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The primary aim of ALBERTIANA is to promote the interdisciplinary collaboration and understanding among the members of the I.U.G.S. Subcommission on Triassic Stratigraphy. Within this scope ALBERTIANA serves both as a newsletter for the announcement of general information and as a platform for discussion of developments in the field of Triassic stratigraphy. ALBERTIANA thus encourages the publication of announcements, literature reviews, progress reports, preliminary notes etc. - i.e. those contributions in which information is presented relevant to current interdisciplinary Triassic research.

CONTENTS ALBERTIANA 11

New addresses and address corrections	1
A. Baud: News about the Permian-Triassic Boundary Working Group	1
J.M. Dickins: IGCP Project 272 - "Late Palaeozoic and Early Mesozoic Circum-Pacific events" Working Group Meeting, Vladivostok, 6-13 September 1992	2
The Chinese Working Group on the Permian-Triassic Boundary: A proposal for the Global Stratotype Section and Point (GSSP) of the Permian-Triassic Boundary	4
E.T. Tozer: What is Ceratites nodosus ?	31
E.T. Tozer: Triassic chronostratigraphic divisions considered again	32
M.J. Orchard: Spathian conodont taxonomy and biochronology	37
Announcement: STS Meeting - Shallow Tethys Conference, Vienna, 1994	39
S.G. Lucas: The Shansiodon Biochron, nonmarine Middle Triassic of Pangaea	40
Forthcoming meetings	43
H. Kerp and H. Visscher: Annotated Triassic literature	44
Addresses of Contributors Albertiana 11	64
Erratum	65

SEE PAGE 66 FOR METHODS OF PAYMENT OF ALBERTIANA 11

Cover: Shansiodon skull (see S.G. Lucas: The Shansiodon Biochron, pp. 40-42)

NEW ADDRESSES AND ADDRESS CORRECTIONS

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NEWS ABOUT THE PERMIAN-TRIASSIC BOUNDARY WORKING GROUP

According to the request of the ICS and the general assembly of the STS in Kyoto to reactivate the P/T Boundary Working Group, a meeting is planned during the Pangea Conference in Calgary, August 15th-19th, 1993 with the following agenda:

Bussiness meeting (new memberships, program for the next years etc.)

Slovakia

2 Scientific papers and proposals

Further information on the meeting will be sent to the working group members in April.

Concerning the chairmanship of the Working Group, please note the following points:

- 1 Dr. Tozer is no longer chairman of the working group. He has been in office since 1981; chairmen of ICS bodies should be replaced after eight years.
- 2 Voting members of the P/T Boundary Working Group have been kindly asked to vote for a new chairman. Votes expressed by the working group members gave the following results:
 - Prof. Yin Hongfu (Wuhan, China) is elected as new Chairman of the PTBWG with 17 approvals (no abstentions, no objections).
 - Prof. Yuri Zakharov (Vladivostok, Russia) is elected as new Vice-Chairman of the PTBWG with 17 approvals (no abstentions, no objections).

A. Baud, Chairman of the STS

Albertiana 11, April 1993

A PROPOSAL FOR THE GLOBAL STRATOTYPE SECTION AND POINT (GSSP)

OF THE PERMIAN-TRIASSIC BOUNDARY

The Chinese Working Group on the Permian-Triassic Boundary ¹

1. Introduction

The Permian Triassic Boundary Working Group was formed in 1981. Its objectives are, as defined by its chairman T. Tozer (1984):

- 1 to select an age within the biochronological hierarchy that will be recommended to the Commission as defining the earliest Triassic.
- 2 to select a stratotype where these earliest Triassic rocks have their typical development.

In 1984, Tozer circulated a questionnaire to all 21 members of the PTBWG concerning the definition of the Permian-Triassic boundary; 18 members answered. The questions and answers were:

- 1 should the boundary be defined in a marine sequence, or in a non-marine one? Marine: 18; non-marine: O
- 2 suggested level for the base of the Triassic:
 - base of Otoceras beds? yes: 16
 - in younger beds (specify)? Base of the Dienerian: 1
 - base of Isarcicella isarcica (base of E3, Khunamuh Formation, Kashmir), 1.
 - In older beds (specify)? 0
- 3 Suggested stratotype section (specify)? Kashmir: 9; South China: 8; abstention: 1 (chairman).
- 4 Suggested parastratotype(s)? This elicited an assortment of suggestions which cannot be concisely summarized.

It seemed thus in 1984 that the PTBWG was approaching a recommendation of the base of the *Otoceras* beds as the earliest Triassic. However, disagreements on the age of *Otoceras* existed then and afterwards (Newell, 1978; Waterhouse, 1978; Sweet, 1979; Kozur, 1980; Bando, 1980; Bhatt et al., 1981; Yin, 1985). These authors suggested a partly or wholly downward extension of the *Otoceras* Zone into the uppermost Permian in the light of its correlation with ammonoids, conodonts and brachiopods. During the field conference in Brescia, July 1986, organized by the Italian IGCP 203 Group, many authors of abstracts dealing with the Permian-Triassic boundary held the opinion that the *Otoceras* beds may partly or wholly overlap Permian strata (Budurov et al., Kozur, Shah and Bhatt, Newell, Yin et al.), while others still favoured the traditional view (Tozer, Dagys, Zakharov).

Paper submitted by Prof. Yin Hongfu.

It is to be noted that a majority of the first group based their views on conodont biostratigraphy. With accumulating doubts on the age of Otoceras, there seems now to be a tendency, as in the cases of many Palaeozoic system boundaries, to look for conodonts as alternatives for ammonoids. Two conodonts, Hindeodus parvus and Isarcicella isarcica, were repeatedly mentioned. The debate was raised again in 1989, when two circulars, respectively from Tozer and Sweet, were distributed among the PTBWG members; one for and the other against the Otoceras bed as earliest Triassic. This disagreement apparently obstructed the way to reach any consensus on the GSSP of the Permian-Triassic boundary. In the past three years little has been done by the PTBWG, yet the problem is becoming urgent because eleven years have passed since the establishment of the working group. During the meeting of the Subcommission on Triassic Stratigraphy which took place at the 29th International Geological Congress (30 August, Kyoto), Chinese PTBWG members were urged, and they promised to raise a proposal for the GSSP of the Permian-Triassic boundary. A Chinese working group meeting was held in December including Sheng Jingzhang and Yin Hongfu (Chinese PTBWG members at home), Jing Yugan (the chairman of SPS), Chen Chuzhen (member of STS) and active scientists on the P/Tboundary, Li Zishun and Yang Jiduan from the Academy of Geosciences, Ministry of Geology of China. Two other PTBWG members at home, Yang Zunyi and Liao Zhuoting, asked for leave but expressed their warm agreement with the formation and aim of the working group. The proposal now submitted to the PTBWG and drafted by Yin is but our first attempt to speed up the resolvement of the P/T boundary problem. Any comments, complements and criticisms will be appreciated and duly handled.

2. Index fossil - Hindeodus parvus (Kozur et Pjatakova) 1976

2.1. Definition of Hindeodus parvus and the Hindeodus parvus Zone

2.1.1. Hindeodus parvus (Kozur et Pjatakova) 1976

When Sweet (1970a) established Anchignathodus typicalis as a new species, he did not designate a holotype. This was later appointed in one of his other papers (1970b). The form species Anchignathodus parvus was established by Kozur et Pjatakova (1976, in Kozur et al., 1976; Kozur, 1977) from the basal Triassic of Achura, Azerbaijan. They included specimens of Anchignathodus typicalis Sweet (1970a, p. 7, 8, Pl. 1, figs. 13, 22) and others as synonyms. Matsuda (1981) attributed A. parvus as Pa element of the multi-element taxon Hindeodus. On the basis of the morphological affinity and close stratigraphic distribution, Sweet first (1988) treated H. parvus as a synonym of *Isarcicella isarcica* with slight morphological difference, but later recognized the species 'parvus' and assigned it tentatively to *Isarcicella* (1992). He argued that *Hindeodus* is a seximembrate genus whereas no ramiform elements of the *Hindeodus* type have been described from any 'parvus' collection. We do not wish to get deeply involved in nomenclatural discussions and are ready to accept either *Hindeodus* or *Isarcicella*. For this paper, we have used the name *Hindeodus* following the assignment of most authors.

According to Kozur (1980), the *H. parvus* group consists of *H. parvus* (Kozur et Pjatakova), *H. turgidus* Kozur, Mostler et Rahimi-Yazd, and *H. latidentatus* Kozur, Mostler et Rahimi-Yazd. *H. latidentatus*, characterized by a separated, wide posterior tooth, occurred at about the same or a little lower (Permian) level in Iran and the Southern Alps (Table 2). *H. turgidus* is a transitional form to *Isarcicella isarcica* (Huckriede) and began later than the other species of the *H. parvus* group. Matsuda (1981) held the opinion that *H. parvus* is closely related to *H. minutus* (Ellison) and may have evolved from it. Transitional forms between *H. minutus* and *H. parvus* occur already in the uppermost *Paratirolites* fauna in Dorasham.

2.1.2. The *Hindeodus parvus* Zone

The base of the *H. parvus* Zone is here recommended as the Global Stratotype Point of the Permian/Triassic Boundary. Because the upper limit of *H. parvus* ranges into the *Ophiceras* Zone or *I. isarcica* Zone (Matsuda, 1981; Kozur et al., 1978; Iran.-Jap. Res. Group, 1981; Pak.-Jap. Res. Group, 1981; Sweet, 1992), the present concept of the *H. parvus* Zone has to be a successive appearance zone (sensu Vella, 1964) topped by the first appearance of *I. isarcica*. Although *H. parvus* occurs since the basal Triassic, it should be noted that in certain sections (e.g. the Shangsi section of Guangyuan, Sichuan, China), its first appearance may be several meters higher than the boundary due to paleoecological unadaptability or failure in collection at the lowest horizons. In this case care should be taken to recognize the correlative level of the base of the *H. parvus* Zone (Table 2 and Appendix 2).

2.2. Merits of H. parvus as an index fossil for the basal Triassic

2.2.1. H. parvus as time-marker for the basal Triassic

In the Meishan section, Changxing, Zhejiang Province of South China (Sheng et al., 1984; Yang et al., 1987), the Permian-Triassic Transitional Beds (Yin, 1985) are 0.22 m thick (Appendix 1). The lowermost bed, a 4 cm thick light grey montmorillonite-illite boundary clay or 'White Clay', is Permian because of the occurrence of the Permian conodonts Gondolella subcarinata changxingensis, G. deflecta, Hindeodus minutus therein. The lower Transitional Bed or 'Black Clay', a 6 cm thick dark brown pyrite-bearing mudstone, yields essentially Permian-type conodonts, brachiopods and ammonoids (Pseudogastrioceras sp.), but it was regarded as Triassic because of the occurrence of Otoceras(?) sp., Hypophiceras cf. martini and Hypophiceras changxingensis (Wang Yigang, 1984). Two H. parvus specimens have been found in the upper part of the upper Transitional Bed, a 16 cm thick light grey dolomitic limestone (Zhang, 1987). The horizon in which they have been found lies exactly 14 cm above the base of the 'Black Clay'. Kozur (pers. comm.) argued that these specimens are not 'parvus', but juvenile specimens of H. latidentatus. However, Ding Meihua and Zhang Kexin disagree (pers. comm.). The presence of *H. parvus* at the base of the upper Changxing Formation in the same locality (Wang and Wang, 1981) was later denied by the authors themselves (Wang, pers. comm.). Here H. parvus predated the bivalve Pseudoclaraia wangi and the conodont I. isarcica.

In the Selong section, southern Tibet, *H. parvus* has been found together with *Otoceras latilobatum* in the lowermost 20 cm of light grey limestone (Yao et Zhang, 1985; Yao et Li, 1987; Wang et al., 1989). However, the different authors give different lists of taxa and a different order of their appearance.

In the Yewa section, Diebu (Tewa), southern Gansu Province, *H. parvus* was found in a light grey mudstone (6 m thick), conformably overlying Upper Permian oolitic limestone with the Changxingian conodont *Gondolella changxingensis* and underlying a thin-bedded limestone containing Upper Griesbachian forms: *Claraia hubeiensis, Lingula tenuissima*, etc.

So far, *H. parvus* has been found in nineteen localities in China, all in the basal Triassic. In all sections the conodont succession of first appearance is in ascending order: *H. minutus*, *H. parvus*, *I. isarcica*. Yin et al. (1986) recorded sixteen of them. The three new occurrences are in the Zhuodong section, Tiandong Co., the Jingya section, Fengshan Co., and the Taiping section, Pingguo Co., all located in W. Guangxi. Yang et al. (1987) took the base of the *H. minutus* Zone as the P/T boundary while Zhang (1987) shifted it to the base of the *H. parvus*

minutus Zone as the P/T boundary while Zhang (1987) shifted it to the base of the *H. parvus* Zone, reasoning that this boundary overlies a tuff layer in the Zhuodeng section, corresponding with the Boundary Clay in South China.

The *H. parvus* Zone is considered to be located at the upper part of the *Otoceras* Zone in the Guryul Ravine section of Kashmir (Pak.-Jap. Res. Group, 1985, p. 263). Matsuda (1981, 1985) also reported that *H. parvus* occurs in the upper *Otoceras* Zone and predates the *I. isarcica* Zone in the Guryul Ravine.

In the Chhidru 3 Section of Chhidru Nala, Salt Range, Pakistan (Pak.-Jap. Res. Group, 1985), the Middle Unit of the Kathwai Member, Mianwali Formation (Lower Triassic) is suggested to be basal Triassic, discomformably overlying the Lower Unit of the Kathwai Member. This sand dolomite yields *H. parvus?* and was assigned to the *Parvus* Zone. In the neighbouring Zaluch 1 section *H. parvus* has been found in the same horizon.

In the C section of Hambast Valley, Abadeh region, Iran, Unit a of the lower Triassic conformably overlies the Upper Permian Hambast Formation. Bed 0 of Unit a (0.2 m thick) is unfossiliferous. The bed immediately above yields *H. parvus*. It predates *Claraia* spp. and *Isarcicella isarcica* (Iran.-Jap. Res. Group, 1981).

The Lower Triassic Karabagliar Formation of the Dorasham 2-3 Section, Transcaucasia, also yields *H. parvus*. It probably first occurs at 0.67-0.71 m above the boundary and also predates *Lytophiceras* and *I. isarcica*. However, a few *Claraia* specimens have been found below the *parvus* horizon (Kotljar et al., 1983; Zakharov, 1985, 1992).

In the Kuh-e-Ali Bashi section, Julfa, northwest Iran, a 1.1 m thick red marl, immediately above the upper Permian Ali Bashi Formation, is considered to be Permian by Teichert et al. (1973) but as Triassic by Altiner et al. (1980, see Tab. 2). The basal part of the overlying *Claraia* limestone is subdivided by Golshani et al. (1986) as an independent *Parvus* Zone yielding *H. parvus*. The *Claraia* limestone itself yields *Claraia* spp., *Ophiceras* and *Isarcicella isarcica*.

H. parvus is also reported from the Gartnerkofel, Carnic Alps, Austria (Schoenlaub, 1991). It occurs both in the Gartnerkofel core and in the Reppwand outcrop; here associated with *H.* cf. *latidentatus*, from the basal Tesero Horizon. *I. isarcica* occurs in the overlying Mazzin Member.

During the Permo-Triassic Field Conference in Brescia (1986), Dr. Perri and other Italian colleagues informed us that *H. parvus* occurs together with *H. typicalis* at the Tesero horizon 3 meters above the base of the Werfen Formation, in the Bulla section, South Tirol. Kozur has also reported *H. parvus* from South Tirol. In the Auronzo Pelus section of Carnic Alps *I. isarcica* has been found in the middle part of Mazzin Member, Werfen Formation. Thus the conodont succession in the Southern Alps is in accordance with the remaining areas of the Tethys (Broglio Loriga and Cassinis, 1992).

From the above statements it is clear that the *H. parvus* Zone represents the basal Triassic. In some sections, *Otoceras* (Guryul Ravine) or *Otoceras*? and *Hypophiceras* (Meishan) indeed appeared earlier than *H. parvus*. Nevertheless, the *Otoceras*?-*Hypophiceras* bed in Meishan contains dominantly Permian fossils, and the lower *Otoceras* bed (Bed 52) of the Guryul Ravine also shows strong Permian aspects, except for the occurrence of *Ophiceras sakuntala*. This problem will be further discussed in the next paragraph concerning *Otoceras*.

2.2.2. The H. parvus Zone symbolizes the origination of Triassic newcomers

Unlike Otoceras, H. parvus is easy to be found in the same section with Pseudotirolites, Paratirolites, Palaeofusulina and other typical Tethyan, latest Permian fossils. Everywhere they concur, the H. parvus horizon is superjacent to the latest Permian fossil horizons. This is confirmed by the following sections: Meishan, Shangsi, Selong, Guryul Ravine, Hambast Valley, Dorasham and Kuh-e-Ali Bashi.

The lowermost Otoceras bed (Bed 52 of Guryul Ravine, Nakazawa et al., 1975) contains mostly Permian brachiopods, gastropods, forams and conodonts, plus Claraia (or Peribositra Chen) bioni which is different from Triassic claraids and will be discussed later. Only Lytophiceras and Glyptophiceras seem Triassic but their identification is now subject to reexamination (Hypophiceras). In the Meishan section (Appendix 1), the dark brown pyrite-bearing mudstone yielding Otoceras sp. contains exclusively Permian fossils, except for two Hypophiceras species. On the other hand Triassic newcomers like Claraia (Meishan), Eumorphotis (Guryul Ravine) and "Proptychites" (Guryul Ravine) have been reported from the H. parvus Zone of these two sections, albeit they occur scarcely and the Permian elements are still dominant.

In the Salt Range (Pak.-Jap. Res. Group, 1985), the Kathwai Member is subdivided into lower, middle and upper units. The Lower Unit contains Permian brachiopods (9 species), forams (6 species), bryozoans, echinoderms and a bivalve; only three cephalopod species bear Triassic generic names such as Ophiceras and Glyptophiceras. The Middle Unit is named H. Parvus-I. isarcica Zone. In its lower part, notably the H. parvus Zone in our sense, abundant Triassic bivalves such as Eumorphotis waageni, Entolium cf. discites, E. n.sp., ophiceratid as well as Permian survivors Crurithyris? sp. and Warthia? sp. have been found. Nine species of forams have been found in the Middle Unit, but they are considered to be derived fossils because the shell-walls are recrystallised and abraded. Also echinoid fragments occur. Thus, in Pakistan the H. parvus Zone is also characterized by mixed Permian relicts and Triassic newcomers, overlying an exclusively Permian fauna and underling the Ophiceras Zone - the Upper Unit of the Kathwai Member. On this basis the Pak.-Jap. Res. Group (1985) reached the following conclusion "(We) suggest the latest Permian age of the Lower Unit, and the Permian-Triassic boundary coincides with the Lower and Middle Unit boundary of the Kathwai Member" (pp. 265-266), which is the base of the H. parvus Zone. From most well-known sections the succession: Pseudotirolites or Paratirolites (terminal Permian) - appearance of H. parvus (upper Lower Griesbachian) - appearance of I. isarcica, Ophiceras and Claraia spp. (Upper Griesbachian) seems well established. It is reasonable to follow the conclusion that the lower Lower Griesbachian which yields only Permian fossils should be Permian while the upper Lower Griesbachian, symbolized by the appearance of H. parvus, should be basal Triassic, because it is from this horizon that Triassic newcomers appeared, though still scarcely. One may argue that H. parvus belongs to a phylogenetic clade rooted in the Permian. Anyhow, it is not a prerequisite that the marker of a new period should belong to a new clade. We have precedent cases at the Ordovician/Silurian boundary (Parakidograptus acuminatus) and the Devonian/Carboniferous boundary Siphonodella sulcata) exemplifying that elements of an old stock symbolize a new period.

2.2.3. H. parvus has a much wider distribution than Otoceras

H. parvus has been found in Kashmir, the Salt Range, Transcaucasia, Iran, China, Italy, Austria and Hungary (Buekk Mt., according to Barabas-Stuhl, 1976, abstract in the Field Conference in Brescia), denoting a pan-Tethyan distribution. In China alone, this species has been found in 19

localities of nine provinces. There may also be certain similar specimens in North America, e.g., that of Paull and Paull (1983, fig. 5c).

The Tethyan origination of *H. parvus* has a remarkable advantage over *Otoceras*, because the Tethys is the only region where the uppermost Permian is likely to be found. This allows easy discovery of Permian and Triassic indicators together, and an accurate tracing of the boundary over wide areas.

