

# Permo-Triassic Boundary in the Himalaya

Von V. GUPTA\*

Permo-Triassic boundary is one of the most important problems in the stratigraphy of the Himalaya in view of the complete development of the fossiliferous succession from the top of Permian to the basal part of Triassic. No attempt has, so far, been made to define this boundary with the exception of two brief notes (1, 2) on the Guryul Ravine section, Kashmir. KUMMEL & TEICHERT (3, 4) have demarcated this boundary in the Salt Range area of Pakistan on the basis of paleontological, palynological and stratigraphical evidences.

The author while carrying out field work in parts of Kashmir, Ladakh, Spiti and Kumaun during the field seasons 1963-72 observed that the Lower Triassic rocks contain *Otoceras woodwardi*, *Ophiceras sakuntala*, *Claraia griesbachi*, etc. and in some cases have yielded Scythian conodonts *Anchignathodus typicalis*, *Neogondolella carinata*, etc. These rocks lie conformably on the fossiliferous Productus Shales yielding representatives of *Cyclolobus* or *Xenodiscus* which are similar to those found in the Chhidruan Stage of Salt Range (5, 6). The brachiopods and other fossils are quite distinct in the rocks of the two systems but a few Permian elements survived (7) in the lower part of the Lower Trias, constituting a zone of mixed fauna, thus making it difficult to define this boundary precisely. The best example for the existence of mixed fauna is found in the Guryul Ravine section near Srinagar, Kashmir where productid brachiopods, including *Spinomarginifera*, have been found associated with the characteristic Lower Triassic pelecypod *Claraia stachei* and ammonites *Otoceras clivei*, *O. draupadi*, *Ophiceras serpentinum*, etc. Representatives of *Otoceras* have also been found associated with productids near Pahlgam (8) in the Anantnag District, Kashmir. Such associations have also been reported from the Kap Stosch area of East Greenland (9). The problem of defining this boundary in the Guryul Ravine section where the mixed fauna is found has been partly solved by the find of conodonts (2). The lower units of the succession have yielded *Anchignathodus typicalis* which are followed by the beds containing *Neogondolella carinata*, *Neospathodus dieneri* and *Neospathodus cristagalli*. The occurrence of these conodonts has also been recorded from the Salt Range and Trans-Indus Ranges of Pakistan. The boundary between the Permian and Triassic Systems in the Guryul Ravine lies somewhere in the *Anchignathodus typicalis* Zone and corresponds to the similar boundary defined in the West Pakistan, Iran and Eastern Greenland where *Anchignathodus typicalis* Zone is followed by the beds which have been referred to *Neogondolella carinata* Zone of SWEET (10). In the Pastun area of Kashmir, the Lower Triassic limestone has also yielded *Neogondolella carinata*. The reported occurrence of *Hindeolella triassica*, *Gondolella* cf. *phosphoriensis*, etc. was not found by the present author who agrees with SWEET (10) that the forms figured by SRAVASTAVA and MANDWAL (11) are nothing else but *Neogondolella carinata* and *Ellisonia triassica*. In the Zewan Spur, the beds lying just above the *Xenaspis* cf. *carbonaria* Zone mark the advent of Triassic succession. Permo-Triassic succession similar to that of Kashmir is also exposed in the Bhallesh area of Kishtwar.

In the Sarchu Plains of Ladakh, the limestones lying just above the Productus Shales have yielded rich collection of *Neogondolella carinata* which marks the base of the Lower Triassic succession. No conodonts have been found in the Permo-Triassic

\*) V. GUPTA, Centre of Advanced Study in Geology, Panjab University, Chandigarh, India.

succession of Spiti which is exposed near Lilang, in the Pin Valley and near Losar. At all these localities the Productus Shales yielding rare specimens of *Cyclolobus oldhami* are followed by the Lower Triassic limestone containing *Otoceras woodwardi* associated with *Otoceras clivei*, *Ophiceras sakuntala* and *Claraia griesbachi*. The occurrence of these fossils (12) suggest a correlation with the Lower Scythian succession established by SPATH (13, 14), according to which the Spiti beds occupy the same geological position as the *Otoceras woodwardi* and *Ophiceras commune* Zone (15, 16, 17) of Arctic Canada and *Otoceras* Zone of Induan (18) in the Northeastern Siberia.

In the Kumaun Himalaya, the Permo-Carboniferous rocks are found in the Kalapani-Kuti areas of Byans, Painkhanda and Eastern Johar. In the Kalapani area the problem of defining this boundary becomes difficult in view of the absence of *Otoceras* or *Claraia* in the beds lying above the Productus Shales. The occurrence of the ammonite genus *Cyclolobus* in the Productus Shales of this region is known from Lebong (19, 20), Lillinthi (21) and Chitichun (22). At Chitichun, *Xenaspis* is found associated with the *Cyclolobus*. The limestones lying just above the Productus Shales in the Nabi Gad near Talla Nabi Dhang which lies 6 kms. from Kalapani have yielded Lower Triassic conodonts (*Neogondolella carinata*, *Anchignathodus typicalis*, *Neospathodus dieneri*, *N. cristagalli* and *Ellisonia* spp.) and these pass conformably into the beds containing representatives of *Ophiceras*, brachiopods and crinoids. As such the beds yielding these conodonts can be taken as the marker beds for the base of the Lower Trias. The conodont fauna at this locality fits in well with the zones established by SWEET (1, 10) for the lower Triassic of Salt Range and Kashmir. In the Tinkar Lipu area of Eastern Byans (19, 23), Productus Shales are overlain by the shaly clay ironstone of Chocolate Series yielding *Anakashmirites nivalis* and *Glyptophiceras kashmiricum*. *Glyptophiceras* is also found in the Guryul Ravine and Zewan Spur of Kashmir where it is associated with the beds containing the Scythian conodont *Neogondolella carinata*.

In the Niti area of Garhwal, the fossiliferous Upper Permian rocks (24, 25, 26) consisting of black shales are exposed at several localities (Sagpudang camping ground, Rimkhim to Sumna, S. E of Ragchya Kharak, Kailashpur, etc.) which pass conformably into the unfossiliferous limestones considered to be of Scythian age in view of the stratigraphic position they occupy. These in turn are overlain by the beds containing representatives of *Ophiceras*, *Ptychites*, etc. In the Painkhanda area, the Lower Triassic succession is exposed in the Shalshal cliff (27, 28, 29, 30), near Rhimkhim which is lithologically and paleontologically similar to the succession exposed near Lilang in the Spiti Valley. The Productus Shales at this locality are followed by the beds containing *Otoceras woodwardi*, *Ophiceras sakuntala*, *Claraia griesbachi*, etc. Similar stratigraphic successions have also been observed in the Dharma and Lissar Valleys of Eastern Johar where the Lower Triassic rocks contain *Ophiceras sakuntala* and *Claraia griesbachi*. No specimen of *Otoceras woodwardi* has so far been found at this locality (27, 31).

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