ALBERTIANA

MAY 1994

13

ISSN 0619-4324

ALBERTIANA

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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.

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SEE PAGE 104 FOR METHODS OF PAYMENT OF ALBERTIANA 13

Cover:

Palaeogeographical map of Late Triassic Pangea (modified from Lucas, p. 46)

SUBCOMMISSION ON TRIASSIC STRATIGRAPHY

"SHALLOW TETHYS 4" CONFERENCE SEPTEMBER 8-11, 1994 AND MEETING OF OUR SUBCOMMISSION

A. Baud

As announced previously (ALBERTIANA, 12, p. 2), a plenary meeting of our International Subcommission on Triassic Stratigraphy will be organized during the "Shallow Tethys 4" Conference, Sept. 8-11, 1994 in Albrechtsberg/Vienna (Austria). During this conference a P/T Boundary Working Group meeting and a regional IGCP Project 359 meeting will also be organized.

According to information received from Dr. Edith Kristan-Tollmann, sixteen papers and twelve posters concern Triassic stratigraphy and seven papers deal with the Permian-Triassic boundary. More than a half day will be necessary for the scientific session and the agenda will be sent to the participants by Dr. Edith Kristan-Tollmann.

Twenty members of our Subcommission have announced their participation.

Our STS business meeting is on September 10 from 20^{00}-22^{00}h.

An excursion to the Carnic Alps (Carboniferous to Triassic) is organized by Prof. E. Flügel from September 5-8.

Please contact Dr. Edith Kristan-Tollmann, Scheibenbergstraße 53/6, A-1180 Wien, Austria (tel. nr. xx-43-1-47 25 184, fax. xx-43-1-40 20 533) for more information, the "Shallow Tethys 4" 3rd circular and possibly for a late registration. Please do not forget to send the title and abstract also to Dr. A. Baud, chairman of the STS until June 30, 1994, for contributions to the STS scientific session and suggestions for the STS business meeting.

NEW NUMBERS AND CORRECTIONS OF TELEPHONE AND FAX NUMBERS

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NEWS FROM THE IUGS SUBCOMMISSION ON GEOCHRONOLOGY

A. Baud

In the last Bulletin of Liason and Informations (vol. 12) of the Subcommission on Geochronology, G.S. Odin gave a very interesting paper on the "Geological time scale 1994". In the Phanerozoic stages table, our Triassic Stages Chart (ALBERTIANA 10, cover) is adopted, but the author opens a discussion about the "ian" suffix for all global stage names and he wrote that he prefers Indu*sian* instead of Indu*an*. Your comments are welcome!

FORTHCOMING MEETINGS

International Symposium on Permian Stratigraphy, Environments & Resources
Guiyang, Guizhou, China, August 28-31, 1994

This meeting is jointly sponsored by the Nanjing Institute of Geology and Palaeontology in conjunction with IGCP 359, IGCP 306, Pangea Project GSGP and other projects, with excursions to Changxing, Shangsi, Xingjiang and Guizhou. The IGCP 359 meeting is to be chaired by Prof. Yin to concentrate on eastern Tethyan and Circum-Pacific Permo-Triassic correlations. There are also good sections for Triassic sequence stratigraphy in the vicinity of Guiyang, suitable for one day excursions. Information can be obtained from: Dr. Wan Xiang-dong, Secretariat of Organizing Committee for ISP, 1994, Laboratory of Palaeobiology & Stratigraphy, Nanjing Institute of Geology Palaeontology, Chi-Ming-Ssu, Nanjing, 210008 China; Tel. 86-25-714443, Fax. 86-25-712207.

III Coloquio de Estratigrafia y Paleoestratigrafia der Permico y Triasico de España
Cuenca, Spain, June 27-29, 1994

A three-day congress with several pre- and post-congress excursions. More information can be obtained from: Alfredo Arche Miralles and José López Gómez. Instituto de Geología Económica CSIC-UCM. Faculdad de Ciencias Geológicas, Universidad Complutense, 28040 Madrid, España.

HINDEODUS PARVUS AS THE INDEX FOSSIL FOR THE PERMIAN-TRIASSIC BOUNDARY: A RESPONSE TO THE CHINESE WORKING GROUP

R.K. Paull and R.A. Paull

Introduction

This brief report is in response to the proposal for the global stratotype section and point (GSSP) by Professor Yin Hongfu (1993) and the Chinese Working Group on the Permian-Triassic Boundary, and our comments concern only the selection of an index fossil or assemblage zone (GSP) for the basal Triassic.

Section 2.2.3 of their proposal contrasts the wide distribution of the conodont *Hindeodus parvus* with the more limited occurrence of the ammonoid *Otoceras.* In this discussion, reference was made to specimens illustrated from North America by Paull and Paull (1983) that might be assignable to *Hindeodus parvus.* We confirm a broad distribution of this pan-Tethyan conodont species in the western United States, and endorse its suitability for use here as a boundary index fossil.

Distribution data on *Hindeodus parvus* (*Isarcicella? parva* of Sweet, 1992) and its various synonyms have long been obscured by the nomenclature problems involving the genera *Anchignathodus, Hindeodus,* and *Isarcicella.* North American conodont workers in the late 1970s and 1980s used the three morphotype concept suggested by Staesche (1964) for *Isarcicella isarcica* (Huckreide) and modified by Sweet (1977), rather than adopting *Hindeodus parvus* (Kozur and Pjatakova) after it was initially designated (Kozur, 1975) as a discrete species. As a result, this form was designated as the laterally adenticulate morphotype of *Isarcicella isarcica* (Huckreide) by Paull and Paull (1983, Fig. 5, p. 88) rather than *Hindeodus parvus,* and we consistently used this terminology in publications throughout the 1980s and early 1990s, although they are synonymous. To avoid confusion in this response to the Chinese Working Group, we will use the terminology consistent with their 1993 report (*Hindeodus parvus*).

Marine Lower Triassic Strata In Western United States

Notably lacking in international discussion has been information regarding lowermost Triassic strata and the Permo-Triassic boundary in the western United States. The depositional area here for early Scythian (Griesbachian) sediments is shown in Figure 1. Early Triassic seas spread from the general site of the ancestral Permian Phosphoria basin. Basal Griesbachian sediments of the Dinwoody Formation strongly reflect the influence of Permian paleogeology (Paull and Paull, in press). Although considerable subsidence affected the depocenter area, depositional conditions were typical of shallow marine, outer shelf environments.

The initial Triassic transgression was rapid, spreading from the basin over the bordering shelf regions to the north, east, and south. The paleoslope was a modest 1 m/km or less (Collinson and others, 1976; Paull and Paull, 1986, in press), and there is little evidence for significant subaerial erosion or extensive solution. In addition, stable tectonic conditions persisted from Permian into Triassic resulting in apparent local conformity of beds across the boundary. This paraconformable contact is typically defined by an abrupt change in lithology from more resistant chert, carbonate, sandstone, or siliceous shale of the Permian to less resistant, calcareous shale or silty mudstone of the lowermost Triassic Dinwoody Formation. Less common basal lithologies include shaly-bedded siltstone and thin-bedded wackestone. Basal Triassic conglomerates containing reworked Permian lithologies are present at only nine of our measured sections, and all of these rim the basin margin.

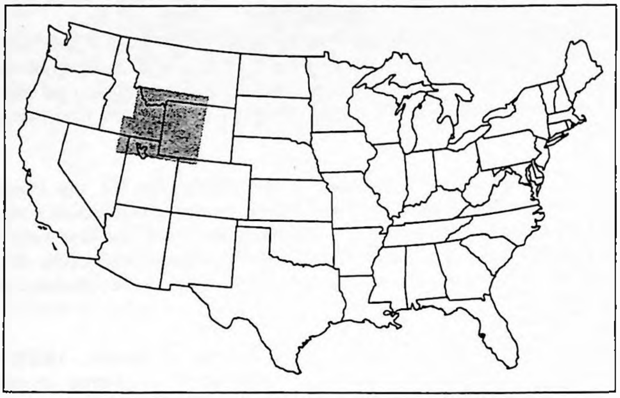

Fig. 1. Distribution of Lower Triassic (Griesbachian) Dinwoody Formation, western U.S.A. Region includes southwestern Montana, western Wyoming, northern Utah, northeastern Nevada, and southeastern Idaho.

Abundant *Lingula* spp. and microgastropods dominate the poorly diverse basal fauna, with pelecypods becoming more abundant and varied above the basal beds. Ammonoids are extremely rare, and are neither plentiful enough nor well-enough preserved for biostratigraphic use until the occurrence of Smithian-age species associated with the *Meekoceras gracilitatis* Zone (of Silberling and Tozer, 1968) within the overlying lower limestone unit of the Thaynes Formation. Microfauna present in insoluble residues commonly includes the conodonts *Hindeodus typicalis, Hindeodus parvus* (or laterally adenticulate *Isarcicella isarcica* as reported in our earlier papers), *Neogondolella carinata*, and rare specimens of laterally denticulate *Isarcicella isarcica*. Microgastropods, including bellerophontids in lowermost Triassic beds, are consistently present, and the bellerophontids seem to have biostratigraphic utility in the basal Triassic. The use of *Bellerophon* spp. as an aid for correlation of basal Lower Triassic strata was first attempted by Sweet (1979) for Permo-Triassic rocks in Kashmir, Pakistan, and Iran. Paull and Paull (1983, 1993) and Paull and others (1989) later utilized microscopic forms of these gastropods to refine correlation in Wyoming and southwestern Montana.

Although our database contains about 200 measured sections of marine Lower Triassic rocks in southwestern Montana, western Wyoming, southeastern Idaho, Utah, and northeastern Nevada, many southern sections are beyond the depositional limits of the Dinwoody Formation.

However, 66 sections contain Griesbachian conodonts and are also basally intact. The broad distribution of these conodonts indicates that this lowermost Triassic biozone extended over 194,000 sq. km.

Frequency Distributions Of Early Triassic Microfauna

Hindeodus typicalis is the most commonly-occurring conodont species in lowermost Triassic strata of the western U.S.A. It is present in 89% of our basal sections. However, its use as an index for the Early Triassic is diminished because its range straddles the Permo-Triassic boundary. Another conodont species that occurs in both uppermost Permian and basal Triassic strata is *Neogondolella carinata.* Although this form is not uncommon in the Lower Triassic Dinwoody Formation, it was recovered from only 32% of the 66 sections used in this study. Its lithologic associations and distribution patterns suggest some degree of paleoenvironmental significance as an indicator of a more offshore setting, and its range may extend higher than *Hindeodus typicalis* in more "basinal" marine environments.

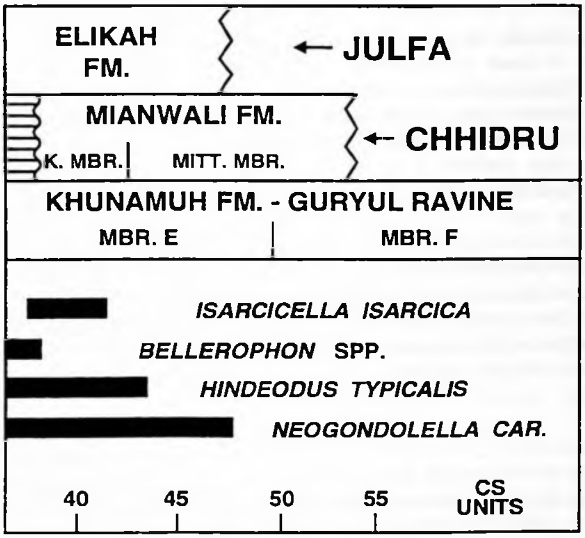

*Fig. 2. Ranges of selected fossils from Sweet's (1979, p. 244) diagram correlating earliest Triassic sections in Iran (Julfa), Pakistan (Chhidru), and Kashmir (Guryul Ravine). At this time, Sweet included the laterally adenticulate morphotype (*Hindeodus parvus *of various authors;* Isarcicella? parva *of Sweet, 1992) with forms now considered to be* Isarcicella isarcica. *The reader's attention is directed to the interval of mutual range overlap of the four components illustrated.*

On the other hand, *Hindeodus parvus* is present in 71% of our basal Triassic sections. It alone has a broad enough distribution and a suitably restricted time range for use as an Early Triassic index fossil.

As described above, the presence of bellerophontid microgastropods in lowermost Triassic strata appears to have time significance and provides a tool for refined correlation within the basal Triassic conodont zone (Zone 1 of Carr and Paull, 1983). Bellerophontids are present in 59% of our basal sections, and accompany *Hindeodus parvus* in 80% of these instances.

The second choice for a global stratotype point proposed by the Chinese Working Group was the acme zone represented by *Isarcicella isarcica* (laterally denticulate forms), *Ophiceras,* and *Claraia* (their IOC assemblage). This alternative proposal for a Lower Triassic index would have little utility in the western U.S.A. *Isarcicella isarcica* is rare in our basal sections (6%) and is most typically present with all or most of the forms *Hindeodus typicalis, Hindeodus parvus, Neogondolella carinata*, as well as bellerophontid microgastropods. As stated in a previous section, ammonoids are absent to very rare until the base of the Smithian and provide no opportunity for biostratigraphic delineation. Also, the range of the pelecypod *Claraia* by itself is too great to be of utility in the western United States.

Range Relationships Of Early Triassic Microfauna

The stratigraphic positions of the *H. parvus* and bellerophontid-bearing horizons above the Permian surface are in close correspondence to each other but vary geographically across the depositional area. These generally equivalent surfaces provide an interesting time-defined horizon and reflect the amount, and possible timing, of regional subsidence. In shelf regions of Utah and Montana, this level averages 37 m, but increases to 175 m in the depocenter area of southeastern Idaho. This surface is about 90 m above the Permian in western Wyoming, but decreases eastward to a few meters in central Wyoming.

The general range relationships between the four conodont species under discussion and the associated microscopic bellerophontids in the western United States bear a strong resemblance to the species range diagram in Sweet's (1979) discussion of Permo-Triassic correlation between sections in Iran (Julfa), Pakistan (Chhidru), and Kashmir (Guryul Ravine) (Fig. 2). This supports our observations and suggests a common bond between Early Triassic microfauna of the Tethys and Circum-Pacific regions.

Conclusions

We confirm the value of *Hindeodus parvus* (*Isarcicella? parva* of Sweet, 1992) as an index fossil for the basal Triassic in the western United States, and support the first recommendation of Professor Yin Hongfu (1993) and the Chinese Working Group on the Permian-Triassic Boundary. The distribution of *Hindeodus parvus* here is sufficiently widespread and its range is short. Despite a lengthy and varied nomenclatural history, the species is readily identifiable. It has also been used as a guide fossil for the Griesbachian in the Permo-Triassic boundary beds of the Cache Creek Group in south-central British Columbia, Canada (Beyers and Orchard, 1989).

Adoption of the second proposal concerning the *Isarcicella isarcica* (laterally denticulate)-*Ophiceras-Claraia* acme zone would have little value in North America because of the limited distribution of the zone's conodont component, the scarcity of ammonoid specimens, and the long range of *Claraia*.

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CONODONTS FROM *OTOCERAS* BEDS: ARE THEY PERMIAN?

M.J. Orchard

Of course, the answer to this question depends entirely on the final definition for the base of the Triassic. The *Otoceras* beds have long been regarded as basal Triassic (Tozer, 1988). However, recently it has been claimed that *Otoceras*-bearing beds at several localities contain conodont fauna like that of the Changhsingian, and are therefore at least partly Permian under proposed conodont-based definitions (Sweet, 1979, 1992; Yin et al., 1988). Below, I summarize new data recently compiled by Orchard, Nassichuk and Lin (in press) from Selong, Tibet, and review other published data bearing on this question. As a complement to this, I have studied conodont collections from Meishan (Wang and Wang, in Zhao et al., 1981), type section of the Changhsingian; from *Paratirolites* beds in northwest Iran (Sweet in Teichert et al., 1976), equivalent to the higher Dorashamian; type material of *Neogondolella carinata* and its associates from the Lower Triassic Dinwoody Formation in western USA (Clark, 1959); and Upper Griesbachian conodonts from the *Proptychites strigatus* Zone of Ellesmere Island in the Canadian Arctic (Mosher, 1973).

The localities where *Otoceras* and conodonts are reported to co-occur are Selong in Tibet, the Guryul Ravine in Kashmir, sections in the central Himalaya (Spiti, Lalung), and in the Arctic. Additional reports of *Otoceras* from South China are unconfirmed, and therefore are not considered here.

Recently, the conodont fauna of the Lower Griesbachian *Otoceras latilobatum* bed at Selong, Tibet has been described by Orchard et al. (in press). The basal Triassic at Selong includes two horizons with *Otoceras*: the *O. latilobatum* horizon below and the *O. woodwardi* horizon above. These might be equivalent to, respectively, the *O. concavum* zone and the *O. boreale* zone in the Canadian Arctic Archipelago (Wang et al., 1989). Conodonts from Selong have formerly been the subject of studies by Rao and Zhang (1985); Yao and Li (1987); Wang et al. (1989); Xia and Zhang (1992); and Wang et al. (1993). Yin (1993, p. 45-47) has recently summarized the section too and highlighted the divergence of views on the conodonts from the *Otoceras* beds. The fauna described by Orchard et al. (op. cit.) comprises *Hindeodus typicalis, Isarcicella? parva, N.* aff. *N. carinata, Neogondolella* aff. *N. changxingensis, N.* n. sp., and *N. tulongensis*. A single *I. isarcica* is reported from the top of the bed. These results differ in detail from those of previous workers, but also partly duplicate records that have been contentious. In summary:

1) The concurrent appearance of *Isarcicella? parva* and *Otoceras* reported by Wang et al. (1989) is confirmed. These taxa might therefore provide complementary indices for definition of basal Triassic.
2) The recovery of *Isarcicella isarcica* confirms the occurrence reported previously only by Rao and Zhang (1985). Selong is the only reported locality where *Otoceras* and *I. isarcica* co-occur.
3) Contrary to reports of authors other than Xia and Zhang (1992), the Changhsingian *Neogondolella changxingensis-N. deflecta* assemblage is not recognized within the *Otoceras latilobatum* bed at Selong.

Conodonts described from the *Otoceras* beds at Guryul Ravine by Bhatt et al. (1981) and Bhatt and Arora (1984) included the Changhsingian species *Neogondolella changxingensis*, *N. deflecta* subsp., and *Hindeodus* cf. *latidentatus*, in addition to the long ranging *H. typicalis* and *N. carinata*, and the potential Triassic index *Isarcicella? parva*. Poor illustration of these conodonts precludes confident assignment but, significantly, the occurrence of the Permian species was not acknowledged in subsequent syntheses. In fact, Matsuda (1984) recorded only a single species of *Neogondolella*, that is *N. carinata*, from the Lower Triassic of Kashmir. He illustrated variants that resemble the Selong species *N. tulongensis* and *N.* n. sp., which may have been formerly misidentified as, respectively, the Permian species *N. deflecta* and *N. orientalis* by other authors (see below).

Conodonts from *Otoceras*-bearing strata in the Kumuan, Spiti, and Zanskar sections of the Himalayan region were also described and illustrated by Bhatt and his colleagues. The first report by Bhatt and Joshi (1978) listed the species from the Spiti River section, but provided no illustrations. As discussed by Nakazawa et al. (1980, p. 83), the listed fauna was almost identical with the fauna of the *Otoceras* beds of the Guryul Ravine. Subsequently, Bhatt et al. (1981) and Bhatt and Arora (1984) listed and illustrated conodont faunas from *Otoceras* localities in the central Himalayas, namely Kumuan, Spiti, and Zanskar, as well as at Guryul Ravine (see above). From these faunas they identified *Neogondolella subcarinata*, *N. changxingensis*, *N. carinata*, *N. orientalis*, *N. planata*, *N. deflecta* subspp., *N. behnkeni*, and *N.* sp. A (Bhatt and Arora, 1984, p. 724). Illustrations of these conodonts, mostly from Lalung in the Spiti Valley, are difficult to assess confidently, but, as with the Guryul Ravine material, examples of *N. tulongensis* and *N.* n. sp. appear to be present whereas typical Permian conodont species are not apparent. This is in agreement with Matsuda (1984, p. 120, 122) who, having examined Spiti collections, explicitly rejected the presence of the Permian "*N. subcarinata* group" in the *Otoceras* beds of Spiti.

In the Arctic, Sweet (in Teichert and Kummel, 1976) reported *Hindeodus typicalis* and *Neogondolella carinata* from the *Otoceras boreale* beds in the Kap Stosch area of east Greenland. Recently, Kozur (1993) reported having seen in the Greenland conodont material of W.C. Sweet, *Neogondolella subcarinata* and *N. orientalis* from the "lower *Hypophiceras* Bed"; *Hindeodus latidentatus* from the "*O. boreale* Bed", and *Isarcicella? parva* from the "*Ophiceras* Bed". These data, which are difficult to reconcile with published data in Teichert and Kummel (1976), are crucial because they represent an exceptional record of *H. latidentatus* with *Otoceras*, a situation that Kozur (1989, p. 390) cites to demonstrate that "..the lower *O. woodwardi* Zone and ..the older *O. concavum* Zone.. corresponds to the late Changhsingian..". No further details or illustrations of Greenland conodont material have been provided since Sweet's work.

Dagis and Korchinskaya (1987, 1989) also reported the association of *Otoceras boreale* and *Neogondolella carinata* in Spitsbergen. Attempts to extract conodonts from the limy matrix of *Otoceras* specimens collected by E.T. Tozer in the Canadian Arctic have not been successful. However, Henderson (1993) reported Changhsingian conodonts from shales at the base of the *Otoceras*-bearing Blind Fiord Formation in the Sverdrup Basin, but the conodonts remain undescribed and their relationship to *Otoceras*-bearing beds is unclear.

Late Permian sections in Transcaucasia (Dorashamian) and south China (Changhsingian) contain a conodont fauna dominated by *Neogondolella subcarinata*, *N. changxingensis*, *N. deflecta*, and *Hindeodus typicalis*. *Hindeodus latidentatus* occurs in the uppermost parts of the Permian in both regions. Reports of the Griesbachian species *N. carinata* throughout the Ali Bashi and

Changhsing formations is, in my view, incorrect. Rather, these elements should be assigned to one or more new species. As alluded to above, many reports of the latest Permian *Neogondolella* species in Griesbachian strata are also judged to be incorrect.

This brief review suggests that there is little, if any, unambiguous conodont data that demonstrates contemporaneity of Lower Griesbachian *Otoceras* and uppermost Permian Changhsingian and Dorashamian stages. A more exhaustive review is given by Orchard et al. (in press). Reports of uppermost Permian conodonts in the Griesbachian, and of Griesbachian conodonts in the uppermost Permian, are refuted or remain unverified. Clearly, further taxonomic revision of *Neogondolella* species from the P-T boundary interval is needed. This is particularly true of *N. carinata* and related species. These revisions will impact significantly on conclusions reached through both traditional and graphic correlation techniques.

