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PERMIAN AND TRIASSIC CONODONTS FROM A SECTION AT GURYUL RAVINE, VIHI DISTRICT, KASHMIR

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ABSTRACT

Eight conodont species are represented in 20 productive samples from a section of Upper Permian and Lower Triassic strata exposed at Guryul Ravine, in the Vihi District of Kashmir. Conodonts from the lowest 68 feet of the sampled section represent the *Anchignathodus typicalis* fauna, which characterizes a zone that straddles the Permian-Triassic boundary in West Pakistan and elsewhere. Rocks above the *A. typicalis* Zone at Guryul Ravine are correlated with the Lower Triassic conodont zones of *Neogondolella carinata*, *Neospathodus dieneri*, and *Neospathodus cristagalli*, which are best known from the Salt Range and Trans-Indus Ranges of West Pakistan. These correlations corroborate the conclusions of TEICHERT, KUMMEL, and KAPOOR (1970) concerning placement of the Permian-Triassic boundary in the Guryul Ravine section and indicate that an appreciable thickness of rock long considered to be Permian is in reality Early Triassic in age.

INTRODUCTION

Within the past few years, conodonts have been found to be widespread in Lower Triassic strata and their biostratigraphic utility is demonstrated by the fact that sequences of these fossils from the Lower Triassic of Pakistan, northern Italy, and western United States are identical or very closely comparable (SWEET, 1970; SWEET *et al.*, 1970). Furthermore, because conodonts are small, remarkably resistant, and less restricted in their occurrence to certain lithofacies than many other groups of fossils, they can often be collected in abundance from rocks that contain no other identifiable or diagnostic fossils. Thus study of the distribution of conodonts in connection with that of other fossils (particularly ammonoids) should ultimately yield a highly refined biostratigraphy for the Lower Triassic, just as comparable study of conodonts in connection with goniatites has done for the Upper Devonian.

As a means of testing and extending to other areas the Lower Triassic conodont biostratigraphy worked out primarily in the Salt Range and Trans-Indus ranges of West Pakistan (SWEET, 1970), I have recently had the welcome opportunity to study a suite of 35 large bulk samples from marine Permian and Triassic rocks in Kashmir (Fig. 1). The samples were collected by CURT TEICHERT (University of Kansas) on June 27, 1968, during a joint visit to Kashmir with BERNHARD KUMMEL (Harvard University), supported by National Science Foundation Grant GA-996. In the field, TEICHERT was assisted by Dr. ASHOK SINGH of the Geology and Mining Department of Jammu and Kashmir. This collection was made especially in hope that it may yield information on the conodont zonation above and below the stratigraphic level which TEICHERT and KUMMEL diagnosed in the field as the boundary between the Permian and Triassic in this section.

Ten of the samples sent to me were obtained from the upper 57 feet of the Permian Zewan Series and the balance were taken at more or less regular intervals from the lower 124 feet of the superjacent Lower Triassic beds. All samples were collected from an exposure on the east side