2.3. Uncertainties of *H. parvus* as an index fossil for the basal Triassic

2.3.1. The nomenclature problem

This problem has been discussed in 2.1.1. Whether 'parvus' should be assigned to Anchignathodus, Hindeodus or Isarcicella remains unsettled, but this uncertainty does not seem to prevent it from serving as index fossil.

2.3.2. The first appearance of *H. parvus* may not be coincident with the basal Griesbachian

According to Nakazawa et al. (1975), in the Guryul Ravine, the Griesbachian stage begins with Bed 52 of Khunamuh E2, where *Otoceras woodwardi*, *Hindeodus minutus* and many Permian fossils have been found. The first appearance of *H. parvus* is at Bed 56 (Matsuda, 1981), 3.4 m above the base of Bed 52.

In Meishan, the Otoceras?-bearing dark brown mudstone does not yield *H. parvus*, but Gondolella subcarinata changxingensis and *G. deflecta* instead. Here *H. parvus* first occurs in the overlying marl, 14 cm above the base of the dark brown mudstone.

In the Shangsi section of Guangyuan, Sichuan Province, *H. parvus* occurs even higher, 3.69-5.49 m (Li et al., 1989) or 5.03-6.39 m (Yang et al., 1987) above the top of the montmorillonite-illite Boundary Clay (Appendix 2). This interval is occupied by *H. decrescens* Dai et Zhang (Li et al., 1989, pl. 39, figs. 11-13) which Kozur suggested to be something like *H. turgidus*.

In the Kuh-e-Ali Bashi section, the yellowish-greenish grey shale inbetween the *Paratirolites* limestone and the basal *Claraia* limestone (or the *H. parvus* Zone in our sense) yields a *H. typicalis* (Sweet, 1973), and was assigned to the Permian Ali Bashi Formation by Teichert et al. (1973). *H. minutus* occurs in the Lower Unit (Salt Range) and Bed 52 (Guryul Ravine), both located inbetween typical Permian and the *H. parvus* Zone.

These data raise doubt that a certain conodont zone, may it be *minutus*, *typicalis* or *decrescens*, could have existed below the *H. parvus* Zone and is coincident with the lower Lower Griesbachian or lower *Otoceras* Zone.

There are cases that *H. parvus* appears immediately above the Permian, such as in the C section of the Hambast Valley, Iran, the Huaying section of Sichuan (Yang et al., 1987), the Zhuodeng section of Tiandong Co., Guangxi (Zhang Shunxing, 1990) and the Selong section of Tibet. However, in Selong it concurs not only with *Otoceras*, but also with the conodonts *G. subcarinata changxingensis*, *G. deflecta* and *I. isarcica* (Yin et al., 1988), which is a rather confusing phenomenon. Moreover, a regional survey in the adjacent Himalaya areas of China, India and Nepal demonstrates widespread disconformity between the Permian and Triassic, and

there is an hiatus below the *parvus* bed with reworked brachiopods, corals and crinoids (Wang et al., 1989). So this mixture may be the result of condensation or reworking.

3. Potential index fossil 1 - Otoceras

3.1. Stratigraphic distribution of the Otoceras Zone

Otoceras is the most well-known traditional time-marker of the basal Triassic since Griesbach (1880). The definition of Otoceras and the Otoceras Zone have been discussed in detail by Kummel (1972) and Tozer (1986, 1988). Detailed stratigraphic data on the Otoceras Zone have been recorded in Arctic Canada, East Greenland, Spitzbergen, NE Siberia and the Himalayas. The details of its occurrences in Alaska are unknown. The Otoceras beds of the Himalayas are generally approximately one meter in thickness. They used to comprise a single O. woodwardi Zone. However, in the Selong section of southern Tibet, Wang et al. (1989) recently distinguished a lower O. latilobatum Zone and an upper O. woodwardi Zone. In the Arctic the Otoceras beds attain a thickness of at least 70 m and are subdivided into two zones (Concavum and Boreale), which are recognized in Arctic canada (Tozer, 1967) and NE Siberia (Dagys et al., 1979). The basal Otoceras zones of the Arctic and the Himalayas are considered by many to be essentially correlative. A correlation of these beds, largely based on Tozer (1986) is given as in Table 1.

3.2. Geographic distribution of Otoceras

The Himalayas and Timor: Shalshal Clif and Spiti (Diener, 1912), Pahlgam and north of Srinagar (Bion, 1914), Guryul and Barus (Nakazawa et al., 1975), Selong (Wang and He, 1976), Nepal (Fuchs, 1977; Waterhouse, 1978). A questionable *Otoceras* has been reported from Timor (Welter, 1922; Bando, 1973), which was not mentioned by most other authors including Tozer.

The Arctic: East Greenland (Spath, 1930), Axel Heiberg Island and Ellesmere Island (Tozer, 1967), North Alaska and Spitzbergen (Kummel, 1972), East Verkhoyansk (Dagys et al., 1979).

South China: "Otoceras cf. woodwardi" from the Qinglong Formation near Longtan Town in the vicinity of Nanjing was described by Hsu (1937) and confirmed by Tozer (1979). However, Sheng et al. (1982) restudied the section and concluded that the fossil horizon, ca. 30 m above the Permian-Triassic boundary, was too high for Otoceras, and Wang (1984) re-identified the specimens as Koninkites, a Dienerian ammonoid. Wang (1984) described Otoceras? sp. from the dark brown mudstone or the middle Transitional Bed (see 2.2.1.) of the Meishan section, Changxing (Appendix 1). This horizon lies immediately above the Permian-Triassic Boundary Clayrock. However, the specimens are crushed and show no suture line. "Otoceras" has been reported from Shangsi (Li et al., 1986) and Susong (Xu and Xia, 1983) but their occurrence was later denied by the authors themselves. Thus the presence of Otoceras in South China is not confirmed.

3.3. Merits of Otoceras as an index fossil of the basal Triassic

3.3.1. Traditional usage of Otoceras beds as basal Triassic

Griesbach (1880) was the first who discovered *Otoceras* in the Himalayas and regarded the Himalayan *Otoceras* beds as Triassic. This view was followed by Mojsisovics (1892) and Waagen (in Mojsisovics et al., 1895). On the other hand, Von Krafft (1901), Frech (1902) and

CHINA	MEISHAN							Ophiceras Zone			Otoceras ?
	SELONG							Ophiceras sakuntala	• Otoceras	woodwardi	Otoceras Istilobatum
LAYAS	SHALSHAL							Ophiceras • tibeticum	Episageceras		Otoceres woodwardi
HIMA	SPITI							Ophiceras sakuntala	Otocores	*	Ophiceras
	KASHMIR		1					Ophiceras Zone	Otocerse	woodward	• Zone
SIBERIA	SETORYM RIVER			Vavilovites			Wordiescenes	Tompo- phiceras	Boreate	9U07 -	Concavum • Zone
LAND	WEGENER					-	Zone	e Zone	sum Zone	- Jone	Zane
GREEN	KAP STOSCH					Rosenkrentzi Zone	Decipiens	Commun	 Subdemise 	· Martin	• Triviale
	ARCTIC			Sverdrupi Zone	Candidus Zone	Strigatus	Zone	Commune Zone	Boreale	8107	Concavum • Zone
	SUBSTAGE	HIAN	HIAN		IAN		IPPER			I DWFR	
	STAGE	SPAT	SMIT	DIENE				GRIES-	BACHIAN		
LOWER TRIASSIC SYSTEM											

• Position of the *Otoceres* beds

Albertiana 11, April 1993

Noetling (1905) maintained that the *Otoceras* beds were Permian. Diener (1912) and later Spath (1934) summarized the discussions on the age of Himalayan *Otoceras* and concluded that it should be used to define the base of the Triassic and thus the Palaeozoic-Mesozoic boundary. This conclusion was generally accepted and became traditional usage for about fifty years.

In 1984, Tozer, chairman of the Permian-Triassic Boundary working Group, circulated a questionnaire to all members of PTBWG asking for opinions on the suggested level for the base of the Triassic: base of *Otoceras*? in younger beds/or in older beds? Of the 18 replies received from 21 members, 16 chose the *Otoceras* beds, one the base of Dienerian, and one the base of the *Isarcicella isarcica* Zone. It is thus clear that until 1984, the traditional usage of the *Otoceras* beds as basal Triassic was generally accepted.

3.3.2. Remarkable faunal change took place between the *Otoceras* beds and their underlying strata

The fauna of the lower *Otoceras* beds is very monotonous compared to the abundant assemblages in the underlying unambiguous Permian strata. Virtually no other indigenous groups have been found, except a few ammonoids including *Hypophiceras*, in the *O. concavum* Zone of Boreal regions, exemplified by the Griesbach Creek section on Axel Heiberg Island and the Setorym section in East Verkhoyan. In the Himalayas, forams, conodonts, bivalves, brachiopods and ophiceratids have been found in association with *Otoceras woodwardi*, but fusulinids, rugose and tabulate corals, productids, goniatitids and trilobites disappeared once and forever immediately below the level. This represents a major phase of the Permian-Triassic mass extinction. Tozer (1986, 1989) advocated that the main phase of mass extinction lies between the *Otoceras* beds and their underlying strata.

3.3.3. The appearance of Otoceras coincides with a major transgression.

The lack of uppermost Permian in the Arctic and the Himalayas represents an overall regression in extra-Tethyan regions. The sediments containing *Otoceras* marked the beginning of a large transgression which extended continuously into definitely Triassic times. It thus seems more logical to set the whole transgressive sequence in the Triassic than to assign its lowest part, the *Otoceras* beds, to the Permian.

3.4. Shortcomings and uncertainties of Otoceras as an index fossil for the basal Triassic

3.4.1. Lack of evidence for the superposition of the Otoceras Zone upon the Pseudotirolites or Paraceratites Zone due to palaeobiogeographic incompatibility

The Changxingian *Pseudotirolites* Zone in South China and the Dorashamian *Paratirolites* Zone in Armenia and Iran are commonly considered to be the youngest Permian. Accurate correlation of these two zones has not been resolved, but most workers agree that they are at least partly contemporaneous. It is embarrassing that so far the succession of *Pseudotirolites* (or *Paratirolites*) Zone - *Otoceras* Zone has not been established in a single section anywhere in the world. The only probability is the Meishan section, Changxing, South China, where *Otoceras*? sp. overlies the Permian *Pseudotirolites*. Nevertheless, as mentioned in 3.2., the crushed specimens of *Otoceras*? sp. are too poor for specific identification and thus cannot give a positive conclusion that these two zones are stratigraphically successive.

Albertiana 11, April 1993

The dilemma is rooted in their biogeographic incompatibility (Yin et al., 1986). *Otoceras* is distributed in the Boreal region and along the northern margin of Gondwana, thus showing a typical bipolarity. This character plus the biotic and isotopic analysis of the matrix have led to the deduction that the occurrence of this genus was restricted to temperate water. Its extraordinary appearance in Changxing, if finally confirmed, may be due to a southward temperate palaeo-current carrying *Otoceras* shells along the Yangtze Valley, which was then positioned in north-south direction according to palaeomagnetic reconstructions. On the other hand, both *Pseudotirolites* and *Paratirolites* show typical tropical distributions. They occurred along the margins of Eurasia and around the tropical microcontinents of Palaeo-Tethys.

3.4.2. Disconformity and unconformity below Otoceras zones

Wherever the Otoceras beds are found, their contacts with the underlying strata are not continuous. In the Guryul Ravine, Kashmir, the Zewan-Khunamuh contact is a distinct bedding plane suggesting a disconformity, although the actual Otoceras horizon (Bed 52 of Nakazawa et al., 1975) seems to be conformable with the underlying Khunamuh E1 (Beds 47-51). In the Selong section, "there are two small hiatuses between the Permian and Triassic strata, with some reworked fossils, such as Permian brachiopods, corals and crinoids being observed just above the irregular top surface of Permian strata and between Unit 4 (Changxingian) and Unit 3 (Prechangxingian)" (Wang et al., 1989). Mapping on Ellesmere and Axel Heiberg islands shows that the bedding plane below the Otoceras beds defines a low-angle unconformity (Nassichuk et al., 1972). At Setorym River, eastern Verkhoyansk, a distinct boundary is also well displayed according to Tozer (1988).

As noted by Tozer (1988), at all these localities the beds below the *Otoceras* Zone, although Permian, are generally not as young as Changxingian. This is a shortcoming because the criteria made in the Guidelines and Statutes of ICS (B. Boundary Stratotypes, 3-5a) require continuity of sedimentation through the boundary interval.

3.4.3. The Permian nature of the lower Otoceras Zone

Ammonoids: The Otoceras concavum subzone of the Arctic usually contains a monotonous assemblage comprising O. concavum, Hypophiceras and reworked Permian brachiopods. Little can be deducted from these meagre data. Tozer (1986) noted that the ammonoids definitely found in the Otoceras beds are Medlicottiaceae, Otoceratidae and Xenodiscidae (including Hypophiceras), all being Palaeozoic holdovers or having their ancestors rooted in Permian. Another Permian relict, Pseudogastrioceras has been reported in the 'black clayrock' (dark brown mudstone) with Otoceras? in Meishan, Changxing (Wang, 1984). Ophiceras has been found in the upper part, not in the lower part of Otoceras beds in the Himalayas. Moreover, there the beds are thinner than in the Arctic, by a factor of nearly 100. Hence the concurrence of both genera may be due to stratigraphic condensation.

Conodonts: In Kashmir, the lower Otoceras beds contain only *H. minutus* (Matsuda, 1985) or *Anchignathodus typicalis*, a conodont with a wide stratigraphic range, primarily Upper Permian. Bhatt et al. (1981) investigated conodonts from the Otoceras beds of sections in the Spiti Valley and Lalung, Spiti, and found that they are characterized by platform-type Late Permian *Gondolella subcarinata* and *G. orientalis* assemblages. In the Otoceras? horizon of the Meishan section only Changxingian conodonts, *Gondolella subcarinata changxingensis*, *G. deflecta*, have been found, together with *H. minutus*.

The Selong section poses some confusion. Three papers have dealt with the lowermost 0.2 m thick Otoceras beds which disconformably overly Permian strata. Wang et al. (1989) distinguished a lower bed with Otoceras latilobatum, Hindeodus parvus and G. subcarinata changxingensis, and an upper bed with O. woodwardi and H. parvus. J.X. Yao and Li (1987) assigned the whole to the O. latilobatum Zone, corresponding with two conodont zones, the lower being G. subcarinata changxingensis-G. deflecta "without typical Triassic elements", while the upper contains H. parvus associated with G. carinata, G. planata, G. subcarinata changxingensis, G. deflecta and Lonchodina mulleri. They wrote: "Considering the conodont characteristics of the Selong section, the G. subcarinata changxingensis-G. deflecta Zone of the lower Otoceras beds should be attributed to the Permian". R.B. Yao and Zhang (1985) gave a more confusing description of the column, which was reiterated in Yin et al. (1986, p. 336). According to them, Isarcicella isarcica occurred at the basal horizon together with Otoceras and G. subcarinata changxingensis, while the latter extended upward into the Ophiceras Zone. This seems to violate the generally accepted conodont succession. We will have to bear this in mind, but put it aside pending the reconfirmation of the indentification of fossil and the horizons of occurrence.

Bivalves: It was largely because of the associated *Claraia* that Bittner convinced Diener to place the *Otoceras* beds in the Triassic. Yin (1983) discussed six records of Permian *Claraia*'s, none of them appeared earlier than Guadalupian. The Permian claraiids are different from the Triassic ones and show some similarities with Permian *Pseudomonotis*, e.g. *P. speluncaria* Schlotheim. They have radial costae on right valves; the byssal notches are wide, sometimes expanded (except for in *C. caucasica* Kulikov et Tkachuk). Chen (in Zhao et al., 1981) established a new genus *Peribositra* for the claraiid discovered in the *Otoceras*? horizon of Meishan, and claimed that *Claraia bioni* Nakazawa (1977) from Khunamuh E1 and E2 of the Guryul Ravine belongs to *Peribositra*. It is clear that the claraiids found in the lower *Otoceras* bed, be it Permian-type *Claraia or Peribositra*, are different from typical Triassic claraiids. In the Dorasham 2-3 section, Armenia, *Claraia intermedia* and *C.* sp. have been reported from beds overlying the Upper Permian and lying below the *H. parvus* horizon; yet their identification should have to be re-examined pending publication of their illustrations.

Brachiopods: A number of brachiopods have been recorded in association with Otoceras. In Greenland such brachiopods have been regarded as Permian fossils reworked from the underlying beds (Teichert et al., 1976). However, in the Himalayas, South China and the Southern Alps, brachiopods from the Otoceras beds and the transitional beds are usually autochthonous. Bed 52 of Khunamuh E1 in the Guryul Ravine yields the Permian genera Marginifera and Pustula. Waterhouse (1978) reported that brachiopods from the Nepalese lower Otoceras beds were all of the Permian type and claimed a latest Permian age for them. In the Chhidru Nala section, Salt Range, the Lower Unit of the Kathwai Member or the H. minutus Zone, roughly corresponding to the lower Otoceras beds, yields Permian brachiopods, reworked forams and bryozoans, and was considered to be Permian (Pak.-Jap. Res. Group, 1985). The overlying Middle Unit was named H. parvus Zone and does not contain any Permian brachiopods. At the base of the Lower Unit, immediately above the white sandstone of the Chhidru Formation, Yan Jiduan and Li Zishun have observed a 0.3 m thick unstable clay bed (Yang and Li, unpublished report, 1987). At least seventeen species of Permian-type brachiopods have been reported from the Transitional Beds in South China (Liao, 1980). The biggest variety is to be found in the lower bed with Otoceras? In the Southern Alps, six Permian-type brachiopods (ranging from Palaeozoic to Lower Triassic) have been discovered together with Bellerophon from the Mixed Fauna beds of the lower Tesero Member, Tesero section in the western Dolomites, Italy (Broglio-Loriga and Cassinis, 1992). In both South China and the Southern Alps, these brachiopods are considered as Permian relicts which survived the extinction at the

Albertiana 11, April 1993

P/T boundary. To summarize, the brachiopods from the lower *Otoceras* bed and its equivalents are all of the Permian type, although it may be argued that they are either reworked or relicts. The same can be said about gastropods and probably also about forams.

3.4.4. Graphic correlation

Sweet (1979, 1986, 1992) published conodont-based graphic correlations for the Permian-Triassic boundary interval and concluded that the *Otoceras* beds overlap the Dorashamian and should thus be Permian. Yin et al. (1986) followed with emphasis on the South China sections and reached conclusions similar to Sweet's, but differing in that the overlap is partly, i.e., only referring to the lower *Otoceras* bed. In a circular to members of SPS, STS and PTBWG, Tozer (1989) criticized Sweet's methodology and stated that the time ranges (Standard Time Units) he deduced are merely interpretations, some of which cannot be demonstrated or denied at any locality, and that Sweet's assumption of continuity of sedimentation and regular, unchanging rate of sedimentation is not proved in the sections he used. Tozer emphasized that in both Guryul and Kuh-e-Ali Bashi, which Sweet used for his graphic correlation, the Permian-Triassic contacts are discontinuous. Graphic correlation has thus only raised the overlap problem but left it unsolved due to strong opposition.

3.4.5. Which species of Otoceras is to be chosen as index for basal Triassic correlation?

Up to 1989 the lower *Woodwardi* Zone and the *Concavum* Zone were regarded as contemporaneous and accepted as the lowermost zonal species. *O. woodwardi* was preferred because it is widespread along the Gondwanan margin of the Tethys, whereas *O. concavum* is restricted to the Arctic islands of Canada and Verkhoyansk. Wang et al. (1989) discovered that *O. latilobatum* underlies *O. woodwardi* and thus assumedly correspond to the *Concavum* Zone in the Selong section. However, if we are to choose *O. latilobatum* as the index fossil, its sole appearance in south Tibet so far seems a shortcoming for wide-range stratigraphic correlation.

4. Potential index fossil 2 - Hypophiceras

Hypophiceras was established by Truempy (1969) as a subgenus of Glyptophiceras. Wang (1984) raised it to the status of a genus on the basis of morphological and stratigraphical differences (Glyptophiceras is basically Smithian); they belong to different families. In East Greenland it occurs together with Otoceras and is generally considered contemporaneous with the latter. The Hypophiceras beds are subdivided into two zones: Triviale and Martini. Their correlation with Otoceras is shown in Table 1. In 1984, Wang described two Hypophiceras species from the Otoceras?-bearing dark brown mudstone of the Meishan section and, after a discussion of the ammonoid fauna associated with Hypophiceras, he formally suggested Hypophiceras sp. was later reported from the basal Triassic bed of the Shangsi section, together with G. subcarinata changxingensis and Pseudogastrioceras sp. (Li et al., 1989; Yang et al., 1987), and also from the Transitional Beds of a few other sections in South China, e.g. the Huangsi section, Hubei.