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THE NONMARINE PERMIAN-TRIASSIC BOUNDARY AND TRIASSIC CONCHOSTRACAN FOSSILS IN CHINA

Liu Shuwen

Nonmarine Permian and Triassic strata are widely distributed in China. They show a clear sequence and an abundance of fossils, such as conchostraca, ostracoda, bivalves, vertebrates, pollen, spores, and megaspores. The Permo-Triassic conchostracan fossils are well studied in Ordos Basin, Shanxi, Xinjiang and southwestern China.

1. The Triassic conchostracan fossils can be divided in eleven assemblages (in ascending order) (Table 1, p. 14):

(1) The *Falsica-Cornia-Cyclotunguzites* assemblage in the middle-lower parts of Guodikeng Formation in Dalongkou, Junggar Basin, Xinjiang.
(2) The *Falsica-Cyclotunguzites* assemblage in the lower part of the Jiucaiyuan Formation to the upper part of Guodikeng Formation in Dalongkou, Junggar Basin, Xinjiang.
(3) The *Leptolimnadia-Paleoleptestheria* assemblage in the upper part of Liujiagou Formation in Shanxi Province.
(4) The *Gabonestheria-Diaplexa* assemblage in the middle part of the Heshanggou Formation in the Ordos Basin.
(5) The *Eosolimnadia-Triasestheria* assemblage in the upper part of the Heshanggou Formation in Shanxi Province.
(6) The *Xiangxiella-Protomonocarina* assemblage in the lower part of the Ermaying Formation in Shanxi Province and in the Badong Formation in southwestern China.
(7) The *Brachyestheria-Pseudoestheria* assemblage in the upper part of the Ermaying Formation in the Ordos Basin.
(8) The *Euestheria-Howellites* assemblage in the Tongchuan Formation in the Ordos Basin and the Banan Formation in southwestern China.
(9) The *Euestheria-Anyuanestheria* assemblage in the Xujiahe Formation in southwestern China.
(10) The *Euestheria* assemblage in the Yanchang Formation in the Ordos Basin.
(11) The *Euestheria-Mesolimnadiopsis* assemblage in the Huangshanjie Formation in Xinjiang.

2. The nonmarine Permian-Triassic boundary: the Dalangkou, Jimusar, Xinjiang is one of the most ideal areas for the study and the establishment of the nonmarine P-T boundary stratotype in China. Permian and Triassic strata are completely exposed and contain abundant conchostracan fossils. They have been collected from the Wutonggou, Guodikeng and Jiucaiyan Formations.

Section measured across the southern limb of the Dalangkou Anticline, Jimusar

Quaternary sediments

- - - - - unconformity - - - - -

The Lower Triassic Jiucaiyuan Formation (T_1)

61	Purplish-red silty mudstone intercalated with thin layers or beds of greyish-green sandstone and siltstone, bearing vertebrate remains	14.92 m
60	Yellowish-green thin-bedded lithic sandstone, with partings of purplish-red silty mudstone with horizontal bedding in the top, containing conchostraca	13.19 m
59	Purplish-red silty mudstone intercalated with greyish green siltstone, silty mudstone and lithic sandstone, horizontal bedding, yielding the vertebrate *Lystrosaurus* sp.	8.10 m
58	Yellowish-greyish green medium-thick bedded lithic sandstone; the upper part contains sandstone concretions	3.03 m

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57	Purplish-red and greyish-brown silty mudstone with intercalated beds of greyish-green lithic sandstone	8.83 m
56	Purplish-red silty mudstone interbedded or banded with greyish-green silty mudstone, with fine horizontal bedding, containing conchostraca: *Falsica* sp., *Beijianglimnadia* sp., *Cyclotunguzites* sp., *Difalsica elongata* Liu, *D. grandis* Liu; Dicynodontia indet.	10.52 m
55	Purplish-red silty mudstone with finely rippled bedding or fine horizontal bedding	16.02 m
54	Mainly purplish-red silty mudstone unevenly interbedded with greyish-green thin-bedded siltstone, with horizontal bedding, and sandstone concretions in the siltstones, yielding conchostraca and vertebrate at the bottom; conchostraca: *Falsica gitaiensis* Liu, *F. beijiangensis* Liu, *F. dalongkouensis* Liu, *Beijianglimnadia rotunda* Liu, *B. multilinearis* Liu, *Sphaerestheria* cf. *minuta* Liu; vertebrate: *Lystrosaurus* sp.	33.31 m
53	Purplish-red silty mudstone with interbeds of greyish-black silty mudstone and greyish-green siltstone, with fine horizontal bedding or rippled bedding, containing *Klausipollenites schaubergeri* (Potonié et Klaus) Jansonius, *Alisporites austrialis* de Jersey, *Vitreisporites pallidus* (Reissinger) Nilsson, *Pteruchipollenites reticorpus* Yang et Li, *Lueckisporites virkkiae* Potonié et Klaus	15.05 m
52	Yellowish-green siltstone alternated with greyish black silty mudstone, with fine rippled or fine horizontal bedding	3.47 m
51	Purplish-red silty mudstone	3.12 m

Age \ Area		Northern China			Southwestern China
		Dalongkou, Junggar Basin	Ordos Basin	Shanxi Province	
Late Triassic (T_3)	8 *Euestheria-Howellites* 9 *Euestheria-Anyuanestheria* 10 *Euestheria* 11 *Euestheria* - *Mesolimnadiopsis*	Huangshanjie Fm.: *Mesolimnadiopsis karamaica* *M. pingliangouensis* *M. zhungaricus* *Euestheria jimsarensis*	Tongchuan Fm. Yanchang Fm.: *Euestheria deforma, E. brodieana,* *E. shensiensis, E.* cf. *multireticulata* *Euestheria gibba, E. tongchuansis* *E. jinsuoguanensis, E. huanglongensis* *E. hanchengensis, E.* cf. *minuta* *E. celeta, E.* cf. *dorsorecta* *Aquilonoglypta hanchengensis* *Howellites hanchengensis* *H. tongchuanensis*		Xujiahe Fm.: *Euestheria minuta, E. yanjiangxiensis* *E. weiyuanensis, E. dazuensis* *E. yipinglangensis, E. yimenensis* *Palaeolimnadia globosa* *Anyuanestheria ornata, A. reticulata* *A. truncata, A. sichuanensis* Banan Fm.: *Howellites curvatus* *H. subquadratus*
Middle Triassic (T_2)	6 *Xiangxiella-Protomonocarina* 7 *Brachyestheria-Pseudestheria*		Ermaying Fm.: *Pseudestheria subgibba* *P. shensiensis* *Brachyestheria subdisca*	Ermaying Fm.: *Protomonocaria binoda* *Trisitum multilineatus* *Gabonestheria shanxiensis* *G. arcuata, G. fusiformis* *Palaeolimnadia pusilla* *Anyuanestheria shanxiensis* *Sphaerestheria minuta* *Punctestheria minuta* *P. cornuta, P. qinxianensis*	Badong Fm.: *Xiangxiella elongata, X. acuta* *X. bicostata, X. xilingxiensis* *Protomonocarina sinensis* *P. buzhuangheensis, P. oblonga* *P. hubeiensis* *Euestheria lepida, E. sparsa* *E. multilinearis, E. hubeiensis* *E. shizibaoensis, E. dactylis* *Palaeolimnadia machaolingensis* *P. paucilineata, P. triangularis* *Diaplexa(?) xuanhanensis* *Dictyolimnadia subquadrata*
Lower Triassic (T_1)	1 *Falsisca-Cornia-Cyclotunguzites* 2 *Falsisca-Cyclotunguzites* 3 *Leptolimnadia-Paleoleptestheria* 4 *Gabonestheria-Diaplexa* 5 *Eosolimnadia-Triasestheria*	Jiucaiyuan Fm.: *Falsisca subovata, F. fabiformis* *Cyclotunguzites brevus, C. dalongkouense* *Cyclestherioides dalongkouense* Guodikeng Fm.: *Falsisca qitaiensis, F. dalongkouemsis* *F. triangularis, Sphaerestheria* cf. *minuta* *Cyclotunguzites qitaiense, C. dalongkouense* *Beijianglimnadia rotunda, B. multilinearis* *B. elegans, Cyclestherioides triangularus* *Falsisca multilinearis, F.* cf. *kanandaensis* *F.* cf. *jeskinoica, Huanghestheria subovata* *H. magnapicalis, H. xinjiangensis* *Cornia beijangensis, C.* cf. *sileenica* *Trinodus minutus* *Cyclotunguzites xinjiangense* *Beijianglimnadia minuta, B. dalongkouensis*	Heshanggou Fm.: *Diaplexa varidicta, Gabonestheria* *clinotuberica, G. guchengchuanensis* *Cornia guchengensis* *Aquilonoglypta xilougouensis* *A. clinoquadrata, Leptonem'a cyclata* *Dictyostriaca subcyclata* *Glyptoasmussia* cf. *quadrata* Sunjiagou Fm.: *Sinolimnadiopsis yaoxianensis* *Huanghestheria longellipsa*	Heshanggou Fm.: *Eosolimnadia subquadrata* *E. xingxianensis* *E. shanxiensis* *Triasestheria shanxiensis* *Palaeolimnadia magnapicalis* Liujiagou Fm.: *Leptolimnadia shanxiensis* *L. jiaochengensis* *Palaeolimnadia shanxiensis* *P. multilineata, P. komiana* *P.* cf. *chuanbeiensis* *Loxomegaglypta jiaochengensis*	Yongningzhen Fm.: *Euestheria minuta* *E. leidayanensis* Feixianguan Fm.: *Euestheria minuta* *E. langdalensis* *Palaeolimnadia pusilla*

50	Variegated siltstone unevenly alternating with silty mudstone, with fine horizontal bedding, containing palynomorphs: *Apiculatisporites spiniger* (Leschik) Qu, *Limatulasporites fossulus* (Balme) Foster, *L. parvus* Qu, *Alisporites sublevis* (Luber) Chen, *Protohaploxypinus limpidus* (Balme et Hennelly) Balme et Playford, *Striatoabieites richteri* (Klaus) Hart, *Lueckisporites virkkiae* Potonié et Klaus, *Taeniaesporites pellucidus* (Goubin) Balme	6.27 m
49	Brownish-red thinly bedded silty mudstone with fine horizontal bedding	3.68 m
48	Yellowish-green and greyish-yellow siltstone with much more yellowish grey-greyish black silty mudstone in the upper part, with fine horizontal bedding, containing conchostraca: *Falsica* sp., *Beijianglimandenia* sp.	5.83 m
49	Brownish-red thinly bedded silty mudstone with fine horizontal bedding	3.68 m
48	Yellowish-green and greyish-yellow siltstone with much more yellowish-grey-greyish black silty mudstone in the upper part, with fine horizontal bedding, containing conchostraca: *Falsica* sp., *Beijianglimnadia* sp.	5.83 m
47	Greyish-black silty mudstone, containing spores and pollen: *Cirratriradites* sp., *Cordaitina rotata* (Luber) Samoilovich, *Klausipollenites schaubergeri* (Potonié et Klaus) Jansonius, *Hamiapollenites limbalis* Zhang; conchostraca: *Falsisca* sp., *Huanghestheria* sp., *Beijianglimnadia* sp.	4.92 m
46	Yellowish-brown thin-bedded siltstone containing numerous lumps of micritic limestone, with horizontal bedding	5.61 m
45	Greyish-brown silty mudstone containing lumps of micritic limestone, with fine horizontal bedding, containing spores and pollen: *Cyclogranisporites aureus* (Loose) Potonié et Kremp, *Calamospora pallida* (Loose) Schopf, Wilson et Bentall, *Alisporites sublevis* (Lub.) Chen, *A. australis* de Jersey, *Vitreiporites pallidus* (Reissinger) Nilsson, *Decussatisporites mulstrigatus* Hou et Wang; megaspores: *Trileites* sp., *Triangulatisporites* sp. *triangulatus* (Zerndt) Potonié et Kremp	10.62 m
43	Predominantly yellowish-green siltstone and pelitic siltstone interbedded unevenly with multicolored pelitic siltstone with intercalation beds of lithic sandstone, with calcareous lumps and fine horizontal bedding, containing spores and pollen: *Cordaitina rotata* (Luber) Samoilovich, *Alisporites sublevis* (Luber) Chen, *Vitreisporites pallidus* (Reissinger) Nilsson; bivalves: *Palaeodonta* cf. *parallela* (Amalitsky), *P. brevis* Liang; conchostraca: *Cornia* sp., *Polygrapta* sp.	13.30 m
42	Mainly greyish-brown mudstone with fine horizontal bedding, and yellowish-green fine sandstone at the top, containing plants: *Knorria* sp., (*Lepidodendron*) *Lepidostrobophyllum* sp. and conchostraca: *Polygrapta* sp.,	2.76 m

41	Yellowish-green siltstone, and in the top, thin-bedded silty mudstone interrelated with calcareous mudstone, with horizontal bedding	5.31 m
40	Greyish-brown silty mudstone, and in the top, brownish-red pelitic siltstone intercalated with yellowish-green pelitic siltstone, contains few of calcareous lumps, with fine horizontal bedding, yielding spores and pollen: *Vesicaspora fusi* Zhou, *Alisporites sublaevis* (Luber) Chen, *Platysaccus alatus* (Luber)	5.17 m
39	Alternation of yellowish-green siltstone with greyish-green lithic sandstone	7.84 m

----- Conformity -----

The Upper Permian Wutonggou Formation (P_2)

38	Grey medium bedded lithic sandstone and sandstone conglomerate, intercalated with silty mudstone containing amount of carbolic, and interbedded with siltstone on the top in the basal part, lens-like silty micritic limestone containing plant: *Paracalamites* cf. *stenocostata* Gu et Zhi, *Callipteris* sp., *Cornucarpus* sp.; conchostraca: *Polygrapta minuta* Liu, *P. xinjiangensis* Liu, *P. wutonggouensis* Liu, *P. dalongkouensis* Liu, *P. oviformis* Liu, *P. qitaiensis* Liu. Sandstone and sandstone conglomerate with medium-oblique bedding, siltstone and mudstone with fine horizontal bedding	23.58 m

2. Section measured across the Northern Lim of the Dalongkou anticline, Jimusar

The Lower Triassic Jiucaiyuan Formation (T_1) Total thickness: 220.6 m

77-57 layer thickness 180.90 m omit

56	Purplish-red silty mudstone with horizontal bedding, yielding vertebrates: *Lystrosaurus* sp., *Chasmatosaurus* sp.	5.72 m
55	Greyish-green and purplish-red silty mudstone, containing calcareous lumps and nucleus, yielding conchostraca: *Falsisca* sp., *Cyclotunguzites* sp.	2.25 m
54	Purplish-red silty mudstone, containing calcareous siltstone small nuclei, yielding vertebrate: *Lystrosaurus robustus* Sun	6.59 m
53	Mainly greyish-green silty mudstone consisting four rhythmic units with yellowish-green siltstone with horizontal bedding, containing spores and pollen: *Limatulasporites limatulus* (Playford) Helby et Foster, *Discisporites psilatus* de Jersey, *Tsugaepollenites jonkeri* Jansonius, *Taeniasporites pellucidus* (Goubin) Balme, *Klausipollenites schaubergeri* (Potonié et Klaus) Jansonius, *Alisporites* sp.; plants: *Pecopteris* sp.; conchostraca: *Falsisca fabiformis* Liu, *Cyclotunguzites brevis* Liu, *C. qitaiensis* Liu, *Cyclestherioides*	

	dalongkouense Liu; ostracoda: *Darwinula triassiana, D. rodundaea*	3.43 m
52	Grey fine lithic sandstone with fine sand siltstone in the upper part, containing great amount of calcareous sandstone lumps	4.13 m
51	Purplish-red silty mudstone	4.37 m
50	Greyish-green siltstone in the lower part and greyish-black silty mudstone in the upper part, with fine horizontal bedding, containing spores and pollen: *Limatulasporites fossulatus* (Balme) Helby et Foster, *Lycospora imperiales* Jansonius, *Lundbladispora* sp., *Taeniasporites pellucidus* (Goubin) Balme, *Protohaploxypinus* sp., *Alisporites* spp.; megaspores: *Trileites* spp., *Maexisporites* spp.	8.94 m
49	Greyish-green thin-medium bedded fine lithic sandstone interbedded with silty mudstone, with horizontal bedding	8.94 m

- - - - - Conformity - - - - -

The Upper Permian-Lower Triassic Guodikeng Formation T(P_2-T_1) Total thickness 144.17 m

48	Purplish-red silty mudstone, siltstone at the bottom and greyish-green silty mudstone at the top, with fine horizontal bedding, containing plants: fragments and spores and pollen: *Punctatisporites* sp., *Limatulasporites* sp., *Alisporites* sp., *Equisetosporites* sp.	4.87 m
47	Greyish-green thin bedded siltstone alternated with silty mudstone with horizontal bedding, containing megaspores: *Maexisporites* sp., *Otynisporites eotriassicus* Fuglewicz, *Trileites* sp., *Triangulatisporites* cf. *triangulatus* (Zerndt) Potonié et Kremp; and conchostraca	1.63 m
46	Purplish-red silty mudstone	4.27 m
45	Yellowish-green and greyish-green siltstone containing few of calcareous nucleus and lumps alternated with silty mudstone	2.25 m
44	Purplish-red silty mudstone containing vertebrate: *Lystrosaurus* sp.	5.20 m
43	Greyish-green siltstone and silty mudstone in the middle part, with fine horizontal bedding, containing ostracoda: *Darwinula quanzyiensis*	2.75 m
42	Purplish-red and dark-red silty mudstone alternated with greyish-green siltstone and silty mudstone, with great amount of small nucleus in the lower part and horizontal bedding in the upper part, containing spores and pollen: *Limatulasporites limatulus* (Playford) Helby et Foster, *Lundbladispora wantangensis* Qu, *Kraeuselisporites disparilis* Qu et Wang, *Taeniaesporites noviaulensis* Leschik, *Alisporites* spp., *Equisetosporites* sp.; megaspores: *Triangulatisporites* cf. *triangulatus* (Zerndt) Potonié et Kremp, *Triangulatisporites* sp., *Trileites* sp., *Verrutriletes* sp.; conchostraca: *Falsisca triangularis* Liu, *F. elongata* Liu, *F. semicircularis* Liu, *Cyclotunguzites dalongkouense* Liu, *C.*	

	qitaiensis Liu, *Cyclestherioides triangularis* Liu, *Sphaerestheria* cf. *minuta* Liu	8.82 m
41	Predominantly grey, greyish-black and few of purplish-red silty mudstone interbedded evenly with yellowish-green and greyish-green siltstone, with a lot of sand balls like round ball, dung and stick in the lower part, with layer-like arranging, and with fine horizontal bedding amount the mudstone, containing megaspores: *Triangulatisporites vermiculatus* Yang et Sun, *Tr.* cf. *triangulatus* (Zerndt) Potonié et Kremp, *Maexisporites* sp.	12.36 m
40	Yellowish-green fine sandstone containing calcareous lumps in the upper part, siltstone containing sand ball on the top	3.08 m
39	Greyish-green siltstone, and in the top, silty mudstone regularly contains sand balls	2.68 m
38	Purplish-red silty mudstone with greyish-black mudstone in the middle part with very development of fine horizontal bedding	4.14 m
37	Yellowish-green siltstone with greyish-black silty mudstone in the middle part	3.94 m
36	Mainly dark red silty mudstone with parts of greyish-black and greyish-green siltstone as well as silty mudstone containing a lot of calcareous lumps, with much more fine horizontal bedding and a few fine intersected bedding, yielding spores and pollen: *Apiculatisporis spiniger* (Leschik) Qu, *Limatulasporites fossulatus* (Balme) Foster, *L. parvus* Qu, *Alisporites sublevis* (Luber) Chen, *Protohaploxypinus samoilovichii* (Jansonius) Hart, *Pr. limpidus* (Balme et Hennelly) Balme et Playford, *Striatoabieites richteri* (Klaus) Hart, *Lueckisporites virkkiae* Potonié et Klaus	12.66 m
35	Greyish-black silty mudstone intercalated with grey siltstone (two rhythmic units) with fine horizontal bedding, containing spores and pollen: *Apiculatisporis xiolongkouensis* Hou et Wang, *Ap. decorus* Singh, *Alisporites sublevis* (Luber) Chen, *Al. australis* de Jersey, *Protohaploxypinus limpidus* (Balme et Hennelly) Balme et Playford, *Triangulisaccus* sp.; megaspores: *Triangulatisporites* cf. *triangulatus* (Zerndt) Potonié et Kremp; a few conchostraca	12.72 m
34	Greyish-black silty mudstone and siltstone at the bottom, and intercalated with organism pelitic limestone like "Sesame cake" called "Zhimabing bed", containing a lot of conchostraca, Ostracods, Bivalves and a few of plants. Plants: *Paracalamites* sp., *Zamiopteris* cf. *glossopteroides* Schmalh., *Walchia* sp., *Samaropsis* sp.; Bivalves: *Palaeonodonta* cf. *parallela*; conchostraca: *Falsisca* cf. *kanadaensis* Novojilov, *F. multilinearis* Liu, *Cornia* cf. *sileenica* Molin, *Huanghestheria subovata* Liu, *H. magnapicalis* Liu, *Trianodus minuta* Liu, *Beijianglimnadia dalongkouensis* Liu, *B. minuta* Liu, *Cyclotunguzites xinjiangenese* Liu	5.97 m
33	Greyish-black silty mudstone a lot of lumps of organism micritic limestone, yielding ostracods, conchostraca and	

		Junggar Basin						
		Conchostraca	Ostracoda	Vertebrates	Bivalves	Plants	Spores/Pollen	Megaspores
Lower Triassic (T_1)	Jiucaiyuan Fm.	*Falsisca - Cyclotunguzutes* Assemblage	*Darwinula triassiana - D. rotundata* Assemblage	*Prolaoertoides jimusarensis* *Santaisaurus yuangi* *Chasmatosaurus youngi* *Lystrosaurus hedini* *L. broomi* *L. youngi* *L. robustus*		*Pecopteris* sp.	*Limatulasporites - Lundbladispra* Assemblage	*Triletes vulgaris - Pusulosporites inflatus* Assemblage
	Guodikeng Fm.	*Falsisca - Cornia - Cyclotunguzites* Assemblage	*Darwinula elongata - D. adducta* Assemblage	*Lystrosaurus* *Dicynodontia* *Jimusaria sinkiangensis*	*Palaeonodonta* cf. *parallela* *P. brevis*	*Paracalamites* sp. *Zamiopteris* cf. *glossopteroides* *Walchia* sp. *Samaropsis* sp. *Knorria* sp. *Lepidostrobophyllum* sp.	*Lundbladispora - Taeniaesporites* Assemblage *Limatulasporites - Lueckisporites* Assemblage	*Triangulatisporites* cf. *triangulatus - Maexisporites - Trileites* Assemblage *Triangulatisporites* cf. *triangulatus - Narkispoites brevispinosus - Otynisporites eotriassicus* Assemblage
Upper Permian (P_2)	Wutonggou Fm.	*Polygrapta* Assemblage	*Darwinula - Panxinia - Suchonella - Darwinuloides* Assemblage	*Striodon magnus*	*Palaeonodonta* sp.	*Paracalamites* cf. *stenocostata* *Callipteris* sp. *Cornucarpus* sp.		

	gastropods; conchostraca: *Falsisca* cf. *jeskinoica* Novojilov, *Cornia beijiangensis* Liu, *Huanghestheria xinjiangensis* Liu, *Lioesteria beijiangensis* Liu, *Beijianglimnadia qitaiensis* Liu, *Cyclotunguzites xinjiangense* Liu	1.47 m
32	Greyish-black silty mudstone alternated with grey pelitic siltstone, yellowish-green siltstone or fine lithic sandstone (four rhythmic units) and with small balls in the lower part of the siltstone	9.08 m
31	Greyish-black mudstone and siltstone at the bottom, with fine horizontal bedding, containing Conchostraca: *Cornia* sp., *Huanghestheria* sp.	8.36 m
30	Greyish-black silty mudstone intercalated with three layers of siltstone with fine horizontal bedding and calcareous nuclei	13.61 m
29	Mainly greyish-black mudstone interbedded unevenly with silty mudstone and siltstone, with fine horizontal bedding and a great amount of fish-scale in the lower part, yielding spores and pollen: *Limatulasporites fossulatus* (Balme) Foster, *Alisporites sublevis* (Luber) Chen, *Protohaploxypinus ovaticorpus* Zhou, *Prot. samoilovichii* (Jansonius) Hart; ostracoda: *Bisulcocypris wutonggouensis* Li, *Panxiania xinjiangensis* Li, *Vymella subglobica* Li, *Darwinula schwegeri* Mishina, *Darwinuloides bugnralanica* Racherarova, *D. sibiricus*; bivalves: *Palaeonodonta* sp.; plant fragments in the sandstone; conchostraca: *Polygrapta* sp.	9.48 m
28	Alternation of greyish-green and purplish silty mudstone with parting of a few of siltstone and fine sandstone, containing calcareous lumps	14.83 m

----- Conformity -----

The Upper Permian Wutonggou Formation (P_2)

The Permian-Triassic strata are completely exposed and contain abundant fossils, such as vertebrates, ostracods, bivalves, plants, megaspores, spores, pollen and conchostracans (Table 2, p. 19). Three assemblages of Permian-Triassic conchostracan fossils can be distinguished (in ascending order):

(1) The *Polygrapta* assemblage: in the lower part of the Guodikeng Formation to the upper part of the Wutonggor Formation. Its age considered to be Late Permian.