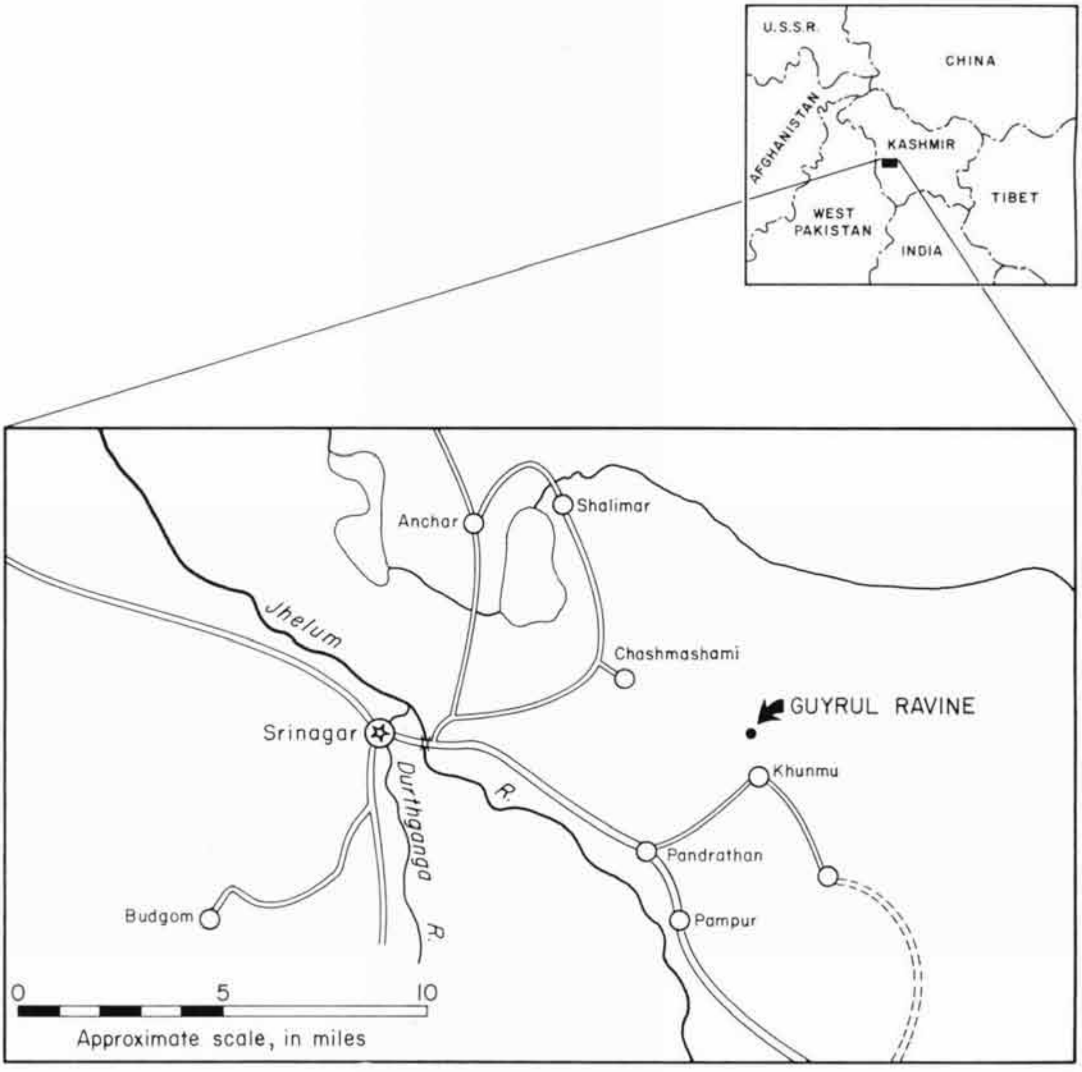

FIG. 1. Outline map of central Kashmir, showing approximate location of the Guryul Ravine section. Map redrafted from central portion of a tourist map of Kashmir, which is quite generalized.

of Guryul Ravine, north of the village of Khunmu, in the Vihi District of Kashmir.

The section at Guryul Ravine (Fig. 2) has been described in several reports (GODWIN-AUSTIN, 1866; HAYDEN, 1907; MIDDLEMISS, 1909), and TEICHERT, KUMMEL & KAPOOR (1970) have recently published additional information about this famous locality. Thus the following remarks are appropriately limited to a discussion and stratigraphic evaluation of conodonts from strata adjacent to the Permian-Triassic boundary at Guryul Ravine. Stratigraphic and geographic context for these remarks, and additional information on the rock sequence, can be obtained by consulting the reports just mentioned.

PREPARATION OF SAMPLES

Thirty-five samples from the Guryul Ravine section, averaging 700 grams in weight, were crushed to fragments about a centimeter in diameter and treated in a 15-percent solution of acetic acid to remove carbonates. After about a week, 25 samples were largely disaggregated by acid treatment. The insoluble residues of 20 of these samples, which were composed mostly of fine quartz sand, were further concentrated in tetrabromoethane and a Frantz isodynamic magnetic separator and yielded numerous conodont-elements. However, ten samples of siliceous sandstone or siliceous dark sandy shale were little affected by acid treatment or other standard disaggregation procedures and no conodont-elements were obtained from them. Laboratory preparation of all samples was carried out by Miss KRISTINE GABLE, student assistant at The Ohio State University. Bulk collections, from which hypotypes were selected, are filed in the micropaleontological laboratories at The Ohio State University, under the general catalog designation "68TK."

KASHMIR CONODONT FAUNAS

All conodont-elements recovered from the 20 productive samples from the Guryul Ravine section are small and well preserved, but black in color, which indicates that they have been somewhat altered thermally. The 1,022 elements collected (Fig. 3) represent eight single- or multi-

