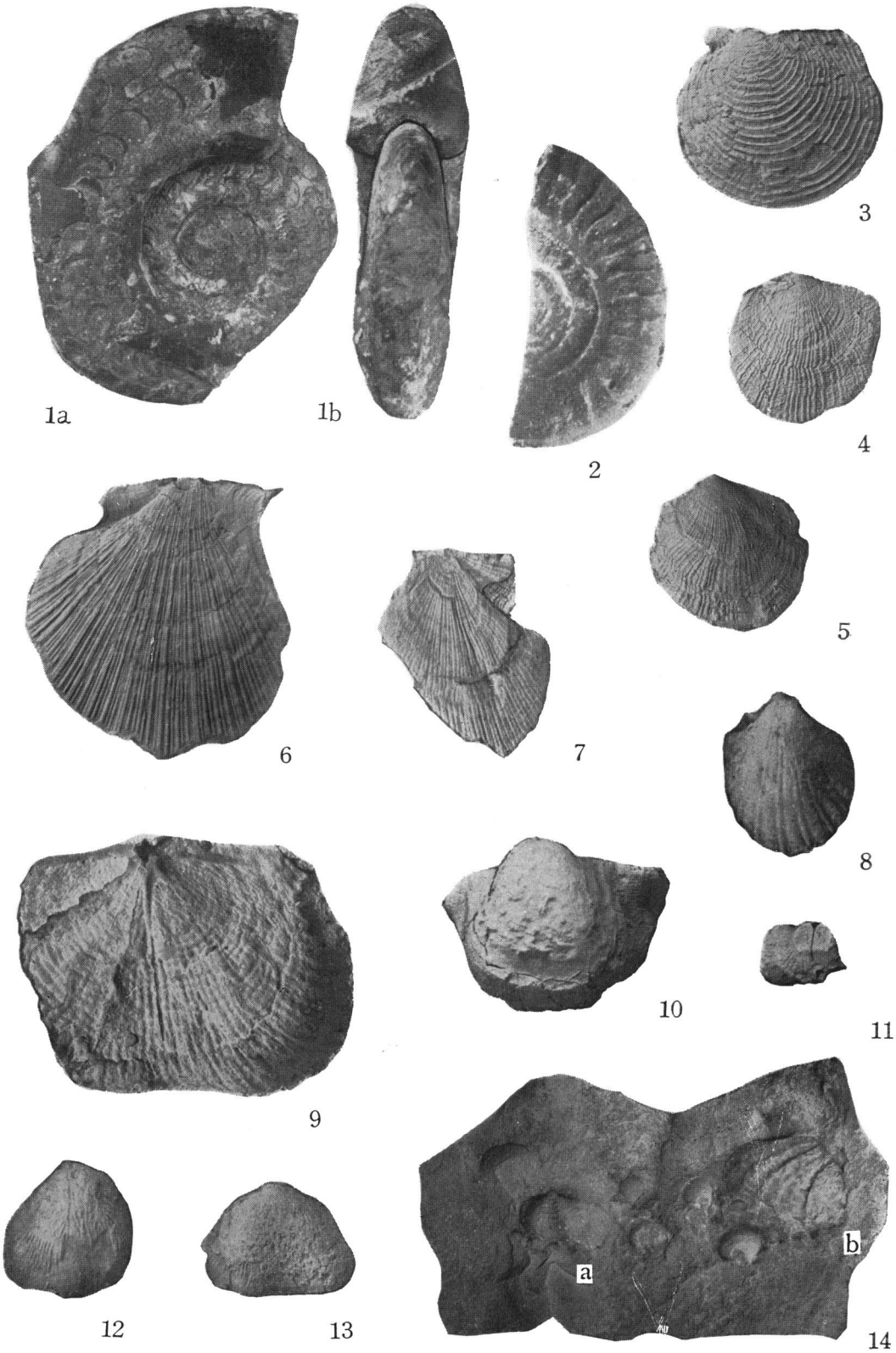
Explanation of Plate 29

(All specimens from Guryul Ravine. Figures 4-14, with whitening)

Figures 1a,b.	*Ophiceras serpentinum* DIENER, Bed 64b, x1.3.
Figure 2.	*Glyptophiceras lissarense* (DIENER), Bed 52a, x1.
Figure 3.	*Claraia concentrica* YABE, Bed 68a, x1.
Figures 4,5.	*Claraia stachei* (BITTNER), SPATH, Bed 47a, x1.
Figure 6.	*Etheripecten* sp. indet., left valve, Bed 48a, x1.
Figure 7.	*Etheripecten* sp. indet., right valve, Bed 47b, x1.5.
Figure 8.	*Cyrtorostra* sp. indet., Bed 48a, x2.
Figure 9.	*Dictyoclostus* sp. indet., Bed 47b, x1.
Figure 10.	*Linoproductus* cf. *cora* (D'ORBIGNY), Bed 48a, x1.
Figure 11.	*Derbyia* sp. indet., Bed 51, x2.
Figures 12,13.	*Waagenoconcha purdoni* (WAAGEN), Bed 48b, x1.
Figure 14.	*Pustla*? sp. indet (b) and *Marginifera himalayensis* DIENER (a), Bed 48b, x1.



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