(2) The *Falsisca-Cornia-Cyclotunguzites* assemblage, represented by *Falsisca, Cornia, Huanghestheria, Trinodus, Beijianglimnadia, Cyclotunguzites* etc.; it has been collected from the middle-lower parts of the Guodikeng Formation. They may have an Early Triassic age, corresponding with the Induan stage of the Russian Platform.

(3) The *Falsisca-Cyclotunguzites* assemblage: occurring in the middle-upper parts of the Guodikeng Formation to the lower part of Jiucaiyuan Formation. The assemblage is considered to be Early Triassic in age.

In the past, the Permian-Triassic boundary was traditionally placed between the Jiucaiyuan Formation and the Guodikeng Formation. In recent years, new investigations have led to the discovery of *Lystrosaurus* in the upper part of the Guodikeng Formation. Therefore the *atrata-*

part of the Guodikeng Formation should be considered as Early Triassic and corresponding to the *Falsisca-Cyclotunguzites* conchostracan assemblage. The Permian-Triassic boundary has thus moved down in the Guodikeng Formation. A closer relationship can be recognized between the *Falsisca-Cornia- Cyclotunguzites* assemblage and the *Falsica-Cyclotunguzites* assemblage than between the *Falsisca-Cyclotunguzites* assemblage and the *Polygrapta* assemblage. Therefore the *Falsisca-Cornia-Cyclotunguzites* assemblage should be Early Triassic. This assemblage is now known from the Sunjiagou Formation, the Ehuobulake Group, the Hongla Formation and the Taohaiyingzi Formation. There is still an argument about the age of the Sunjiagou Formation. 1957 Zhang Wenzhao found marine bivalves which he identified as *Aviculopecten* in Sunjiagou Formation of Houzhougonmiao, Qishan County, in the northern Weihe basin, Shaanxi province and dated them as Late Permian (P_2). 1979 Yang Zunyi et al. reinvestigated the marine fossils of this area and identified *Eumorphotis multiformis, Promyalina putiatinensis* and *Homomya impressa* etc., and dated this formation as Early Triassic (T_1). This age assessment is similar to that indicated by the *Falsisca-Cornia-Cyclotunguzites* assemblage, i.e. Early Triassic. The *Polygrapta* assemblage is Late Permian. Therefore the Permian-Triassic boundary should be placed between two assemblages. i.e. between the layers 31 and 30 in the Guodikeng Formation in the northern limb of the Dalongkou Antiction, Jimusar. Layer 29 containing the ostracods *Panxiania xinjiangensis* Li, *Vymella subglobica* Li, *Darwinula schwegeri* Mishina, *Darwinuloides bugnralanica* Racherarova, *D. sibiricus* and the conchostrac *Polygrapta* sp. is Late Permian in age. So the layers 48 to 31 of the Guodikeng Formation in the northern limb of the Dalongkou Antiction are Early Triassic and the layers 30-28 are Late Permian. In the southern limb of the Dalongkou Antiction, the Permian-Triassic boundary may be placed between layers 47 and 46 layer in the Guodikeng Formation. This means that layers 57-47 are Lower Triassic and layers 46-39 layers are Upper Permian. The correlation of Late Permian-Lower Triassic conchostracan fossils in China, Russian and Germany is shown on Table 3 (p. 22-23).

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[1] Note from the editor: Unfortunately, most of the references supplied were incomplete. Additions have been made where possible. Readers may contact the author for further details.

	China											
	Dalongkou, Junggar Basin			Ordos Basin and Shanxi Province			Kuqa, Xinjiang		Jingxi County Liaoning		Ju Ud Meng Nei Mongol	
Lower Triassic (T_1)	Cangfanggou Group	Jiucaiyuan Formation	*Falsisca fabiformis* *Cyclotunguzites brevis* *Cyclestherioides dalongkouense*	Shiquianfeng Group	Liujiagou Formation	*Leptolimnadia shanxiensis* *Palaeolimnadia multilineata* *Loxomegaglypta jiaochengensis*	Ehuobulake Group		Hongla Formation		Taohaiyingzi Formation	
Lower Triassic (T_1)	Cangfanggou Group	Guodikeng Formation	*Falsisca qitaiensis* *Difalsisca elongata* *Cyclotunguzites dalongkouense* *Beijianglimnadia rotunda*	Shiquianfeng Group	Liujiagou Formation		Ehuobulake Group		Hongla Formation		Taohaiyingzi Formation	
Lower Triassic (T_1)	Cangfanggou Group	Guodikeng Formation	*Falsisca multilinearis* *Cornia* cf. *sileenica* *Huanghestheria subovata* *Beijianglimnadia qitaiensis* *Cyclotunguzites xinjiangense* *Trinodosus minuta*	Shiquianfeng Group	Sunjiagou Formation	*Sinolimnadiopsis yaoxianensis* *Huanghesteria longellipsa*	Ehuobulake Group	*Falsisca multilinearis* *Cornia kuqaensis* *Diaplexa* cf. *veridicta* *Pseudestheria nanjiangensis*	Hongla Formation	*Bipemphigus liaoningensis* *Dictyolimnadia jinxiensis*	Taohaiyingzi Formation	*Palaeolimnadiopsis deminuta* *Pemphicyclus trochoides* *Sphaerestheria* cf. *sibirica*
Late Permian (P_2)	Cangfanggou Group	Guodikeng Formation	*Polygrapta* sp.	Shiquianfeng Group	Sunjiagou Formation		Ehuobulake Group					
Late Permian (P_2)		Wutonggou Formation	*Polygrapta minuta* *P. xinjiangensis* *P. wutonggouensis* *P. oviformis* *P. qitaiensis* *P. dalongkouensis*		Sunjiagou Formation		Ehuobulake Group	*Palaeolimnadia* cf. *komiana* *P. pusilla* *Pseudestheria* cf. *toricata* *P.* cf. *norvikensis* *Cyclestherioides* cf. *dalongkouensis*				

	Russia							Germany		
	Tunguzi Basin			Rkut Region		Kuznetzk Basin		Thuringian Basin		
Lower Triassic (T_1)	Korvunchan Group	Kotchetshum Formation	*Falsisca bolodekitensis*	Induan Stage		Maltsevian Formation		Buntsandstein Series	Volpriehausen Fm.	*Liolesiina radzinskii* *Liograpta mangaliensis*
		Nitim Formation	*Falsisca turaica* *Limnadia khovorkilica* *L. vana*						Bernburg Fm.	*Palaeolimnadiopsis* sp. *Cornia germari* *Vertexia tauricornis* *Sedovia* cf. *udorica* *S. bergessensis*
		Puklaikt Formation	*Falsisca zavjalovi* *F. kanadaensis* *Cornia torilarvata* *Trisitum spissilineatum* *Limnadia pygmaea* *Echinolimnadia mattoxi*		*Falsisca verchojanica* *Cornia vosini* *C. sileenica* *Cyclotunguzites gutta* *Sphaerestheria aldanensis*		*Palaeolimnadiopsis kouznetskensis* *Cornia sibirica*		Nordhausen Fm.	*Falsisca eotriassica eotriassica* *Falsisca eotriassica postera*
Late Permian (P_2)		Tutungtsai Formation	*Polygrapta chatangensis* *P. laptevi* *Pseudestheria novacastrensis* *P. obliqua*	Tuerkialhaho Formation		Jelunakofu Formation		Zechstein Series		

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PERMIAN/TRIASSIC BOUNDARY AT SELONG-XISHAN (TIBET)

H.H.J. Geldsetzer

I am co-leader and secretary of IGCP Project 293 "Geochemical Event Markers in the Phanerozoic" (the other co-leader is Professor Xu Dao-Yi in Beijing). I have examined with Dr. Kun Wang the isotopic variations of Corg across the P/T boundary in basinal sediments of British Columbia (Williston Lake) and we can document a sharp drop of $\delta^{13}C$ at the suspected boundary. We believe the boundary coincides with an abrupt change from cherty siliceous shale below to slightly siliceous shales above. Fossil control is poor in the British Columbia section but much better in the almost identical palaeo-setting of the Sverdrup Basin in Arctic Canada where the same lithologic change occurs but isotopic data are lacking so far.

Now we want to establish isotopic profiles across the P/T boundary at Selong, Tibet. This will be done in early April 1994 in conjunction with Drs. W.W. Nassichuk and Rui Lin of this institute and Dr. Kun Wang who will shortly move to the University of Ottawa. On the Chinese side we will cooperate with Professor Jin Yugan, Chairman of the Laboratory of Palaeobiology and Stratigraphy at the Nanjing Institute of Geology and Palaeontology and three of his colleagues, Professors Wang Zhi-Hao, Zhu Zhi-Li and He Guo Xiong. Professor Zhu Zhi-Li and myself will do the actual field work. I will try my best to have isotopic and microfacies analysis done in time for the Permian Conference at Guiyang, China, from August 28 to 31, 1994. Most of the palaeontological work will be done at the Nanjing Institute.

The P/T section at Selong, Tibet, has become one of the key sections because of excellent fossil control which is due to its favourable palaeo-setting - a rich benthic community on a carbonate slope. The presence of all faunal stages strongly suggests that the area did not experience exposure at the time of the P/T event, a common problem for most fossil-rich and thus shallow-water sections. The boundary section at Selong has not been examined for isotopes and Platinum Group Elements (PGE). This is our goal and the geochemical results may strengthen attempts to propose this accessible section as a stratotype.

THE ANISIAN/LADINIAN BOUNDARY: RETROSPECTIVE AND NEW CONSTRAINTS

P. Brack and H. Rieber

Introduction

Discussions on the Anisian/Ladinian boundary have been revived in the past two decades mainly as a result of new fossil finds in Europe, but also because of the different stratigraphic positions assigned to the same boundary in Europe and North America. Important new data particularly on ammonoids and conodonts from the Southern Alps, Hungary and Greece have resolved many of the former discrepancies and thus allow a reassessment of the topic. The discussion culminated in last year's field workshop in the Southern Alps and Hungary (see fieldguide book edited by M. Gaetani 1993). The main result of this workshop is a detailed correlation of boundary successions in the Southern Alps and Hungary as outlined briefly by M. Gaetani in the last issue of ALBERTIANA (No.12, p.5-8). According to this report the IUGS Subcommission on Triassic Stratigraphy plans to arrive at a final proposal for the boundary position by 1995.

In this short article we present some arguments against using historical or priority reasons in the definition of the Anisian/Ladinian boundary. In our opinion the boundary should be drawn exclusively on the basis of the best available stratigraphic data. Whether the definition should be based on a biostratigraphic scale with high resolution power alone (e.g. the ammonoid scale) or on a combination of different scales including also additional stratigraphic tools can be decided only after the simultaneity of events between different scales is demonstrated adequately.
An attempt is also made to correlate the most important low latitude boundary successions in Europe and North America. This graph is intended as a reference for the assessment of individual boundary sections.
Finally a proposal is made for a Anisian/Ladinian boundary position based on ammonoids. A suitable reference section for the stage boundary is also suggested.

History

Almost 100 years ago, in a discussion of a paper by Mojsisovics (1892), Bittner (1892) proposed the term 'ladinisch' as a substitute of what Mojsisovics until 1898 (see Mojsisovics 1902) called 'norisch' or 'Norische Stufe'. The expression 'ladinisch' was obviously derived from the 'Ladini' people in the Dolomites and should describe a time-span represented by a succession of strata in the Southern Alps (i.e. the 'Buchenstein Beds', the 'Wengen Beds' and, if necessary, the 'Cassian Beds'). Up to then these beds were considered as equivalents of Norian ('Juvavian') Hallstatt-limestone intervals, an error which Mojsisovics (1892) himself had recognised.

B. Karnische Stufe.		Norische Alpen (Salzkammergut).	Lombardische Alpen.	Südtiroler Alpen.
C. Norische Stufe.	1. Halorische Gruppe.	1. Schichtgruppe des Amm. (Arc.) Metternichi der Hallstätter Kalke. 2. Zlambach-Schichten. 3. Reichenhaller Kalke. 4. Salzlagerstätten.	**Amm. (Arc.) Metternichi** Kalk von Ardese.	Kalk- und Dolomitmassen
		Partnach-Dolomit	Kalk von Ardese.	Kalk- und Dolomitmassen
	2. Oenische Gruppe.	Pötschenkalk. Arcesten und Trachyceraten. Amm. dolериticus ? Glaukonitkörner.	Porphyrtuffe. ("San Cassiano") "Keuperpflanzen"	Kieselige Bänke mit Halobia Lommeli.
		Halobia Lommeli in knolligen kieseligen Bänken	**Bactryllium Meriani, Schmidi, canaliculatum. Halobia Lommeli. Amm. doleriticus, Archelaus**	(Doleritische Sandsteine i.d. VenetianischenAlpen. **Amm. doleriticus, Archelaus.**)

Table 1: Mojsisovics 1869 ('Ueber die Gliederung ...'; Jb.k.k.geol.R.A.;19,Taf.p.129)

		Niveaus der Trias des Bakony	
Obere-Trias.		**Füréderkalk:** Halobia Lommeli, kleine Trachyceraten.	?
		Niveau des Arc. Tridentinus: Arc. Tridentinus, Trachyceras Archelaus, Trach. pseudoarchelaus, Amm. Szaboi, Halobia Lommeli u.s.w.	Pötschenkalk
Untere-Trias.	Muschelkalk	**Niveau des Cer. Reitzi:** Cer. Reitzi, Cer. Zalaensis, Cer. Böckhi, Cer. n.sp. indet, Arc. batyolcus u.s.w.	Vertreter des Oberen-Muschelkalkes und der Anhydrit-Gruppe ?
		Sehr kieselige, petrefactenfreie Schichten.	
		Halobia sp. **Niveau des Arc. Studeri:** Arc. Studeri, Cer. binodosus, Halobia Sturi, Spirif. Mentzeli u.s.w.	Stur's Reiflingerkalk. Nach Sandberger: Oberer Wellenkalk

Table 2: Böckh 1873 ('Die geologischen Verhältnisse ...I.Theil; Mitt. Jb.k.ung.geol.Anst.,2,p.154)

	Mediterrane Triasprovinz.	Juvavische Triasprovinz.
Norische Stufe	Wengener Schichten. Zone der *Daonella Lommeli* und des *Trachyc. archelaus.*	Unterer Hallstätter-Kalk, mit einer Reihe von altersverschiedenen Faunen.
	Horizont des *Trachyc. Reitzi.* Buchensteiner Kalk von Gröden.	Zlambach-Schichten
Muschelkalk	Oberer Muschelkalk. Zone des *Arc. Studeri.*	Zone des *Arc. Studeri.*
	Unterer Muschelkalk. Zone des *Trachyc. Balatonicum.*	Zone des *Trachyc. Balatonicum, paläontologisch noch nicht nachgewiesen*

Table 3: Mojsisovics 1874 ('Faunengebiete ...'; Jb.k.k.geol.R.A.,24/1,p.88-92)

<table>
<tr><th></th><th colspan="2">Mediterrane Triasprovinz.</th><th colspan="2">Juvavische Triasprovinz.</th></tr>
<tr><td rowspan="5">Norische Stufe</td><td rowspan="2">Z. d. Trachyceras Archelaus u. d. Daonella Lommeli</td><td rowspan="2">Wengener Schichten (Esino)</td><td>Z. d. Ditymites tectus</td><td rowspan="4">Hallstätter Marmor</td></tr>
<tr><td>Z. d. Arcestes ruber</td></tr>
<tr><td rowspan="3">Z. d. Trachyceras Curionii u. d. Trachyceras Reitzi</td><td rowspan="3">Buchensteiner Schichten</td><td>Z. d. Pinacoceras parma u. d. ...</td></tr>
<tr><td>Z. d. Pinacoceras metternichi u. d. ...</td></tr>
<tr><td>Z. d. Choristoceras haueri</td><td>Zlambach-Schichten</td></tr>
<tr><td rowspan="2">Muschelkalk</td><td>Z. d. Trachyceras trinodosum</td><td>Virgloria-Kalk z.Th.</td><td>Z. d. Trachyceras trinodosum</td><td>Rother Kalk d. Schreier-Alpe</td></tr>
<tr><td>Z. d. Trachyceras binodosum u. d. Trachyceras Balatonicum.</td><td>Schichten von Dont, Val Inferna und Recoaro</td><td>Z. d. Trachyceras binodosum u. d. Trachyceras Balatonicum.</td><td>Schwarze Kalke</td></tr>
</table>

Table 4: Mojsisovics 1879 ('Dolomit-Riffe ..; Hölder, Wien; p.79-80)

Norische Stufe	Zone des *Trachyceras archelaus.*	a) Facies der Wengener Schichten b) Facies der thonarmen Schichten
	Zone des *Trachyceras Reitzi.*	a) Facies der Buchensteiner Schichten b) Facies der gelben, kieselreichen Kalke des Bakonyer Waldes
Muschelkalk	Zone des *Ceratites trinodosus.*	a) Facies der lombardischen Prezzo-Kalke b) Facies der thonarmen Kalksteine c) Facies der westlombardischen Dolomite
	Zone des *Ceratites binodosus.*	a) Facies der Dontkalke b) Facies des rothen Dolomits von Val Inferna c) Facies des weissen Crinoidenkalks d) Facies der gelben plattigen Kalke des Bakonyer Waldes

Table 5: Mojsisovics 1882 ('Die Cephalopoden der mediterranen Triasprovinz'; Abh.k.k.geol.R.A.,10,p.311-316)

Table 6

Norische Stufe	Z. des *Trachyceras Archelaus*
	Z. des *Trachyceras Curionii*
Muschelkalk	Z. des *Ceratites trinodosus*
	Z. des *Ceratites binodosus*

Mojsisovics 1892 ('Die Hallstätter Entwicklung ...'; Sitzber. kais. Akad.Wiss. Wien, mat.-nat.Cl., 101, p.780)

Table 7

(Mediterrane Triasprovinz)

Norisch	obernorisch (Longobardisch)	Z. des *Protrachyceras Archelaus*	Wengener Schichten
	unternorisch (Fassanisch)	Z. des *Dinarites avisianus*	Marmolatakalk
		Z. des *Protrachyceras Curionii*	Buchensteiner Schichten
Anisisch	Bosnisch	Z. des *Ceratites trinodosus*	Oberer Muschelkalk
	Balatonisch	Z. des *Ceratites binodosus*	Unterer Muschelkalk

Mojsisovics, Waagen & Diener 1895 ('Entwurf einer Gliederung ...'; Sitzber. kais. Akad.Wiss. Wien, mat.-nat.Cl., 104, p.1279)

Bittner 1892

('Was ist norisch ?'; Jb.k.k.geol.R.A.,42,p.392)

'ladinisch' = 'norisch' (sensu Mojsisovics 1892)

'für die Gruppe der Buchensteiner und Wengener Schichten' (i.e. Southern Alps; Dolomites)!

Mojsisovics' 'Norische Stufe' was introduced in 1869 mainly on the basis of differences in ammonoid faunas from Hallstatt Limestones of the Norian Alps near Salzburg (Tab.1). Parts of these rocks were included in the upper portion of the 'Halorische Gruppe'. This latter followed on top of massive carbonates and beds with *Halobia lommeli*. Sediments bearing *Halobia lommeli* (also called the 'Niveau des *Amm. (Trachyceras) doleriticum*') were known already from various other areas in the Eastern and Southern Alps. Mojsisovics (p.128) specified the *Lommeli* Beds as the lowermost portion of the 'Oenische Gruppe' at the base of his 'Norian' and considered them as 'immediately' overlying ('... sich innig anschliessend ...') the 'Muschelkalk'. Unfortunately neither a type-section was given nor was a fossil succession sufficiently well established for an unambiguous definition. Moreover, five years later terms like 'oenisch' and 'halorisch' were abandoned again (Mojsisovics 1874) and according to Bittner (1892, p.388) only two decades later little was left of the correlations in Mojsisovics' 1869 scheme.