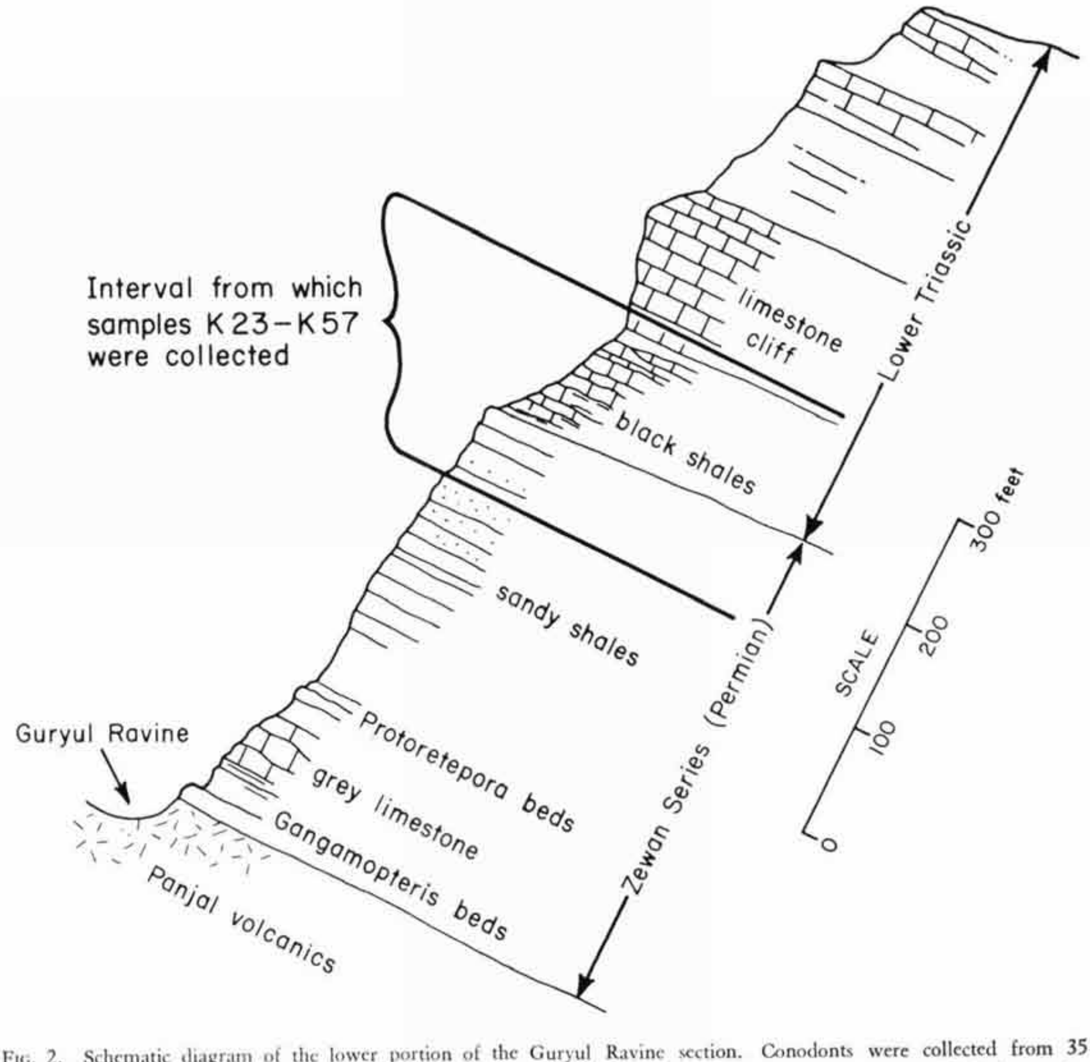

FIG. 2. Schematic diagram of the lower portion of the Guryul Ravine section. Conodonts were collected from 35 samples collected in the interval bracketed. From Teichert, Kummel and Kapoor (1970), who modified the section from Middlemiss (1909).

SAMPLE NUMBER	FEET ABOVE BASE OF SAMPLED SECTION	*Anchignathodus typicalis*	*Ellisonia teicherti*	*Neogondolella carinata*	*Ellisonia triassica*	*Ellisonia gradata*	*Neospathodus dieneri*	*Neospathodus cristagalli*	*Ellisonia robusta*	CONODONT ZONES
K57	193				12	6	9	14	3	*Neospathodus cristagalli*
K56	181				6	5	8	3	2	
K55	176						45	68	11	
K54	170				26	45	40	1	6	
K53	166				23	17	79	53		
K52	161				5	7	24	15		
K51	156						1	1		
K50	148				22	1	16	3		
K49	144				22	5	110	27		
K48	137				1					
K47	129							1		
K46	123				12	1	20			*N. dieneri*
K45	118									
K44	113			1						*Neogondolella carinata*
K43	107			95	8	24				
K42	102									
K41	97	26	18	10	8	13				*Anchignathodus typicalis*
K40	91	11	5	13	1					
K39	86									
K38	81	1								
K37	80									
K36	73									
K35	68									
K34	62									
K33	58				1					
K32	57									
K31	52									
K30	48	2								
K29	43									
K28	29	1	1		7					
K27	20									
K26	13									
K25	11									
K24	5									
K23	0									

Permo-Triassic Boundary of Teichert, Kummel & Kapoor 1970 (between K33 and K32)

FIG. 3. (*Explanation on facing page.*)

element conodont species, the distribution and frequency of occurrence of which are indicated in the figure.

Two species, *Ellisonia triassica* MÜLLER (Pl. 1, fig. 2, 10, 19, 24), and *Ellisonia gradata* SWEET, n. sp. (Pl. 1, fig. 1, 5-6, 9), represented by 154 and 124 specimens, respectively, have an extended range in the Guryul Ravine section (Fig. 3) and can be accorded little stratigraphic significance. Ranges of the remaining six species, however, are relatively short and singly, or in combination with others, these species characterize four distinctive conodont faunas.

The oldest fauna represented in samples from the Guryul Ravine section is distinguished by *Anchignathodus typicalis* SWEET, n. sp. (Pl. 1, fig. 13, 22) and *Ellisonia teicherti* SWEET, n. sp. (Pl. 1, fig. 3-4, 7-8, 12). Neither species is particularly well represented in the sparingly productive samples from the lower 86 feet of the Guryul Ravine section (Fig. 3), but both have the same range.

Samples K43 and K44, from an interval 10 to 15 feet above the highest *Anchignathodus typicalis*, are dominated by specimens of *Neogondolella carinata* (CLARK) (Pl. 1, fig. 20, 23), a cosmopolitan species in which I also tentatively include the conodonts that CLARK (1959) described as *Gondolella nevadensis* and *G. planata*. *N. carinata* is also represented in samples K40 and K41 (Fig. 3), which belong in the interval dominated by *A. typicalis* and *Ellisonia teicherti*, but no *N. carinata* elements were recovered from samples above K45.