So far all the Chinese specimens of *Hypophiceras* consist of crushed shell remains or molds, although obscure suture lines have been illustrated for *H. changxingensis* Wang. Both this new species and the other identified species, *H.* cf. *martini* have only been reported from Meishan,

with *H. martini* being the upper zone fossil in Greenland. So far no one has claimed the status of the main index fossil for the basal Triassic for it, thus it seems better to retain it as a potential index fossil.

5. A second choice - Isarcicella isarcica-Ophiceras-Claraia

This assemblage has been recommended by many authors as index fossils for the basal Triassic (Kozur, 1980; Yao and Li, 1987; Sweet, 1992). The boundary is suggested between the Lower and the Upper Griesbachian (Gangertian and Ellesmerian) Substages (Table 1). Both *Ophiceras* and *Claraia* have sparse occurrences in the Lower Griesbachian and even in the Late Permian (*O. connectens* in the Salt Range, claraiids in Late Permian as mentioned above). Even *I. isarcica* can occasionally be found in the underlying *Parvus* Zone, but it is in the early Upper Griesbachian that they simultaneously underwent flourishing speciation and reached high abundance. Hence it is reasonable to place *I. isarcica-Ophiceras-Claraia* in one acme zone symbolizing the lower Upper Griesbachian.

5.1. Merits of I. isarcica-Ophiceras-Claraia as index fossils for the basal Triassic

5.1.1. The IOC assemblage is the first real Triassic fauna

As noted above, the fauna of the lower Otoceras bed consists almost entirely of Permian fossils. Although the *H. parvus* Zone yields a few Triassic newcomers, it is still dominated by Permian-type elements. It is from the *IOC* assemblage that Triassic components become dominant. *Isarcicella* is a short-lived Triassic conodont, and both *Ophiceras* and *Claraia* are well-known Triassic forms. Most Permian-type brachiopods and ammonoids (except for *Crurithyris* and a few others) became extinct just below this level. So are Permian-type condonts (*changxingensis*, *deflecta*). Their mixture in the Selong section may be the result of reworking or condensation. The boundary between the Lower and Upper Griesbachian marks an extinction and a major origination event.

5.1.2. The IOC assemblage has a worldwide distribution

This assemblage has been found throughout the Tethys from the Alps to South China and along both its Gondwanan and Eurasian margins. Although *I. isarcica* has not yet been reported from the Arctic regions, the abundant *Ophiceras-Claraia* assemblages there allow confident interregional correlations.

5.1.3. Continuity of sedimentation in the Lower-Upper Griesbachian interval is confirmed in most localities

5.1.4. The *IOC* Acme Zone is a multispecies fossil zone preferable for biostratigraphic signatures

for GSSP guidance, as advocated in the Guidelines and Statutes of the ICS

5.2. Shortcomings and uncertainties of the *IOC* assemblage as index fossils for the basal Triassic

The main problem of the IOC assemblage is that together they form an acme zone, not a range

zone. Both *Ophiceras* and *Claraia* made their first appearance before the late Griesbachian, mixed with *Otoceras*, *H. parvus*, or occur in the Transitional Beds of South China. Even *I. isarcica* appears in the *Parvus* Zone (Chhidru Nara), or vice versa (Hambast C section, Iran). This will induce correlation uncertainties if we cannot differentiate their first appearances from their acme zone. Moreover, traditional usage would make people preferring the Lower Griesbachian to Upper Griesbachian as the basal Triassic.

6. Correlation of the Changxingian-lower Griesbachian interval of major Tethyan and marginal Gondwanan sections

Based on data collected by various authors, a tentative correlation table is given here for the purpose of re-assessing the capability of the Global Boundary Stratotype Section candidates of major sections. There are famous Arctic sections, e.g., Loc. 6.75, Kap Stosch, (Teichert and Kummel, 1976) and Pingel Dal, Jameson Land, E. Greenland (Grasmuck and Truempy, 1969); Griesbach Creek, Axel Heiberg Island (Tozer, 1961, 1967); Setorym River, E. Verkhoyan, Siberia (Dagys et al., 1979). They are not listed in the table because their data are insufficient for a detailed correlation as is displayed in the table. Moreover, all Arctic sections lack an appreciable part of the Upper Permian, and are thus not considered as suitable GSSP candidates.

The correlation is based on biostratigraphy and partly on lithology, taking little account on the thickness. Six subdivisions have been established for correlation.

1. The Paratirolites Zone

2. The Pseudotirolites-Pleuronodoceras Zone

Many authors regarded *Paratirolites* and *Pseudotirolites* as contemporaneous (e.g. Tozer, 1986). These two genera seldom occur together. *Paratirolites* flourished in western Asia while *Pseudotirolites* is restricted to eastern Asia. The present table which tentatively places *Paratirolites* lower than *Pseudotirolites* is based on two discoveries. In South China *Paratirolites* is associated with the lower Changxingian *Sinoceltites* (Kucaoping, Xixiang Co., Shaanxi, Yang et al., 1987, p.177) and *Shevyrevites* (Jiaozishan, Anshun Co., Guizhou, Zheng, 1981). In Dorasham, Zakharov (1992) established an upper Changxingian *Pleuronodoceras* was originally included in *Pseudotirolites* and is synchronous with it.

By the way, the *Pseudotirolites* and *Pleuronodoceras* recorded in the Kuh-e-Ali Bashi section (Teichert et al., 1973) was later discussed and declined by Zheng (1981) and Chao et al. (1981).

3. The Boundary Claystone, or 'white claystone' of volcanic origin

It is widespread in South China. In Iran, a clay bed has been reported at the supposed Permo-Triassic boundary in the Abadeh section (Iran.-Jap. Res. Group, 1981), and similar beds occur in the Gheshlagh section, eastern Elburz (Altiner et al., 1979). In the Southern Alps, a clay bed has been discovered between the Bellerophon and Werfen Formations in the Casera Federata section and also in the lower part of the Tesero Member (Field guidebook for the Brescia Meeting on Permo-Triassic, 1986).

In the Gartnerkofel borehole the sample at the Bellerophon-Tesero boundary (sample 205, Boeckelmann, 1991) is remarkably missing, implying something lithologically softer than carbonates. The boundary rocks of the Dorasham and Kuh-e-Ali Bashi are shales. In their unplushed report Yang Jiduan and Li Zishun (1987) noticed an unstable claybed between the Chhidru Formation and the Lower Unit of the Kathwai Member in the Nammal section of the Salt Range. Further study is required whether all these boundary rocks are synchronous.

4. The Lower Otoceras woodwardi Zone or O. latilobatum Zone

This subdivision is mainly distributed in marginal Gondwana (Guryul, Chhidru and Selong). It is characterized by *H. minutus*, *G. subcarinata changxingensis*, *G. deflecta*, Permian brachiopods and forams, plus rare claraiids including 'Peribositra'. The fauna is predominantly Permian. The 'black clay' (Appendix 1) at Meishan, yielding Otoceras?, Hypophiceras etc., is probably its equivalent in South China. The discovery of Pseudotirolites? in the 'black clay' (bed 6, Appendix 2) of Shangsi poses a remarkable problem because this implies a partly overlap of the Otoceras bed with Pseudotirolites bed, if the specimen was correctly identified. Its equivalents in Abadeh, Kuh-e-Ali Bashi and Dorasham are actually unknown and it is possible that they are either missing (disconformity) or form part of Pleuronodoceras Zone.

5. The H. parvus Zone

This zone corresponds with upper *Otoceras* Zone and is delineated by the first appearance of *H. parvus* and topped by the base of *I. isarcica-Claraia-Ophiceras* Acme Zone. It differs from subdivision 4 in the fact that both Triassic elements (*I. isarcica, Claraia, Ophiceras, Unionites*) and Permian brachiopods can be found in this horizon. On the other hand the former never flourished as they did in subdivisions 4 and 6.

6. The I. isarcica-Claraia-Ophiceras Acme Zone

Notes to Table 2 - Correlation of the Chanxingian-Upper Griesbachian interval of major Tethyan and marginal Gondwanan sections (see opposite page)

- Note 1: Mixed bed 1+2 (Sheng et al., 1984) corresponds with the Transitional Beds (Yin, 1985).
- Note 2: Kozur (pers. comm.) claimed that H. descrescens (Dai et Zhang) should be H. turgidus.
- Note 3: Yao et Zhang (1985) reported *G. subcarinata changxingensis* at this level, which was not confirmed by Yao et Li (1987) and Wang et al. (1989).
- Note 4: Yao et Zhang (1985) reported *I. isarcica* at this level, which was rather confusing and not confirmed by Yao et Li (1987) and Wang et al. (1989). If this is true, some kind of condensation or reworking could be assumed (see 2.3.2. and 3.4.3.).
- Note 5: Bed 5 corresponds lithologically and faunistically with Mixed bed 1 from Meishan and thus with subdivision 4. Bed 6 is also encluded in 4 because of the faunal similarity.
- Note 6: The base of *Claraia* beds probably corresponds with Bed 22a of Teichert et al. (1973), from where Sweet identified *H. typicalis*, a species he originally included *H. parvus*. Sweet also identified one *H. typicalis* specimen (here in subdivision 4) from the topmost part of the Ali Bashi Formation, and suggested a conformity contact with overlying Elikah Formation. A 1.1 m thick red marl lies at the basal Triassic (or top Permian). Kozur, Tozer, Sweet, Bando and the Iran.-Jap. Res. Group maintained that the two formations were conformable, while Altiner et al., Golshani et al. held the opinion that they were disconformable.

GARTNERKOFEL Holser et al., 1991	Mazzin I. isarcica H. turgidus H. parvus	Tesero-L.Mezzin H. pervus H. minutus H. cf. latidentatus	~	sample 2057	Bellerophon Fm Hemiordius	Globivalvulina
TESERO Broglio Lorige et el., 1986; Broglio Lorige et Cessinis, 1992	Mazzin, Bed 46 up Pseudoclaraia wangi C. griesbachi	U.Tesero-L.Mazzin Beds 16-45 <i>Unionites-Lingula</i> <i>H. pervus</i> no Perm. brechio. & forems	Beds 7c-15 Mixed feuna <i>H. Isticlentatus</i> Perm. brachiopods & forams	clay bad (Casera Fad.)	Beilrophon Fm Bed 1-7b,	a forams
DORASHAM 2-3 Kotijar et al., 1983; Zakharov, 1985, 1992	Claraia Bods 25- 34 (Zak. 1992) Claraia Lytophiceras I. isarcica H. turgidus	Beds 20-24 (Zakharov, 1992) <i>H. parvus</i> <i>Claraia</i> (rare) <i>H. latidentatus</i> (Kozur, 1980)	~	~	Pleuronodoceres occidentele zone	Peratirolites kitti zone G. subcerinate H. minutus Perm. forams
KUH-E-ALI BASHI Teichert et al., 1973; Attiner et al., 1980; Golshani et al., 1986	Ciereie Beds Claraie Ophiceres I. isercice	base of Clareia Beds <i>H. parvus</i> <i>H. typicelis</i> "6 Clareie	~	~	-7	Ali Bashi Fm Paratirolites G. carinata C. subcarinata
HAMBAST C (Abadah) Iren. Jap. Res. Group. 1981	L. Triassic Unit a, Bed 2-5 Clareia, Xenodiscus H. parvus H. turgidus I. isaerica G. orientalis	Unit a, Bed 1 H. pervus H. typicelis	~	Unit a, Bed O (cley)		Hambast Fm, U. Paratirolites Iranites Julfotoceras G. subcarinata H. typicalis
SELONG Yeo et Zheng, 1985; Yeo et Li, 1987; Weng et el., 1989	Ophiceras G. carinata	0. woodwardi H. pervus *3	O. latilobatum H. minutus H. parvus I. isarcica *4 G. sub. changxingensis G. deflecta 'Pevibositua		G. sub. G. sub. changxingensis Perm. brachlo.	1
CHHIDRU NALA Kummel et Teichert, 1970; PekJap. Res. Gr., 1985	Kathwai Upper Unit Ophieras G. carinata	Middle Unit H. pgrvus H. minutus I. isercica	Lower Unit <i>H. minutus</i> Perm. brechio.	unstable clay *6		Chhideu Fm
GURYUL RAVINE Nakazawa et al., 1975; Matsuda, 1981; Kapoor, 1992	Kuhnamuh E3 + upper E2 Ophicerss C. griesbachi G. cerinate	E2 Bed 55-58 O. woodwardi H. parvus H. minutus	E2 Bed 52-54 O. woodwardi Lytophiceras sekuntala 'Peribositre' H. minutus	~	7 Kuhnemuh E1 Perm. brachlo. & forams 'Peribositre'	Zewan D
SHANGSI Li et al. 1996, 1999; Yang et al., 1987	Bed 9-15 Ps. wangi C. yriesbachi H. parwus H. decrescens I. isarcice	Bed 7-8 Clarais H. decrescens	Bed 6 'Black Clay' Hypophicaras G. sub. chengxingensis Red 5 *5 Metophiceras Pseudotirolites? C. sub. chengxingensis	Boundery Clay	Pseudoceratiles Plauronodoceras G. sub changxingensis G. deflecta	L. Dalong
MEISHAN Sheng et al., 1984, 1987; Wang, 1984; Yang et al., 1987; Zhang, 1987	Mixed bed 3 Ophiceras Pseudochreia wangi C. griesbachi	Mixed bed 2 H. pervus H. minutus	Mixed bed 1 Black Clev Otoceres Hypophiceres Hindeodus minutus G. sub. G. dellecta 'Peribositra' Perm. brachio.	Boundery Clay G. sub. Changxingensis G. dellecta H. minutus	Palaeotusuline Pleuronodoceras Rotodiscoceras G. sub. changxingensis G. deflecta	L. Changxing
BED	G	n	4	m	5	-

Summary

H. parvus is suggested as the index fossil for the basal Triassic, and *Otoceras* and *Hypophiceras* are suggested as as potential index fossils. However, biostratigraphic research at species level is needed for *Otoceras* because the lower *Otoceras* Zone may be Permian. An alternative or second choice is to take the *Isarcicella isarcica-Ophiceras-Claraia* assemblage as index fossils, i.e., to take the *Isarcicella isarcica-Ophiceras-Claraia* assemblage as index fossils, i.e., to take the *Isarcicella* isarcica-Ophiceras-Claraia assemblage as index fossils, i.e., to take the *Isarcicella* isarcica-Ophiceras-Claraia boundary. The Griesbachian-Dienerian and the Dienerian-Smithian boundaries have been suggested as candidates for the Permian-Triassic boundary (Newell, 1978; Waterhouse, 1976, 1978). Pros and againsts for these two candidates have been published elsewhere and will not be repeated here because of the lack of new data and lively arguments recently.

2. Six subdivisions are established for a detailed boundary correlation of major sections in the Tethys and the marginal Gondwana regions. These subdivisions are tentative. Subdivisions 1 and 2 may be contemporaneous. Subdivision 3 is regionally restricted. Subdivisions 2 and 4 may be partly overlapping. Requirement of a non-overlapping stratigraphic column prefers the selection of global stratotype sections in same biogeographic region, preferably in Tethys.

Appendix 1 - The Meishan section (Zhongxin Dadui Quarry Section), Changxing County, Zhejiang Province, south China

A number of papers have been published on the sections of Meishan and Shangsi. They gave different fossil lists and measurements of thickness, sometimes even different descriptions of the rocks for the same beds. In these appendices we try to integrate information from various authors in order to give non-Chinese readers a comprehensive understanding of these two sections.

Different descriptions will be quoted with sources in parenthesis, and comments will be made where necessary. The first thickness refers to the author(s) first mentioned; the second thickness (in parenthesis) refers to the author(s) next mentioned.

The Meishan section is located about 25 km NW of Changxing, where the Changxing (or Changhsing) Limestone Formation represents the highest Permian-Changxingian of the world. In the Meishan area six quarries are being excavated and the limestone is used for construction. The type locality of the Meishan section, the Zhongxin Dadui quarry section, is located near Baoqing Village, about 0.5 km east of the west end of Meishan Mountain. The section is about 150 m long, beginning in the Dzhulfian Longtan Formation in the south and ranging into the Induan Yinkeng Formation in the north. The sequence is continuous and not faulted, dipping NW (ca. 320°) with an inclination nearly 40°. For the purpose of our proposal only the portion spanning the *Pseudotirolites* Zone - *Pseudoclaraia wangi* Zone is recorded.

20

1.

STRATIGRAPHICAL DESCRIPTION

(Zhao et al., 1981; Sheng et al., 1984; Yin, 1985; Yang et al., 1987)

Lower Triassic - Lower Chinglung (Qinglong) Formation or Yinkeng Formation

14.	Greyish yellow mudstone with concretions of limestone, yielding <i>Claraia stachei</i> (Bittner) in the middle part, and <i>Palaeonucula</i> sp., <i>Claraia</i> sp. in the lower part	6.00 m
13.	Yellow illite-montmorillonite clay	0.02 m
	Mixed bed 3 (Sheng et al., 1984) or <i>Pseudoclaraia wangi</i> Zone (Yin, 1985), corresponding to the <i>IOC</i> Acme Zone	
12.	Greyish yellow marl containing C. griesbachi (Bittner)	0.30 m
11.	Yellow illite-montmorillonite clay	0.02 m
10.	Greyish yellow mudstone yielding <i>Pseudoclaraia wangi</i> (Patte), <i>Claraia dieneri</i> Nakazawa (Sheng et al., 1984), or, dark grey fine siltstone yielding ammonoids: <i>Ophiceras</i> sp.; bivalves: <i>Claraia griesbachi</i> (Bittner), <i>C.</i> sp., <i>Pseudoclaraia</i> <i>wangi</i> (Patte) (Yang et al., 1987)	0.98 m (1.00 m)
9.	Yellow illite-montmorillonite clay	0.04 m
8.	Blueish grey marl containing ophiceratids (Sheng et al., 1984), <i>Pseudoclaraia wangi</i> (Patte), <i>C. griesbachi</i> (Bittner) (Yang et al., 1987)	0.46 m
7.	Greyish yellow marl (Sheng et al.), or, argillaceous lime- stone (Yang et al.). It yields <i>Pseudoclaraia wangi</i> and ophi- ceratids (Sheng et al.); brachiopods: <i>Paryphella orbicularis</i> (Liao); conodonts: <i>Anchignathodus</i> sp., <i>Gondolella</i> sp., <i>Xaniognathodus elongatus</i> Sweet (Yang et al.)	0.36 m (0.26 m)
6.	Greyish yellow mudstone	0.02 m
5.	Greyish yellow clay	0.02 m
	Mixed bed 2 (Sheng et al., 1984) or upper the Transitional Bed (Yin, 1985)	
4.	Light grey dolomitic marl (Sheng et al.), or, medium-bedded silt limestone (Yang et al.), containing brachiopods: Aco- sarina cf. minuta (Abich), Crurithyris flabelliformis (Liao), Fusichonetes pigmaea (Liao), Neochonetes sp.(?), Pary- phella orbicularis (Liao), P. triquetra Liao, Waagenites sp., W. barusiensis (Davidson); conodonts: H. parvus (Kozur et Pjatakova), H. minutus (Ellison), Prioniodella ctenoides (Tatge), Lonchodina mulleri Tatge (Yang et al., 1987). Two specimens of H. parvus were discovered and illustrated by Zhang (1987) 14 cm above the base of bed 3. However, Kozur duybted that they may be imposite H. letterature	0.16 m (0.15)
	Nozur obubleu that they may be juvenile h. latidentatus	0.16 m (0.15 m)

Mixed bed 1 or the lower Transitional Bed

'Black Clay' (Permian?). Greyish yellow mudstone with small crystals of pyrite (Sheng et al.) or Dark brown, calcareous mudstone (Yang et al.), yielding ammonoids: Otoceras? sp., Hypophiceras cf. martini (Truempy), H. changxingense Wang, Tompophiceras sp., Metophiceras sp., Pseudogastrioceras sp.; bivalves Peribositra baoginensis Chen; brachiopods: Paracrurithyris pigmaea (Liao), Waagenites barusiensis (Davidson), Paryphella sulcatifera Liao, Neowellerella pseudoutah (Huang), Araxathyris minuta Grunt (Sheng et al., 1984); also brachiopods: Cathaysia chonetoides (Chao), Crurithyris flabelliformis Liao, Neochonetes convexa Liao, Paryphella orbicularis (Liao), P. triquetra Liao, Uncinunellina sp., Waagenites cf. soochowensis (Chao), W. wongiana (Chao); conodonts: Gondolella subcarinata changxingensis Wang et Wang, G. deflecta Wang et Wang, G. carinata Clark (Yang et al., 1987; Zhang, 1987)

0.06 m (0.07 m)

------ conformity 1(1) ------

Upper Permian--Changxing Formation

The Pseudotirolites-Palaeofusulina Zone

Permian-Triassic Boundary Clayrock ('White Clay'): white illite-montmorillonite claystone yielding conodonts: Gondolella subcarinata changxingensis Wang et Wang, G. deflecta Wang et Wang, G. orientalis Barskov et Koroleva (Yang et al., 1987)

Grey medium-bedded micrite yielding fusulinids: *Palaeo-fusulina* sp.; ammonoids: *Rotodiscoceras* sp. 2⁽²⁾; conodonts: *Gondolella subcarinata changxingensis* Wang et Wang, *G. deflecta* Wang et Wang (Yang et al.) 0.04 m

0.20 m

- Note 1: Tozer (1986, 1988) regarded the P/T contact in the Meishan section as discontinuous and the brachiopods in the Transitional Bed as reworked. Chinese authors, however, without exception hold the opinion that the contact is conformable and that the brachiopods are autochthonous. Because the Boundary Clayrock was formerly placed in the Triassic, what Tozer's discontinuous contact is actually situated between beds 1 and 2. Even there, the contact is to us clearly conformable. The Boundary Clayrock is now shifted to the Permian because of the discovery of Permian conodonts in it.
- Note 2: Rotodiscoceras is a typical ammonoid genus of the Pseudotirolites Zone. The assemblage of Bed 1 thus definitely denotes a latest Changxingian age. Zhao et al. (1981) found a number of forams, corals, cephalopods, bivalves, brachiopods and algae, among which are Pleunodoceras mirificum Zhao, Liang et Zheng, P. multinodosum Chao et Liang, Rotodiscoceras asiaticum Chao et Liang, Pachydiscoceras changhsingense Chao et Liang and Changhsingoceras meishanense Chao et Liang, all character-

Albertiana 11, April 1993

22

3.