In 1870 (p.102) and 1872 (p.9) Mojsisovics explicitly correlated the limestones with *Arcestes tridentinus* of Bakony with the 'Buchenstein Beds' of the Southern Alps and with the Pötschen Limestone of the Northern Alps. All these units were considered as members of the 'Oenische Gruppe' (and hence of the 'Norische Stufe').

In 1872/73 Böckh described an ammonoid fauna with *Ceratites reitzi* from Bakony. Apparently he had some doubts about the affiliation of their host beds and grouped these vaguely with the 'Muschelkalk' (note the dotted line in Böckh's scheme, Tab.2). In the text, however, he specified the limestones with *C. reitzi* as the lowermost member of the 'Oenische Gruppe'. Nevertheless, Böckh realised that the *Reitzi*-level found below the red limestones with *Arc. tridentinus* of Bakony would be somewhat older than the south-tyrolian 'Buchenstein Beds' (these two units following Mojsisovics were considered as equivalents)!

In the same period a single ammonoid specimen was found by Gümbel at an unspecified level in the 'Buchenstein Beds' near Pufels (northwestern Dolomites). Mojsisovics (1873, p.432) determined the fossil as *Trachyceras* cf. *reitzi* and the determination (a form close to *T. reitzi*) was indeed confirmed by Böckh. Consequently a new time-equivalence i.e. between the 'Buchenstein Beds' of the Gröden Valley (Southern Alps) and the *Reitzi*-level (instead of the beds with *Arcestes tridentinus*) in Hungary was suggested (Mojsisovics 1873, pp.432/433; 1874 p.91). The 'Buchenstein Beds' and their equivalents thus moved to the base of the 'Norische Stufe' ('Horizont/Zone des *Trachyc. reitzi*'; Tab.3). The new ammonoid from Pufels was never illustrated and remained a 'cf.' until 1879. Three years later (Mojsisovics 1882) it appeared along with additional *Reitzi*-specimens from Prezzo as a true *Trachyceras reitzi* ! Mojsisovics himself was apparently uncertain about a suitable label for the deepest ammonoid

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Tables 1-7: *Evolution of views on the Anisian/Ladinian (i.e. Muschelkalk/'Norian') boundary interval compiled from various schemes published between 1868 and 1895. In 1892 Bittner suggested that the usage of the expression 'norisch' should stay with a rock-unit whose stratigraphic position had been shifted upward (i.e. the Norian (Juvavian) Hallstatt-Limestones; Mojsisovics 1892). For the remaining time-interval represented by the south-alpine 'Buchenstein Beds' and 'Wengen Beds' he proposed the new term 'ladinisch' instead (= 'norisch' of 'non-Hallstatt' successions in Mojsisovics 1892).*
Units at the base of the 'Ladinian/Norian' are highlighted.

zone of his 'Norische Stufe'. Possibly he was also not fully convinced of all his correlations. The labels thus changed in almost every new scheme (Tabs.4-6) and *Trachyceras reitzi* was eventually replaced by a unambiguous south-alpine 'Buchenstein'-ammonoid i.e. the *Trachyceras (Protrachyceras) curionii* (Tabs.6,7).

After Mojsisovics' period things became even less clear. Additional specimens determined as *Protrachyceras reitzi* were found below *Protrachyceras curionii* in the 'Buchenstein Beds' of the Brescian Prealps (Horn 1913, 1914) and serious doubts arouse about the chronostratigraphic constancy of the siliceous nodular limestones throughout the Southern Alps (see e.g. Tornquist 1916).

New schemes were drawn subsequently for the Middle Triassic with three instead of two or just one unit between the *Trinodosus* and *Archelaus* Zones (Pia 1930, Rosenberg 1958, Assereto 1969). The *Curionii*-Zone and its equivalents followed on top of the Zone with *Protrachyceras (Ceratites) reitzi*. Finally Assereto (1969) concluded that the fauna with *Aplococeras avisianum* had to be placed at a deeper stratigraphic level than what was originally assumed by Mojsisovics et al. (1895). Unfortunately the *Avisianum* Zone was positioned below and not above the *Reitzi* Zone. It thus appeared as if the Anisian/Ladinian boundary position at the base of the *Reitzi* Zone would be a corresponding time marker in the Southern Alps and Hungary.

In a discussion of a talk by H. Rieber, N.J. Silberling identified for the first time ammonoids from a tethyan succession (M.S. Giorgio) as *Nevadites* (Rieber 1974, p.169: footnote 3). Krystyn and Mariolakos (1975) then recognised specimens of this genus also at Epidhavros (Greece). Finally Krystyn (1983) proposed a new scheme for the ammonoid zones in which a *nevadites* Zone lies between a *Parakellnerites* Zone (below) and the *Curionii* Zone (above).

In the meantime in North America a independent time scale had been established by Silberling and Tozer (1968). The base of the Ladinian was drawn at the base of the *Subasperum* Zone. To date this has not changed and the American scale was also adopted in recent compilations of global cycle and sea-level charts (e.g. Haq et. al. 1988).

Which scheme - which priority?

The compiled tables No.1-6 show that at least four different versions existed for the base of the 'Norische Stufe' when Bittner (1892) introduced the term 'ladinisch'. If 'priorities' should be considered in a modern definition of the Anisian/Ladinian boundary, then which one should be referred to? A possible candidate could be Mojsisovics' 1892-scheme (Tab.6), the topic of Bittner's discussion. Hence the 'Zone des *Trachyceras curionii*' would be the basal unit of the 'Ladinian/Norian'. If, alternatively, the very first definition of the 'Norische Stufe' is considered (Tab.1), the boundary would correspond to the base of the 'Wengen' or equivalent beds (with *Halobia lommeli* and *Amm. doleriticus, Archelaus*). A third candidate, the 1882-scheme (Tab.5) with the 'Zone des *Trachyceras reitzi*', is ambiguous because it comprises faunas from two non time-equivalent and geographically distinct units (the 'Buchenstein Beds' of the Southern Alps and the 'yellow, siliceous limestones of Bakony'; see discussion below)! Or would yet another scheme be more appropriate, but for which reasons?

This short, but not exhaustive summary of historical concepts clearly shows two points: (A) an objective choice of any priority argument is obviously problematic and (B) such arguments can hardly be a constructive contribution to the boundary problem.

New data from the Southern Alps

The new bedrock collections of ammonoids from the south-alpine 'Buchenstein Beds' and age equivalent platform carbonates (Brack and Rieber 1986, 1993) now clearly demonstrate inconsistencies in previous conclusions:

(1) A ammonoid fauna characterised by *Kellnerites, Reitziites* and *Hungarites* was found in the Brescian Prealps (e.g. Bagolino, Pèrtica) well below the levels with *Nevadites*. Interestingly, in south-alpine localities from which the species *reitzi* was reported earlier (e.g. Mojsisovics 1882, Horn 1913-14) this stratigraphic interval is either not exposed at all (Marcheno, Prezzo) or it may only marginally overlap with accessible strata (Pufels) from which to our knowledge no ammonoids have been reported to date. Therefore, we suppose that specimens from the Southern Alps previously referred to as *reitzi* most likely belong to the genus *Nevadites*. Representatives of this genus were indeed collected by us at all these places! The early correlation of the '*reitzi*-tuffs' in Hungary with the 'Buchenstein Beds' in the Dolomites (e.g. Mojsisovics 1882) is thus not confirmed (Fig.1, Seceda section).

(2) The 'Lower Plattenkalke' of the northwestern Dolomites (e.g. Seceda, Fig.1) may just approach or marginally overlap with the *Reitziites*-horizons at Bagolino. This conclusion is based on the distribution of volcaniclastic layers (Fig.1). Moreover, the base of the 'Lower Plattenkalke' is presumably non-isochronous throughout the Dolomites. Bittner's (1892) implicit definition of the base of the Ladinian with the 'Buchenstein Beds' in the Southern Alps (Dolomites) lacks a type-section and is therefore ambiguous.

(3) Faunas with *Aplococeras avisianum* from platform carbonates in the Dolomites (Latemar, Cernera) are correlative with fossils in the upper part of the 'Lower Plattenkalke' of the 'Buchenstein Beds' in the northwestern Dolomites (Seceda). Their stratigraphic position is thus established firmly for the first time and corresponds at Bagolino to strata between the *Reitziites*-horizons and the interval with *Ticinites* and *Nevadites*.

The Tethyan scheme of ammonoid zones and correlations of Anisian/Ladinian boundary sections from Europe and North America based on ammonoids and Daonellas

In the Southern Alps (Brescian Prealps/Giudicarie) a clear sequence of ammonoid levels is found in a continuous pelagic succession spanning the entire Upper Anisian to Upper Ladinian time interval (Balini 1992, Brack and Rieber 1993). Based on this succession the zonal scheme between the *Trinodosus* Zone and the *Curionii* Zone has been revised. Because ammonoid zones are better named after ammonoid species instead of genera (whose names are more likely revised later), we change two previously used zone labels as follows:

(A) '*Reitzi* Zone' replaces '*Reitzi/Kellnerites* Zone'. Faunal content as in Brack and Rieber (1993). This zone closely corresponds to the redefined *Reitzi* Zone in Hungary (Vörös 1993). The position of the *Lardaroceras* beds is still open. Their inclusion into the *Reitzi* Zone would cause only a small downward shift (less than two metres) of the lower zone boundary in the reference section at Bagolino.

(B) '*Secedensis* Zone' (after *Nevadites secedensis*) instead of '*Nevadites* Zone'. Faunal content as in Brack and Rieber (1993). A very minor upward shift of 0.5 m results for the lower zone boundary in the reference section at Bagolino when representatives of the genus *Ticinites* are excluded from this zone.

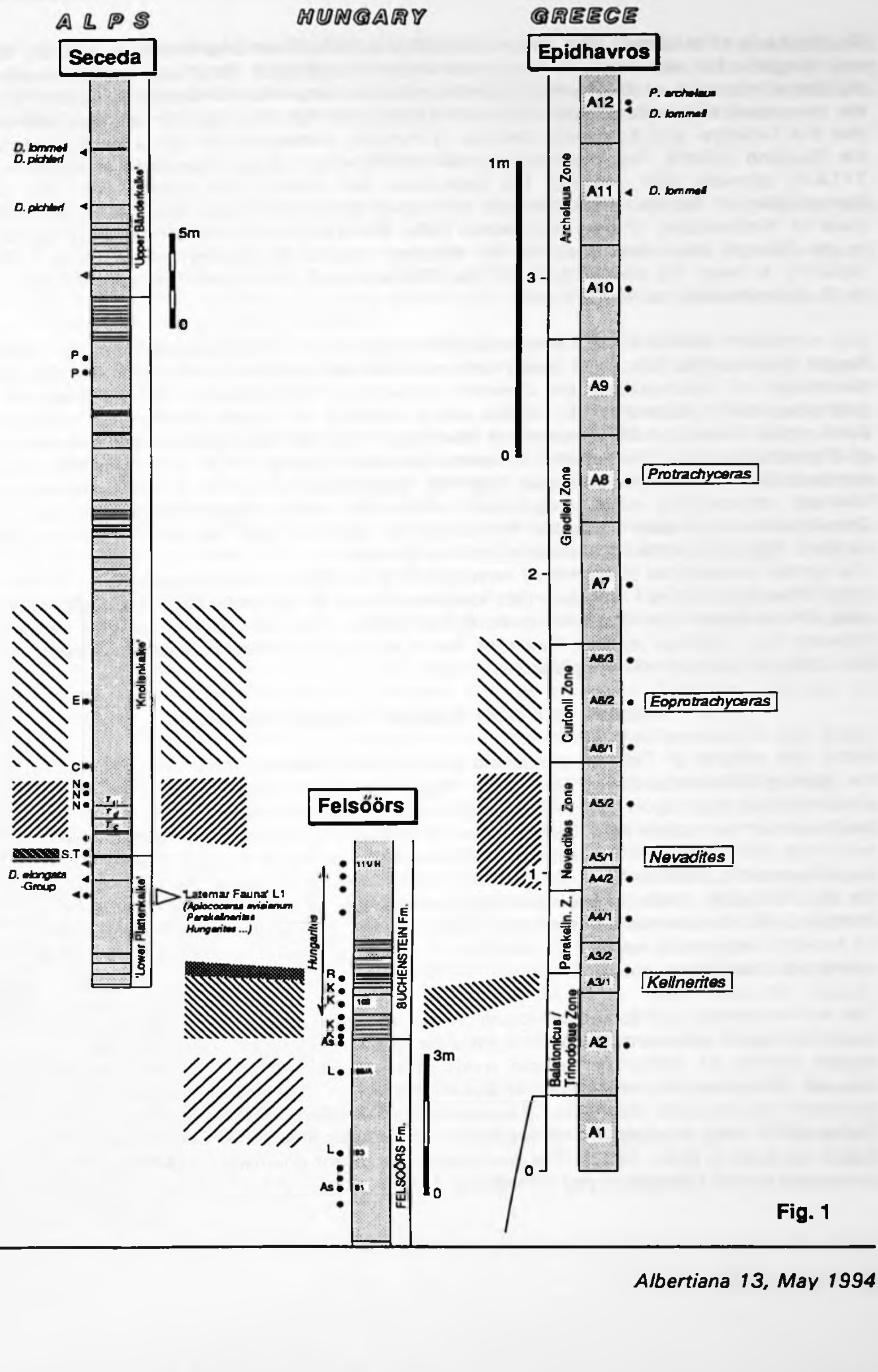
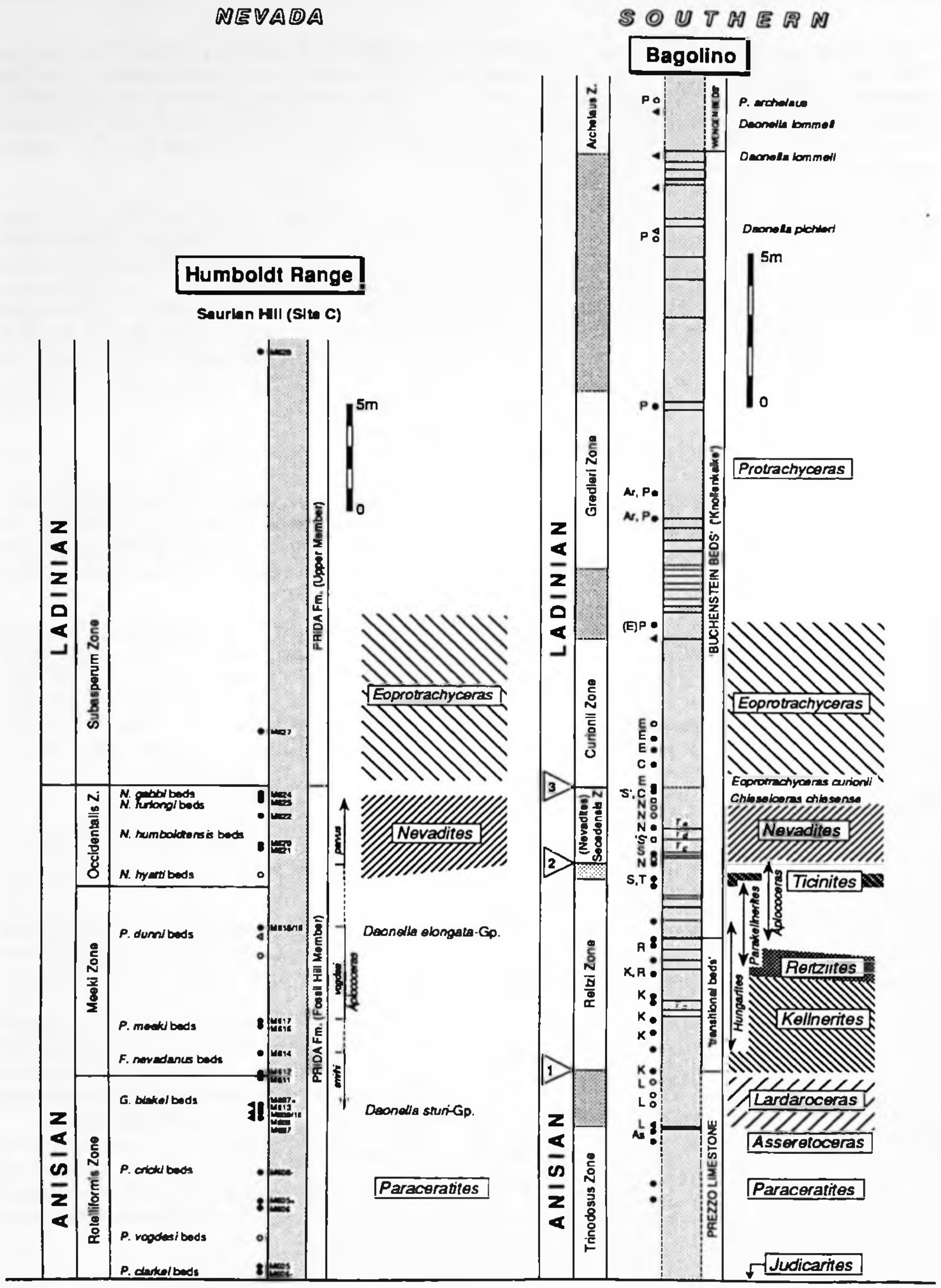

ALPS
HUNGARY
GREECE
Seceda
Epidhavros
Felsöörs
D. lommeli
D. pichleri
D. pichleri
'Upper Bänderkalke'
5m
0
'Knollenkalke'
'Lower Plattenkalke'
D. elongata -Group
'Latemar Fauna' L1
(Aplococeras avisianum
Parakellnerites
Hungarites ...)
Hungarites
BUCHENSTEIN Fm.
FELSÖÖRS Fm.
3m
0
1m
0
3
2
1
0
A12
P. archelaus
D. lommeli
A11
D. lommeli
Archelaus Zone
A10
A9
A8
Protrachyceras
Gredleri Zone
A7
A6/3
A6/2
Eoprotrachyceras
Curionii Zone
A6/1
A5/2
Nevadites Zone
A5/1
Nevadites
A4/2
A4/1
Parakelln. Z.
A3/2
A3/1
Kellnerites
Balatonicus / Trinodosus Zone
A2
A1

Fig. 1


NEVADA
SOUTHERN
Humboldt Range
Saurian Hill (Site C)
LADINIAN
ANISIAN
Subasperum Zone
Occidentalis Z.
Meeki Zone
Rotelliformis Zone
N. gabbi beds
N. furlongi beds
N. humboldtensis beds
N. hyatti beds
P. dunni beds
P. meeki beds
F. nevadanus beds
G. blakei beds
P. cricki beds
P. vogdesi beds
P. clarkei beds
PRIDA Fm. (Upper Member)
PRIDA Fm. (Fossil Hill Member)
5m
0
Eoprotrachyceras
Nevadites
Daonella elongata-Gp.
Daonella sturi-Gp.
Paraceratites
Bagolino
Archelaus Z.
Gredleri Zone
Curionii Zone
(Nevadites) Secedensis Z.
Reitzi Zone
Trinodosus Zone
'BUCHENSTEIN BEDS' ('Knollenkalke')
'transitional beds'
PREZZO LIMESTONE
P. archelaus
Daonella lommeli
Daonella lommeli
Daonella pichleri
Protrachyceras
Eoprotrachyceras
Eoprotrachyceras curionii
Chiesiceras chiesense
Nevadites
Ticinites
Aplococeras
Parakellnerites
Hungarites
Reitziites
Kellnerites
Lardaroceras
Asseretoceras
Paraceratites
Judicarites

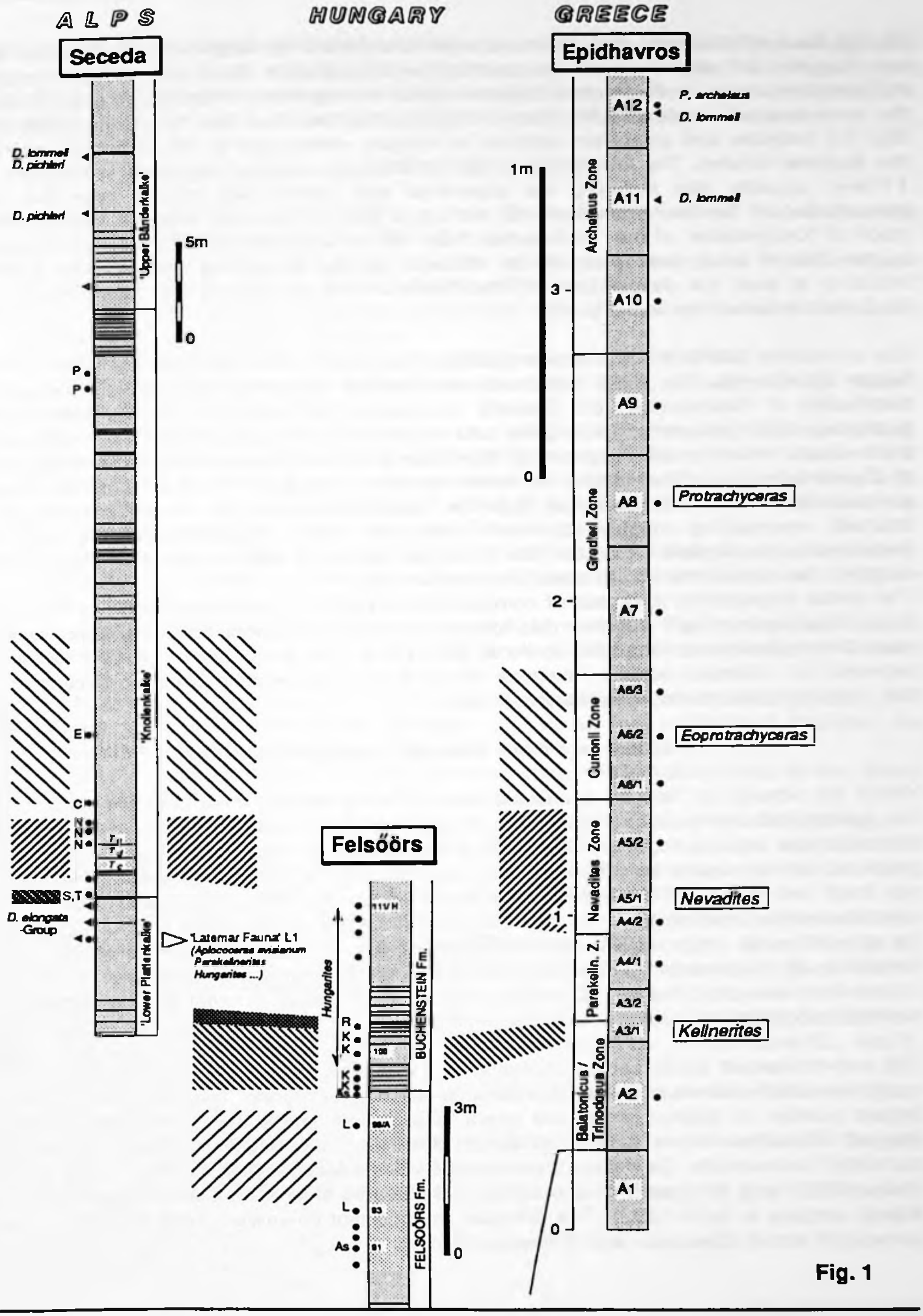

ALPS
HUNGARY
GREECE
Seceda
Epidhavros
Felsőörs
D. lommeli
D. pichleri
'Upper Bänderkalke'
'Knollenkalke'
'Lower Plattenkalke'
5m
0
P
E
C
N
S,T
D. elongata -Group
'Latemar Fauna' L1
(Aplococeras avisianum Parakellnerites Hungarites ...)
Hungarites
R
K
L
As
BUCHENSTEIN Fm.
FELSOÖRS Fm.
3m
1m
Archelaus Zone
Gredleri Zone
Curionii Zone
Nevadites Zone
Parakelln. Z.
Balatonicus / Trinodosus Zone
A12
A11
A10
A9
A8
A7
A6/3
A6/2
A6/1
A5/2
A5/1
A4/2
A4/1
A3/2
A3/1
A2
A1
P. archelaus
Protrachyceras
Eoprotrachyceras
Nevadites
Kellnerites

Fig. 1

On the basis of published data the correlation is excellent not only between Bagolino section and Hungary, but also between the south-alpine 'Buchenstein Beds' and the thin interval of Hallstatt-Limestones at Epidhavros (note the order of magnitude difference in scale!). Only for the lowermost two beds at Epidhavros (A1-2) this does not hold true. It becomes also evident that the Felsoōrs- and equivalent sections in Hungary correspond to only a narrow interval on the Bagolino column. The lowermost portion of siliceous nodular limestones at Felsoōrs (beds 111A-H, possibly also including the uppermost tuff layers) may overlap with the 'Lower Plattenkalke' at Seceda. Equivalents to the upper part of the latter and the entire following stack of 'Knollenkalke' of the 'Buchenstein Beds' in the northwestern Dolomites are represented in the Balaton area most probably by siliceous nodular limestones (above beds 111) and including at least the deeper parts of the 'Nemesvamos Limestone' s.s. (see Kovacs 1993, Fig.3; Felsoōrs section: 'upper part').