Neospathodus dieneri SWEET, n. sp. (Pl. 1, fig. 17) is first represented in sample K46 (Fig. 3) and ranges to the top of the part of the Guryul Ravine section sampled by TEICHERT. Except for representatives of the ubiquitous *Ellisonia triassica* and *E. gradata*, however, *N. dieneri* is the only distinctive species represented in sample K46. This sample, then, distinguishes the third conodont fauna of the Guryul Ravine section.

All but one sample from strata in the interval 129 to 193 feet above the base of the Guryul Ravine section yield specimens of *Neospathodus cristagalli* (HUCKRIEDE) (Pl. 1, fig. 18, 21), which is thus an index to a fauna that also includes *Ellisonia gradata*, *E. triassica*, *Neospathodus dieneri*, and, in the upper part of its range, *E. robusta* SWEET, n. sp. (Pl. 1, fig. 11, 14-16).

In summary, conodont-elements from the Guryul Ravine section, Kashmir, represent four conodont faunas, dominated, in ascending order, by 1) *Anchignathodus typicalis* and *Ellisonia teicherti;* 2) *Neogondolella carinata;* 3) *Neospathodus dieneri;* and 4) *Neospathodus cristagalli.* The ranges of these faunas are indicated in Figure 3.

CORRELATION

Anchignathodus typicalis and *Ellisonia teicherti*, which have the same range in the Guryul Ravine section, characterize a conodont fauna described from uppermost Permian and lowermost Triassic rocks in West Pakistan, northern Italy, and Idaho (STAESCHE, 1964; SWEET, 1970; SWEET *et al.*, 1970) and is also represented in undescribed collections from rocks of presumably similar age in northwestern Iran and eastern Greenland. Rocks distinguished by these conodonts are included by SWEET (1970) in an *Anchignathodus typicalis* Zone, which has a lower limit at a still-undefined level in the uppermost Permian and an upper boundary in lowermost Triassic strata that also yield the ammonoids *Ophiceras* and *Glyptophiceras*. In West Pakistan and other areas in which the *Anchignathodus typicalis* Zone has been identified, typical zonal fossils also include representatives of *Neogondolella carinata*, but this species ranges well above the upper limit of the *A. typicalis* Zone. Thus it is reasonable to conclude that at least the 68 feet of rock in the Guryul Ravine section between the base of sampled unit K28 and the top of sampled unit K41 (Fig. 3) belong in the *A. typicalis* Zone and that the Permian-Triassic boundary is somewhere within this interval, as it seems to be in West Pakistan, northwestern Iran, and eastern Greenland. On the basis of the distribution of bivalves and brachiopods, TEICHERT, KUMMEL, & KAPOOR (1970) draw this boundary between Kashmir samples K32 and K33 (Fig. 3).

In several sections in the Salt Range and Trans-Indus Ranges (SWEET, 1970) rocks just above the highest ones with *Anchignathodus*

FIG. 3. Distribution and frequency of occurrence of conodont-elements in samples from the Guryul Ravine section, Kashmir. Conodont zones represented by these samples are indicated along the right-hand side. Numbers in columns headed by specific names indicate the number of elements of those species recovered from individual samples.

typicalis yield representatives of *Neogondolella carinata* in great abundance and to the virtual exclusion of other types of conodont-elements. These strata were set aside by SWEET as the *Neogondolella carinata* Zone, but with the reservation that it might be just a local peak zone, identifiable only in sections in West Pakistan. In the Guryul Ravine section, however, samples K43 and K44 (Fig. 3) are dominated by *N. carinata* and lack conodonts diagnostic of zones recognized elsewhere below or above the *N. carinata* Zone. The rocks from which these samples were taken are thus logically correlated with the *N. carinata* Zone, which may then be more widely recognizable than SWEET (1970) anticipated. These strata may also represent approximately the same level from which SRIVASTAVA & MANDWAL (1966) collected about 400 conodont-elements that seem largely to be referable to *N. carinata* (CLARK) and *Ellisonia triassica* MÜLLER. SRIVASTAVA & MANDWAL's material was derived from Lower Triassic strata at Pastun, in the Anantnag District, Kashmir.

The third fauna of Kashmir, which is dominated by *Neospathodus dieneri*, is represented in a single sample that is separated by 10 feet of barren strata from the highest beds yielding abundant *Neogondolella carinata*. Thus correlation of this fauna with the sequence in West Pakistan is not entirely certain. That is, in West Pakistan *N. dieneri* first occurs in a thin unit immediately above the *Neogondolella carinata* Zone and characterized by an undescribed species of *Neospathodus* that is restricted to it. However, *N. dieneri* is first abundantly represented in West Pakistan in a 3- to 4-foot interval that succeeds that zone, and SWEET (1970) named the beds characterized by abundant *N. dieneri* the *Neospathodus dieneri* Zone. Because sample K46 lacks specimens both of the index to strata just below the *N. dieneri* Zone of West Pakistan, and *Neospathodus cristagalli*, the index to strata immediately above the *N. dieneri* Zone, the rocks from which this sample was collected are assigned tentatively to the *N. dieneri* Zone in Figure 3. It should be noted, however, that *N. dieneri* is the longest-ranging species of *Neospathodus* in West Pakistan sections, and that correlation of sample K46 with the *N. dieneri* Zone depends more on the absence in this sample of the indexes to sub- and superjacent zones than on anything particularly diagnostic about its conodont fauna.