1.

2.

istic ammonoids of *Paratirolites* Zone, in the underlying 2.77 m thick dark grey, medium-bedded micrites.

Note 3: Carbon isotope values change abruptly from positive to negative across the P/T boundary in the Meishan section (Chen et al., 1984). Palaeomagnetic results has been reported from the P/T interval of the adjacent section D of Meishan. Unstable iridium anomaly and sphaerules have been recorded from the Boundary Clayrock and the overlying *Otoceras?* bed. However, due to the discovery of high quartz and other volcanic minerals and shards, plus typical structures and texture discovered in other localities, the Boundary Clayrock is now generally accepted as of volcanic origin (Yin et al., 1992).

APPENDIX 2 - SHANGSI SECTION (CHANGJIANGGOU SECTION), GUANGYUAN COUNTY, SICHUAN PROVINCE, SOUTH CHINA

The Shangsi section is situated at 32°7'N and 105°30' E near the Qingshuihe River, a tributary of the Jialingjiang River. Although Shangsi is a small village, it is accessible easily by the train running from Baoji (in Shaanxi Province) to Chengdu (capital of Sichuan Province) via Guangyuan, and by the Sichuan-Shaanxi Highway passing through Shangsi, 50 km from the county seat and 300 km from Chengdu. The section is located in the Changjianggou Valley about 1 km north of Shangsi Village, along the feeder-way of the Sichuan-Shaanxi Highway. The monoclinal section running from north to south is nearly 500 m long, with a continuous outcrop of the Permian-Lower Triassic sequence. The strata dips to SE about 136-145° at an inclination of about 40°. No fault has been recognized. For the purpose of our proposal only a small portion spanning the *Pseudotirolites* Zone-*I. isarcica* Zone is described here.

STRATIGRAPHIC DESCRIPTION

(Li et al., 1986, 1989; Yang et al., 1987)

Lower Triassic, Fexianguan Formation, Member 1

15.	Grey medium breccia-bearing micrite, yielding conodonts: <i>Isarcicella isarcica</i> (Huckriede), <i>I. staeschei</i> (Huckriede), <i>Hindeodus parvus</i> (Kozur et Pjatakova), <i>H. minutus</i> (El- lison), <i>H. anterodentatus</i> (Dai et Tian), <i>Neohindeodella</i> sp.	2.68 m
14.	Grey laminated algae-sheeted limestone. Conodonts: <i>H. parvus</i> (Kozur et Pjatakova), <i>Enantiognathus ziegleri</i> (Diebel)	0.96 m
13.	Interbedded yellowish green thin-bedded argillaceous mi- crite and grey laminated algae-sheeted dolomitic limestone. Conodonts: <i>H. parvus</i> (Kozur et Pjatakova), <i>H. minutus</i> (Ellison)	2.69 m
12.	Yellowish green marl with grey argillaceous micrite intercal- ations. Bivalves: <i>Claraia</i> sp.; conodonts: <i>H. parvus</i> (Kozur et Pjatakova), <i>H. decrescens</i> (Dai et Zhang); palynomorphs: <i>Chordasporites</i> sp., <i>Abietineaepollenites</i> sp., <i>Pinuspollenites</i> sp., <i>Catonispollenites</i> sp.	1.80 m

23

 Yellowish green fine thin-bedded illite-montmorillonite mudstone with minor intercalations of marks. Bivalves: Claraia griesbachi (Bittner), <i>Pseudoclaraia wangi</i> (Patte), <i>Towapteria scythica</i> (Wirth); condonts: <i>H. decrescens</i> (Dai et Zhang), <i>H. minutus</i> (Ellisoni, <i>Neohindeodella triassica</i> (Muller), <i>Neospathodus</i> sp., <i>Ellisonia</i> sp.; palynomorphs: Verrucosisporites sp., <i>Nacearpidites</i> sp., <i>Cedripites</i> sp., <i>Taeniaesporites</i> sp., <i>Jugasporites</i> Sp., <i>Cedripites</i> Sp., <i>Contexporters</i> Schen, <i>C. hubei</i> ensis Chen Greenish grey calcareous shale and slity shale. Bivalves: <i>Pseudoclaraia wangi</i> (Patte), <i>Claraia griesbachi</i> (Bittner); conodont: <i>H. decrescens</i> (Dai et Zhang) Yellowish green thin-bedded sandy shale (bed 24 of Yang et al., 1987; Bed 28d of Li et al., 1986, 1989). Bivalves: <i>Pseudoclaraia wangi</i> (Patte), <i>Claraia et al.</i>, 1987; Bed 28d of Li et al., 1986, 1989). Ophiceratids; conodont: <i>H. decrescens</i> (Dai et Zhang) O.60 m (0.74 m) Transitional Bed 1^m Greenish grey slity shale (Bed 23 of Yang et al., 1987; Bed 28d of Li et al., 1986, 1989). Bivalves: Towapteria scythica (Wirth), <i>Claraia</i> sp.; gastropod: <i>Polygyrina</i> sp. O.49 m (0.64 m) Cight yellow and greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1889). Bivalves: Towapteria scythica (Wirth), <i>Claraia</i> sp.; gastropod: <i>Polygyrina</i> sp. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1889). Bivalves: <i>Mololusi?</i> sp.; ammonidis: <i>Hypophiceras</i> sp., <i>Cycadopites</i> sp. Black Clay' (Permian?)^{16,30}, Dark grey mont			
 10. Greenish grey calcareous shale and silty shale. Bivalves: Pseudoclaraia wangi (Patte), Claraia griesbachi (Bittner), C. yunnanensis (Yin et Hsu), C. guizhouensis Chen, C. hubei- ensis Chen 0.43 m 9. Yellowish green thin-bedded sandy shale (bed 24 of Yang et al., 1987; Bed 28d of Li et al., 1986, 1989). Bivalves: Pseudoclaraia wangi (Patte), Claraia cf. griesbachi (Bittner); conodont: H. decrescens (Dai et Zhang) 0.60 m (0.74 m) Transitional Bed 1⁽¹¹⁾ 8. Greenish grey silty shale (Bed 23 of Yang et al., 1987; Bed 28c of Li et al., 1986, 1989). Ophiceratids; conodont: H. decrescens (Dai et Zhang) 0.49 m (0.64 m) 7. Light yellow and greenish grey thin-bedded limestone inter- calated with shale (upper part of Bed 22 of Yang et al., 1987; Bed 28b of Li et al., 1986, 1989). Bivalves: Towap- teria scythica (Wirth), Claraia sp.; gastropod: Polygyrina sp. 0.24 m 6. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: Modiolus? sp.; ammonoids: Hypophiceras sp., Glyptophiceras sp.; conodonts: G. sub- carinata (Sweet), G. subcarinate changxingensis (Wang et Wang), G. sp., Hindeodella sp.; palynomorphs: Circumpollis sp., Cycadopites sp 5. 'Black Clay' (Permian?)^(2,3). Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: Claraia guangunensis Li; ammonoids: ?Huana- noceras sp., Pseudogastrioceras sp., Metophiceras sp., Tompophiceras sp., Pseudogastrioceras sp., Metophiceras sp., Tompophiceras sp., Pseudogastrioceras sp.; Seudotirolites? sp. is represented by crushed specimens with traverse ribs and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987) 	11.	Yellowish green fine thin-bedded illite-montmorillonite mudstone with minor intercalations of marls. Bivalves: <i>Claraia griesbachi</i> (Bittner), <i>Pseudoclaraia wangi</i> (Patte), <i>Towapteria scythica</i> (Wirth); conodonts: <i>H. decrescens</i> (Dai et Zhang), <i>H. minutus</i> (Ellison), <i>Neohindeodella triassica</i> (Muller), <i>Neospathodus</i> sp., <i>Ellisonia</i> sp.; palynomorphs: <i>Verrucosisporites</i> sp., <i>Kraeuselisporites</i> ? sp., <i>Alisporites</i> sp., <i>Pinuspollenites</i> sp., <i>Jugasporites</i> sp., <i>Taeniaesporites</i> sp., <i>Jugasporites</i> sp.	1.91 m
 9. Yellowish green thin-bedded sandy shale (bed 24 of Yang et al., 1987; Bed 28d of Li et al., 1986, 1989). Bivalves: <i>Pseudoclaraia wangi</i> (Patte), <i>Claraia</i> cf. griesbachi (Bittner); conodont: <i>H. decrescens</i> (Dai et Zhang) Transitional Bed 1¹⁰ 8. Greenish grey silty shale (Bed 23 of Yang et al., 1987; Bed 28c of Li et al., 1986, 1989). Ophiceratids; conodont: <i>H. decrescens</i> (Dai et Zhang) 0.49 m (0.64 m) 7. Light yellow and greenish grey thin-bedded limestone intercalated with shale (upper part of Bed 22 of Yang et al., 1987; Bed 28b of Li et al., 1986, 1989). Bivalves: <i>Towapteria scythica</i> (Wirth), <i>Claraia</i> sp.; gastropod: <i>Polygyrina</i> sp. 6. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: <i>Numpophiceras</i> sp., <i>Glyptophiceras</i> sp.; conodonts: <i>G. subcarinata</i> (Sweet), <i>G. subcarinata changxingensis</i> (Wang et Wang), <i>G. sp., Hindeodella</i> sp.; palynomorphs: <i>Circumpollis</i> sp., <i>Cycadopites</i> sp. 5. 'Black Clay' (Permian?)^(2,3). Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: <i>Claraia guangyuanensis</i> Li; ammonids: <i>?Huananoceras</i> sp., <i>Pseudogastrioceras</i> sp., <i>Metophiceras</i> sp., <i>Tompophiceras</i> sp., <i>Pseudotirolites</i>? sp.; <i>Pseudotirolites</i>? sp.; <i>bseudotirolites</i>? sp	10.	Greenish grey calcareous shale and silty shale. Bivalves: <i>Pseudoclaraia wangi</i> (Patte), <i>Claraia griesbachi</i> (Bittner), <i>C. yunnanensis</i> (Yin et Hsu), <i>C. guizhouensis</i> Chen, <i>C. hubei-ensis</i> Chen	0.43 m
 Transitional Bed 1⁽¹⁾ 8. Greenish grey silty shale (Bed 23 of Yang et al., 1987; Bed 28c of Li et al., 1986, 1989). Ophiceratids; conodont: <i>H. decrescens</i> (Dai et Zhang) 7. Light yellow and greenish grey thin-bedded limestone intercalated with shale (upper part of Bed 22 of Yang et al., 1987; Bed 28b of Li et al., 1986, 1989). Bivalves: <i>Towapteria scythica</i> (Wirth), <i>Claraia</i> sp.; gastropod: <i>Polygyrina</i> sp. 6. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: <i>Modiolus</i>? sp.; ammonids: <i>Hypophiceras</i> sp., <i>Glyptophiceras</i> sp.; condonts: <i>G. subcarinata</i> (Sweet), <i>G. subcarinata changxingensis</i> (Wang et Wang), <i>G.</i> sp., <i>Hindeodella</i> sp.; palynomorphs: <i>Circumpollis</i> sp., <i>Cycadopites</i> sp. 5. 'Black Clay' (Permian?)^(2,3). Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: <i>Claraia guangyuanensis</i> Li; ammonoids: <i>?Huananoceras</i> sp., <i>Pseudogastrioceras</i> sp., <i>Netophiceras</i> sp., <i>Tompophiceras</i> sp., <i>Pseudotirolites</i>? sp.; <i>Aseudotirolites</i>? sp.; <i>Aseudotirolites</i>? sp. is represented by crushed specimens with traverse ribs and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987). 	9.	Yellowish green thin-bedded sandy shale (bed 24 of Yang et al., 1987; Bed 28d of Li et al., 1986, 1989). Bivalves: <i>Pseudoclaraia wangi</i> (Patte), <i>Claraia</i> cf. <i>griesbachi</i> (Bittner); conodont: <i>H. decrescens</i> (Dai et Zhang)	0.60 m (0.74 m)
 8. Greenish grey silty shale (Bed 23 of Yang et al., 1987; Bed 28c of Li et al., 1986, 1989). Ophiceratids; conodont: <i>H. decrescens</i> (Dai et Zhang) 7. Light yellow and greenish grey thin-bedded limestone intercalated with shale (upper part of Bed 22 of Yang et al., 1987; Bed 28b of Li et al., 1986, 1989). Bivalves: <i>Towapteria scythica</i> (Wirth), <i>Claraia</i> sp.; gastropod: <i>Polygyrina</i> sp. 6. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: <i>Modiolus?</i> sp.; ammonids: <i>Hypophiceras</i> sp., <i>Glyptophiceras</i> sp.; conodonts: <i>G. subcarinata</i> (Sweet), <i>G. subcarinata changxingensis</i> (Wang et Wang), <i>G.</i> sp., <i>Hindeodella</i> sp.; palynomorphs: <i>Circumpollis</i> sp., <i>Cycadopites</i> sp. 5. 'Black Clay' (Permian?)^(2,3). Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: <i>Claraia guangyuanensis</i> Li; ammonoids: <i>?Huananoceras</i> sp., <i>Pseudogastrioceras</i> sp., <i>Metophiceras</i> sp., <i>Tompophiceras</i> sp., <i>Pseudotirolites?</i> sp.; <i>Pseudotirolites?</i> sp. is represented by crushed specimens with traverse ribs and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987) 		Transitional Bed 1 ⁽¹⁾	
 Light yellow and greenish grey thin-bedded limestone inter- calated with shale (upper part of Bed 22 of Yang et al., 1987; Bed 28b of Li et al., 1986, 1989). Bivalves: Towap- teria scythica (Wirth), Claraia sp.; gastropod: Polygyrina sp. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: Modiolus? sp.; ammonoids: Hypophiceras sp., Glyptophiceras sp.; conodonts: G. sub- carinata (Sweet), G. subcarinata changxingensis (Wang et Wang), G. sp., Hindeodella sp.; palynomorphs: Circumpollis sp., Cycadopites sp Black Clay' (Permian?)^(2,3). Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: Claraia guangyuanensis Li; ammonoids: ?Huana- noceras sp., Pseudogastrioceras sp., Metophiceras spp., Tompophiceras sp., Pseudogastrioceras sp.; Pseudotirolites? sp. is represented by crushed specimens with traverse ribs and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987) 	8.	Greenish grey silty shale (Bed 23 of Yang et al., 1987; Bed 28c of Li et al., 1986, 1989). Ophiceratids; conodont: <i>H. decrescens</i> (Dai et Zhang)	0.49 m (0.64 m)
 6. Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: Modiolus? sp.; ammonoids: Hypophiceras sp., Glyptophiceras sp.; conodonts: G. subcarinata (Sweet), G. subcarinata changxingensis (Wang et Wang), G. sp., Hindeodella sp.; palynomorphs: Circumpollis sp., Cycadopites sp 5. 'Black Clay' (Permian?)^(2,3). Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: Claraia guangyuanensis Li; ammonoids: ?Huananoceras sp., Pseudogastrioceras sp., Metophiceras sp., Tompophiceras sp., Pseudogastrioceras sp.; Pseudotirolites? sp. is represented by crushed specimens with traverse ribs and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987) 	7.	Light yellow and greenish grey thin-bedded limestone inter- calated with shale (upper part of Bed 22 of Yang et al., 1987; Bed 28b of Li et al., 1986, 1989). Bivalves: <i>Towap-</i> <i>teria scythica</i> (Wirth), <i>Claraia</i> sp.; gastropod: <i>Polygyrina</i> sp.	0.24 m
5. 'Black Clay' (Permian?) ^(2,3) . Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: Claraia guangyuanensis Li; ammonoids: ?Huana- noceras sp., Pseudogastrioceras sp., Metophiceras spp., Tompophiceras sp., Pseudotirolites? sp.; Pseudotirolites? sp. is represented by crushed specimens with traverse ribs and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987)	6.	Greenish grey thin-bedded limestone intercalated with shale (lower part of Bed 22 of Yang et al., 1987; Bed 28a of Li et al., 1986, 1989). Bivalves: <i>Modiolus?</i> sp.; ammonoids: <i>Hypophiceras</i> sp., <i>Glyptophiceras</i> sp.; conodonts: <i>G. sub- carinata</i> (Sweet), <i>G. subcarinata changxingensis</i> (Wang et Wang), <i>G.</i> sp., <i>Hindeodella</i> sp.; palynomorphs: <i>Circumpollis</i> sp., <i>Cycadopites</i> sp	0.17 m
and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987)	5.	'Black Clay' (Permian?) ^(2,3) . Dark grey montmorillonite-illite claystone, extremely thin and horizontally bedded (base of Bed 22 of Yang et al., 1987; Bed 27c of Li et al., 1989). Bivalves: Claraia guangyuanensis Li; ammonoids: ?Huana- noceras sp., Pseudogastrioceras sp., Metophiceras spp., Tompophiceras sp., Pseudotirolites? sp. is represented by crushed specimens with traverse ribs	
conformity		and ventro-lateral nodules. Their suture line and ventral form are unknown due to poor preservation (Yang et al., 1987).	0.04 m
Upper Permian, Dalong Formation, Pseudotirolites Zone		Upper Permian, Dalong Formation, Pseudoticolites Zone	

Albertiana 11, April 1993

4.	Boundary Clay or 'White Clay' ⁽¹⁾ . Light grey montmoril- lonite-illite claystone, extremely thin and horizontally bedded (Bed 21 of Yang et al., 1987; Bed 27b of Li et al., 1989) 0.06 m (0.07 m
3.	Dark grey very thin-bedded siliceous shale (Bed.20 of Yang et al., 1987; Bed 27a of Li et al., 1989). Brachiopods: <i>Crurithyris changjianggouensis</i> Zhan, <i>C. pigmaea</i> (Liao); ammonoids: <i>Pseudogastrioceras</i> sp., <i>?Schizoloboceras</i> sp., <i>Pseudotirolites asiaticus</i> (J.K.L.), <i>P.</i> sp.; conodonts: <i>Gondo- lella subcarinata</i> (Sweet), <i>G. subcarinata changxingensis</i> (Wang et Wang), <i>G. deflecta</i> (Wang et Wang), <i>G. tulon- gensis</i> (Wang et Wang), <i>G.</i> sp. 0.04 m (0.05 m)
2.	Grey thin-bedded siliceous micrite (upper part of Bed 19 of Yang et al., 1987; Bed 26 of Li et al., 1989). Ammonoids: <i>Pseudotirolites disconnectus</i> Chao, Liang et Zheng, <i>Pleuro- nodoceras</i> sp.; conodonts: <i>Gondolella subcarinata</i> (Clark), <i>G. guangyuanensis</i> (Dai et Zhang), <i>Prioniodella</i> sp., <i>Enantio- anathus</i> sp. 0.20 m (0.25 m)
1.	Yellowish green to light grey mudstone, topped by dark grey, thin bedded marl (lower part of Bed 19 of Yang et al., 1987; Bed 25 of Li et al., 1989). Ammonoids: <i>Pseudo-</i> <i>tirolites disconnectus</i> Chao, Liang et Zheng, <i>P. acutus</i> Chao

Note 1: Beds 7, 8 and probably 6 are about the horizon of *H. parvus* which is regretfully lacking here. Further collection will carried out this year.

et Liang. In Bed 19 of Yang et al. Pseudogastrioceras sp.,

Qiangjiangoceras sp., Lopingoceras sp. are also found

- Note 2: In Bed 4 numerous volcanic glass shards, tuffaceous textures, lithic and lithic-ferruginous sphaerules have been discovered, denoting its volcanic origin (Yin et al., 1992). This bed is lithologically and stratigraphically correlated with Bed 2 of the Meishan section. An unstable iridium anomaly (up to 2.48 ppb) has been detected for Bed 5. Oxygen and carbon isotopes change abruptly from positive in top Permian to negative in the basal Triassic (Li et al., 1986).
- Note: Li et al. (1989) placed the P/T boundary between Bed 5 and Bed 6 because the fossils of Bed 5 are Permian. However, Bed 5 is partly or wholly corresponding with Bed 3 of the Meishan section. Both are called 'black claystone' yielding similar fossils, display an iridium anomaly, and overlie the 'white claystone' or Boundary Claystone. It may be argued that in both sections the boundary should be placed between the 'black claystone' and overlying bed. However, in that case the *Hypophiceras-Otoceras?* assemblage (Bed 3 of the Meishan section) would be placed in the topmost Permian, causing correlation problems. A find of *Pseudotirolites?* in Bed 5 of Shangsi is worthwhile to notice, because this record leaves the question whether *Pseudotirolites* can be overlapping with the *Otoceras* beds (here represented by *Hypophiceras*).