The correlation between the Tethyan sections and a selected succession from the Humboldt Range (Saurian Hill, Site C) is based only on a limited number of macrofaunal elements: the distribution of *Paraceratites*, the *Daonella sturi*-group, representatives of the *Daonella elongata*-group and *Aplococeras* (*A. vogdesi* and *A. parvus*), the range of *Nevadites* (although the south-alpine *Nevadites* differ somewhat from their American counterparts) and the appearance of *Eoprotrachyceras*. The number of ammonoid-levels recognised in the Humboldt Range is comparable with the distribution at Bagolino. Surprisingly even the thickness ratios of rock intervals representing roughly equivalent ammonoid zones (*Meeki/Occidentalis* and *Reitzi/Secedensis*) are similar! Moreover the thickness scale of the Saurian Hill column closely matches the scale of the 'Buchenstein Beds' at Seceda.
The similar proportional thickness of corresponding pelagic intervals in sections as far away as those illustrated in Fig.1 suggest that long-term rates of accumulation of pelagic sediments were almost linear over long time spans at each place. The rates vary by up to a factor of 15 between the siliceous nodular limestone facies of the 'Buchenstein Beds' at Seceda and the thin 'Hallstatt Limestones' at Epidhavros.

Proposal for a stage boundary based on ammonoids

Within the scheme of Tethyan ammonoid zones outlined above, three principal candidates for the Anisian/Ladinian boundary have been suggested (Fig.1: positions No.1 to 3; for a short discussion see also report by M. Gaetani in the last issue of ALBERTIANA, No.12, p.8). All three positions can be properly identified in sequence at Bagolino and in nearby sections (e.g. Pèrtica; see Brack and Rieber 1993). As previously discussed and based on the currently available data, we still consider position No.3 (i.e. the base of the *curionii* Zone) as the best suited candidate for the following reasons: (A) representatives of *Eoprotrachyceras* can be relatively easily identified, (B) the boundary immediately postdates the appearance of *Chieseiceras chiesense* - an excellent ammonoid marker, (C) position No.3 has the greatest potential for a high resolution worldwide correlation.

The non-condensed stratigraphic succession at Bagolino is at present the best exposed, easily accessible south-alpine section suitable for a far reaching reference. This is the section with the largest number of distinct ammonoid levels in sequence and spanning the full critical time-interval (*Trinodosus* Zone to *Curionii* Zone). Moreover, the Bagolino section can be safely correlated (ammonoids, Daonellas, characteristic volcaniclastic layers; for details see Brack and Rieber 1993) with stratigraphic successions in the nearby area of M. Corona (Stabol Fresco and Adanà sections in Balini 1992). This provides an important downward expansion of the detailed ammonoid record (*Binodosus* and *Trinodosus* Zones).

A final decision on the stage boundary should indeed be made only after additional stratigraphic data on alternative scales are available. Research on conodonts on samples from Bagolino and high-quality radiometric dating of a sequence of volcaniclastic layers from south-alpine sections is in progress. Preliminary data are promising and first results will become available soon.

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THE BASE OF THE ANISIAN. A CANDIDATE GLOBAL STRATOTYPE SECTION AND POINT FROM CHIOS ISLAND (GREECE)

G. Muttoni, D. V. Kent and M. Gaetani

Introduction

In recent years there have been reappraisals of a variety of significant stratigraphic sections across the Spathian/Anisian (Early/Middle Triassic) boundary (Wang, 1985; Bucher, 1989; Tozer and Talon, 1990; Gradinaru, 1991; Gaetani et al., 1992). At present, sections in Oman, Dobrudgea (Romania) and Chios (Greece) appear to be the most relevant sections described in pelagic Tethyan environments. All of them are comprised of pinkish to reddish nodular limestones with low sedimentation rates.

The Himalayan sections do not seem to be suitable, essentially because the boundary occurs within the so-called Niti Limestone (Nicora et al., 1984), where ammonoids are badly preserved and almost impossible to chisel out. As regards magnetostratigraphy it is worth noting that, although a paleomagnetic survey has not been attempted, the Color Alteration Index of conodonts (4 to 5) suggests that the region underwent high regional heating (more than 300 °C?) that may have reset the magnetization.

In SE China (Yangtze Platform) the critical interval is condensed and is characterized by mixed ammonoid faunas (Wang, 1985), whereas in Nevada the critical interval around the boundary falls within the poorly fossiliferous "Brown Sandstones" (Silberling and Wallace, 1969). As Bucher (1989) reports, the first ammonoid-bearing level above this terrigenous unit is the *J. welteri* horizon.

Thus, the most suitable sections for the Global Stratotype Section and Point (GSSP) of the base of the Anisian seem to be, at present, the western Tethyan Oman, Dobrudgea and Chios sections.

(i) The paleontological content of the Oman sections has been described by Tozer and Talon (1990) (ammonoids) and Orchard (1994, in press) (conodonts). A magnetostratigraphic survey performed by Y. Gallet et alii gave no useful results (Gallet, pers. comm., March 1994).

(ii) During the last ten years the Dobrudgea sections (Desli Caira and Agighiol) have been visited by several members of the International Subcommission on Triassic Stratigraphy (ISTS), under the leadership of E. Gradinaru (Bucarest). A summary on the ammonoid and conodont stratigraphic distributions was presented at the ISTS meeting at Lausanne (October 1991) by Gradinaru. Finally, samples for paleomagnetism, presently under study, have been recently collected at Desli Caira and Agighiol by the French team (Gallet et al., 1993).

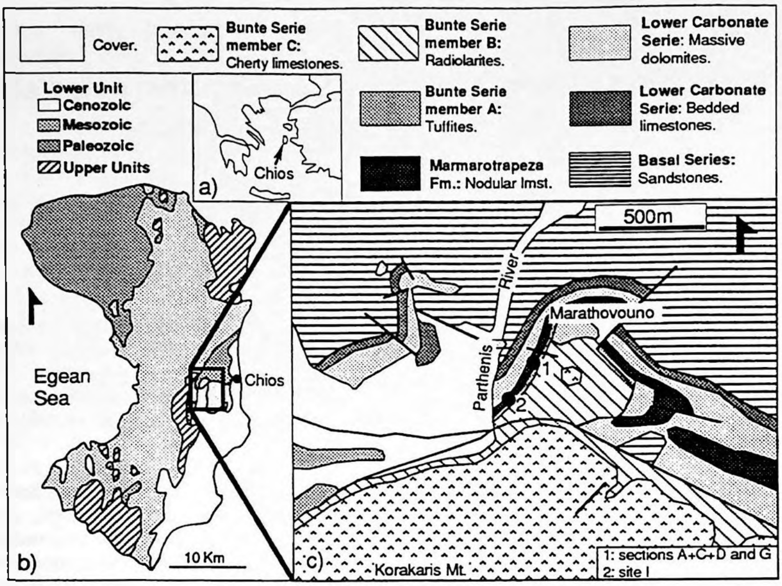

Fig. 1 *(a) Geographic location and (b) simplified geological map of Chios Island (after Gaetani et al., 1992); (c) geological sketch map of the Marathovouno hillock area (after Lazzaroni, 1991).*

(iii) The Chios sections are located on the Island of Chios (Greece) (Fig. 1). Their paleontological content has been revisited by Gaetani et al. (1992) (ammonoids and conodonts) and Muttoni and Rettori (1994) (foraminifers). A comprehensive magnetobiostratigraphic study has been recently carried out by G. Muttoni, D. V. Kent and M. Gaetani (in preparation) at section A+C+D and section G of Gaetani et al. (1992), equivalent to sections CMII and CMI of Bender (1970) (Fig. 2). In this paper we anticipate part of the magnetostratigraphic results and we propose one of the Chios sections as a candidate Global Stratotype Section and Point for the base of the Anisian.

Paleomagnetic analysis

Sections A+C+D and G have been sampled stratigraphically, from base to top, with an average sampling interval of 25 cm. A site located a few hundred meters away and characterized by a different bedding attitude (site I) has also been sampled to perform a fold test which could hopefully constrain the age of acquisition of the characteristic remanence. The total number of thermally demagnetized specimens is 232. Remanence measurements were performed in a 2G 3-axis cryogenic magnetometer located in a magnetically shielded room at the paleomagnetics laboratory of Lamont-Doherty Earth Observatory.

Vector end point demagnetograms reveal three progressively isolated components. After removal of a low unblocking temperature present-day field or spurious component between 0 and 200 °C, and of a "B" component with north-westerly declinations and positive inclinations between 300 and 600 °C (which is not discussed here for brevity purposes), a dual polarity northwest-and-down or south-east and up "C" component regarded as characteristic and carried by hematite is revealed between 625/650 and 680 °C. At site I the characteristic "C" component has been isolated in only two specimens.

The precision parameter of the three site-mean "C" directions increases by a factor of 9.8 with full (100%) correction for bedding tilt. Although site I is represented by only two sample directions, the fold test on the site-means is positive at the 95% level of confidence according to the criteria of McFadden and Jones (1990). Thus, the available data seem to suggest that the reversal-bearing characteristic component pre-dates tilting which, according to Jacobshagen (pers. comm., 1993), must have been caused by the Late Cretaceous and/or Eocene compression related to the structuration of the Hellenides mountain range.

The overall mean direction after full (100%) tilt correction is Dec. 274.3°, Inc.=33.1° (a95=11.4°, k=118, N=3) and points to a paleolatitude of 18°N for the characteristic magnetization.

The polarity option chosen (i.e., north west and down = normal) and the derived paleolatitude are compatible with the paleogeographic reconstruction of the western Tethys of Marcoux et al. (1993), where the Serbo-Pelagonian zone, to which Chios belongs, was located north of the equator during the Middle Triassic, between 10° and 20°N.

A normal-reversed-normal polarity sequence has been recognized at both sections A+C+D and G. Following the nomenclature introduced by Alvarez et al. (1977), the polarity zones have been named, in ascending stratigraphic order, Chios A^+, Chios B^- and Chios C^+.

At sections A+C+D and G the ChiosA^+/ChiosB^- boundary occurs at the base of a cm-thick condensed horizon. The overlying ChiosB^-/ChiosC^+ boundary is affected by a minor fault at section A+C+D, whereas at section G occurs at the base of a cm-thick hard ground (Fig. 2). Paleontological observations suggest that the hiatuses present at both the condensed horizons and the hard grounds are not very important.

The position of the Early/Middle Triassic boundary

During Triassic time, biochronology of pelagic limestones is mainly based on ammonoids and conodonts.

At the Marathovouno sections, the appearance of the conodont *Gondolella timorensis* Nogami slightly predates the first occurrence of the ammonoid assemblage with *Aegeiceras, Paracrochordiceras, Paradanubites* and *Japonites* (Fig. 2). In Gaetani et al. (1992), the position of the Early/Middle Triassic boundary was placed at the base of this ammonoid assemblage mainly for two reasons.

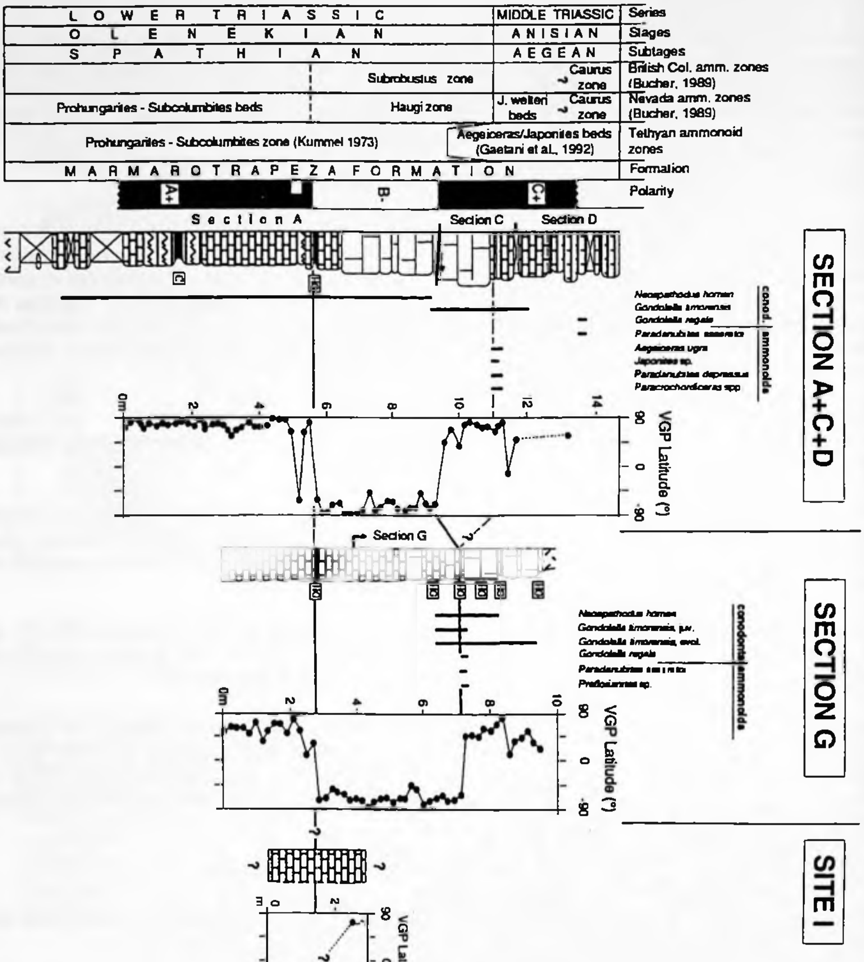

Fig. 2 *Lower/Middle Triassic boundary-bearing sections A+C+D and G of Gaetani et al. (1992). The central columns show the VGPs latitude plotted as function of stratigraphic thickness and the derived polarity sequence. The occurrence/appearance of the most important conodonts and ammonoids used to define the boundary are indicated by solid bars. Polarity zones are designated by letters with the prefix "Chios" in ascending alphabetical order, followed by "+" (normal) or "-" (reversed). The Early/Middle Triassic boundary on ammonoids falls close to the base of the polarity zone "Chios C+". In the lithology logs, "HG" stands for hard ground and "C" for condensation.*

1) The ammonoid assemblage marks a real change in the ammonoid evolution. Several Anisian genera first appear, whilst most typically Spathian forms are absent. The *Aegeiceras, Paracrochordiceras, Paradanubites* and *Japonites* assemblage is the oldest so far described in Anisian sections, and is considered coeval with the *J. welteri* horizon of Nevada (Bucher, 1989). A similar assemblage characterizes the earliest Anisian sediments of Oman (Tozer, and Talon, 1990) and of Dobrudgea (Romania) (Gradinaru, 1991). In the central part of the Tethys, ammonoids of this assemblage are present in the so-called mixed fauna described by Wang (1985).
2) For historical reasons, in Triassic stratigraphy an ammonoid-based boundary is preferred to a conodont-based boundary, if the two are not coincident.

The ammonoid record is however not continuous in the Marathovouno sections, due to poor preservation conditions, whereas conodonts, although less abundant, constitute a more continuous record and their stratigraphic range may be described in terms of "appearance" rather than of "first occurrence", which is more appropriate for the ammonoid distributions.

The Early/Middle Triassic boundary traced at the occurrence of the Anisian ammonoid assemblage, and hence the base of the Anisian, lies close to the base of the normal polarity interval "Chios C$^+$". However, the transition between the polarity intervals "ChiosB$^-$" and "Chios C$^+$" is close also to the appearance of *Gondolella timorensis* (Fig. 2).

According to these observations, two options for the position of the base of the Anisian can be considered, either to maintain the base of the Anisian at the occurrence of the new Anisian ammonoid stock, or to start the Anisian at the first occurrence of *G.timorensis*. This latter option, useful in those sections where ammonoids are not present, implies the definition of a stage boundary cutting across an ammonoid zone but would make it almost coincident with a paleomagnetic polarity reversal.

Conclusions

The sections A+C+D and G provide a consistent pattern of magnetic reversals which can be correlated to the Early/Middle Triassic boundary, either placed on the basis of ammonoids or conodonts. Thanks to the rich paleontological content, the Marathovouno section A+C+D of Assereto et al. (1980) (= section CMII of Bender, 1970) is a good candidate as a GSSP for the base of the Anisian. The narrow sampling rate adopted tends to exclude the presence of undetected short polarity intervals.

The magnetostratigraphy from the Marathovouno hillock sections has been tentatively correlated to the Early Triassic South China sequence of Steiner et al. (1988) and the composite Early Triassic stratotype sections from the Canadian Arctic of Ogg and Steiner (1991).

As concerns the biostratigraphic correlations between Chios and the Arctic sections, according to Gaetani et al. (1992) and Bucher (1989) the *Prohungarites-Subcolumbites* Zone of Chios is correlative with the *Subrobustus* Zone in the Canadian Arctic-British Columbia, whilst the *Aegeiceras/Japonites* beds partly overlaps, in the Canadian Arctic-British Columbia, with the *Caurus* Zone. For these observations we may conclude that the polarity zones Chios A$^+$ and Chios B$^-$ correlate, respectively, with the polarity zones SpN1 and SpR2 of the Arctic stratotypes. On the other hand, the normal interval Chios C$^+$ does not have a correlative in the Arctic sections, where the presence of a hiatus affecting essentially the Aegean (first substage of the Anisian) is testified by the occurrence of the Middle Anisian *Varium* Zone immediately above the Spathian *Subrobustus* Zone.

A more detailed discussion on the paleomagnetism and magneto-biostratigraphy of the Chios sections is in preparation by G. Muttoni, D. V. Kent and M. Gaetani for submission to Earth and Planetary Science Letters.

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TOWARD A NONMARINE TRIASSIC TIMESCALE

Spencer G. Lucas

Introduction

In August 1992, at the 29th International Geological Congress in Kyoto, Japan, the STS approved a proposal by S. G. Lucas, V. Lozovsky and Cheng Zhengwu to form a working group on the nonmarine Triassic timescale (the proposal was published in ALBERTIANA 10, p. 41). The working group thus formed contains eight members: Spencer G. Lucas, Albuquerque, New Mexico, U.S.A. (chairman); Vladlen Lozovsky, Moscow, Russia (vice-chairman); Cheng Zhengwu, Beijing, China (vice-chairman); Inna Dobruskina, Jerusalem, Israel; Heinz Kozur, Budapest, Hungary; Roberto Molina-Garza, Albuquerque, New Mexico, U.S.A.; Paul Olsen, Palisades, New York, U.S.A.; and R. S. Tiwari, Lucknow, India. I hope that one or two more members will be added to the working group, preferably from South America or Africa. Expertise and research interests of the members of the working group encompass sequence stratigraphy, cyclostratigraphy, radiometric dating, magnetostratigraphy, palynology, megafossil paleobotany, invertebrate micropaleontology (ostracods, charophytes and conchostracans), paleoichnology and vertebrate paleontology.

The working group first met in Albuquerque last October during the International Symposium and Fieldtrip on the Nonmarine Triassic (see report by Lucas and Morales elsewhere in this issue). During this meeting, the group discussed five issues raised by the chairman: (1) nomenclature of Triassic time intervals based on nonmarine chronology; (2) relative significance of different fossil groups to nonmarine Triassic biochronology; (3) nonmarine type sections (standards) for intervals of Triassic time; (4) integration of radiometric ages and magnetochronology with biochronology; and (5) relationship of the working group's efforts to current work on the SGCS (standard global chronostratigraphic scale) for the marine Triassic. This discussion demonstrated general consensus on key matters of philosophy and procedure early in the history of the working group. Here, I discuss these issues briefly and present the consensus of the working group.

Nonmarine Nomenclature for Triassic Time Intervals

Few members of the STS will remember that Huxley (1869) argued that the term Poikilitic should replace the term Triassic. In so doing, Huxley advocated the term that Conybeare earlier used for the nonmarine Newer Red Sandstones in Great Britain. Huxley proposed that Poikilitic refer to the interval of time represented by reptile faunas from India, South Africa and Europe now considered Triassic. There is thus historical precedent for naming time intervals of the Triassic based on nonmarine considerations, and this precedent shows how such names have been totally forgotten.

Members of the working group agree that no terminology at the stage or series level should be proposed for the Triassic based on nonmarine sections. Instead, we will work with the Triassic SGCS as outlined by Visscher (1992), even though this SGCS still has problems, particularly in the precise definition of boundaries.