Samples K47 through K57 (Fig. 3) yield the youngest of the Kashmir Triassic conodont faunas known to date. This fauna, distinguished by abundant representatives of *Neospathodus cristagalli* (HUCKRIEDE), is closely similar to one that ranges through some 25 feet of the Mianwali Formation in West Pakistan, above the *Neospathodus dieneri* Zone. SWEET (1970) included West Pakistan strata dominated by *N. cristagalli* in a *N. cristagalli* Zone, and it is clear that the 64 feet or so of rock in the Guryul Ravine section that yield *N. cristagalli* in abundance are to be included in that zone. Valid representatives of *N. cristagalli* have not been identified until now outside of West Pakistan, hence this report extends the geographic range of both *N. cristagalli* and the *N. cristagalli* Zone. It should also be noted that *Ellisonia robusta*, which makes its first appearance in West Pakistan in the upper half of the *N. cristagalli* Zone, is also well represented (Fig. 3) in the upper half of the interval here assigned to the *N. cristagalli* Zone. It may well be that the range of *E. robusta* can be used to subdivide the *N. cristagalli* Zone further, but its extent is too poorly controlled as yet to serve this function in more than the two areas compared in this report.

SUMMARY

Conodonts from the upper 57 feet of the Zewan Series and the lower 124 feet of the overlying Lower Triassic beds in the section at Guryul Ravine, Kashmir, represent four distinctive conodont faunas that may be correlated with those of the *Anchignathodus typicalis*, *Neogondolella carinata*, *Neospathodus dieneri*, and *Neospathodus cristagalli* Zones of the Salt Range and Trans-Indus Ranges of West Pakistan. The conclusion of TEICHERT, KUMMEL, & KAPOOR (1970) that the Permian-Triassic boundary in the Guryul Ravine section should be drawn below MIDDLEMISS's (1909) "black shales" unit (Fig. 2) is thus confirmed by the nature and distribution of conodonts in this section. That is, conodont distribution suggests that the top of the Zewan Series (Fig. 2) is approximately at the same biostratigraphic level as the top of the Chhidru Formation of West Pakistan, and that the lower 124 feet of the Triassic sequence that overlies the Zewan Series in Kashmir contains the faunal equivalent of the Kathwai Member and the lower part of the Mianwali Member of the Mittiwali Formation of West Pakistan.

The latter are clearly Lower Triassic on the basis of the ammonoids they contain, and the fact that they are both thinner and lithologically different from presumably equivalent strata in Kashmir indicates that conodont-defined zones maintain their distinction across facies boundaries and into regions of distinctly different depositional style.

DIAGNOSES OF NEW GENERA AND SPECIES

Most of the conodonts represented in samples from the Guryul Ravine section of Kashmir are assignable to species based on extensive collections of unaltered material from Permian and Triassic strata in the Salt Range and Trans-Indus ranges of West Pakistan. These collections, and the primary type-series of all the species represented in them, are described in detail in a major study (Sweet, 1970) that was completed in 1967 and was in press at the time this much shorter note was prepared. For technical reasons, however, it is likely that this note will be published a few months in advance of the study of Permo-Triassic conodonts from West Pakistan; hence the previously undescribed genera and species from Kashmir are established formally in the brief diagnoses that follow. The types of all these taxa are illustrated, and the taxa are more fully characterized, in my study (Sweet, 1970) of Permian and Triassic conodonts from the Salt Range and Trans-Indus ranges of West Pakistan. Thus, although establishment of the genus and five species diagnosed herein will date from publication of this report, specimens of the species illustrated on Plate 1 are all to be regarded as hypotypes and not as members of the primary type-series of any of these taxa. This procedure is somewhat irregular, but it does not violate any of the provisions of the *International Code of Zoological Nomenclature*.

The specimens illustrated on Plate 1 and the types of all species diagnosed in this report are filed in the micropaleontological collections of The Orton Museum of Geology, at The Ohio State University, Columbus, Ohio. A duplicate set of Kashmir hypotypes is filed in The University of Kansas Museum of Invertebrate Paleontology, Department of Geology, Lawrence, Kansas.

ANCHIGNATHODUS Sweet, n. gen.

Diagnosis.—*Anchignathodus* includes conodonts with skeletal apparatus composed solely of paired, individually asymmetric elements that are more or less conspicuously arched, straight, or slightly bowed blades. A series of high, laterally compressed denticles, which are discrete, fused, or overgrown, forms a distinctive anterior crest: denticles posterior to the apex of this crest decrease in size and length to the posterior extremity of the element. The attachment surface is enclosed by a broadly flaring sheath that is lachrymiform in plan and tapers toward, but extends to, the posterior extremity of the element. Beneath the anterior blade, however, the attachment surface is confined to a narrow groove, which extends nearly to the anterior end of element. In elements of at least one species, nodelike denticles occur on the supper surface of the laterally flaring sheaths.

Type Species.—*Anchignathodus typicalis* Sweet, n. sp.

ANCHIGNATHODUS TYPICALIS Sweet, n. sp.

Plate 1, figures 13, 22

Spathognathodus cf. *minutus* (Ellison) Huckriede, 1958, p. 162, 167, pl. 10, fig. 8.