0.15 m (0.15 m)

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Albertiana 11, April 1993

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Albertiana 11, April 1993

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Albertiana 11, April 1993

WHAT IS CERATITES NODOSUS ?

E.T. Tozer

A picture of Ceratites nodosus, taken from the illustration in Zittel's textbook, adorns the cover of Albertiana 8 (1990). We all used to think that this Muschelkalk ammonoid was the best known Triassic fossil. Its reputation is now endangered! An argument has developed between the writer and Max Urlichs, the question being, what exactly is Ceratites nodosus? We disagree about two things: what is the type specimen, and what is the correct, full name. I contend that the type specimen, first illustrated by Scheuchzer (1718), and again by Rieber and Tozer (1986, fig. 1), is in the Scheuchzer Collection at the Palaontologischen Museum der Universität Zurich and that the correct name is Ceratites nodosus (Bruguière). He would choose a different type specimen, which is in the Schlotheim collection at the Museum für Naturkunde an der Humboldt Universität, Berlin, and illustrated for the first time by Urlichs and Mundlos (1987, p. 7, fig. 1). He would name the fossil Ceratites (Ceratites) nodosus (Schlotheim). Urlichs thinks that the two specimens represent different species, but I'm not so sure. He has asked the International Commission on Zoological Nomenclature to rule in his favour (Urlichs, 1991). I have contested the case (Tozer, 1992). Some people have taken his side. Others are taking mine. Comments are published in the Bulletin of Zoological Nomenclature. Eventually the Commission will pass judgement but it may take a while because quite a few people have expressed opinions.

The Albertiana cover picture does not portray a candidate for the type, indeed the whereabouts of the specimen from which it was drawn seems to be unknown.



The specimen figured on the cover of ALBERTIANA 10, reproduced from Zittel's textbook

On the subject of early illustrations of *Ceratites nodosus* (Bruguière), I recently discovered a specimen of some interest in the Natural History Museum London, identified as such by L.F. Spath (1934, p. 478). Nobody seemed to have noticed that this specimen had been illustrated in the famous book - "The Posthumous Works of Robert Hooke..." published in 1705 (Tozer, 1990). This is probably the earliest illustration of a Triassic ammonoid for which the specimen is known to be extant.

31

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TRIASSIC CHRONOSTRATIGRAPHIC DIVISIONS CONSIDERED AGAIN

E.T. Tozer

On the cover of Albertiana 10 (November 1992), there is a Table showing division of the Triassic into 7 stages. This Table is described (p. 10) as having been approved by a great majority of Triassic Subcommission (STS) members. The two notable features of this Table are: (1) the recognition of only two stages, Induan and Olenekian in the Early Triassic, and (2) the adoption of Rhaetian as the ultimate Triassic stage. In February 1992 I voted against both in response to a questionnaire circulated by the STS Chairman, Aymon Baud. In September 1992 I expressed my opposition in print (Tozer, 1992). Here again I dispute the majority rule. The present membership of STS comprises 34 voting members. Only two, N.J.Silberling and myself, speak for the data from the marine Triassic of North America. Silberling has shown me his response to the STS questionnaire. In this he expressed reluctance to accept both proposals, arguing that to do so, without giving definitions of the boundaries, was meaningless. The majority cited in Albertiana 10 thus does not speak for the data from the marine Triassic of North America. These data are of paramount significance and cannot be dismissed in any attempt to provide chronostratigraphic divisions that can be used world-wide.

Albertiana 11, April 1993

STS was conceived in 1968, and came into being in 1972. I was present at its conception and have been a Vice-Chairman from its beginning (Tozer, 1985). Ever since the beginning we have discussed Triassic chronostratigraphic divisions. Several different Tables have appeared in issues of Albertiana (Visscher, 1983, 1984, 1985; Tozer, 1986). Two earlier Tables and the 1992 Cover Table are reproduced here. The two earlier Tables (Visscher 1985; Tozer, 1986) made it clear that it was not appropriate to adopt an inflexible attitude as to whether some named divisions were stages or substages. It was felt that exercising dictatorial authority on this matter would not be universally acceptable. This is exactly what has now happened with the new Table. This proposal that the Triassic is divisible into 7 stages, no more, no less, is not acceptable to me. I have already determined that it is not acceptable to many other workers in North America concerned with the marine Triassic.



 Table 1. Triassic (sub)stage terminology accepted at meetings of the STS, Moscow, 1984 (redrawn from Visscher, 1985, ALBERTIANA 3, p. 1)

In this article I therefore make a case for not accepting Henk Visscher's advice "that it would be unwise to continue discussion of Triassic stage nomenclature" (Visscher, 1992, p. 1). The matter cannot be considered closed.

Readers unfamiliar with the role and mandate of the Triassic Subcommission (STS) may not realise that STS is not the ultimate and unquestionable authority in these matters. The Statutes of the Commission on Stratigraphy (ICS) make it clear that ICS, not the Subcommissions make the final decisions. Subcommissions can only recommend. The ICS statutes also make it clear that the real job of the Subcommissions and working groups is to study and propose boundary stratotypes, not simply to bless names without regard to their precise definition. This was recognized by the ICS Chairman, J. Remane, who, at the 1992 STS meeting in Kyoto, remarked, concerning the Triassic divisions, that "most of the work is yet to be done, before arriving to the formal acceptance by the ... ICS." (Albertiana 10, p. 12).



Table 2. Triassic (sub)stage terminology (redrawn from Tozer 1986, ALBERTIANA 5, p. 11)

The Subcommissions and Boundary Working groups hopefully can perform a useful function by proposing to the Commission that specified stratotypes be accepted to define boundaries between chronostratigraphic divisions. The Subcommission does not perform a useful function by simply dictating that the Triassic is now to be considered divisible into 7 stages. It is not useful to assert that there are to be only two stages (Induan, Olenekian) in the Early Triassic. Nor is it useful to simply say that the Triassic ends with a Rhaetian Stage. Without a proposal or a designation for its stratotypic base, Rhaetian is meaningless.

I have been concerned with the Induan-Olenekian business for more than 30 years, ever since the names were proposed as chronostratigraphic divisions by L.D. Kiparisova and Yu.D. Popov in 1956. At first I tried to use them (Tozer, 1963) but later on, after the original boundary definition was changed, it became impossible to make good use of the names. The fairly complicated early history of these names is recounted in Tozer (1965, p. 9, 10). Since then, thanks to the detailed stratigraphic studies of Dagys (1985), Olenekian can be readily interpreted. Induan, however, as noted by Kozur (1992), remains a very ambiguously defined division.

In order to express our views and interpretations in a language which is free and unambiguous it is essential that both ICS and STS recognize a form of authority comparable with that exercised by the International Commission on Zoological Nomenclature (ICZN). Paleontologists have to know these rules. Many other geologists probably do not know them. Because the ICS and ICZN have some objectives in common I feel justified in spelling out some aspects of the ICZN rules that should provide a guide to ICS matters. The ICZN rules govern the naming of animals. The rules are followed and respected by everybody who deals with animals, living and extinct. Rules apply at all levels, i.e. to all taxa, from subspecies up through species, subgenus, genus, family etc. all the way up to phylum. The rules clearly distinguish between objective and

subjective matters. The most important objective rules apply to type specimens. Type specimens are necessary to fix, unambiguously, the nature of subspecies and species. An example of the role played by the ICZN in this context is provided by a note elsewhere in this issue on *Ceratites nodosus*. The taxa of higher categories (subgenus, genus, family etc.) are not based on specimens but on the taxa included. Under the rules subgenera and genera must have type species but beyond that, the ICZN, wisely, would not dream of dictating to a scientist what additional species belong in these taxa, i.e. the scope of taxon is a subjective matter, giving any investigator the freedom to express his own views. Families and other taxonomic entities are treated in the same way. Different investigators commonly disagree about the scope of species, genera, families etc. One person's species or genus may be a synonym of an earlier named species or genus in the view of another person. Again, ICZN, wisely, does not make judgements on such questions. The rules merely define the conventions that must be followed. If a scientist wants to recognize an animal as a distinct species, the ICZN only demands that a type specimen be designated; for a distinct genus a type species is required.

	RHAETIAN	
LATE TRIASSIC	NORIAN	
	CARNIAN	
MIDDLE TRIASSIC	LADINIAN	
	ANISIAN	
EARLY TRIASSIC	OLENEKIAN	
	INDUAN	

Table 3. The 1992 ALBERTIANA 10 Cover Table

Similar principles should be applied to chronostratigraphic divisions. If STS is to seek ICS approval of names for chronostratigraphic divisions they should recognize that the rank of a division should not be dictated. Griesbachian may be treated as a stage (cf. genus) in North America (e.g. in Silberling and Tozer, 1968; Paull, 1988; Paull et al., 1989) but as a substage (cf. subgenus) of the Induan in Svalbard (Weitschat and Dagys, 1989, p. 184). The difference in rank is subjective. It should not be the concern of STS and ICS. What matters is that the scope of Griesbachian is interpreted as defined in unambiguous stratotypic terms. This level of definition is comparable with definition of a species, for which a type specimen is required. Griesbachian is defined in this way, as are the Dienerian, Smithian and Spathian divisions.

I therefore maintain that the Albertiana 3 (1985) Table (here reproduced as Table 1), with 12 named chronostratigraphic divisions, accepted by the STS at the Moscow IGC (1984), is far more useful than the Albertiana 10 Table (1992) (here reproduced as Table 3) which was proposed at the Kyoto IGC (1992). The Albertiana 3 Table shows nearly all the Triassic chronostratigraphic divisions down to the level of stage currently used in North America, the Arctic and Tethys. There are many other names. For those who are interested, no less than 95, from the level of Series down to Substage are listed and briefly described in the Appendix in Tozer (1984: 144-149).

A division of the Lower Triassic into four stages is in general use in Alaska, Canada, the Western United States (Silberling and Tozer, 1968; Paull, 1988; Paull et al., 1989) and has been recommended as the standard by Sweet (1988, p. 270). Ranked as stages or substages one or more of the four divisions have been recognized by name in Austria, Chios (Greece), Iran, Oman, and the Himalayas (Holser et al., 1991; Gaetani et al., 1992; Tozer, 1972; Tozer and Calon, 1990; Wang et al., 1989). Does this not demonstrate their usefulness ? They should be accepted as stages or substages according to the judgement of the people considering these chronostratigraphic divisions. Who knows, somebody may decide that the Griesbachian should be ranked as a Series ! Not likely, perhaps, but it should not be considered against the rules. At one time I treated Dienerian and Smithian as substages of a Nammalian Stage but I have now reverted to treating them as stages. This, again, should not be considered against the rules.

I would urge my STS colleagues to concentrate on something useful, like advancing our science by describing and proposing boundary stratotypes instead of merely promulgating bureaucratic decrees. As a start let's consider a stratotype boundary for the Permian-Triassic boundary. Having been Chairman of the Permian-Triassic boundary Working Group from 1981 to 1992, when I closely monitored work done on this subject, I take this occasion to endorse and support the proposal by Wang et al., (1989) that this boundary stratotype be placed at the base of the *Otoceras* beds in the Selong section, Tibet. This proposal is compatible with the interpretation of the Permian-Triassic boundary given by Nakazawa (1992), and the correlation charts for East Asia given by Yin (1992).

This article has benefited from comments and suggestions by Hugo Bucher, Walter Nassichuk, Mike Orchard and Norman Silberling all of whom permit me to say that they agree with the opinions expressed.

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SPATHIAN CONODONT TAXONOMY AND BIOCHRONOLOGY

M.J. Orchard

Recent studies of new conodont collections from the Spathian and Lower Anisian of North America (Bucher, 1989; Orchard, in press) and Oman (Tozer and Calon, 1990; Orchard, ms.), and of type material from Chios (Bender, 1970) and the Salt Range (Sweet, 1970) have resulted in revisions of neospathodid taxonomy and biochronology. This contribution summarizes the main results of these studies. Full details will be published elsewhere. E.T. Tozer and H. Bucher are acknowledged for providing many of the samples from which these conodonts were extracted.

Five successive neospathodid faunas are now recognized spanning much of the Spathian and predating the appearance of *Chiosella timorensis* (Nogami), which is dated as Early Anisian in North America and Oman.

1. The oldest is characterized by *lcriospathodus collinsoni* (Solien) which was already known in the *Columbites* beds of USA. The species is the index to a conodont zone that has been recognized by most previous workers. The occurrence in the *Columbites* beds has been confirmed and a similar fauna has now been found in Oman, where several co-occurring new species are recognized.

- 2. The second fauna includes common *Neospathodus homeri* (Bender) which is now restricted to forms with a distinct posterior process and concomitant elongate basal cavity. Thus emended, the species appears above the *Columbites* beds and ranges up to the *Prohungarites* beds in North America, although it is rare in the latter. Large collections of this fauna from Oman, interpreted as a little older than the *Prohungarites* beds of North America, also contain a new species regarded as a precursor to the index of fauna 3.
- 3. The third neospathodid fauna is identified by the appearance of *Neospathodus* triangularis (Bender). This species has been misidentified numerous times in the literature, which has resulted in a reputed range throughout the late Smithian and Spathian. The type material from Chios features a folded basal cup and posterior accessory denticles as well as a triangular basal cavity. Interpreted on this basis, the species occurs in the *Prohungarites* beds of USA, and has now been found in Oman. Elements previously identified as *N. triangularis* in the Salt Range are assigned to at least two new species.
- 4. A fourth interval is characterized by a new Neospathodus species, formerly included in N. ex gr. homeri, that has a broad, posteriorly truncated basal cavity. This species is long ranging but is the dominant neospathodid in the Prohungarites through Parapopanoceras haugi Zone beds in western USA, the Keyserlingites subrobustus Zone in western Canada, and the type timorensis Zone of West Pakistan (Sweet, 1970). The report of 'Neogondolella' timorensis (Nogami) in the N. haugi Zone of Nevada (Collinson and Hasenmueller, 1978) was based on this species.
- 5. Based on a restudy of the holotype from Chios, N. gondolelloides (Bender) is regarded as a valid species, which characterizes a fifth, somewhat hypothetical interval that has not yet been found in the USA. The species is not a synonym of C. timorensis as held by several previous workers, but appears to have a morphology intermediate between it and Neospathodus. The holotype apparently originates below the appearance of C. timorensis in Chios (Bender, 1970; Gaetani et al., 1992), and is regarded as latest Spathian in age.

In Oman, Chiosella timorensis has been discovered in association with Japonites subacutus. In Timor, the species is newly recorded from a mixed fauna with Keyserlingites, Paracrochordiceras, and Leiophyllites (Tozer, in press). In North America, C. timorensis is only known from the Lower Anisian Japonites welteri beds in Nevada (Bucher, 1989; Orchard, in press), but occurs also in undated strata in allochthonous terranes of the Canadian western Cordillera (Orchard and Bucher, 1992). The species does not occur higher in the Lower Anisian, in samples from the Pseudokeyserlingites guexi beds, or Silberlingites mulleri and Lenotropites caurus zones, which are dominated by Neogondolella ex gr. regale Mosher sometimes accompanied by Nicoraella spp.

Gladigondolella species are common in the Spathian-Lower Anisian of Oman, but are absent in North America. Neogondolella is absent in Oman, but several species occur sporadically in the North American collections, rarely in the Prohungarites beds through P. haugi Zone of Nevada, but commonly in the subrobustus Zone of Canada. Presence/ absence of the gondolelloids seems to be strongly facies controlled.

Some ramiform elements from Oman are regarded as parts of pectiniform-ramiform multielement species, but others constitute widely distributed, age diagnostic apparatuses lacking pectiniforms. These include *Aduncodina* from the fauna 1 (*collinsoni* Zone), which is also known from this level in China, and '*Oncodella*' n. sp. A from high in fauna 2 through fauna 3. This

Albertiana 11, April 1993

latter species occurs also in the USA, Canada, Primorye, Malaysia, Nepal, and Pakistan.

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STS Meeting - Shallow Tethys Conference

A plenary meeting of the International Subcommission on Triassic Stratigraphy is planned during the 'Shallow Tethys Conference' in Vienna (Wien), Austria to be held during the first week of September 1994. Detailed information will be given in the next issue of ALBERTIANA. For preliminary registration or information, please contact Dr. A. Baud, chairman of the STS.

THE SHANSIODON BIOCHRON, NONMARINE MIDDLE TRIASSIC OF PANGAEA

Spencer G. Lucas

Abstract

The dicynodont reptile Shansiodon Yeh (= Tetragonias Cruickshank, = Vinceria Bonaparte, = Rhinodicynodon Kalandadze, = Angonisaurus Cox and Li) has a broad distribution in nonmarine Triassic deposits of Pangaea. Shansiodon is known from China, Russia, South Africa, Zambia, Tanzania and Argentina. Its distribution defines a Shansiodon biochron of Middle Triassic (early Anisian) age.

Introduction

The dicynodont reptile *Lystrosaurus* has long exemplified the potential Triassic dicynodonts have for long-range correlation. Found in Lower Triassic strata in South Africa, India, Russia, China, Laos?, Australia? and Antarctica, its distribution defines a *Lystrosaurus* biochron that is equivalent to part of Induan time. The distributions of some other Triassic dicynodonts define similar biochrons that can be recognized across broad expanses of Pangaea. One of these is *Shansiodon* of early Middle Triassic age.

Taxonomy of Shansiodon

Robust biochronologies result from sound, morphologically (not stratigraphically or geographically) based taxonomies. Recognition of a *Shansiodon* biochron reflects a taxonomic revision of the genus that I will publish elsewhere but summarize here. Yeh (1959) first described *Shansiodon* from China and it has a skull (Fig. 1) that is triangular in outline with a wide and short face and a downwardly bent and blunt snout. The pre- and postorbital regions of the skull are of equal length, nasal ridges and bosses are present, and the canines are set in moderately developed caniniform processes.

In the collections of the IVPP (Institute of Vertebrate Paleontology and Paleoanthropology) in Beijing, there are 10 skulls from the Ermaying Formation in Shansi, China that provide a gauge of the range of cranial variation of *Shansiodon*. This range of variation encompasses morphologies that have been identified as distinct genera outside of China. Clearly, these genera are synonyms of *Shansiodon*: *Tetragonias* Cruickshank, 1967; *Vinceria* Bonaparte, 1967; *Rhino-dicynodon* Kalandadze, 1970; *Dolichuranus* Keyser, 1973; *Rhopalorhinus* Keyser 1973; and *Angonisaurus* Cox and Li, 1983. The close relationship of these genera and their possible synonymy has already been suggested by Keyser and Cruickshank (1978), Cooper (1980) and King (1988).

40

The Shansiodon biochron

Recognition of the above synonymy gives *Shansiodon* a broad distribution across Pangaea. The following localities and horizons are the basis of the *Shansiodon* biochron:

- 1. Ermaying Formation, Shansi, China, type locality of the genus (Yeh, 1959; Cheng, 1980).
- 2. Donguz Svita, Orenburg region, Russia, type locality of *Rhinodicynodon* (Kalandadze, 1970).
- 3. Manda Formation, Tanzania, type locality of *Tetragonias* and *Angonisaurus* (Huene, 1942; Cruickshank, 1967; Cox and Li, 1983).
- Omingonde Formation, South Africa, type locality of *Dolichuranus* and *Rhopalorhinus* (Keyser, 1973).
- N'taware Formation, Zambia, which has produced a skull of *Dolichuranus* (Crozier, 1970).
- Cerro de las Cabras Formation, Mendoza Province, Argentina, type locality of Vinceria (Bonaparte, 1967).