Nomenclature for nonmarine Triassic time intervals will be confined to the level of biozone or assemblage zone. Good examples of this include the *Dinophyton* Zone of Ash (1980) for a late Carnian floral zone in North America and the *Paleorhinus* biochron (biochron is the time equivalent to a biozone) of Hunt and Lucas (1991) to refer to that part of late Carnian time represented by the occurrences of the phytosaurian reptile *Paleorhinus*. Vertebrate biostratigraphers have long used land-vertebrate "ages", more precisely referred to as land-vertebrate faunachrons (lvfs), as time terms equivalent to assemblage zones of vertebrates.

LATE TRIASSIC STAGE/AGE	EASTERN NORTH AMERICA (NEWARK SUPERGROUP)	WESTERN UNITED STATES (CHINLE GROUP)
RHAETIAN	CLIFTONIAN	APACHEAN
NORIAN	NESHANICIAN	REVUELTIAN
CARNIAN	CONEWAGIAN	ADAMANIAN
	SANFORDIAN	OTISCHALKIAN

Fig. 1. Land-vertebrate faunachrons for the Late Triassic in western (Chinle Group) and eastern (Newark Supergroup) North America.

Huber et al. (1993a) and Lucas and Hunt (1993a) recently proposed lvfs for the Late Triassic of North America (Fig. 1) that reflect much more precise correlation than was previously possible.

In megafossil paleobotany, the term flora is used to refer to temporally significant fossil-plant assemblages (Fig. 2). A principal goal of the working group is to identify and delineate such biostratigraphic/biochronologic units, to correlate them to each other and to relate them to the marine Triassic SGCS.

Relative Significance of Different Fossil Groups

One problem that has hindered progress toward agreement on the SGCS for the Triassic has been attempts to emphasize ammonoid biochronology over conodont biochronology or vice versa. Current disagreement over placement of a GSSP for the Permian-Triassic boundary largely reflects this.

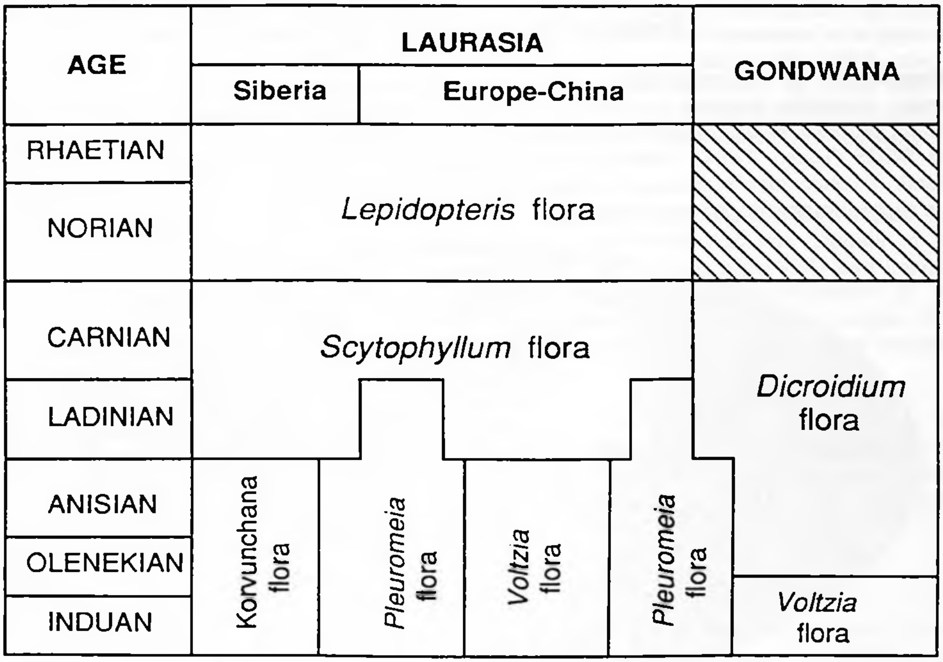

Fig. 2 Triassic megafossil plant assemblages (after Dobruskina, 1993).

The working group readily identified palynomorphs, megafossil plants, conchostracans and tetrapod vertebrates as the Triassic nonmarine fossil groups with the greatest biochronological potential. Most nonmarine Triassic ostracods are darwinulaceans whose taxonomy has been greatly oversplit; they appear to be of limited value in correlation. Triassic charophytes are not well studied, and nonmarine Triassic fishes have proven to be facies fossils with relatively long temporal ranges (e.g., Huber et al., 1993b).

Palynomorphs have a long and strong history of application to Triassic chronology. Their cross-correlation value in relating nonmarine and marine Triassic biochronology exceeds that of any other fossil group (e.g., Dunay and Fisher, 1974). Megafossil plants abound in most nonmarine Triassic strata and have long been important to correlations.

Tetrapod biochronology has a long and successful record of application to nonmarine Triassic biochronology. Refined schemes exist for most of the Triassic, and great precision has been achieved recently in Early and Late Triassic correlations (e.g., Ochev and Shishkin, 1989).

Conchostracan correlations of nonmarine Lower and Middle Triassic strata are well demonstrated (Kozur, 1993; Kozur and Mock, 1993; Kozur et al., 1993). However, there is a need to develop a Late Triassic conchostracan biostratigraphy/biochronology. Both conchostracans and terrestrial vertebrates do occur in some marine Triassic strata and aid in cross-correlation of marine and nonmarine biochronologies. Most important to all members of the working group is to integrate correlations based on all of these fossil groups, not to favor a priori one group over another.

Nonmarine Standards for Triassic Time

Stratotypes for chronostratigraphic units (stages) are not needed in the nonmarine realm. However, standard sections should be identified and their chronological potential analyzed. Standard sections of strata and stratotype sections have been identified for the Triassic portion of the SGCS (Tozer, 1984). Although much work remains to be done on the Triassic SGCS, a workable Triassic biochronology, based principally on ammonoids and conodonts, is in place that is rooted in standard and stratotype sections of marine strata.

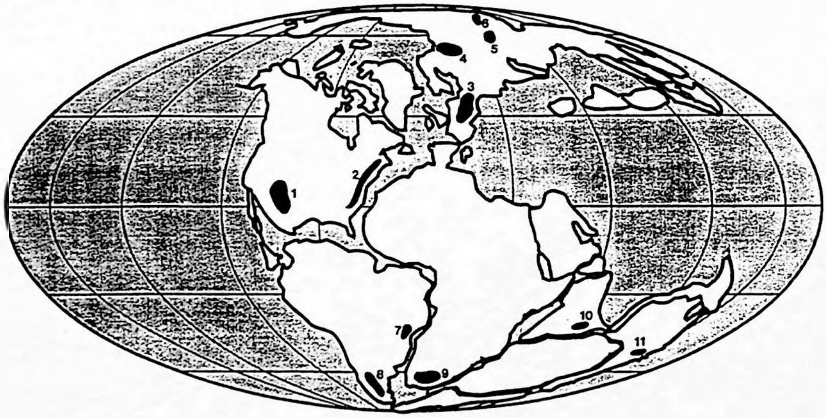

Fig. 3. Map of Late Triassic Pangaea showing location of some possible nonmarine Triassic standards: 1 - Moenkopi and Chinle basins, U.S.A.; 2 - Newark Supergroup basins, U.S.A.Canada; 3 - Buntsandstein and Keuper basins, Europe; 4 - Cis-Urals, Russia; 5 - Junggur basin, China; 6 - Ordos (Shanganning) basin, China; 7 - Parana basin, Brazil; 8 - Ischigualasto- Villa Union, Cuyo and associated basins, Argentina; 9 - Karoo basin, South Africa; 10 - Pranhita-Godavari Valley, India; 11 - Sydney basin, Australia.

In the nonmarine stratigraphic terranes of the Triassic, quite a different situation exists. No such standard or stratotype rock sections have been identified for nonmarine Triassic strata, and their correlation is either made by direct (though usually imprecise) reference to the marine SGCS or by nonmarine biochronological constructs such as the *Lystrosaurus* "Zone". Lucas (1992) and Lozovsky (1993) advocated identifying standard sections of nonmarine Triassic strata for use in correlation. These are not intended to be the stratotypes of stages, but instead are reference sections to aid in the correlation of nonmarine Triassic strata. One of the immediate tasks of the working group is to identify and evaluate the correlation potential of such standard sections (Fig. 3).

Radiometric Ages and Magnetochronology

Few radiometric ages can be related unambiguously to Triassic marine biochronology. Indeed, Forster and Warrington (1985) identified fewer than 20 reliable numerical ages relevant to the calibration of Triassic stage boundaries. Abundant igneous rocks associated with nonmarine Triassic strata, especially those of Late Triassic age, represent great untapped potential to improve Triassic geochronometry. A good example is the Ar/Ar age of 227 ± 0.3 Ma reported by Rogers et al. (1993) from a tuff near the base of the Ischigualasto Formation in Argentina. A late Carnian (probably early Tuvalian) tetrapod fauna occurs just above this tuff (Lucas and Hunt, 1993b), and this suggests an age for the Julian-Tuvalian boundary of about 227 Ma. Another example is provided by the basalts and intrusives of the nonmarine Newark Supergroup of eastern North America, which have long provided numerical ages relevant to calibration of the Triassic-Jurassic boundary (e.g., Olsen et al., 1989).

No seafloor exists from which to derive a magnetostratigraphic timescale for the Triassic. Such a magnetochronology must be patched together from magnetostratigraphic studies of both marine and nonmarine Triassic strata. The reviews of Molina-Garza et al. (1991) and Lozovsky and Molostovsky (1993) indicate that most reliable Triassic magnetostratigraphy is from nonmarine sections. Indeed, the recently drilled 5.5-km-thick core of nonmarine strata of the Newark Supergroup in New Jersey-Pennsylvania should provide the most detailed magnetochronology of most of the Late Triassic (Kent et al., 1993).

Members of the working group recognize the vast potential for radiometric ages and magnetostratigraphy locked in nonmarine Triassic rocks. They believe these data should be pursued vigorously, and that correlation of nonmarine and marine Triassic biochronology is essential to improving the Triassic geochronometric scale and developing a complete Triassic magnetostratigraphic scale.

Relationship to the Marine Triassic SGCS

All members of the working group agree on the importance of relating nonmarine Triassic chronology to the marine Triassic SGCS. I am reminded here of Hedberg's (1976, p. 81) assertion:

> "The units of a Standard Global Chronostratigraphic Scale are valid only as they are based on sound, detailed local and regional stratigraphy. Accordingly, the route toward recognition of uniform global units is by means of local or regional stratigraphic scales... It is better to refer strata with accuracy to local or regional units rather than to strain beyond the current limits of time correlation in assigning these strata to units of a global scale.

We need to improve Triassic nonmarine correlations to understand better the history of physical and biological events on Triassic Pangaea. This pursuit - developing a better timescale for the nonmarine Triassic - can take place independent of work on the marine Triassic SGCS. However, ultimately, the improved nonmarine Triassic chronology must be related to the marine chronology. As this article indicates, integration of nonmarine and marine Triassic chronologies will improve the Triassic SGCS and thus further the goals of all members of the STS."

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DISCUSSION OF TRIASSIC CHRONOSTRATIGRAPHIC DIVISIONS MUST CONTINUE

E.T. Tozer

Baud (1993) describes me as inconsistent and a proponent of "absolute sterile discussion" because I continue to express concern on questions of Triassic chronostratigraphic classification, in particular subdivisions within the Lower Triassic, and whether or not the Rhaetian ranks as the latest Triassic stage (Tozer, 1993). He seems to think that votes taken following the 1991 STS meeting in Lausanne, recorded in Albertiana 10, November 1992, should end further discussion.

The charge that I am inconsistent is easily dismissed. I recorded objections and problems in relation to the Induan and Olenekian stages nearly 30 years ago (Tozer, 1965) and since then have consistently eschewed their use. My assessment of the Rhaetian given in 1979, which necessitates treatment of the Norian as the ultimate Triassic Stage, has remained unchanged.

Five volumes in the "Geology of North America" series, published by the Geological Society of America and the Geological Survey of Canada (1989-1993), deal with the marine Triassic. Induan and Olenekian are nowhere used. In all these volumes Norian has the status of the ultimate Triassic stage. This seems to show that the views of STS, as expressed by the majority, pay insufficient attention to current stratigraphic practice in North America. This is not surprising because at the latest count, North America had only three of the 34 voting members.

In this light, are these discussions sterile and should they end ? I think not. The pages of Albertiana include important contributions to the problems. My paper is not the only one provoked by opinions expressed in Lausanne. Kozur (1992) has drawn attention to the serious shortcomings of the Induan Stage within a hierarchy of international chronostratigraphic divisions. The difficulties involved with recognizing a Rhaetian Stage have been considered in many Albertiana articles (Ager, 1987, 1988, 1990; Dagys, 1988; Golebiowski, 1990; Krystyn, 1990; Silberling and Nichols, 1988; and the writer (Tozer, 1988, 1990). Understandably different viewpoints are propounded. This is to be expected. It is fortunate that Albertiana exists in which these different views can be expressed. In science free speech and the expression of minority views is no less important than adoption of decisions made by majorities many of whom admit that they do not fully understand the problem.

Baud fears that Albertiana "Readers ... may be disturbed by Toyer's (sic) (1993) paper." They should not be. The authors cited above, and others engaged in research related to these questions, have been heard and should be heard from again if they have further contributions. These discussions are neither disturbing nor sterile.

Baud also suggests that readers may be unfamiliar with the role of the Subcommission (STS), seemingly with the implication that the votes on the Lower Triassic stages and Rhaetian, which followed the 1991 Lausanne Meeting, establish a mandatory scheme of stratigraphic nomenclature for the Triassic. On this point readers should clearly understand that Subcommissions are subordinate components of the International Commission on Stratigraphy (ICS). Proposals of Subcommissions are in no sense mandatory until approved by the Commission and ratified by the International Union of Geological Sciences (IUGS). In my previous article (Tozer, 1993) I was mistaken in stating that the ICS is the ultimate authority. Ultimate authority for ratification in fact rests with Council of the IUGS. Until now ICS and IUGS have not received any STS proposals. The first undertakings of STS in this regard should be to propose boundary stratotypes (GSSPs). When GSSPs have been decided on by STS they must be approved and ratified by ICS and IUGS. If any exercise is sterile, I maintain it is recommendation that stages names be adopted without designation of their boundary stratotypes. Most of the Albertiana papers listed below address these problems in terms of boundary definitions. The ballot circulated by Baud, with the results recorded in Albertiana 10, p. 10, did not. What use is an Induan-Olenekian boundary, or a Rhaetian Stage, if not defined in terms of GSSPs ? Towards these resolving these questions, the debate must continue. Readers need not be disturbed and should remember that nothing is obligatory until ratified by the IUGS.

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GOLEBIOWSKI, R., 1990. The Alpine Kössen Formation, A key for European topmost Triassic Correlations. Albertiana, 8: 25-35.

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KRYSTYN, L., 1990: A Rhaetian Stage - chronostratigraphy, subdivisions and their intercontinental correlation. Albertiana, 8: 15-24.

SILBERLING, N.J. and NICHOLS, M. K. 1988. Comment on "A defence of the Rhaetian Stage. Albertiana, 7: 7-8.

TOZER, E.T. 1965. Lower Triassic Stages and Ammonoid zones of Arctic Canada. Geological Survey of Canada, Paper 56-12.

TOZER, E.T., 1988. Rhaetian: a Substage not a Stage. Albertiana, 7: 9-15.

TOZER, E.T., 1990. How many Rhaetians ? Albertiana, 8: 10-13.

TOZER, E.T., 1993. Triassic chronostratigraphic divisions considered again. Albertiana, 11: 32-37.

INTERNATIONAL SYMPOSIUM AND FIELDTRIP ON THE NONMARINE TRIASSIC

Spencer G. Lucas and Michael Morales

The International Symposium on the Nonmarine Triassic took place in Albuquerque, New Mexico, 17-19 October 1993. The New Mexico Museum of Natural History and Science and the Museum of Northern Arizona cosponsored the meeting. A five-day fieldtrip (20-24 October) followed the symposium, to examine nonmarine Triassic strata and fossil localities of the southern Colorado Plateau in northern New Mexico and northern Arizona.

The symposium reflected growing interest in the nonmarine Triassic in its 52 oral presentations. Ninety earth scientists from 15 countries (Argentina, Australia, Austria, China, Denmark, England, France, Germany, Hungary, India, Israel, Italy, Russia, South Africa and United States) participated, including geophysicists working on magnetostratigraphy, sedimentologists, sequence stratigraphers, taphonomists, paleoichnologists, palynologists, micropaleontologists, paleobotanists, invertebrate paleontologists and vertebrate paleontologists. Highlights of the presentations included: (1) new magnetostratigraphic and cyclostratigraphic data from a 5.5-km-thick core drilled in the Newark basin of Pennsylvania-New Jersey; (2) permineralized floras from Antarctica and Arizona; (3) sequence-stratigraphic analyses of nonmarine Triassic strata in the western United States and Russia; (4) tectonic evolution of the Germanic Triassic basin; (5) co-occurrence of *Lystrosaurus* and *Dicynodon* in China and South Africa; (6) Late Triassic vertebrates from eastern Greenland; (7) new palynostratigraphic and tetrapod-based biochronology; and (8) new systematic studies of some of the earliest dinosaurs and their footprints.

After the symposium, 53 participants continued on the fieldtrip. The first three days of the trip focused on Upper Triassic Chinle Group strata, including visits to the famous dinosaur quarry at Ghost Ranch and the classic Chinle Group section in the Petrified Forest National Park. The remainder of the trip examined Lower-Middle Triassic strata of the Moenkopi Formation in northern Arizona, including the well-known fossil vertebrate quarries developed by Dr. Samuel P. Welles of the University of California Museum of Paleontology, to whom the symposium was dedicated. Stops of the fieldtrip focused on sequence stratigraphy, sedimentation, tetrapod biostratigraphy/biochronology and nonmarine trace fossils.

The symposium also brought together the Working Group on a Nonmarine Triassic Timescale of the IUGS Subcommission on Triassic Stratigraphy. The working group was formed in August 1993 at the 29th International Geological Congress in Kyoto, Japan. The first meeting of all eight members of the group took place in Albuquerque. Discussion of the group focused on working toward a state-of-the-art correlation of nonmarine Triassic strata to be presented in a symposium to be held at the 30th International Geological Congress in Beijing, 1996. Group members reached consensus on several issues, concluding that: (1) a separate nomenclature of Triassic time intervals for the nonmarine realm is not needed; nomenclature above the zone/biochron level should be that of the SGCS (standard global chronostratigraphic scale); (2) the most significant fossil groups for nonmarine Triassic chronology are palynomorphs, megafossil plants, conchostracans and tetrapod vertebrates, and no one group should be preferred a priori over others; (3) identification of standard sections for the nonmarine Triassic is a desirable goal; (4) important radiometric age data and magnetostratigraphic data are present in nonmarine Triassic rocks and need to be vigorously developed and integrated with biochronology; and (5) work on nonmarine Triassic correlations needs to proceed without concern for the problems that afflict the marine Triassic SGCS but with the ultimate goal of relating these correlations to the SGCS.

The published proceedings of the symposium (85 articles, 18 abstracts), including a 59-page field guide, appeared as THE NONMARINE TRIASSIC edited by Spencer G. Lucas and Michael Morales: New Mexico Museum of Natural Hististory and Science Bulletin, 3, 536 pp. The volume can be ordered by sending $ 55.- payable to "NMMNH Foundation Paleontology" to Spencer G. Lucas, NMMNH. 1801 Mountain Road N. W., Albuquerque, NM 87104 USA.

TRIASSIC JURASSIC BOUNDARY

The IUGS/ICS Triassic - Jurassic Boundary Working Group (TJBWG) is now associated with the IUGS Subcommission on Jurassic Stratigraphy (SJS). The TJBWG is concerned with the selection of a Global Stratotype Section and Point for the base of the Hettangian which constitutes both the base of the Jurassic and its boundary with the Triassic. The secretary of the TJBWG, Dr. G. Warrington, is also a member of the Subcommission on Triassic Stratigraphy (STS) and thus provides a link between that group and the SJS on matters regarding the system boundary. STS members who are active in the study of the Rhaetian sequences and the boundary with the overlying Hettangian, but who are NOT also members of the SJS or TJBWG, are invited to send summaries of their current work, results and views do Dr. Warrington as soon as possible, and not later than 31 August 1994. This will allow such work to be fully considered in connection with a TJBWG meeting which will be held during the 4th International Congress on Jurassic Stratigraphy and Geology, in Mendoza, Argentina (18 - 23 October 1994).

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BRITISH TRIASSIC PALAEONTOLOGY: SUPPLEMENT 17

G. Warrington

Since the completion of the author's previous supplement (No. 16; ALBERTIANA, 12: 51-52) on British Triassic palaeontology, the following works relating to aspects of that subject have been published or have come to his notice:

BENTON, M.J., HART, M.B. and **CLAREY, T.** 1993. A new Rhynchosaur from the Middle Triassic of Devon. Proc. Ussher Soc., 8: 167-171.

BOSÁK, P., FORD, D.C., GLAZEK, J. and **HORÁCEK, I.** (eds). 1989. Paleokarst, a systematic and regional review. Developments in Earth Surface Processes 1. Elsevier, Amsterdam, 725pp.

COOPER, A.H. and **BURGESS, I.C.** 1993. Geology of the country around Harrogate. Mem. Br. Geol. Surv., 1:50000 geological sheet 62 (England and Wales). HMSO, London, xii + 105pp.

FORD, T.D. 1989. Paleokarst of Britain. Pp. 51-70 in BOSÁK, P. et al. 1989 (q.v.).

FYFE, J.A., LONG, D. and **EVANS, D.** 1993. United Kingdom offshore regional report: the geology of the Malin-Hebrides sea area. London: HMSO for the British Geological Survey, viii + 91pp.

GAUNT, G.D. 1994. Geology of the country around Goole, Doncaster and the Isle of Axholme. Mem. Br. Geol. Surv., 1:50000 geological sheets 79 and 88 (England and Wales). HMSO, London, xii + 169pp.

HORÁCEK, I. and **KORDOS, L.** 1989. Biostratigraphic investigations of paleokarst. Pp. 599-612 in BOSÁK, P. et al. 1989 (q.v.).

KELLAWAY, G.A. 1991. The work of William Smith at Bath (1799-1813). Pp. 25-54 in KELLAWAY, G.A. (ed.), Hot Springs of Bath. Investigations of the thermal waters of the Avon Valley. Bath City Council, 288pp.

KELLAWAY, G.A. and **WELCH, F.B.A.** 1993. Geology of the Bristol district. Mem. Br. Geol. Surv., 1:63360 geological special sheet (England and Wales). HMSO, London, xii + 199pp.

LEWIS, D.N. 1993. Catalogue of the type and figured specimens of fossil Asteroidea and Ophiuroidea in the Natural History Museum. Bull. nat. Hist. Mus. (Geol.), 49(1): 47-80.