Spathognathodus isarcicus Huckriede, Staesche, 1964 (*partim*), p. 288-289, fig. 60, 61 (*non* fig. 6, 62, 63, 64).

Anchignathodus typicalis (*nom. nud.*), Stepanov *et al.*, 1969, p. 64.

Diagnosis.—A species of *Anchignathodus* characterized by slightly arched and bowed bladelike elements, 2 to 2.5 times as long as wide, in which denticles posterior to the cusp tend to diminish regularly in length to the tip of the unit.

Remarks.—Elements of *Anchignathodus typicalis* are morphologically closest to those on which Ellison (1941) based *Spathodus minutus*, a species herein referred to *Anchignathodus*. However, elements of *A. minutus* are about 3 times as long as wide, whereas those of *A. typicalis* are more expanded laterally and range from 2 to 2.5 times as long as wide. In addition, denticles of *A. typicalis* elements tend to diminish gradually in length between cusp and posterior end of the unit, whereas in *A. minutus* elements there tends to be an abrupt offset in the lateral profile immediately posterior to the cusp, and the 6 or 8 denticles following the cusp are all about the same length.

Types.—Holotype (OSU 28017) and paratype (OSU 28016) from sample T63-122, which was collected 1-5 inches above the base of the Kathwai Member of the Mianwali Formation exposed on the west side of Chhidru Nala, Salt Range, West Pakistan. Kashmir hypotypes figured in this report, OSU 28766, 28767.

ELLISONIA Müller, 1956

Upper Permian and Triassic rocks yield representatives of at least seven multielement conodont species characterized by skeletal apparatuses that include some combination of hibbardelliform, ligonodiniform, lonchodiniform, prioniodiniform, cladognathodiform, and enantiognathiform elements. One of these species clearly includes the types of *Ellisonia triassica* Müller, 1956, hence all are referred to *Ellisonia*, the scope of which is thus appreciably expanded.

In describing species of multielement *Ellisonia*, Sweet (1970) attempts to avoid confusion by referring to various types of elements in the apparatus with capital letters. In the diagnoses that follow, *U* stands for bilaterally symmetrical, unpaired elements, and all other elements, which were probably paired in the original skeleton, are designated "*L* elements." In those skeletal apparatuses in which there were apparently several different kinds of *L*-elements, *LA*, *LB*, *LC*, *LD*, *LE*, and *LF* variants are distinguished.

Type Species.—*Ellisonia triassica* Müller, 1956.

ELLISONIA GRADATA Sweet, n. sp.

Plate 1, figures 1, 5-6, 9

Lonchodina latidentata (Tatge) Huckriede, 1958, p. 151, pl. 10, fig. 32, 38, 39.

Roundya n. sp. A. Huckriede, 1958, p. 161, pl. 10, fig. 20.

Gen. et spec. indet. A. Huckriede, 1958, p. 163, pl. 10, fig. 28.

Diagnosis.—A species of *Ellisonia* with a skeletal apparatus that includes *U*-elements with a straight, denticulated posterior process; *LA*- and *LC*-elements with two anterolateral processes; *LB*-elements with short posterior and long anterior processes, some of which are bifid; and "white matter" that is distributed in irregular "clouds" so that all elements have a "spotted" appearance.

Remarks.—*Ellisonia gradata* is distinguished from other species of multielement *Ellisonia* by skeletal elements in which "white matter" is distributed in irregular "clouds." *LB*-elements with bifid anterior processes are characteristic parts of the apparatus of *E. gradata*, but are not known to have been skeletal components of *E. triassica*, type species of *Ellisonia*. The skeletal apparatus of the latter, on the other hand, includes "*LF*-elements" (Sweet, 1970), which are structures that have no morphologic counterparts in the apparatus of *E. gradata*.

Types.—Syntypes (OSU 28027-28033, inclusive) from sample K3-12, which was collected from the lower part of a black to olive shale just above *Gyronites*-bearing beds in the lower Mittiwali Member of the Mianwali Formation exposed on the west side of Chhidru Nala, Salt Range, West Pakistan. Kashmir hypotypes figured in this report, OSU 28749-28752, inclusive.

ELLISONIA ROBUSTA Sweet, n. sp.

Plate 1, figures 11, 14-16

Diagnosis.—A species of *Ellisonia* with a skeletal apparatus composed of elements with peglike denticles; *U*-elements with long, straight posterior processes; *LA*- and *LC*-elements with two anterolateral processes; *LB*-elements with long posterior processes and long anterior processes; some of which are bifid, and "white matter" that is uniformly and densely developed throughout all elements.

Remarks.—Elements of *Ellisonia robusta* and *E. gradata* are similar but are readily distinguished by the fact that even the smallest skeletal units of *E. robusta* lack the cloudy distribution of "white matter" characteristic of *E. gradata*, and large elements are uniformly and densely white. In addition, *LB*-elements of *E. robusta* have a well-developed posterior process that is much longer and much better developed than is the corresponding structure in *LB*-elements of *E. gradata*.

Types.—Syntypes (OSU 28034-28038, inclusive) from sample K3-14, which was collected from the lower part of a shale unit just above *Gyronites*-bearing beds in the lower Mittiwali Member of the Mianwali Formation exposed on the west side of Chhidru Nala, Salt Range, West Pakistan. Kashmir hypotypes figured in this report, OSU 28762-28765, inclusive.