Most authorities have considered these localities to be broadly correlative and of early Anisian age (e.g., Anderson, 1980; Cooper, 1980). The distribution of *Shansiodon* supports their precise correlation. Much as the *Caurus* Zone defines a biochron for part of early Anisian time in the marine Triassic, the *Shansiodon* biochron is an interval of Middle Triassic time that can be recognzied across much of the nonmarine Triassic of Pangaea.

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Fig. 1 Skulls of Shansiodon from the Ermaying Formation in Shansi, China. A, C and F are lateral views; B, D and G are dorsal views, and E is a ventral view. A-B, C-E and F-G are different views of the same skull. From Yeh (1959) and Cheng (1980).

FORTHCOMING MEETINGS

International Subcommission on Triassic Stratigraphy Anisian-Ladinian-Carnian Boundaries Working Group

Southern Alps - Balaton Highlands - June-July 1993

Meeting and field trip in the Southern Alps and Balaton Highlands during the last week of June or the first week of July 1993. For more information see ALBERTIANA 10, pp. 32-33, or contact:

Maurizio Gaetani Dipartimento di Scienze della Terra Via Mangiagalli 34 20133 Milano Italy Tel: 39-2-23698229 Fax: 39-2-70638261 Marco Balini Dipartimento di Scienze della Terra Via Mangiagalli 34 20133 Milano Italy Tel: 39-2-23698226

Nonmarine Triassic Symposium

Arizona and New Mexico - October 17-24, 1993

An international symposium with field trip in Arizona and New Mexico, U.S.A., October 17 through 24, 1993. For more information see ALBERTIANA 10, p. 48, or write to:

Spencer G. Lucas and Michael Morales c/o New Mexico Museum of Natural History 1801 Mountain Road, N.W. Albuquerque, New Mexico 87104-1375 U.S.A.

ANNOTATED TRIASSIC LITERATURE

Hans Kerp & Henk Visscher¹

ANDERSON, J.M. and ANDERSON, H.M., 1989. Palaeoflora of Southern Africa - Molteno Formation (Triassic). Volume 2. Gymnosperms (excluding *Dicroidium*). A.A. Balkema, Rotterdam, 567 pp.

This is the second of six projected volumes in a monograph series on the palaeoflora of the Molteno Formation (Upper Triassic, Carnian), South Africa. It consists of a revision of all gymnosperm foliage (but largely excluding *Dicroidium* revised in Vol. 1) found in the Molteno Formation in particular and the Gondwana Triassic in general. The latter includes 22 genera (4 new) and 90 species (40 new), of which the Molteno yields 17 genera and 60 species. The taxonomic approach followed is aimed at achieving a natural taxonomy in palaeobotany. The very rich material is excellently illustrated on 330 plates thus showing the diversity of this flora and its taxa. This volume contains also numerous light-microscopic and SEM pictures of cuticles.

ANGIOLINI, L., DRAGONETTI, L., MUTTONI, G. and NICORA, A., 1992. Triassic stratigraphy in the island of Hydra (Greece). Riv. It. Paleont. Strat., 98: 137-180.

The Triassic succession exposed on Hydra starts with a few metres of quartzarenites (Aghios Nikolaos Fm., Scythian) vertically making transition to a thick carbonate unit (Eros Limestone, Spathian-Pelsonian) subdivided into three lithozones and one member. During the Pelsonian an extensional tectonic phase dissects the Eros carbonate platform. Its consequent downwarping results in the deposition of a pelagic sequence spanning the Pelsonian-Late Triassic time interval. The succession generally consist of few metres of nodular limestones (Han Bulog Limestone, Late Pelsonian-Early Ladinian) associated with green tuffs, followed by few hundred metres of cherty limestones (Adhami Limestone). In the eastern part of the island a thick carbonate bank (Pankrator Limestone) develops, spanning the Illyrian to Late Triassic time interval. An overlying pelagic sequence, Jurassic in age, marks the downwarping of the Pankrator carbonate platform. A typical passive continental margin succession is thus recorded in the Triassic of Hydra, suggesting its affinity with the Subpelagonian domain.

ANIČIĆ, B., 1991. Geological setting of the Orlica Mountain. Geologija, 33: 233-287. (In Slovenian with English summary)

The Lower Triassic of the Orlica Mountain consists dolomite marl, siltstone with Anodontophora and Eumorphotis venetiana, and limestone with Meandrospira pusilla and Myophoria costata. The Anisian consists of dolomite. The Ladinian includes shales, platy limestones with conodonts Epigondolella mungoensis and Gladigondoella malayensis and diabase and tuffs. The Norian/Rhaetian exhibits a dolomitic facies prevailingly, partly also that of the Dachstein limestone.

The help of Sabine Gibas, Heike Hagemann (Münster), Dr. Zwier Smeenk (Utrecht) and Prof. Anton Ramovš (Ljubljana) in tracing literature is gratefully acknowledged.

Albertiana 11, April 1993

ASH, S.R. and CREBER, G.T., 1992. Palaeoclimatic interpretation of the wood structures of the trees in the Chinle Formation (Upper Triassic), Petrified Forest National Park, Arizona, USA. Palaeogeogr. Palaeoclimatol. Palaeoecol., 96: 299-317.

Typically, the fossil woods in the Upper Triassic Chinle Formation in Petrified Forest National Park, Arizona, USA do not show annual growth rings but contain irregular interruptions similar to those found in trees now growing in the humid tropics. These interruptions could be due to endogenous hormonal effects or to occasional local variations in water supply. Therefore, it is concluded that the Late Triassic fossil forests in the park lived in conditions that permitted continuous tree growth. Limited data from areas outside of the park suggests that similar conditions prevailed in adjacent areas in the southwestern United States during the Late Triassic. Although this region is reported to have been under influence of a monsoonal circulation pattern during the Late Triassic, the growth of the trees does not appear to have been greatly effected.

BANDEL, K., 1992. Platyceratidae from the Triassic St. Cassian Formation and the evolutionary history of the Neritomorpha (Gastropoda). Paläont. Z., 66: 231-240.

Orthonychia alata (Laube 1869) represents the youngest known member of the Platyceratidae. It lived in the the Late Triassic, in shallow water of the Tethys. Like its Paleozoic relatives it was parasitic on a crinozoan host. Features of the larval shell place *Orthonychia* in the Neritomorpha. The parasitic Platyceratidae represent a specialized group of the Neritomorpha which must have branched off from normal herbivorous neritomorph stock during the Ordovician.

BERMAN, D.S. and REISZ, R.R., 1992. *Dolabrosaurus aquatilis*, a small lepidosauromorph reptile from the Upper Triassic Chinle Formation of North-Central New Mexico. J. Paleont., 66(6): 1001-1009.

Dolabrosaurus aquatilis n. gen. and sp., a small amphibious or aquatic reptile from the Upper Triassic Chinle Formation of north-central New Mexico, is described on the basis of portions of the vertebral column and partial fore- and hindlimbs of a single specimen. Comparison with other Triassic reptiles indicates that D. aquatilis is most closely related to Drepanosaurus unguicaudatus, a small, enigmatic lepidosauromorph from the Upper Triassic Zorzino Formation of the Italian Alps. Both species are assigned to a new family, Drepanosauridae, with Dolabrosaurus recognized as more primitive in some aspects of its vertebral and pedal morphology. The precise assignment of Drepanosauridae within the Lepidosauromorpha remains uncertain.

BRUCKSCHEN, P., NEUSER, R.D. and RICHTER, D.K., 1992. Cement stratigraphy in Triassic and Jurassic limestones of the Weserbergland (northwestern Germany). Sedimentary Geology, 81: 195-213.

Cement stratigraphy of the Korallenoolith (Oxfordian) and Trochitenkalk (Upper Muschelkalk) Formations, southern Lower Saxony Hills of Germany, is based on investigation of 232 carbonate samples by cathodoluminescence (CL). This enables subdivision of cements into four main generations.

ČAR, J., 1990. Angular tectonic-erosional unconformity in the deposits part of the Idrija Middle Triassic tectonic structure. Geologija, 31/32: 276-283. DAGYS, A., 1993. Geographic differentiation of Triassic brachiopods. Palaeogeogr. Palaeoclimatol. Palaeoecol., 100: 79-87.

The main palaeobiogeographic patterns and trends of Triassic brachiopods are analyzed. During the Triassic taxonomic diversity of brachiopods increased and this was accompanied by intensification of their geographic differentiation. Thus, the maximum differentiation was attained during the Late Triassic, for which at least five biochores of first rank (Boreal, northern Tethyan, peri-Gondwanian, Notal or Maorian and eastern Pacific) may be distinguished.

DELEVORYAS, T., TAYLOR, T.N. and TAYLOR, E.L., 1992. A marattialean fern from the Triassic of Antarctica. Rev. Palaeobot. Palynol., 74: 101-107.

The marattialean fern *Scolecopteris antarctica* sp. nov. is described from early Middle Triassic silicified peat collected in Antarctica. The synangia are radial and borne on pecopterid-type pinnules; spores appear to be alete. This is the first report of the genus in Mesozoic sediments and suggests that modern marattialeans may not have been related to the Paleozoic forms.

DICKINS, J.M., 1993. Climate of the Late Devonian to Triassic. Palaeogeogr. Palaeoclimatol. Palaeoecol., 100: 89-94.

Remarkable changes are apparent in climate during Late Devonian-Triassic times. Mostly the climate was rather different from the present. The faunas and floras offer much evidence for understanding the climate but in turn, understanding the palaeogeography of the faunas and floras is dependent on understanding of the climate and changes in climate.

By the end of the Permian, the Earth was very warm. In the Early Triassic no equatorial humid zone can be identified and whereas the tropical zone was hotter than at present, the polar zones were also warm. The Early Triassic appears to have been universally dry.

The climate remained warm during the Middle and Late Triassic but humid zones can be recognized. The climate also showed some apparent asymmetry.

The peculiarities of the climate, and the change of the climate, from the Late Devonian-Triassic are not readily explainable either on the basis of the present climate or a similar distribution of land and sea. Nor are they readily explainable on reconstructions commonly accepted such as Pangea formed in the ?Carboniferous, as is often claimed. Probably more basic data are required before any satisfactory explanations are possible and as well as terrestrial effects including a change in the angle of the earth's rotation, extra-terrestrial planetary and galactic effects require study.

DIEDERICH, F., 1992. Der höhere Mittlere Buntsandstein bei Marburg/Lahn - Interpretation der faziellen Entwicklung und ihre stratigraphische Bedeutung. Zbl. Geol. Paläont., Teil I, 1991, H. 12: 2767-2784.

Four lateral profiles of fluvial deposits have been studied in detail, using a boundingsurface-hierarchy analysis. The interpretation of facies models on fluvial anatomy and microform-characteristics shows a continual development of the fluvial character changes. The fluvial system gradually develops starting from the top of an aeolian sequence (Detfurth-Folge). It passes through the following stages: braidplain stage, braided river system stage, solitary meandering river stage. The end of this fluvial formation is marked by the transgression of the brackish-marine sediments of the "Röt-Folge" (Upper Buntsandstein).

This regional-geologically relevant result of the investigation contradicts to the commonly used stratigraphy ("Folgen-Gliederung"), which is based on the fining upward structured "cycles".

DOGLIONI, C., MASETTI, D. and NERI, C., 1991. Late Carnian extensional tectonics in the Dolomites. Rend. Soc. Geol. It., 14: 43-48.

The Dolomites exhibit N-S-striking normal faults of Late Carnian age. An example of Late Carnian graben in the southern cliff of the Tofana di Rozes is illustrated. The deposits of the Raibl Group thicken within the graben. The feature is coherent with the general Mesozoic left lateral transtensional tectonics deforming the whole Alpine area.

DOZET, S., 1990. Triassic beds of Kočevje and Gorski Kotar area. Rudar.-Metal. Zbornik. 37: 141-160. (In Slovenian with English summary)

The Triassic sedimentation in Kočevje and Gorski Kotar area (south Slovenia and southwest Croatia) is represented by two formations: the Gorsko Kotar-Kočevje many-coloured carbonate clastic formation with the Lower Scythian part and the Upper Julian/Tuvalian part, and the Norian/Rhaetian "Hauptdolomit" formation.

DOZET, S., 1990. The Triassic clastic-carbonate sequence of sediments in Kočevje and Gorski Kotar area. Rudar.-Metal. Zbornik, 37: 391-408.

The predominantly dolomitic Scythian and the predominantly dolomitic Lower Carnian sequences, which were formed in a stable semi-arid climate are described.

DOZET, S., 1990. The Lofer cyclothemes in the Main dolomite (Hauptdolomit) of the Kočevje area. Rudar.-Metal. Zbornik, 37: 507-528.

The general Triassic geology of the Kočevje area is discussed. The complete Lofer cyclothemes in the Norian/Rhaetian dolomite consist of (1) a disconformity at the base, (2) supratidal member A (red or green residual sediments), (3) intertidal member B (fenestral dolomites, stromatolithes ...), and (4) subtidal member C - micritic dolomite with megalodontids.

DOZET, S., 1991. Norian oncoids in the Main dolomite of the Kočevje area. Rudar. Metal.-Zbornik, 38: 79-95. (Slovenian with English summary)

Coated rounded bodies in the Main dolomite of the Kočevje area, southern Slovenia, without filamentous structure are ranged along oncoids. Microfacies with oncoids are described. Oncoid structure, its main characteristics, environment of origin, diagenetic change, vertical extension, and significance for chronostratigraphy are discussed. Seventeen levels of oncolitic limestones have been ascertained.

GAETANI, M., JACOBSHAGEN, V., NICORA, A., KAUFFMANN, G., TSELEPIDIS, V., FANTINI SESTINI, N., MERTMANN, D. and SKOURTIS-CORONEOU, V., 1992. The Early-Middle Triassic boundary at Chios (Greece). Riv. Ital. Paleont. Strat., 98: 181-204.

The sections of Marathovouno hillock in Chios, proposed by Assereto (1974) as stratotype for the base of the Anisian, have been revisited. An additional new section, Parthenis, near the town of Chios, was also considered.

The ammonoid fauna of the Late Spathian, fairly rich in the Parthenos section, fully belongs to the *Prohungarites/Subcolumbites* zone, sensu Kummel (1973). Additional ammonoid collections have been made from the stratotype section of Assereto, as well as from section G, where the Aegean *Paradanubites* has been found above the condensed horizon. In the Parthenis section the earliest Anisian is missing because of a

sedimentation gap. Several post-Aegean ammonoids have been found in red limestones olistoliths within the Variegated Series (Bunte Serie).

The conodonts gave a more continuous record throughout all the sections. The most significant species to be considered are: *Neospathodus homeri, Gondolella timorensis* and *Gondolella regale*. The first occurrence of *G. timorensis* overlaps the *N. homeri* range for more than 1 m in thickness, below the bed with the ammonoid *Aegiceras. G. regale* seems to be never associated with *N. homeri* and appears later than the typical Aegean ammonoid fauna. Microfacies analysis revealed the presence of long-ranging foraminifers.



Geological evolution cartoon, emphasizing the tensional drowning of the carbonate ramp, the block faulting affecting the Marmarotrapeza Fm., and the presence of olistholites within the Variegated Series (Bunte Serie) (from: Gaetani et al., 1992)

As far as the base of the Anisian is concerned, we may advance the following statements. (1) The base of the stage may be traced with the FAD of *Aegiceras*, *Partacrochordiceras*, *Paradanubites* and *Japonites*. (2) The FAD of *G. timorensis* slightly precedes the Aegean ammonoid FAD. Thus, if the boundary is drawn on the base of ammonoids, *G. timorensis* FAD is latest Spathian in age. (3) *G. regale* FAD occurs later than the Aegean ammonoid fauna FAD. By correlation to the Nevada Star Peak Canyon section, the Aegean fauna of Chios seems correlative to the *Japonites* welteri beds of Bucher (1989).

GARZANTI, E., NICORA, A. and TINTORI, A., 1992. Paleozoic to Early Mesozoic stratigraphy and sedimentary evolution of central Dolpo (Nepal, Himalaya). Riv. It. Paleont. Strat., 98: 271-298.

A study of the stratigraphic succession of the central Dolpo (Rarap-Atali area, Nepal) which ranges from Cambro?-Ordovician to Middle Jurassic. The Triassic Tamba Kurkur Fm. consists of two pelagic carbonate horizons of Dienerian and Smithian age, separated by dark pelites. Marly limestones and marls were deposited from the Spathian through the Carnian (Mukut Fm.), and are overlain by the thick Tarap Shale. A basal condensed bed is followed by dark pelites yielding Early Norian ammonoids, by thick siltstones with phosphatic nodules and next by dark shales and calcareous

siltstones with large *Zoophycos*-type burrows. The upper part of the unit contains up to fine-grained quartzo-feldspathic sandstones, nodular marly limestones and ironstone horizons ("upper assemblage"). The Late Triassic shallowing-upward succession is capped by dolomitic and colitic quartzarenites with spectacular herringbone structures (Quartzite Series).

GAUTRET, P., 1991. Présence d'un Stromatopore calcitique dans le Trias de Turquie (Nappes d'Anatalya, Alakir Cay). Geobios, 24: 417-421.

Aragonitic skeletons are the major constituent in the Triassic fauna of the North Tethys (Madreporaria and Sponges). A few genera belonging to the Demospongea have however produced a high magnesium calcitic skeleton, with a granular microstructure. This biomineralization type, that was previously known only from spinctozoan in the Triassic, has been discovered in a typically stromatoporoid architecture. The combination of such architectural, microstructural and mineralogic characters suggests phylogenetic relationships between this Triassic form and some stromatoporoids of the Jurassic or Cretaceous, characterized by a calcitic granular skeleton.

GORIČAN, Š. and BUSER, S., 1990. Middle Triassic radiolarians from Slovenia (Yugoslavia). Geologija, 31/32: 133-197.

The radiolarian fauna from five Middle Triassic localities in central and northwestern Slovenia (Zaklanec, Mokronog, Bohinj, Vojsko and Vršič) is described. The sections consist of tuff and tuffite alternating with micritic limestone with chert. 89 species were identified; four of them newly described: *Dumitricasphaera ? pennata, Falcispongus uncus, Holzmadia pyramidalis* and *Plafkerium? firmum*. The investigated radiolarian fauna from the localities Zaklanec, Bohinj and Vojsko proves the Upper Illyrian-Fassanian age, and the fauna from the localities Vršič and Mokronog evidence a Langobardian age.

GRADSTEIN, F.M., GIBLING, M.R., SARTI, M., VON RAD, U., THUROW, J.W., OGG, J.G., JANSA, L.F., KAMINSKI, M.A. and WESTERMANN, G.E.G., 1991. Mesozoic Tethyan strata of Thakkhola, Nepal: evidence for the drift and breakup of Gondwana. Palaeogeogr. Palaeoclimatol. Palaeoecol., 88: 193-218.

The Thakkhola region of Central Nepal contains at least 1.5 km of coastal neritic and (upper) slope deposits of Late Triassic to mid-Cretaceous (latest Albian) age. New paleomagnetic, paleobiogeographic and paleoflow data confirm that the strata were deposited on the northern Gondwana margin, bordering Tethys while Thakkhola lay at mid-latitudes (28-41°S). Most of this paper is devoted to Jurassic to mid-Cretaceous rocks.

GRADZISKI, R., 1992. Deep blowout depressions in the aeolian Tumlin Sandstone (Lower Triassic) of the Holy Cross Mountains, central Poland. Sed. Geol., 81: 231-242.

A sedimentological study of the Tumlin Sandstone, an up to 105 m thick aeolian deposit. The accumulation process was occasionally interrupted by the formation of up to 200-300 m wide blowout depressions and which reached at least 30 m beneath the generalized depositional surface of the dune field.

GRUNOW, A.M., DALZIEL, I.W.D., HARRISON, T.M. and HEIZLER, M.T., 1992. Structural geology and geochronology of subduction complexes along the margin of Gondwanaland: new data from the Antarctic peninsula and southernmost Andes. Geol. Soc. Amer. Bull., 104: 1497-1514.

Subduction complexes along the Andean margin in central and southern Chile yield mid-Paleozoic to early Mesozoic ages. Yet they crop out within 100 km of the modern trench that shows evidence of accretion along much of its length. The scarcity of uplifted subduction-complex rocks younger than mid-Mesozoic along the Chilean margin and in parts of the Scotia Arc suggests to us that these old, crystalline rocks, uplifted in the Triassic and Jurassic, represent a boundary in the forearc beyond which tectonic erosion does not easily occur.