SAVAGE, R.J.G. 1993. Vertebrate fissure faunas with special reference to Bristol Channel Mesozoic faunas. J. Geol. Soc. Lond., 150: 1025-1034.

SIMMS, M.J. 1990. Triassic palaeokarst in Britain. Cave Science, 17: 93-101.

SMART, P.L., PALMER, R.J., WHITAKER, F. and **WRIGHT, P.V.** 1988. Neptunian dikes and fissure fills: an overview and account of some modern examples. Pp. 149-163 in JAMES, N.P. and CHOQUETTE, P.W. (eds), Paleokarst. Spinger-Verlag, New York, xi+416pp.

STORRS, G.W. and **GOWER, D.J.** 1993. The earliest possible choristodere (Diapsida) and gaps in the fossil record of semi-aquatic reptiles. J. Geol. Soc. Lond., 150: 1103-1107.

TAYLOR, M.A. & CRUIKSHANK, A.R.I. 1993. A plesiosaur from the Linksfield erratic (Rhaetian, Upper Triassic) near Elgin, Morayshire. Scott. J. Geol., 29: 191-196.

TRESISE, G. 1993. Triassic vertebrate footprints from Cheshire: localities and lithologies. Modern Geol., 18: 407-417.

TRESISE, G. 1993. Triassic footprints from Lymm Quarry, Cheshire in the collections of Warrington Museum. Archives of Nat. Hist., 20: 307-332.

TRESISE, G. 1994. The Runcorn quarries and the footprint finds of the 1840s. Proc. Geol. Ass., 105: 125-140.

WARRINGTON, G. 1993. Palynology. Pp. 144-146 in KELLAWAY, G.A. and WELCH, F.B.A. 1993 (q.v.).

WARRINGTON, G., COPE, J.C.W. & IVIMEY-COOK, H.C. 1994. St Audrie's Bay, Somerset, England: a candidate Global Stratotype Section and Point for the base of the Jurassic System. Geol. Mag., 131: 191-20.

This contribution is published with the approval of the Director, British Geological Survey (N.E.R.C.).

RECENTLY PUBLISHED BOOKS

S.G. Lucas and M. Morales (eds.), 1993. The Nonmarine Triassic. Transactions of the International Symposium and Field Trip on the Nonmarine Triassic, 17-24 October 1993, Albuquerque, New Mexico. New Mexico Museum of Natural History and Science, Bulletin 3, 536 pp.

Transactions of congresses generally have the bad reputation of being published several years after date. Therefore many colleagues prefer to publish their results in regular journals which are usually faster. Moreover, one has an more or less idea how the printed version of a paper will look like. However, fortunately there are also good examples of high quality symposium volumes published shortly after the conference. The transactions volume of the Symposium on the Nonmarine Triassic is such an example.

The meeting was held in October 1993 and that same year a more than 500 pages thick volume was published. This volume dedicated to Dr. Samuel P. Welles contains 85 papers and 18 abstracts on a very wide variety of topics, ranging from plant microfossils to mammals and from sequence stratigraphy to radiometric dating of continental deposits. This book includes review papers as well as more specialistic contributions. All parts of the world are represented. Although the volume contains many interesting papers, it is impossible to review all the individual contributions. Nevertheless it is clear that this volume presents an excellent overview of the state-of-the-art of the nonmarine Triassic. Papers are presented in alphabetical order and the volume includes a very clearly written and richly illustrated 59 page field guide for the non-marine Triassic of the southern Colorado Plateau, New Mexico and Arizona. The book is firmly bound in a soft cover, printed on heavy legal size paper, the reproduction of the illustrations, including the half-tones, is excellent and the price is more than reasonable. Therefore there are more than enough reasons to congratulate the authors with this achievement.

This book which is a must for everybody who works in the nonmarine Triassic and that belongs in all research libraries can be ordered by sending US $ 55.- payable to "NMMNH Foundation Paleontology" to Spencer G. Lucas, NMMNH, 1801 Mountain Road N.W. Albuquerque, NM 87104, USA.

All contributions, except for those only published as abstracts, are listed in the Annotated Triassic Literature, this issue pp. 57-101.

Hans Kerp

DOBRUSKINA, I.A., 1994. Triassic floras of Eurasia. Österr. Akad. Wiss., Schriftenr. Erdwiss. Kom., 10: 422 pp.

The first part of this comprehensive overview of the Triassic record of plant megafossils concentrates on the description and stratigraphic position of most of the known plant-bearing beds throughout Europe and Asia. A large number of areas are separately treated by providing lithostratigraphic, biostratigraphic and chronostratigraphic information, as well as locality maps, schematic geological maps and stratigraphic sections.

The second part concerns the recognition of separate Triassic floras and their distribution patterns in time and space. It includes an analysis of flora replacement in different regions from the end of the Permian to the end of the Triassic, the determination of stages in the development of the Triassic flora, and the distribution patterns of the principal taxonomic categories. A phytogeographic zonation is proposed and discussed in the light of information on climatic variation. In addition, the Triassic floras of Eurasia are compared with floras from North America and the Southern Hemisphere.

The third part contains complete lists of the fossil plants described or figured from localities in Europe and Asia, together with the corresponding references.

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J. Guex and A. Baud, 1994. Recent developments on Triassic stratigraphy. Mémoires de Géologie (Lausanne), 21, 182 pp.

The proceedings of the Triassic Symposium held in Lausanne, 20-25 October 1991 are now available. This book contains the following contributions:

Baud, A. and Guex, J., Foreword
Bucher, H., New Ammonoids from the Taylori zone (middle Anisian, Middle Triassic) from Northwestern Nevada (USA), pp. 1-8.
Budurow, K. and Trifonova, E., Progress in concepts about conodont and foraminifera zonal standards of the Triassic in Bulgaria, pp. 9-14.
Dagys, A.S., Lower Triassic stage, substage and zonal scheme of north-eastern Asia, pp. 15-24.
Dagys, A.S. and Dagys, A.A., Global correlation of the terminal Triassic, pp. 25-34.
Hirsch, F., Triassic multielement conodonts versus eustatic cycles, pp. 35-52.
Kolar-Jurkovsek T., Microfauna from the upper y of Karavanke Mts (Slovenia), pp. 53-62.
Kotlyar, G.V. and Sadovnikov, G.N., Events related to the Permian/Triassic boundary, pp. 63-68.
Moerk, A., Triassic transgressive-regressive cycles of Svalbard and other Arctic areas a mirror of stage subdivision, pp. 69-82.
Nakazawa, K., Ishibashi, T., Kimura, T., Koike, T., Shimizu, D. and Yao, A., Triassic biostratigraphy of Japan based on various taxa, pp. 83-104.
Orchard, M.J., Conodont biochronology around the Early-Middle Triassic boundary new data from North America, Oman and Timor, pp. 105-114.
Pálfy, J., Paleoecological, biostratigraphic and paleobiogeographic fingerprints of brachiopod faunas case studies from the Anisian of Hungary, pp. 115-120.
Shishkin, M.A., Problems of global correlation of the continental Triassic on the basis of tetrapods, pp. 121-126.
Sobolev, E.S., Stratigraphic range of Triassic boreal Nautiloidea, pp. 127-138.
Tiwari, R.S. and Vijaya, Synchroneity of palynological events and patterns of extinction at Permo-Triassic boundary in terrestrial sequence of India, pp. 139-154.
Tozer, E.T., Significance of Triassic stage boundaries defined in North America, pp. 155-170.
Zakharov, Y.D. and Shkolnik, E.L., Permian-Triassic cephalopod facies and global phosphatogenesis, pp. 171-182.

This volume can be ordered for Sfr. 30.- (or $ 20.-) from the Department of Geology, Secretariat, UNIL-BFSH2, CH-1015 Lausanne, Switzerland. Bank account Nr. 710.179.6 at Banque Cantonale Vaudoise, 1002 Lausanne.

Yang Zunyi, Wu Shunbao, Yin Hongfu, Xu Guirong and Zhang Kexin (Eds.), 1993., Permo-Triassic events of South China. Geological Publishing House, Beijing, 190 pp. ISBN 7-116-01151-X/P.972.

This multi-author book on the Permian - Triassic boundary in south China that was first published in Chinese (1991) is now also available in an English edition. The English edition comes in an attractive soft cover and can be ordered from the Geological Publishing House in Beijing. For a review of this volume refer to Albertiana 12 (pp. 57-58).

ANNOTATED TRIASSIC LITERATURE

Hans Kerp and Henk Visscher[1]

ANDERSON, J.M. and ANDERSON, H.M., 1993. Terrestrial flora and fauna of the Gondwana Triassic: Part 1 - Occurrences. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 3-12.

This review of the geographic and stratigraphic distribution of the megaplants, insects and tetrapods of the Gondwana Triassic shows them to have been very variously preserved, sampled and studied. When plotted geographically at degree square resolution and stratigraphically at the resolution of formation, the megaplants show to be clearly the most comprehensively represented: 97 megafloras from 21 basins (84 degree squares) are known; the tetrapods follow with 34 palaeofaunas from 18 basins (43 degree squares); while the insects fall a poor third with only 10 palaeofaunas from 6 basins (16 degree squares). The five Gondwana continents each contribute uniquely to the preserved fossil record: Australia, for instance, furnishes by far the fullest sequence of megafloras, while South Africa and South America yield the richest Lower and Middle to Upper Triassic tetrapod faunas, respectively. Though the current uneven sampling is sufficient to reveal the broad outlines of the coevolution of Gondwana Triassic terrestrial life, sampling and study of a distinct majority of the floras and faunas, most notably the insects, still remains in its infancy. By far the greater part of the potential sample remains to be tapped.

ANDERSON, J.M. and ANDERSON, H.M., 1993. Terrestrial flora and fauna of the Gondwana Triassic: Part 2 - Co-evolution. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 13-25.

Plotting and analysis of available geographic, stratigraphic and abundance data reveals the broad co-evolutionary outlines of Gondwana megaplants, insects and tetrapods through the Triassic. Pivotal is the adaptive radiation of *Dicroidium* and other seed fern genera following the decimation of life towards the close of the Permian. Species of no more than ten genera dominate the known Gondwana Triassic plant communities and define the ecosystems in which the terrestrial invertebrates and vertebrates evolved. The radiation of insects, most emphatically the beetles and cockroaches, was such that by the close of the Triassic most modern orders can be recognized. The beetles rose from obscurity in the late Permian to become the most diverse of 20 orders; and possibly initiated insect pollination. The pattern of adaptive radiations among the tetrapods, particularly the herbivorous cynodonts and rhynochsaur sand the carnivorous/insectivorous archosaurs, parallels that of the plants and insects. The framework of Gondwana terrestrial floral/faunal co-evolution is in place, the details and subtleties await further research.

[1] The help of Dr. Zwier Smeenk (Utrecht), Sabine Gibas, Heike Hageman and Gaby Schwenzien (Münster) and Prof. Anton Ramovš (Ljubljana) in tracing literature is gratefully acknowledged.

Angiolini, L., 1993. Ultrastructure of some Permian and Triassic Spiriferida and Anthyridida (Brachiopoda). Riv. it. Paleont. Strat., 99(3): 283-306.

Twelve species of Permian and Triassic Spiriferida and Athyridida from various localities and formations have been analyzed in order to provide new data on the ultrastructure of these brachiopods. Ultrastructural analysis of the genus *Tetractinella* has provided new elements (e.g. the thickness of the secondary layer, the transverse profile of the secondary layer fibres and their thickness) that enable distinction between the species *T. trigonella* and *T. hexagonalis*. Ultrastructural features, such as the shape and the dimensions of the secondary layer fibres, have also led to the ultrastructural differentiation of three species of the genus *Trigonotreta* (*Trigonotreta*, sp., *T. stokesi* and *T. lyonsensis*). Furthermore the ultrastructure of *Clavigera bisculcata, Elivina tibetana, Spiriferella rajah, Spirelytha petaliformis, Martinia tschernyschewi* and *Mentzelia mentzeli* has been investigated for the first time and new data on *"Retzia" beneckei*, are provided.

Aoudjehane, M., Bouzenoune, A., Rouvier, H. and **Thibieroz, J.**, 1992. Halocinèse et dispositifs d'extrusion de Trias dans l'Atlas saharien oriental (NE Algérien). Géol. Méditerranéenne, XIX(4): 273-287.

Most of the extrusion bodies in the Eastern Saharan Atlas occur in the form of piercing domes constituted by Triassic evaporites. They are elongated for several kilometers from North-East to South-West, and are flanked at their extremities by upturned periclines composed of bioclastic to reefal limestone massifs, which are Aptian-Albian in age. On the lateral flanks of some of these bodies, a steep antiform and an outer synform may be developed, both of which are recumbent upon compressed, pitching beds of Upper Cretaceous age.

Ash, S.R. and **Morales, M.**, 1993. Anisian plants from Arizona: The oldest mesozoic megaflora in North America. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 27-29.

The oldest known Mesozoic flora in North America comes from deposits of the Holbrook Member (early Anisian) of the Early-Middle Triassic Moenkopi Formation Northwest of Winslow, Arizona. The flora helps bridge the large gap that exists in the late Paleozoic-early Mesozoic floral record of North America. It is also significant because the Moenkopi Formation has yielded few identifiable plant fossils in the past.

Baudelot, S., Durand-Delga, M., Esteras, M. and **Freneix, S.**, 1993. Le Trias des 'Tariquides' (arc de Gibraltar), indice d'une zone paléogéographique originale à l'Ouest de la Méditerranée. C.R. Acad. Sci. Paris, 317, Sér. II (12): 1649-1658.

The Triassic of the 'Tariquides', a tectonic unit of the Gibraltar Arc, shows a distinctive development. The succession starts (Los Pastores, near Algeciras) with argillites and bright gypsum, followed by often coloured pelites and sandstones, that are dated by Cordevolian palynomorphs and Late Ladinian-Early Carnian bivalves (mainly Trigoniacea, Myophoriidae). These beds are overlain by light dolomites with pelitic horizons, Julian-Early Tuvalian in age according to palynomorphs, followed by thick late Triassic (?) dolomites (Gibraltar, Jebel Moussa). The Tariquide Triassic domain was probably located between the Subbetic (Germano-Andalusian) realm and the Alpine realm, known from the present Betic-Riffian internal zones.

Below, R., 1993. Peridiniales (Dinophyta) und Acritarchen im Rhät und Lias, Luxemburgs - Palynofazies - Indikatoren für marine Ablagerungsbedingungen. Zitteliana, 20: 9-13.

The palynofacies of Triassic-Jurassic boundary beds from well Mersch F 606 (Luxemburg) is analysed. Within several samples acritarchs as well as dinoflagellate-cysts are present to common. They clearly document the marine influence on sedimentation within the Trier-Luxemburg-Bay. Special attention must find the presence of rich dinoflagellate-cyst-associations in the red(!) sediments of Upper Rhaetian age.

Boni, M., Ianacce, A., Torre, M. and **Zamparelli, V.**, 1994. The Ladinian-Carnian reef facies of Monte Caramolo (Calabria, southern Italy). Facies, 30: 101-118.

In the Triassic of the San Donato Unit (Calabrian Apennines, Italy) a perireefal facies association of limestones and dolomites, hosting a Ladino - (?Carnian) fauna, has been recognized. This facies association is flanked by black, ostracod-bearing, calcareous marbles and evolves to peritidal dolomites, Carnian and possibly Norian in age, characterized by strong synsedimentary tectonics. The San Donato Unit has been strongly affected by alpine tectonics, resulting in pervasive deformation and metamorphic recrystallization (greenschist facies); nevertheless, careful observation on selected outcrops enabled the distinction of the following main facies: (1) sponges-biogenic crusts-cement boundstone, (2) reef debris rudstone, and (3) dasycladacean packstone-grainstone. These three facies types and their fossil content are described in detail. Compared with the reefoidal facies so far described in southern Italy, along the margin of the Lagonegro Basin, the reef facies of Monte Caramolo record a shallower and higher energy depositional environment without silicoclastic input. In fact, the Monte Caramolo reef association shows many affinities with the Wettersteinkalk equivalents occurring in the Northern Calcareous Alps; the Caramolo buildups probably developed as a true ecological barrier between a restricted lagoon and a yet undefined basin.

Boucher, L.D., Taylor, E.L. and **Taylor, T.N.**, 1993. *Dicroidium* from the Triassic of Antarctica. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 39-46.

Late Triassic *Dicroidium* seed fern foliage is described from compressions and impressions collected at Mt. Falla in the Beardmore Glacier region (Falla Formation). Associated floral components include fern and gymnosperm foliage, and several reproductive structures. Morphological and cuticular features among more than 200 *Dicroidium* specimens were compared in order to delimit species. These include: *D. odontopteroides, D. lancifolium* and *D. dubium*. Fronds are pinnate, and many of the specimens illustrate the dichotomously forking rachis. Pinnule shapes vary from ovate to lanceolate and are lobed in one species. Venation patterns include taeniopteroid, odontopteroid, and alethopteroid. Cuticular features are well-preserved in some specimens and show epidermal cell arrangements, surface ornamentation, and stomatal and trichome base arrangement. This is the first description of *Dicroidium* cuticle from Antarctic compressions. The geographic and stratigraphic distribution of *Dicroidium* species from the Triassic of Antarctica is summarized.

Brack, P. and **Rieber, H.**, 1993. Towards a better definition of the Anisian/Ladinian boundary: New biostratigraphic data and correlations of boundary sections from the Southern Alps. Eclogae geol. Helv., 86/2: 415-527.

Stratigraphic sections of basinal "Buchenstein Beds" in the NW Dolomites and eastern Lombardy are correlated on the basis of the distribution of macrofossils (ammonoids, Daonellas) and volcaniclastic layers. In Lombardy, these strata are bracketed by other

Middle Triassic basinal sediments (Prezzo Lst., "Wengen Beds"), and the entire succession hosts a clear macrofossil (ammonoids, Daonellas) record ranging from the late Anisian to the late Ladinian. In the Anisian/Ladinian boundary interval this record appears to be relatively coherent when compared to equivalent standard sections in the western Tethys area. It allows the full integration of rich faunas from isolated localities in coeval platform carbonates (Latemar and Cernera) and intra-platform deposits (Monte San Giorgio). The combined series of fossils includes successive levels with key species of *Judicarites*, *Paraceratites*, *Kellnerites*, *Hungarites*, *Reitziites*, *Parakellnerites*, *Aplococeras*, *Ticinites*, *Halilucites*, *Stoppaniceras*, *Nevadites*, *Chieseiceras*, *Eoprotrachyceras*, *Arpadites* and *Protrachyceras* among other ammonoids and Daonellas. The non-condensed ammonoid succession is suitable for a partial revision of the Tethyan zonal subdivision. It also indicates a slightly, but distinctly diachronous base of the "Buchenstein Beds" or its single members. Thus the original location of the Anisian/Ladinian boundary at the base of the "Buchenstein Beds" (Bittner 1892) is ambiguous. The boundary between the *Nevadites* Zone and the *Curionii* Zone is at present the best constrained alternative. Not only can this marker be pinpointed in stratigraphic columns in the Southern Alps (i.e. the original "type-area" of the stage boundary) but it can also be traced to sections further afield in western Tethys and in North America. Radiometric age data are available on volcaniclastic rocks but do not yet allow a conclusive correlation of the Ladinian Stage with the numerical time-scale. The best estimate at present is from 232-225 Ma. These values are in confict, however, with other current estimates. The recognition of corresponding levels in starved basinal sediments and carbonate platforms with clear large-scale architectures promises a detailed calibration and comparison of the individual platform to basin evolution histories. For the upper Anisian to Ladinian platforms in the western Dolomites our data suggest a period of initially rapid but then decreasing up- and outbuilding at Latemar (*Reitzi/Kellnerites* Zone to *Gredleri* Zone) followed by a short phase of distinct lateral progradation (late stage at Rosengarten). Even higher rates of creation of accommodation space at Cernera in the central Dolomites prevented any significant progradation of this platform before its ultimate drowning close to the Anisian/Ladinian boundary. Based on new fossil collections the generic and specific assignments of several ammonoids and Daonellas are revised in the paleontological part. This includes a description of the new genera *Reitziites* and *Latemarites* and of the new species *Kellnerites bagolinensis* n. sp., *Latemarites latemari* n. sp., *Parakellnerites zoniaensis* n. sp., *Ticinites brescianus* n. sp., *T. dolomiticus* n. sp., *Stoppaniceras evolutum* n. sp., *Nevadites avenonensis* n. sp., *N. bittneri* n. sp., *N. secedensis* n. sp., *N. crassiornatus* n. sp. and *Daonella cerneraensis* n. sp. and *D. sotschiadensis* n. sp.

Brenner, W. and **Foster**, C.B., 1994. Chlorophycean algae from the Triassic of Australia. Rev. Palaeobot. Palynol., 80(3/4): 209-234.

Among living green algae assigned to the order Chlorococcales and order Zygnematales certain species develop resistant outer organic walls and/or cysts during their life cycles; as such they have the potential to become fossils. Based on morphology, comparison between living algae and microfossil remains are made with varying degrees of confidence, and a possible evolutionary pathway for certain chlorococcalean coenobial families is suggested. Twelve genera are reviewed from earliest to latest Triassic palynological assemblages from northwestern Australia; and the following taxa are described as new: *Plaesiodictyon mosellanum* ssp. *symmetricum* ssp. nov.; *Pl. mosellanum* ssp. *variabile* ssp. n.; *Pl. decussatus* sp. n.; *Pl. decussatus* ssp. *decussatus* ssp.n.; *Pl. decussatus* ssp. *tetracornuta* ssp. n.; *Tetraporina protrusa* sp. n.;

Crucigeniella? torques sp. n. and *Paleorhaphidia akestra* gen. et sp. n. Their suggested natural affinities are useful in palaeoenvironmental interpretations of mostly freshwater or low-salinity habitats.

BUCUR, I.I., STRUTINSKI, C. and POP-STRATILA, D., 1994. Middle Triassic carbonate deposits and calcareous algae from the Sasca Zone (southern Carpathians, Romania). Facies, 30: 85-100.

The Sasca zone situated in the innermost part of the Getic Domain of the South Carpathians comprises mainly Triassic deposits of Scythian-Anisian (?Ladinian) that can be ascribed to four different members constituting the Sasca Formation. Three of the members consist of carbonate deposits. Their microfacies types are characterized and the Valea Susara Limestone Member has yielded a relatively rich association of foraminifers and calcareous algae. The assemblage with *Meandrospira dinarica*, *Pilammina densa*, *Oligoporella pilosa* and *Poncetella hexaster* identified in these limestones indicates a middle Anisian age (Pelsonian-lowermost Illyrian).

BUDAI, T., LELKES, G. and PIROS, O., 1993. Evolution of Middle Triassic shallow marine carbonates in the Balaton Highland (Hungary). Acta Geol. Hung., 36: 145-165.