ELLISONIA TEICHERTI Sweet, n. sp.

Plate 1, figures 3-4, 7-8, 12

?*Lonchodina* n. sp. A. Huckriede, 1958 *(partim)*, p. 153, pl. 10, fig. 3 (not pl. 10, fig. 2).

?*Hindeodella* sp. a. Bender & Stoppel, 1965, p. 344-345, pl. 15, fig. 6.

Ellisonia teicherti (nom. nud.), Stepanov *et al.*, 1969, p. 64.

Diagnosis.—A species of *Ellisonia* with a skeletal apparatus that consisted of *U*-elements with no posterior processes, and *LA*-, *LB*-, *LD*-, and *LE*-units with short anterior and long posterior processes, needlelike denticles, and an escutcheonlike attachment surface on the inner side of the element. All elements are opaque and almost uniformly white in even earliest stages of growth.

REMARKS.—*Ellisonia teicherti* is distinguished from *E. triassica* and other known species of multielement *Ellisonia* by uniformly white skeletal elements with an escutcheonlike attachment surface and needlelike denticles.

TYPES.—Syntypes (OSU 28039-28047, inclusive) from sample T63-122, collected 1-5 inches above the base of the Kathwai Member of the Mianwali Formation exposed on the west side of Chhidru Nala, Salt Range, West Pakistan. Kashmir hypotypes illustrated in this report, OSU 28757-28761, inclusive.

NEOSPATHODUS Mosher, 1968

Neospathodus includes a group of obviously related species, the only skeletal elements of which were apparently blade-shaped units with a well-developed anterior process; a posterior process that is short, secondary, vestigial, or absent; midlateral ribs of varying prominence that are produced laterally in late developmental stages of some species to form platforms; and a basal surface that includes a basal pit surrounded laterally and posteriorly by a looplike ridge and a laterally flaring brim, which may be wholly or partially "inverted."

TYPE-SPECIES.—*Spathognathodus cristagalli* HUCKRIEDE, 1958.

REMARKS.—*Neospathodus* is represented by a number of stratigraphically very useful species in Upper Permian and Triassic strata. SWEET (1970) recognizes ten species of this genus in the uppermost Permian and Lower Triassic rocks of the Salt Range and Trans-Indus ranges of West Pakistan, but only two of these are diagnosed here. Elements typical of these two species were included by HUCKRIEDE (1958) in *Spathognathodus cristagalli*, which thus needs revision.

NEOSPATHODUS CRISTAGALLI (Huckriede, 1958)

Plate 1, figures 18, 21

Spathognathodus cristagalli HUCKRIEDE, 1958 *(partim)*, p. 161-162, pl. 10, fig. 14, 15 (*non* pl. 10, fig. 1-13, 18a, 18b, which = *N. dieneri*, n. sp.).

non "Spathognathodus" cristagalli Huckriede, LINDSTRÖM, 1964, p. 64 (= *N. dieneri*, n. sp.).

non Spathognathodus cristagalli Huckriede, MOSHER & CLARK, 1965, p. 556, 564, 565, pl. 66, fig. 8.

non Neospathodus cristagalli (Huckriede) MOSHER, 1968, p. 930, pl. 115, fig. 1, 2 (pl. 115, fig. 1 = *N. homeri* (BENDER); pl. 115, fig. 2 = *N. triangularis* (BENDER)).

DIAGNOSIS.—A species of *Neospathodus* characterized by bladelike skeletal elements with 5 to 13 denticles, a width to height to length ratio of about 1:3:4 at all stages of growth, a greatest height slightly posterior to unit midlength, a short terminal posterior cusp of broadly subtriangular lateral profile, and a basal margin that turns conspicuously upward beneath the posterior third of the unit.

TYPES.—Figured hypotypes, OSU 28769, 28770.

NEOSPATHODUS DIENERI Sweet, n. sp.

Plate 1, figure 17

Spathognathodus cristagalli HUCKRIEDE, 1958 *(partim)*, p. 161-162, pl. 10, fig. 10-13, 18a,b (*non* pl. 10, fig. 14, 15, which = *N. cristagalli* (HUCKRIEDE)).

"Spathognathodus" cristagalli LINDSTRÖM, 1964, p. 64.

DIAGNOSIS.—A species of *Neospathodus* characterized by blade-shaped skeletal elements with 4 to 13 denticles, a width to height to length ratio of about 1:2:2.3 at all stages of growth, a greatest height at or just anterior to the posterior end of the unit, a long terminal posterior cusp, and a basal margin that turns upward prominently beneath the posterior third to half of the unit.

REMARKS.—Elements of *Neospathodus dieneri* differ conspicuously from those of *N. cristagalli* in lateral profile and in ratios of width to height to length (1:2:2.3 in *N. dieneri;* 1:3:4 in *N. cristagalli*). Among described species that may be referable to *Neospathodus, N. dieneri* elements are grossly most similar to those from the Zechstein of Germany on which BENDER & STOPPEL (1965) based *Spathognathodus divergens*. Elements of the latter, however, are relatively wider than those of *N. dieneri*, and the posteriorly expanded segment of the base is longer and of a different shape than the comparable portion of *N. dieneri* elements.