GRUSZCZYNSKI, M., HOFFMAN, A., MALKOWSKI, K. and VEIZER, J., 1992. Seawater strontium isotopic perturbation at the Permian-Triassic boundary, West-Spitsbergen, and its implications for the interpretation of strontium isotopic data. Geology, 20: 779-782.

Brachiopod shell samples from the Kapp Starostin Formation, West Spitsbergen, provide evidence for a large and rapid drop in seawater strontium isotopic ratios close: to the Permian-Triassic boundary. The strontium isotopic shift is associated with similarly dramatic declines in carbon and oxygen isotope curves recorded in the same samples. This pattern can be explained by a paleoceanographic model that we have proposed previously, a model in which there is replacement of a largely stagnant, stratified ocean by a vigorously mixed one at the Permian-Triassic boundary.

HAAG, M. and HELLER, F., 1991. Late Permian to Early Triassic magnetostratigraphy. Earth Plant. Sci. Newsl., 107: 42-54.

A Late Permian to Early Triassic magnetostratigraphic reference section is presented. The Lower Triassic part is based on results from marine limestone sections in South China published earlier. Reliable new Permian data are added here which have been collected in the Nammal gorge (Salt Range, Northwest Pakistan) where marine sediments have been deposited quasi-continuously with occasional minor hiatuses during the late Palaeozoic to early Mesozoic.

In the lower Upper Permian several normal polarity zones are recognized. This contradicts the current assumption that rocks of this age belong to the long, reversely polarized Kiaman hyperzone. The Kiaman interval must end and the Illawarra hyperzone of mixed polarity must begin in or prior to the lowermost Upper Permian. The Upper Permian/Triassic boundary at Nammal as well as in the Chinese sections is situated very close to a transition from a reversed to a normal polarity zone., The Upper Permian an Nammal together with the Lower Triassic South China sections is estimated to cover about 20 Ma. Nearly 30 polarity changes are observed which result in an average reversal frequency very similar to that observed during the early Tertiary. The reversal rate after the end of the long-lasting reversed Kiaman hyperchron apparently increases in a manner similar to that after the end of the Cretaceous Long Normal Superchron. Only few polarity zones are found in the lower Upper Permian while progressively more frequent reversal follow in the Lower Triassic.



Composite magnetostratigraphic polarity profile for the Upper Permian (Nammal gorge) to Lower Triassic (South China). Time scale not linear. (From: Haag and Heller, 1991).

HADA, S., SATO, E., TAKESHIMA, H. and KAWAKAMI, A., 1992. Age of the covering strata in the Kurosegawa Terrane: dismembered continental fragment in southwest Japan. Palaeogeogr. Palaeoclimatol. Palaeoecol., 96: 59-69.

Several hitherto poorly known formations from the Kurosegawa terrane have been dated with radiolarians. They range in age from mid-Permian to Middle Jurassic.

HOHENEGGER, J. and TATZREITER, F., 1992. Morphometric methods in determination of ammonite species, exemplified through *Balatonites* shells (Middle Triassic). J. Paleont., 66: 801-816.

Specimens of the ammonite genus *Balatonites* from the Middle Triassic of Austria and Hungary are analyzed morphometrically to obtain growth invariant character states. A

51

new method transforming growth dependent qualitative characters into age invariant metric variables is developed. Weighted standardization as a method preserving univariate discriminatory efficiency is applied to character states preceding numerical classification procedures, resulting in a clearer separation of homogeneous groups in comparison to simple standardized data. All clustering and ordination procedures produce two identical classes, which are interpreted according to the cohesion concept as distinct biological species. In adherence to the taxonomic rules they are denominated as *Balatonites egrerius* Arthaber and *Balatonites* (Mojsisovics).

JADOUL, F., GERVASUTTI, M. and FANTINI SESTINI, N., 1992. The Middle Triassic of the Brembana Valley: preliminary study of the Esino Platform (Bergmasc Alps). Riv. It. Paleont. Strat., 98: 299-324.

The stratigraphy and paleogeography of the Ladinian Esino Limestone outcropping in Valle Brembana-Valle Parina, have been integrated with the biostratigraphic analysis of the cephalopod fauna. A complex internal structure of the Upper Anisian-Ladinian Esino carbonate platform has been identified. Six different lithozones have been recognized, they record the stratigraphic-paleogeographic evolution of the Esino Limestone. This carbonate platform developed through three stages: (1) construction of a lower edifice (Late Anisian-?Early Ladinian) representing the first phase of carbonate platform diffusion on structural highs, which were already the site of carbonate deposition during the Middle Anisian (peridetrital dolomites of the Angelo Limestone); (2) buildup of the carbonate complex (main edifice). In this phase (Early Ladinian-Late Ladinian p.p.) the most important one, growth took place by prevalent aggradation; (3) development of the upper edifice and progradation of the platform in the Late Ladinian. In this phase inner platform facies with diagenetic caps at the top of peritidal cycles are common. Studies in progress of ammonoids and gastropods allowed the recognition of different fossil assemblages which date from Early Ladinian to Late Ladinian.

JAMNIK, A., RAMOVŠ, A. and TURNŠEK, D., 1990. *Heterastridium conglobatum* Reus, 1865 (?hydrozoan) in the Norian limestone of the Kamnik Alps (Slovenia, NW Yugoslavia). Geologija, 31/32: 199-207. (In Slovenian with English summary)

Heterastridium conglobatum presents the first finding in Slovenia. The rock is a biosparitic reef limestone containing numerous corals and sponges. It represents an equivalent of the Dachstein reef limestone of the northern Calcareous Alps.

JELEN, B., 1990. The Karnian bivalves (Mollusca) from Lesno Brdo, Slovenia, NW Yugoslavia and their paleobiological significance. Geologija, 31/32: 11-127.

An integrated study approach to the paleobiology of the Karnian bivalves from one of the most important Slovenian Triassic sites was undertaken. The performed biostratinomic investigation indicated that the site could be considered as little altered biocoenosis.

In taxonomic analysis the typological evaluation was combined with biometric evaluation. For the first time in Slovenia 19 species and 8 subspecies were recognized of totally 33 taxa found. One of these three new species and one new subspecies (*Trigonodus ramovsi* n.sp., *Trigonodus abdominalis* n.sp., *Trigonodus extraordinarius* n.sp. and *Trigonodus problematicus crassus* n. subsp.).

A new method was developed to establish morphological boundaries of ecological and reproductive isolation within much varying genus *Trigonodus*. This method was based on biometrical and adaptive functional morphological researches. The causes of

speciation in genus *Trigonodus* and subspeciation in species *Myophora kefersteini* were examined as well as similarities of both evolutionary trends.

Diverse paleoecological, sedimentological and geochemical methods were applied to find the mode and the extend to which abiotic and biotic factors controlled the community structure and functioning. A synthesis of the results suggested high stress mixohaline lagoonal conditions as the main community controlling factor.

Also, comment on faunal paleogeographical, biostratigraphical and chronostratigraphical aspects was given.

JURKOVŠEK, B. and JELEN, B., 1990. Fossil lamellibranch from the Carnian beds at Orle. Geologija, 31/32: 129-132. (In Slovenian with English summary)

A short supplement on the present knowledge of the fossil lamellibranch fauna from the Carnian beds at Orle, east of Ljubljana. *Trigonodus bittneri*, *T. carniolicus*, *T. abdominalis*, *T. problematicus* and *T.* sp. are mentioned.

KAYA, O. and MOSTLER, H., 1992. A Middle Triassic age for low-grade greenschist facies metamorphic sequence in Bergama (Izmir), western Turkey: the first paleontological age assignment and structural-stratigraphic implications. Newsl. Stratigr., 26(1): 1-17.

Low-grade greenschist facies metamorphic rocks are widely exposed in western Turkey. Paleozoic and Mesozoic ages have been assigned in previous work on the basis of suggested ages for the bounding sedimentary rocks. To the north of Bergama (Pergamon, Izmir), the upper part of a stratigraphically continuous succession of metamorphic rocks (the Madradağ Formation) consists, in ascending order, of micaceous and chloritic phyllite, mafic metatuff, interstratified marble and mafic metatuff, and phyllite and metachert. This succession is overlain unconformably by the Late Triassic sequences of turbidites and olistostromes (the Diskaya Formation). The Late Triassic basal strata contain clasts derived from the immediately underlying metamorphic rocks. The recrystallized limestone interlayers in the phyllite at the top of the Madradağ Formation and recrystallized limestone blocks in the Diskaya Formation contain a common condont fauna indicating a Middle Triassic age (boundary of Late Anisian/Early Ladinian) for the early termination of the metamorphic sequence.

KOLAR-JURKOVŠEK, T., 1990. New ostracod and conodont species from the Triassic strata of Slovenia (NW Yugoslavia). Geologija, 31/32: 219-224.

The new ostracod species *Polycope ladinica* from the Ladinian beds of the Julian alps, and the new conodont species *Neogondolella celeiana* from the Langobardian-Cordevolian beds occurring near Celje, are described.

KOLAR-JURKOVŠEK, T., 1991. Microfauna of Middle and Upper Triassic in Slovenia and its biostratigraphic significance. Geologija, 33: 21-170. (In Slovenian with English summary)

Dispersed microfauna remains from 24 Middle and Upper Triassic localities in Slovenia were studied. Twenty seven radiolarian species are briefly described. Seven species of holothuroids and 24 conodont species are described. In addition, seven ostracod species and four species of fish scales are described. Six range zones, two assemblage zones, one interval zone and one subzone were established. The studied localities belong to the Dinaric and Sephardic conodont provinces.

LE Roux, J.P., 1992. Palaeogeographic reconstructions of sandstones using weighted mean grain-size maps, with examples from the Karoo Basin (South Africa) and the Sydney Basin (Australia). Sedimentary Geology, 81: 173-180.

Although sandstone grain-size maps can be a powerful means of reconstructing ancient depositional environments, they have rarely been used in the past. In this paper, two case studies are presented to illustrate the potential of this technique where other, more conventional methods may not be applicable. In the first case, a braided to anastomosing river system in the Triassic Molteno Formation of South African Karoo Basin is examined. The second case study examines an offshore shoal in the Permian Nowra Sandstone of the Sydney Basin in Australia.

LIN, QI-BIN, 1992. Late Triassic insect fauna from Toksun, Xinjiang. Acta Palaeont. Sinica, 31(3): 331-342.

A new fossil insect fauna, the Toksun insect fauna from the Upper Triassic Huangshanjie Formation of Kerjie, Toksun county, Xinjiang is described and illustrated. The material includes 17 species belonging to the Blattoidea, Plecoptera, Homoptera, Heteroptera, Mecoptera and Coleoptera. Comparisons are made with other Triassic insects faunas, e.g. the *Apheloscyta* Assemblage of South China, the Ipswich fauna from the Upper Triassic of Australia, the Omineo insect fauna of Japan and the Issyk-Kul insect fauna of Russia.

LITWIN, R.J. and ASH, S.R., 1993. Revision of the biostratigraphy of the Chatham Group (Upper Triassic), Deep River Basin, North Carolina, USA. Rev. Palaeobot. Palynol., 77: 75-95.

Paleontological evidence from the Upper Triassic Chatham Group in the three subbasins of the Deep River Basin (North Carolina, USA) supports a significant revision of the ages assigned to most of this non-marine continental sedimentary sequence. This study confirms an early(?) or mid-Carnian age in the Sanford subbasin for the base of the Pekin Formation, the lowest unit of the Chatham Group. However, diagnostic late Carnian palynomorphs have been recovered from coals in the lower part of the Cumnock Formation in the Sanford subbasin, and from a sample of the Cumnock Formation equivalent in the Wadesboro subbasin. Plant megafossils and fossil vertebrates from rocks in the Sanford subbasin also support a late Carnian age for the Cunnock Formation and its equivalents. The overlying Sanford Formation, which has not yet been dated paleontologically, probably includes beds of Norian age, as over 1000 m of strata may be present between the Cumnock Formation coals (dated here as late Carnian) and the top of the Sanford Formation. This chronostratigraphic interval appears similar to, but slightly longer than, the preserved in the Dan River-Danville and Davie County basins 100 km to the northwest. Our evidence, therefore, indicates that the Chatham Group was deposited over a much longer time interval [early(?) to mid-Carnian through early Norian] than previously was believed.

Lucas, S.G., 1992. A Nonmarine Standard for Part of Late Triassic Time. Park Science, 12: 18-19.

For Late Triassic nonmarine environments, the 100% rock exposure over a large area, the extent and duration of collecting and research, and the prolific fossil record of the Petrified Forest National Park are unparalelled. Therefore, as a key to ordering and interpreting an interval of Late Triassic geological and biological events on land, the sequence in the park should provide a global standard for geologists and paleontologists. This standard, for example, documents a complex evolutionary turnover of terrestrial vertebrates about 223 million years ago, at about the junction of the Carnian

and Norian. This turnover is not the mass extinction identified by some authors but a more subtle replacement that took place over the course of millions of years.

LUCAS, S.G., 1992. Timing of the origin of dinosaurs. Earth Science Newsletter, 4: 1-5.

A review of the earliest occurrences of dinosaurs in the Carnian of the Western United States, Brazil, Argentina, Morocco and India. A nearly simultaneous first record of dinosaur fossils across a broad expanse of the Late Triassic Pangaean supercontinent has been documented. A their first appearance, both saurischian and "protoornithischian dinosaurs can already be distinguished and by the early Norian at least 20 genera of dinosaurs can be recognized. This suggests that either the origin and initial evolution was vary rapid, or that dinosaur origin and much dinosaur evolution took place long before the late Carnian.

LUCAS, S.G. and HUNT, A., 1992. Triassic Stratigraphy and Paleontology, Chama Basin and Adjacent Areas, North-Central New Mexico. New Mex. Geol. Soc. Guidebook, IV: 151-172.

Triassic strata in the Chama Basin and along the flanks of the Nacimiento and Jemez Mountains of Rio Arriba and Sandoval Counties, New Mexico, pertain to the middle Triassic Moenkopi Formation (Anton Chico Member) and the Upper Triassic Chinle Group (Agua Zarca, Salitral, Poleo, Petrified Forest and Rock Point Formations). The Moenkopi Formation is present only along the flanks of the Nacimiento and Jemez Mountains in Sandoval County. It is as much as 39 m thick and consists mostly of greyish red siltstone, mudstone and immature, trough-crossbedded sandstone. The Agua Zarca Formation is as much as 61 m thick and consists mostly of troughcrossbedded, quartzose sandstone and siliceous conglomerate. Near Coyote in Rio Arriba County, it overlies "mottled strata" developed in the top of the Pennsylvanian-Permian Cutler Formation. The Salitral Formation is as much as 102 m of mostly purplish, smectitic mudstone. The Poleo Formation is up to 41 m thick and is mostly greyish yellow, trough-crossbedded litharenites and subarkoses and minor amounts of both intrabasinal and siliceous conglomerate. Above the poleo Formation, as much as 200 m of strata, dominated by reddish brown, smectitic mudstones, constitute the Petrified Forest Formation. South of San Miguel Canyon in Sandoval County, the poleo formation is not present, and all of the mudstone section above the Agua Zarca formation is assigned to the Petrified Forest Formation. Locally, near San Ysidro, the Correo Member is present at the top of the Petrified Forest Formation. In the Chama physiographic basin, the Rock Point formation, as much as 70 m thick and mostly reddish brown and greyish red siltstone and ripple-laminar sandstone, disconformably overlies the Petrified Forest Formation. Three Formations of the Chinle Group in northcentral New Mexico contain biochronologically important fossils, notably the aetosaur Longosuchus (late Carnian) in the Salitral formation, the aetosaur Typothorax and the phytosaur Pseudopalatus (early-middle Norian) in the Petrified Forest Formation, and a new genus of phytosaur (late Norian/Rhaetian) in the rock Point Formation. these fossils and lithostratigraphy allow precise correlation of the Chinle Group strata exposed in north-central New Mexico with other Upper Triassic strata in New Mexico.

LUKAS, V., 1992. Zur Diagenese der Karbonate des Unteren Muschelkalk (Trias). N.Jb.Geol. Paläont.Abh., 185(1): 85-113.

Diagenetic phenomena observed in different kinds of bioclastic carbonate sands and mudstones (Horizon of the Terebratel-Beds, Lower Muschelkalk, Triassic) are referred to stages in the diagenetic history of these rocks. The typical texture of the "Wellenkalk" (nodular mudstone) is the result of bioturbation, compaction, diagenetic carbon-

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MEYER-BERTHAUD, B., TAYLOR, E.L. and **TAYLOR, T.N.,** 1992. Reconstructing the Gondwana seed fern *Dicroidium*: evidence from the Triassic of Antarctica. Geobios, 25(3): 341-344.

The discovery, in Antarctic rocks of the Middle Triassic, of leaves with *Dicroidium* anatomy attached to stems with undivided vascular cylinder and pycnoxylic wood of the widespread *Dadoxylon* type, calls into question the long-accepted reconstruction of *Dicroidium* fronds attached to *Rhexoxylon* stems. Although *Dicroidium* leaves are common throughout Gondwana, *Rhexoxylon* is known only from western Gondwana (Argentina, Brazil and South Africa). The anatomy of the Antarctic axes, including the presence of numerous buds, suggests a plant with more complex architecture than that proposed in the reconstruction of *Dicroidium* in Western Gondwana. Two hypotheses for the belated discovery of this additional "*Dicroidium* plant" are proposed.

MITZUTANI, S. and KOJIMA, S., 1992. Mesozoic radiolarian biostratigraphy of Japan and collage tectonics along the eastern continental margin of Asia. Palaeogeogr. Palaeoclimatol. Palaeoecl., 96: 3-22.

The stratigraphy of Jurassic accretionary complexes consist of Carboniferous to Permian limestone associated with greenstone, and Triassic bedded chert. Radiolarian enable the dating of these rocks and the complex tectonic history is discussed.

MOLINA-GARZA, R.S., VAN DER VOO, R. and URRUTIA-FUCUGAUCHI, J., 1992. Paleomagnetism of the Chiapas Massif, southern Mexico: evidence for rotation of the Maya Block and implications for the opening of the Gulf of Mexico. Geol. Soc. Amer. Bull., 104: 1156-1168.

A paleomagnetic study of a series of 180 samples from the batholithic complex and overlying redbeds of the Chiapas Massif in southern Mexico. Three distinct ancient paleomagnetic directions have been identified, respectively for the Late Permian, the Late Triassic(?)-Early Jurassic and the Middle-Late Jurassic. The Late Triassic(?)-Early Jurassic red beds of the Todos Santos Formation yields a paleopole at 22.6°N, 170.6°E (4 sites, K = 56.8, A_{95} = 12.3°).

MPODOZIS, C. and MAHLBURG KAY, S., 1992. Late paleozoic to Triassic evolution of the Gondwana margin: Evidence from Chilean Frontal Cordilleran batholiths (28°S to 31°S). Geol. Soc. Amer. Bull., 104: 999-1014.

Upper Palaeozoic to Triassic Chilean granitoids in the Andean Frontal Cordillera between 28°S and 31°S record crustal and mantle conditions at the Gondwana margin during the final assembly and initial breakup of the Pangea supercontinent. This period overlaps the end of Paleozoic terrane accretion and precedes Andean subduction. Integration of new trace-element and isotopic data with other information on the granitoids and the regional geology leads to a tectonic model that has implications for other parts of the Gondwana margin. In the model the Carboniferous to Early

Permian is a period of oblique convergence. Associated Elqui complex granitoids are diverse. Those in the Guanta and Montosa units are predominantly related to subduction processes, whereas those in the Cochiguis and El Volcán units are dominated by melting of the subduction complex and older crust. Progressive oblique collision of the last pre-Pangea terrane (Equis) along the margin resulted in the crustal thickening associated with shortening deformation of foreland basinal sedimentary rocks and uplift of the Elqui complex. Subsequent gravitational collapse of the inactive slab and lithospheric delamination resulted in the production of large amounts of basalt, which intruded and melted the crust, producing the post-collisional Ingaguás complex. The Los Carricitos granitoids formed in thickened crust, whereas the Collay, El Colorado and El Léon units formed in thinner crust. The Ingaguás complex is part of the Chonyoi granite-rhyolite province, whose formation, similar to that of other Gondwana silicic provinces, was probably accentuated by anomalously hot upper mantle associated with the Pangea supercontinent.

MUTTI, M., 1992. Facies a tepee del Calcare Rosso (Ladinico superiore, Alpi Lombarde): meccanismi di formazione ed implicazioni per la stratigrafia del Ladinico-Carnico lombardo. Giorn. Geol., ser. 3a, 54: 147-162.

The upper Ladinian Calcare Rosso of the Lombardic Alps is composed of m-scale tepee packages repeatedly capped by terra rossa karstic paleosoils. Tepee facies have been traditionally considered exclusively as the product of subaerial exposure in an arid climatic setting, therefore incompatible with wet-climatic karsts. Types and volume of cements and internal sediments of the Calcare Rosso tepees actually differ from tepee facies described in other Triassic Alpine platforms. Two types of tepees have been recognized. The author discusses the formation of tepee structures proposed a new stratigraphic classification for the study area.

OGG, J.G. and STEINER, M.B., 1991. Early Triassic magnetic polarity time scale - integration of magnetostratigraphy, ammonite zonation and sequence stratigraphy from stratotype sections (Canadian Arctic Archipelago). Earth Planet. Sci. Newsl., 107: 69-89.

Stratotypes defining the stages of the Early Triassic (Griesbachian, Dienerian, Smithian and Spathian) are located on Ellesmere and Axel Heiberg islands in the northern Canadian Arctic. Ammonite-rich horizons are within a clastic outer shelf-to-slope facies of thick progradational wedges of mudstones and siltstones. Three sections were sampled for magnetostratigraphy and interpreted for transgressive and regressive pulses of sedimentation. Using the ammonite zonation as a guide, the transgressiveregressive cycles and magnetostratigraphies have been correlated among the sections and to the published Triassic sequence stratigraphy time scale, thus enabling definition of the magnetic polarity pattern for the upper Griesbachian to Smithian stages in multiple sections. The Griesbachian and Dienerian stages each have two pairs of normal- and reversed-polarity chrons; the Smithian is predominantly of normal polarity, and the Spathian is predominantly of reversed polarity. This magnetic polarity time scale may help to resolve age correlations of North American redbed facies and to define the Permian-Triassic boundary.



Composite scale of magnetic polarity pattern and zones, biostratigraphy (ammonites zones and stages), lithostratigraphy and sequence stratigraphy for the Early Triassic as derived from the Canadian Arctic sections. (from: Ogg and Steiner, 1991).

After correction for variable structural orientations, the means directions of magnetization from the three sites converge at 296° declination, 57° inclination (k = 60, $a_{95} = 16.5^{\circ}$; equivalent pole = 41°N, 161°E; paleolatitude = 38°N), which is consistent with the pole derived from nearby Early Permian volcanics and supports a postulated post-Early Triassic, pre-Tertiary counterclockwise rotation of this region with respect to cratonic North America.

PAL, A.K., CHAUDHURI, P.N., BOSE, S. and GHOSH, R.N., 1992. A Middle Triassic age for Kamthi (Hingir) Formation of the Lower Gondwana Ib-Hingir basin, Orissa, India: New Palaeobotanical Evidence. Newsl. Strat., 27(1/2): 33-39.

PLACER, L. and KOLAR-JURKOVŠEK, T., 1990. The age of the Pseudozilian beds in the east part of the Sava folds. Rudar.-Metal. Zbornik, 37: 529-534.

The Pseudozilian beds of the Sava folds east of Ljubljana, central Slovenia, belong to the Ladinian and Cordevolian, their uppermost part probably even younger.

POGUE, K.R., WARDLAW, B.R., HARRIS, A.G. and HUSSAIN, A., 1992. Paleozoic and Mesozoic stratigraphy of the Peshawar Basin, Pakistan: correlations and implications. Geol. Soc. Amer. Bull., 104: 915-927.

The most complete Paleozoic sequence described from Pakistan is exposed in bedrock inliers and in ranges fringing the eastern Peshawar basin. Interbedded quartzite and

argillite of the Precambrian and Cambrian Tanawal Formation is overlain unconformably by the Cambrian(?) Ambar Formation. Misri Banda Quartzite unconformably overlies the Ambar and contains Ordovician *Cruziana* ichnofossils. New conodont discoveries restrict the ages of overlying formations as follows: Panjpir Formation, Llandoverian to Pridolian; Nowshera Formation, Lochkovian to Frasnian; and Jafar Kandao Formation, Kinderhookian to Westphalian. The Karapa Greenschist, consisting of metamorphosed lava flows, separates the Jafar Kandao from Upper Triassic (Carnian) marbles of the Kashala Formation. The Upper Triassic and Jurassic(?) Nikanai Ghar Formation forms the top of the section.

The newly dated Carboniferous to Triassic horizons provide the first firm age constraints of the protoliths of the high-grade Swat metasediments. The dating of the metasediments has, in turn, provided age constraints on pre-Himalayan tectonism and associated intrusions.

PUNINA, T.A., 1991. New finds of Thevenus Jabionzeria in the Triassic of the maritime territory. Palaeont. J., 4: 114-116.

Descriptions are given of the three new Upper Triassic species of the genus Gallouzeria-G. kiparisovae, G. krasnovi and G. singularis.

RAMOVŠ, A., 1989. Upper Tuvalian limestones (Carnian, Upper Triassic) in the Hallstatt development also in Kaminško-Savinjske Alps. Rudar.-Metal. Zbornik, 36: 191-197. (in Slovenian with English summary)

The coral and other reef builders from Pokljuka (Julian Alps) were divided into three horizons. The two lower horizons contain fossils typical for the "Cassian complex" as known in the Italian Dolomites, Austrian Alps, Pamir, and elsewhere, Cordevolian-Julian in age. The third horizon with *Rhopalodendron poklukensis* n.gen. n.sp., *Bledosmilia tuvalica* n.gen. n.sp., and *Protoheterastraea minor* n.sp. shows a drastic change of fossil assemblage. It laterally interferes with Tuvalian halobiids and was attributed to the Tuvalian. The Tuvalian corals and other reef builders are not yet known in the world. The reef complex of Poljuka was formed on the Julian carbonate platform, which was, in comparison with the southerly lying Dinaric platform much more dissected during the Carnian. On the platform existed, within shallow areas, deeper marine intraplatform channels. Carnian reef complexes of Pokljuka and its fossil assemblage can partly be compared with Wetterstein development of the Hochstaufen-Rauschberg in the Northern Calcareous Alps.

RAMOVS, A., 1989. Development of the Scythian (Lower Triassic) in the northern Julian Alps (Slovenia). Rudar.-Metal. Zbornik, 36: 623-636.

According to the biostratigraphic subdivision of the Werfen Formation in the Dolomites it is possible that in the northern Julian Alps the lower part of the Scythian sequence corresponds with the Gastropod Oolite Member and the Campil Member (= Nammalian). Upwards follows the Val Badia Member with *Tirolites cassianus* and *Natiria costata*. Above occurs the Cencenighe Member with crinoid horizons and the foraminifer *Meandrospira pusilla* and the pelecypod *Costatoria costata*. Black limestones, schisty micaceous marls and sandy limestones partly belong to the S. Lucano Member. It is remarkable that in the Lower Scythian with *Claraia clarai* (= Suissi Member) and other horizons are completely unknown from the northern Julian Alps. This may be due to tectonics.

RAMOVŠ, A., 1990. A new locality of *Pseudofurnishius murcianus* van den Boogaard, 1966 (Conodonta) in Slovenia (NW Yugoslavia). Rudar. Metal. Zbornik, 37: 355-357. (In Slovenian with English summary)

The conodont *Pseudofurnishius murcianus* was found in blackish platy Upper Ladinian limestone at Skrnik near Idrija, west Slovenia. The known occurrence of the typical Langobardian form was extended from the wider Ljubljana area about ten kilometres west-north-westwards.

RAMOVŠ, A., 1990. Ausbildung der Ladin-Stufe (Mitteltrias) in den nördlichen Julischen Alpen. Geologija, 31/32: 241-266. (in Slovenian with German abstract)

The northern part of the western Julian Alps lies at the structural boundary with several Late Palaeozoic units. The predominantly clastic Ladinian is characterized by small occurrences of volcanics and tuffs. In the eastern Julian Alps, the upper horizon of the Ladinian primarily consists of thin-bedded dark greyish limestones, marls and slaty marls with abundant macro- and microfossils, In the lower part several layers with lumachelles with several still undescribed pectinids and large bivalves of the *Trigonodus* type. Trocholinids and Involutinids are rock-building. The overlying horizon contains numerous calcareous algae, e.g. *Teutloporella triasina* and *T. nodosa*. This unit is followed by a nodular limestone with several patch reefs built up by "*lsastrea esinensis*" and "*l. haueri*". The upper part of this approximately 50 m thick Langobard sequence is formed by a nodular grey limestone with smaller chert nodules in the upper part. The described fossiliferous beds were hitherto unknown in Slovenia and the Southern Alps. Similar fossil associations have not yet been described.

RAMOVŠ, A. and JAMNIK, A., 1991. The first proof of the deeper marine Norian (Upper Triassic) beds with conodonts and holothurian skeletons in the Kamnik Alps (Slovenia). Rudar. Metal.-Zbornik, 38: 365-367.

In the central part of the Kamnik Alps (Southern Alps) the deeper marine Hallstatt development of the Northern Calcareous Alps partly continued from the Upper Carnian into the Norian. In the locality Sleme south of Skuta Mountain well bedded dark grey micritic Norian limestone with chert nodules and lenses contain very rich holothurian skeletons; 35 species were determined. The Norian age was provided also with conodont *Epigondolella abneptis*.

RAMOVŠ, A. and TURNŠEK, D., 1991. The Lower Norian (Latian) development with coral fauna on Razor and Planja in the northern Julian Alps (Slovenia). Razprave IV. cl. Akad. Sci. Art. Slovenica, 32: 175-312, pl. 1-8.

The uppermost Carnian limestone in Hallstatt cephalopodic development of the *Anatropites* domain passes upwards conformingly into the lowermost part of the Norian. In the lower part it is layered without microfossils. The upper stratum passes upwards into unbedded sponge/coral reef limestone which reaches up to the 2601 m high peak of Razor. The description of seven species of corals is given, among which *Cyclophyllia raricorallita* and *Margarosmilia nova* are new. In the lower part of the Razor reef limestone coral assemblages with *Retiophyllia* sponges are overgrown by spongiostromate crusts with sessile foraminifers. In smaller lenses pelecypod lumacheles with *Halobia* ex gr. *lenticularis* occur. A part of the reef was colonized by *Cyclophyllia cyclica*. In the higher part of the Razor traverse the rock-building coral *Protoheterastraea razorensis* is found, accompanied by individual larger corals of the genus *Coryphyllia*, sponges *Cryptocoelia* and stromatoporoids of type *Cylicopsis*.

Russo, F., NERI, C., MASTANDREA, A. and LAGHI, G., 1991. La fauna dell'Alpe di Specie (Carnico, Dolomiti orientali): inquadrimento stratigrafico e diagenesi. Rend. Soc. Geol. It., 14: 145-148.

The fauna of the Alpe di Specie (Seelandalpe), NW Dolomites, is one of the most important Carnian stromatopore and coral faunas known. The authors present new data on the stratigraphy, facies and diagenesis of the fossiliferous horizons.

SAN ROMAN, J. and AURELL, M., 1992. Palaeogeographical significance of the Triassic-Jurassic unconformity in the north Iberian basin (Sierra del Moncayo, Spain). Palaeogeogr. Palaeoclimatol. Palaeoecol., 99: 101-117.

In this basin analysis founded on extensive field studies the authors mainly focus on the Jurassic. They conclude that in the Iberian basin, the lowstand episode during the Hettangian was mainly induced by the breakup of the Upper Triassic ramp.

SENFF, M., 1992. First evidence of Variostomidae (Foraminifera) in Upper Triassic marine carbonate rocks of South America. N. Jb. Geol. Paläont. Mh., 11: 683-691.

The benthic foraminifer *Diplotremina subangulata* Kristan-Tollmann is a characteristic faunal element of marine Late Triassic sediments and has been until now, described from the whole Tethys realm as well as from western North America. The occurrence of this species in marine carbonate rocks of the Colombian Payandé Formation is the first evidence from South America and shows once more its extraordinarily wide geographic distribution. With respect to the worldwide occurrence of benthic micro-faunas in Late Triassic times, the question arises, which mechanism was responsible for their transport across the Triassic Pacific.

STEINER, M. and LUCAS, S., 1992. A Middle Triassic paleomagnetic pole for North America. Geol. Soc. Amer. Bull., 104: 993-998.

Two stratigraphic sections were sampled through the early Anisian Anton Chico Member of the Moenkopi Formation in northeastern New Mexico. Two polarities of magnetization are present: a normal-polarity interval succeeded by a reversed-polarity interval and followed by a short normal- and reversed polarity couplet. Detailed thermal demagnetization (10 to 17 steps) was employed to separate magnetic vectors. The secondary magnetization is largely a direction similar to the present-day and/or axial field directions. Demagnetization above 520°C reveals a near horizontal characteristic magnetization. The lithology of the stratigraphic sequence is such that the reversed polarity is contained almost exclusively within coarse sandstone lithologies, and hence, the reversed-polarity characteristic magnetization direction is rarely completely separated from the secondary magnetization. Because of this, the paleopole was calculated from only the lower normal-polarity portion of the section. The pole, calculated from the samples of two localities, is located at 121.4°E, 43.2°N, a_{ss} = 5.3). This Middle Triassic paleopole is in good agreement with published Triassic paleomagnetic poles for cratonic North America and statistically overlaps the Early Triassic paleopoles. The large-scale relative motion during the Triassic between the magnetic pole and the North American plate is constrained by this study to have begun after early Middle Triassic time; it suggests that as much as 10° of apparent-polar wander occurred between the late Anisian-Ladinian (late Middle Triassic) and the middle to late Carnian (early Late Triassic), a time interval of 11 and 14 m.y.

TURNŠEK, D. and BUSER, S., 1991. Norian-Rhaetian coral reef buildups in Bohinj and Rdeči rob in southern Julian Alps (Slovenia). Razprave IV. cl. Akad. Sci. Art. Slovenica, 32: 215-257, pl.1-7. From the localities in Bohinj and Rdeči rob 15 species of corals, two species of stromatoporoids, one chaetitid and two species of sponges are described. Ten coral species were found for the first time in Slovenia. All fossils are typical reef organisms. A comparison of the reef fauna with that of other localities in Slovenia of Norian/Rhaetian age in the northern Julian Alps is made. They have nine species of reef fossils in common. On the basis of the position of the studied Norian/Rhaetian reef of the southern Julian Alps along the southern margin of the former Julian carbonate platform it can be presumed that these reefs represent the edge of the platform which was in contact with the southern Slovenian basin.

TURNŠEK, D. and RAMOVŠ, A., 1987. Upper Triassic (Norian-Rhaetian) reef buildups in the northern Julian alps (NW Yugoslavia). Razprave IV. cl. Acad. Sci. Art. Slovenica, 28: 27-67. During the Norian and Rhaetian the Julian carbonate platform was a stable unit with uniform subsidence which enabled the formation of up to 1000 m of reef limestone (Dovški križ, Šplevta, Kopica). Between the valleys of Vrata and Krma the Dachstein reef limestone is only 300 m thick. There, already at the beginning of the Middle Norian the biolithitic facies was interrupted and only the deposition of bedded Dachstein limestone continued until the end of the Triassic. Fossil builders belong to corals, sponges, calcareous algae, microproblematica. Corals belong to 23 species and 16 genera. Two species are new: *Elysastraea juliana* and *Tropidendron mlinaricensis*. Corals are the most important and prevailing reef builders. Spongiostromate crusts contribute important volumes to the biolithe. In the Norian/Rhaetian Dachstein reef limestone 21 more important and interesting communities could be distinguished.

WEEMS, R.E., 1992. The "terminal Triassic catastrophic extinction event" in perspective: A review of Carboniferous through Early Jurassic terrestrial vertebrate extinction patterns. Palaeogeogr. Palaeoclimatol. Palaeoecol., 94: 1-29.

A catastrophic terminal Triassic extinction event among terrestrial vertebrates is not supported by available evidence. The current model for such an extinction is based on at least weak or untenable assumptions: (1) a terminal Triassic extinction-inducing asteroid impact occurred, (2) a Terminal synchronous mass extinction of terrestrial vertebrates occurred, (3) a concurrent terminal Triassic marine extinction occurred, (4) all terrestrial vertebrate families have similar diversities and ecologies, (5) changes in familial diversity can be gauged accurately from the known fossil record, (6) extinction of families can be compared through time without normalizing for changes in familial diversity through time, (7) extinction rates can be compared without normalizing for differing lengths of geologic stages, and (8) catastrophic mass extinctions do not select for small size. These assumptions have resulted in unsupportable and (or) erroneous conclusions. Carboniferous through Jurassic terrestrial vertebrate families mostly have evolution and extinction patterns unlike the vertebrate and extinction patterns during the terminal Cretaceous event. Only the Serpukhovian (mid Carboniferous) extinction event shows strong analogy to the terminal Cretaceous event. Available data suggest no terminal Triassic extinction anomaly, but rather a prolonged nearly steady decline in the global terrestrial vertebrate extinction rate throughout the Triassic and earliest Jurassic.

WESTERMANN, G.E.G., 1992. Formation and function of suspended organic cameral sheets in Triassic ammonoids - discussion. Paläont. Z., 66: 437-441.

A discussion of the paper by Weitschat and Bandel (1991, Palaont. Z., 65: 269-303) on the organic components in phragmacones of Boreal Triassic ammonoids with a short reply by the authors of the latter publication.

WOPFNER, H., 1992. Riftphasen und deren Einfluß auf das Öl- und Gas-Potential tansanischer Karoo-Becken. Zbl. Geol. Paläont., Teil I, 1991, H. 11: 2703-2712.

Intra-Karoo unconformities and lithology and geometry of specific siliciclastic facies of Tanzanian Karoo basins demonstrate the existence of syndepositional rift movements during Permian and Early Triassic times. The specific facies associations comprise influx of immature siliciclastica due to source rejuvenation, coarsening upwards sequences and scarp foot fan wedges interfingering with lacustrine and deltaic successions. Apart form the initial movement of the megacycle of Karoo deposition, major tectonic pulses occurred during the later part of the Sakmarian, around the middle of the Artinskian, near the end of the Kazanian and about the Permian-Triassic boundary. Each of these events was associated with sedimentary overlap, indicating a progressive widening of the individual rift systems. The event near the Permian-Triassic boundary, which was probably associated with detachment mechanisms, caused the foundering of eastern parts of the cratonic rift to the pericratonic basin stage. Karoo deposition was terminated by a Middle to Late Triassic tectonic event of apparently global significance.

YIN, H.F., 1992. Triassic paleobiogeography of Eastern Asia. Earth Science, J. China Univ. Earth Sci., 17: 123-136.

The Early and Middle Triassic paleobiogeographic provincialization of Eastern Asia consists of the northern temperate North Laurasia Realm, the northern warm-temperate Central Laurasia Realm, the tropical-subtropical Cathaysian Tethys region and Gondwana Tethys Region. Remarkable changes took place in the Late Triassic. Eastern Asia north of the Gondwana Region displayed a tripartition consisting of the Circum-Pacific Realm, the tropical-subtropical Tethys Realm and the temperate-warm Laurasia Realm. The provincialization is controlled both by temperature-latitude separation and plate-ocean and continent separation. As to its significance in plate tectonics, the provincialization demonstrates that during the Triassic the Mesogea or Mesotethys Ocean existed along the Yarlung Zangbo line, that east of 100°E in eastern Asia there was no vast oceanic separation, although small ocean basins might exist in areas between Yarlung Zangbo and Kunlun-Oinling. It also denotes that the Paleopacific tectonic realm formed in the Late Triassic.

The papers listed above have come to the compiler's notice since the publication of the last issue of ALBERTIANA. Authors are kindly requested to send reprints or copies of the title page (with full reference and a (short) abstract, preferably in English, French or German) of their recently published papers to the editor of ALBERTIANA.

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ALBERTIANA 11

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This issue of ALBERTIANA has been compiled and edited by Hans Kerp.

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ERRATUM

Unfortunately, Olenekian and Induan became reversed in Table 2 of Lucas' paper 'Nonmarine standards for Triassic time' (ALBERTIANA, 10, p. 39). Although we are sure that everyone realised that this was a typographical error, we here give a corrected version of this table.

		Г	BIOCH	RONS	
		GCSS	Reptilia	Amphibia	
		RHAETIAN			
	ATE	NORIAN	Pseudopalatus	Apachesaurus	
	1		Rutiodon	Buettneria	
TRIASSIC		CARNIAN	Palaeorhinus	Metoposaurus	
	DLE	LADINIAN	Dinodontosaurus	Mastodonsaurus	
	MID	ANISIAN	Kannemeyeria	Eryosuchus	
	X			Parotosuchus	
	EARL	OLENEKIAN	Garjainia		
		INDUAN	Lystrosaurus	Benthosuchus	



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