TYPES.—Holotype (OSU 28078) from sample K4-LCL, derived from the "Lower Ceratite Limestone" (lower part of Mittiwali Member of Mianwali Formation) exposed on the east side of Chhidru Nala, Salt Range, West Pakistan. Kashmir hypotype figured in this report, OSU 28768.

REFERENCES CITED

BENDER, HANS, & STOPPEL, DIETER, 1965, *Perm-Conodonten:* Geol. Jahrb., v. 82, p. 331-364, 1 fig., pl. 14-16.

CLARK, D. L., 1959, *Conodonts from the Triassic of Nevada and Utah:* Jour. Paleontology, v. 33, no. 2, p. 305-312, 1 fig., pl. 44-45.

ELLISON, SAMUEL, 1941, *Revision of the Pennsylvanian conodonts:* Jour. Paleontology, v. 15, no. 2, p. 107-143, pl. 20-23.

GODWIN-AUSTIN, H., 1866, *On the Carboniferous rocks of the Valley of Kashmere:* Geol. Soc. London, Quart. Jour., v. 22, p. 29-45.

HAYDEN, H. H., 1907, *The stratigraphical position of the Gangamopteris beds of Kashmir:* Geol. Survey India, Records, v. 36, no. 1, p. 23-39.

HUCKRIEDE, REINHOLD, 1958, *Die Conodonten der mediterranen Trias und ihr stratigraphischer Wert:* Paläont. Zeitschr., v. 32, p. 141-175, pl. 10-14.

LINDSTRÖM, MAURITS, 1964, *Conodonts:* Elsevier Publishing Co., Amsterdam, 196 p., 64 fig.

MIDDLEMISS, C. S., 1909, *Gondwanas and related marine sedimentary systems of Kashmir:* Geol. Survey India, Records, v. 37, no. 4, p. 286-327.

MOSHER, L. C., 1968, *Triassic conodonts from western North America and Europe and their correlation:* Jour. Paleontology, v. 42, no. 4, p. 895-946, pl. 113-118.

———, & CLARK, D. L., 1965, *Middle Triassic conodonts from the Prida Formation of northwestern Nevada:* Jour. Paleontology, v. 39, no. 4, p. 551-565, 2 fig., pl. 65, 66, 1 tabl.

MÜLLER, K. J., 1956, *Triassic conodonts from Nevada:* Jour. Paleontology, v. 30, no. 4, p. 818-830, pl. 95, 96.

SRIVASTAVA, J. P., & MANDWAL, N. K., 1966, *Record of conodonts from India:* Current Science (India), v. 35, no. 24, p. 621-622, fig. 1-7.

STAESCHE, ULRICH, 1964, *Conodonten aus dem Skyth von Südtirol:* Neues Jahrb. Geologie Paläontologie, Abh., Heft 119, p. 247-306, fig. 3-73, pl. 28-32.

STEPANOV, D. L., GOLSHANI, F., & STÖCKLIN, J., 1969, *Upper Permian and Permian-Triassic boundary in North Iran:* Geol. Survey Iran, Rept. no. 12, 72 p., 28 pl.

SWEET, W. C., 1970, *Uppermost Permian and Lower Triassic conodonts of the Salt Range and Trans-Indus Ranges, West Pakistan:* in Stratigraphic Boundary Problems: Permian and Triassic of West Pakistan, B. Kummel, & C. Teichert (eds.), Dept. Geology, Univ. Kansas, Spec. Publ. 4 (in press).

———, MOSHER, L. C., CLARK, D. L., COLLINSON, J.W., & HASENMUELLER, W. A., 1970, *Conodont biostratigraphy of the Triassic:* in Symposium on Conodont Biostratigraphy, W. C. Sweet & S. M. Bergström (eds.), Geol. Soc. America, Mem. 127 (in press).

TEICHERT, CURT, KUMMEL, BERNHARD, & KAPOOR, H. M., 1970, *Mixed Permian-Triassic fauna, Guryul Ravine, Kashmir:* Science, v. 167, no. 3915, p. 174-175, 1 fig.

EXPLANATION OF PLATE 1

All specimens are from the Permo-Triassic section in Guryul Ravine, Vihi District, Kashmir. Figures are of coated specimens, × 85, which are cataloged in the Orton Museum of Geology, The Ohio State University.

FIGURE

1, 5-6, 9. *Ellisonia gradata* SWEET, n. sp. Sample K54. OSU 28749-28752.

2, 10, 19, 24. *Ellisonia triassica* MÜLLER. Samples K41, K53, K54. OSU 28753-28756.

3-4, 7-8, 12. *Ellisonia teicherti* SWEET, n. sp. Samples K40, K41. OSU 28757-28761.

11, 14-16. *Ellisonia robusta* SWEET, n. sp. Samples K54, K56, K57. OSU 28762-28765.

13, 22. *Anchignathodus typicalis* SWEET, n. gen., n. sp. Sample K41. OSU 28766-28767.

17. *Neospathodus dieneri* SWEET, n. sp. Sample K54. OSU 28768.

18, 21. *Neospathodus cristagalli* (HUCKRIEDE). Sample K53. OSU 28769-28770.

20, 23. *Neogondolella carinata* (CLARK). Sample K41. OSU 28771.


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