In the Triassic of the Transdanubian Central Range the shallow marine carbonates show a characteristic. The first shallow subtidal carbonates of great areal extension appeared in the Middle Triassic. Well developed "true" platforms with elevated build-ups and steep slopes towards the basins existed only during the Carnian, and they were separated from one another by intrashelf basins filled with clastic sediments. These were the precursors of the huge shallow marine platforms of the Norian-Rhaetian (Hauptdolomite, Dachstein Formation).

BUDAI, T. and VÖRÖS, A., 1993. The Middle Triassic events of the Transdanubian Central Range in the frame of the Alpine evolution. Acta Geol. Hung., 36: 3-13.

The first, Pelsonian facies differentiation in the Transdanubian Central Range coincided with a global sea-level rise but the effects of the local extensional tectonism were decisive. The late Illyrian event (drowning of all carbonate platforms) can be due to sudden tectonic subsidence and to the simultaneous effect of volcanic ash falls. The late Illyrian-early Ladinian rhyolitic-trachytic tuffs are widespread whereas the late Ladinian, intermediate-mafic volcanoclastics seem to be restricted to the eastern part of the TCR. Further evidence, such as distribution of diagnostic facies and paleobiogeography of brachiopods and ammonites strongly suggest that, in the Middle Triassic, the Transdanubian Central Range belonged to the southern shelf of the Meliata ocean in close vicinity of the Southern Alps.

BÜRGIN, T. and FURRER, H., 1993. Kieferreste eines großen Strahlenflossers (Osteichthyes; Actinopterygii) aus der ostalpinen Obertrias der Bergüner Stöcke (Kanton Graubünden, Schweiz) und Diskussion der Validität von *?Birgeria costata* (Münster 1839). Eclogae geol. Helv. 86(3): 1015-1029.

Remains of a remarkably huge fish jaw have been found in the Upper Triassic of Graubünden. Similar fossils are known from Germany, the Great Britain and Italy; they either have been identified as *Saurichthys costatus* Münster 1839, *Bigeria costata* (Münster 1839) and *Saurichthys longidens* Agassiz 1843. In our view, the typical structure and ornamentation of the huge laniaries do not allow a classification into any of the known species of the genera *Saurichthys* or *Birgeria*. Based on the fragmentary nature of the new and the previously described material we renounce erecting a new genus.

Carter, E.S., 1993. Biochronology and paleontology of uppermost Triassic (Rhaetian) radiolarians, Queen Charlotte Islands, British Columbia, Canada. Mémoires de Géologie (Lausanne), 11, 175 pp.

A rich radiolarian fauna from continuous strata of the Sandilands formation (late Norian - Sinemurian), Queen Charlotte Islands provides the basis for new radiolarian zonation for the Rhaetian defined by Unitary Associations (U.A.). The late Norian *Betraccium deweveri* Zone ranges into post-*Monotis* basal strata of the Sandilands formation (late Norian or earliest Rhaetian). Immediately above this zone, three successive radiolarian assemblages occur whose age is correlated with late Triassic ammonoid biochronology of Tozer (1979). Two formal zones are established which allow worldwide correlation of the Rhaetian using radiolarians. The *Proparvicingula moniliformis* Zone contains radiolarians of assemblage 1 and Assemblage 2; it represents the lower Rhaetian and is approximately equivalent to the *Amoenum* Zone. The *Globolaxtorum tozeri* Zone contains radiolarians of Assemblage 3; it represents the upper Rhaetian and is equivalent to the *Crickmayi* Zone. One family, five genera and 63 species are described as new. The new assemblages and zones demonstrate there is good zonation at the end of the Triassic; zonation that can be universally identified; zonation that is clearly separate from any late Norian definition; and zonation that clearly precedes that of earliest Jurassic faunas. This study shows that radiolarians can provide a new and promising biostratigraphic tool that will contribute significantly to a meaningful definition of the Rhaetian.

Cassinis, G., Neri, C. and **Perotti, C.R.**, 1993. The Permian and Permian-Triassic boundary in Eastern Lombardy and western Trentino (Southern Alps, Italy). In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 51-63.

An overview of the structural development and the stratigraphy of the Permian of the Southern Alps. With regard to the P/T boundary, in the whole investigated area the Lower Triassic marine deposits of the Servino-Werfen Formations overlie the continental clastics of the Verrucano Lombardo-Val Gardena Sandstone. These transgressive deposits are represented at the base by "paralic" wavy to flaser bedded siltstones, followed upwards by oolitic dolostones correlatable to the Tesero Horizon (marking the very early Scythian in the Dolomites). Although biostratigraphic control is very poor, we can reasonably state, on the basis of the overall stratigraphic relationships, that the base of the transgressive Scythian deposits is slightly diachronous, younger to the west than to the east, but probably still included in the early Griesbachian.

Clayton, J.L. and **Koncz, I.**, 1994. Petroleum geochemistry of the Zala basin, Hungary. AAPG Bulletin, 78(1): 1-22.

The Zala basin is a subbasin of the Pannonian Basin. Oil and smaller amount of gas are produced from Upper Triassic through Miocene reservoirs. Geochemical studies of oils and rocks in the basin indicate that two, and possibly three, genetic oil types are present. The main source rock is the Upper Triassic (Rhaetian) Kōssen Marl Formation or its stratigraphic equivalent. Oils derived from Triassic source rock are recognisable by their isotopic and biological marker position, and a high content of metals. In other areas of Europe, Upper Triassic source rocks have been correlated with large oil accumulations, or are postulated to be good potential source rocks. Knowledge of the geochemical characteristics of oils derived from these Upper Triassic source rocks and understanding of the source rock distribution and maturation history are important for recognising Triassic oil-source bed relationships and for further exploration in other basins in Hungary and other parts of Europe.

Cornell, W.C. and Tekbali, A.O., 1993. Age and environmental significance of palynomorphs from the Al Aziziyah Formation, Northwestern Libya. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 69-73.

Palynomorphs recovered from the Middle Triassic Al Aziziyah Formation encountered in the Ras Al Tabil borehole, western Libya, are compared with those of the European Alpine and Germanic Triassic assemblages. They include *Samaropollenites speciosus* and *Lunatisporites noviaulensis mollis*, previously reported only from strata above the lower Ladinian. A Late Triassic age is ruled out because palynomorphs which are well documented in strata younger than the Ladinian in Algeria, Tunisia and Libya were not identified. Frequent occurrences of the *Triadospora* complex, as well as *Aratrisporites sp., Kuglerina meieri, Duplicisporites granulatus, D. verrucosus, Zonalasporites cinctus* and *Palaeospongisporis europaeus*, and the absence of typical late Anisian elements, indicate a late Ladinian age. The absence of microplankton and the prevalence of bisaccate pollen and pteridophytic spores in the Al Aziziyah Formation indicate a terrestrial depositional setting.

Cornet, B., 1993. Applications and limitations of palynology in age, climatic, and paleoenvironmental analyzes of Triassic sequences in North America. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 75-93.

The palynostratigraphy of the Newark Supergroup basins of Eastern North America, particularly for the Newark, Gettysburg, Richmond, and Taylorsville basins, is presented and compared to that of the Chinle Formation and Dockum Group of Arizona and Texas. Seven palynofloral zones are recognized in the Newark Supergroup ranging in age from early Carnian to Pliensbachian? Three zones ranging in age from middle Carnian to early Norian are recognized in the Chinle Formation, but only the older two zones are recognized in the Dockum Group. New well data from the Richmond and Taylorsville basins allow the recognition of the *Aratrisporites* last acme zone, the oldest Carnian palynoflora, as well as the discovery of a Dockum-Chinle palynofacies (late Carnian) within those basins. Evidence is presented for the existence of major climatic and floral cycles on the order of two million years duration. The applications and limitations of taxonomic distribution versus palynofacies succession in age determination and correlation of nonmarine Triassic successions are addressed.

Cornet, B., 1993. Dicot-leaf and flowers from the Late Triassic tropical Newark Supergroup rift zine, U.S.A., Modern Geology, 19: 81-99.

Pannaulika traissica Cronet n. gen. et sp., a dicot-leaf, is described from late Carnian lacustrine black shales of the Dan River/Danville Basin of North Carolina and Virginia. Associated bicarpellate receptacle, achene, and multicarpellate spike are also described. A probable anthophyte affinity is based on comparisons with living and/or extinct ferns, pteridosperms, and anthophytes. It is considered to have had an upland tropical origin.

Cuny, G., 1993. Discovery of mammals in the Upper Triassic of the Jura (France). In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 95-99.

A tooth of *Thomasia* group 2 (Mammalia, Haramiyidae) and a upper premolariform of a Kuehneotheriidae (?) (Mammalia) from the Rhaetian of the French Jura are described. Stratigraphical implications of this discovery are discussed.

DeFauw, S.L., 1993. The Pangaean dicynodont *Rechnisaurus* from the Triassic of Argentina. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 101-105.

A large dicynodont facial fragment, recovered from the lower Puesto Viejo Formation of Argentina, is found to belong to the genus *Rechnisaurus*. Two additional specimens (a very large snout fragment and an associated collection of smaller skull pieces, including a left maxilla) are tentatively referred to this genus as well. The correlation of the "Agua de los Burros local fauna" with the *Lystrosaurus* zone fauna is not tenable; the former assemblage is probably significantly younger. Considering, the widerspread occurrence of *Rechnisaurus* in Anisian age deposits of India, East Africa (Tanzania), N. China, Inner Mongolia and now Argentina, it is a viable candidate for defining a Pangaean biochron.

Deroin, J.-P. and Prost, A.E., 1993. Déformation tardi-hercynienne du batholite de Villefort (Mont Lozère et Massif de la Borne). Ses rapports avec les sédiments permiens du Pont-de-Montvert (Cévennes, Sud-Est du Massif central). Géol. France, 2: 23-30.

In the area of the Mont Lozère and Borne, the detailed field analysis allows to establish the chronology of the Late Hercynian deformation. Before the Late Hercynian strike-slip faulting along the Villefort Fault the two batholithes dated from 305 to 290 Ma formed the so-called Villefort batholith. The geological mapping, the sedimentological study, and the structural study of the arkosic deposits of the Pont-de-Montvert Basin show that this basin is Lower Permian (Autunian) in age. These arkosic deposits take place in post-collision detrital processes beginning in the Stephanian with coarse conglomerates, continuing during Permian times with arkosic or debrisflow deposits, and ending in Triassic with finer arkoses and sandstones initiating the Mesozoic series of the South-East French Basin. We emphasize the existence of an Upper Palaeozoic palaeosurface, quite distinct from the Triassic palaeosurface. The tectonomagmatic evolution of the Cévennes is finally discussed.

Dobruskina, I., 1993. Relationships in floral and faunal evolution during the transition from the Paleozoic to the Mesozoic. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 107-112.

An overview of the floral development in the Permian and Triassic in Siberia, the European-Sinian Area and Gondwana. Late Permian and Triassic floras have common features with Palaeophytic as well as with Mesophytic floras and are regarded as transitional.

Dobruskina, I., 1993. The first data on the Seefeld conifer flora (Upper Triassic; Tirol, Austria). In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 113-115.

A short note on the Seefeld flora which is the the only well-dated middle Norian flora from Eurasia and consists for 90% of conifers. A few remarks are made on the palaeogeography and palaeoecology.

Dosztály, L., 1993. The Anisian/Ladinian and Ladinian/Carnian boundaries in the Balaton Highland based on Radiolarians. Acta Geol. Hung., 36: 59-72.

In the Balaton Highland radiolarians were found from the Illyrian to the Julian sub-stages. Volcanism during Ladinian provided favourable conditions for radiolarians, and therefore these fossils are often found in large numbers. The rich fauna allows a detailed biostratigraphic classification (in some cases this is only possible with radiolaria). Complex biostratigraphic investigations (on ammonites, conodonta, radiolaria) carried out in the Balaton Highland allowed the establishment of a radiolaria zonation. The radiolaria zonation could be correlated with the ammonite and conodont zonations. Stage boundaries coincide with zone boundaries.

DUBIEL, R.F., 1993. Depositional setting of the Owl Rock Member of the Upper Triassic Chinle Formation, Petrified Forest National Park and Vicinity, Arizona. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 117-121.

Sedimentologic research on the Owl Rock Member of the Upper Triassic Chinle Formation has identified lacustrine and lacustrine-margin deposits along Chinle Mesa and Pilot Rock in the northern part of Petrified Forest National Park. The Owl Rock in the Park is the southern extension of a lacustrine system in the Chinle that was centred about the Four Corners area of the Colorado Plateau. Gastropods at the base of the Owl Rock at three localities attest to the original lacustrine setting for some of the beds, however, many of the strata were subsequently altered by pedogenesis under drier conditions and lowered lake levels that subaerially exposed the strata.

ERWIN, D.H., 1994. The Permo-Triassic extinction. Nature, 367: 231-236.

The end-Permian mass extinction brought the Palaeozoic great experiment in marine life to a close during an interval of intense climatic, tectonic and geochemical change. Improved knowledge of latest Permian faunas, coupled with recent advances in isotopic studies and biostratigraphy, have greatly enhanced our understanding of the events of 250 million years ago and have begun to provide answers to many questions about the causes of extinction.

ETTER, W., 1994. A new penaeid shrimp (*Antrimpos mirigiolensis* n. sp., Crustaceae, Decapoda) from the Middle Triassic of the Monte San Giorgio (Ticino, Switzerland). N. Jb. Geol. Paläont. Mh., 1994 (4): 223-230.

A new penaeid shrimp, *Antrimpos mirigiolensis* n. sp., is described from the Middle Triassic Grenzbitumenzone of the Monte San Giorgio, Canton Ticino, Switzerland. This "Fossil-Lagerstätte" has yielded an exceptional fish and reptile fauna together with some invertebrate species of which most are considered nektonic or pseudoplanktonic. It is concluded that the newly described specimen is not autochthonous but has been washed into the sedimentary basin from a near-shore environment.

FARLOW, J.O. and LOCKLEY, M.G., 1993. An osteometric approach to the identification of the makers of Early Mesozoic tridactyl dinosaur footprints. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 123-131.

Employing dinosaur footprints for paleoecological purposes, such as making interpretations of the composition of dinosaur faunas obviously depends on accurate identifications of trackmakers. The authors describe a method that attempts to identify trackmakers by comparing phalangeal length ratios estimated from tracks with comparable ratios measured from skeletal material.

FLÜGEL, E. and HAGDORN, H., 1993. Dasycladaceen aus dem Oberen Muschelkalk (Mitteltrias) des Hohenloher Landes, Süddeutschland. Zitteliana, 20: 93-103.

There are only few reports on Triassic dasycladacean green algae from the non-Tethyan marginal-marine environments of the Muschelkalk until now (Upper Silesia, Lotharingia, Black Forest area). A monospecific florula consisting of *Griphoporella künzelsauensis* n. sp. is described from a small pelecypod/crinoid bioherm within the

Upper Trochiten Kalk of northern Württemberg, southwest Germany. Litho- and biostratigraphical data indicate a Late Anisian age not only for the Künzelsau dasycladacean flora but also for the other dasycladacean localities known from the Upper Muschelkalk.

FRÉCHENGUES, M., PEYBERNÈS, B., MARTINI, R. and ZANIETTI, L., 1993. Ladinian-Carnian benthonic foraminifera from the "Muschelkalk" of the French and Spanish Pyrenees to the East of the Garonne. Revue de Micropaléontologie, 36(2): 111-120. (in French with English abstract)

The carbonate Transgressive Systems Tracts included within the two depositional sequences from the "Muschelkalk" of the Pyrenees (DS_{237}, Late Anisian - Early Ladinian and DS_{232}, Late Ladinian - Carnian *pro parte*) contain assemblages of alpine-type benthonic foraminifera and palynomorphs. The first sequence is pointed by the local presence of *Meandrospira* gr. *pusilla-dinarica* which was only recognized in the Spanish Pyrenees, not studied herein. The second one includes a diversified microfauna which is relatively constant along the totality of the range, Spanish Pyrenees included. The corresponding assemblage, illustrated for the first time in this part of the Pyrenees to the East of the Garonne, is characterized by numerous Involutinacea (*Aulotortus praegaschei, Triadodiscus eomesozoicus* and *Lamelliconus multispirus*) and also by Endothyridae (*Endothyranella wirzi*), Duostominidae and Glomospirillinae. This assemblage is similar to the synchronous one which was recently quoted in the Catalonian Pyrenees, Balearic Islands (Minorca) and Corsica.

FRISIA, S. and WENK, H.-R., 1993. TEM and AEM study of pervasive, multi-step dolomization of the Upper Triassic Dolomia Principale (Northern Italy). J. Sediment. Petrol., 63(6): 1049-1058.

Microstructures, textures, and composition of dolomites from different facies and stratigraphic level of a carbonate platform sequence 1000-2000 m thick in the Brenta Dolomites and Eastern Lombardy (Italy) are interrelated. Mimetic, unimodal (4 μm), planar-e dolomite and polymodal (20-200 μm), planar-s to nonplanar matrix dolomite show calcian and stoichiometric areas in the same crystals. Ca-rich areas (53-56 mole % Ca) have pervasive modulated microstructure. As stoichiometric composition is approached (51-52 mole % Ca), modulations are coarser and less pervasive. Stoichiometric zones show few dislocations. Dolomites with excess calcium and modulated microstructures appear to have positive $\delta^{18}O$ values. Matrix dolomite crystals with more abundant slightly calcian and stoichiometric areas have negative $\delta^{18}O$ values. Void-filling dolomites are stoichiometric and contain only a few dislocations. The onset of solid-state diffusion is recorded in some void-filling dolomites formed at temperatures above 60°C. Regionally extensive dolomitization was almost completed by the end of the Triassic. Late hydrothermal dolomitization did not cause neomorphism of early replacive dolomites.

GALL, J.-C. and GRAUVOGEL-STAMM, L., 1993. Paleoecology of terrestrial ecosystems from the Buntsandstein (Lower Triassic) of Eastern France. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 141-146.

Remarkable fossiliferous localities occur in the Grès à Voltzia of the Vosges (Eastern France) that belong to the Buntsandstein or Lower Triassic of the German basin but of which the age is Anisian. Three facies have been recognized in the Grès à Voltzia: (a) thick sandstone lenses containing land plant debris and stegocephalian bone fragments; (b) silt/clay lenses with well preserved fossils of aquatic and terrestrial organisms including medusoids, annelids, *Lingula*, bivalves, limulids, crustaceans and fish, as well as spiders, scorpions, myriapods, insects, land plants (lycopods, sphenophytes, gymnosperms) and tracks of reptiles; and (c) calcareous sandstone with a sparse marine fauna. Evidence from the sediments and fossils points to a deltaic sedimentary environment. Facies 1 corresponds to point bars deposited in strongly sinuous channels; facies 2 represents the settling of fine material in brackish ponds from the overbank plain; facies 3 results from brief inclusions of sea water during storms. The paleogeographical position of the Grès à Voltzia delta was near the Eastern edge of Pangea. Comparison of the Grès à Voltzia biota with examples from the Carboniferous shows that most groups of the fauna occurring in the transitional environments of the Triassic has been little affected by the Permian extinctions.

GAUFFRE, F.-X., 1993. Biochronostratigraphy of the Lower Elliot Formation (southern Africa) and preliminary results on the Maphutseng Dinosaur (Saurischia: Prosauropoda) from the same formation of Lesotho. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 147-149.

The analysis of part of the material, coming from the rich Maphutseng outcrop, Upper Triassic of Leshoto, yields the following results: it is a typical prosauropod dinosaur showing none of the characteristics leading towards the sauropod line. On the basis of the *Euskelosaurus* diagnosis (Van Heerden 1979), it seems that Maphutseng specimens are consistent with the attribution to this genus. These fossils permit knowledge of almost all of the skeleton. The phylogenetic position of *Euskelosaurus* within the Plateosauridae (Galton 1990) is temporarily confirmed, but remains uncertain within this family. On the presence of a typical faunal assemblage of Traversodontidae and Rauisuchidae (Shubin and Sues 1991), the Lower Elliot Formation is considered to be Carnian age, maybe even early Carnian.

GAUFFRE, F.-X., 1993. The prosauropod dinosaur *Azendohsaurus laaroussii* from the Upper Triassic of Morocco. Palaeontology, 36(4): 897-908.

Azendohsaurus laaroussii was described by Dutuit as an ornithischian dinosaur on the basis of a dentary fragment and two isolated teeth from the Upper Triassic Argana Formation of Morocco. It was subsequently suggested to be a mixture of ornithischian and saurischian remains. Study of further material demonstrates that all the *A. laaroussii* material represents a single valid taxon within the Prosauropoda. However, there is insufficient taxonomic information to place it more precisely and it is considered as Prosauropoda *incertae sedis*. *A. laaroussii* derives from the *Paleorhinus* biochron and is hence Carnian in age and one of the earliest known dinosaurs. Some apomorphic characters attributed to the Ornithischia by Sereno and to the Sauropodomorpha by Gauthier are shown to be invalid. A new synapomorphy of the Prosauropoda is proposed, based on the construction of the maxillary.

GAWLICK, H.-J., 1993. Triassische Tiefwasserfazieskomponenten (Kieselkalke, Radiolarite) in der jurassischen Strubbergbrekzie am Tennengebirgsnordrand (Nördliche Kalkalpen, Österreich). Jb. Geol. B.-A., 136(2): 347-350.

At the northern edge of the Tyrolian Tennengebirge in the southern Salzburg area occur Triassic deepwater pebbles in Jurassic mass flows (Strubbergbreccie), proved by fragments of conodonts. The pebbles are comparable with the Triassic deepwater facies described by MANDL & ONDREJIČKOVA (1991), MANDL (1992) and KOZUR & MOSTLER (1991/1992). So the Meliaticum, known from the Western Carpathians, is identified as far as the Hallstatt facies-zone in the Northern Calcareous Alps.

Gawlick, H.-J. and Königshof, P., 1993. Diagenese, niedrig- und mittelgradige Metamorphose in den südlichen Salzburger Kalkalpen - Paläotemperaturabschätzung auf der Grundlage von Conodont-Color-Alteration-Index-(CAI)Daten. Jb. Geol. B.-A., 136(1): 39-48.

The thermal maturity of the southern Salzburg area between Golling and Annaberg was estimated by using the Conodont Colour Alteration Index (CAI). These data indicate increasing thermal maturity from the diagenesis in the North to epimetamorphic conditions in the South. More than 500 conodont samples are used for estimation of regional thermal patterns. The observed CAI values of conodonts are in general agreement with illite-crystallinity data. It is possible to verify diagenetic and metamorphic conditions, especially within tethyan pelagically influenced carbonate rocks at the southern rim of the northern Calcareous Alps. The coherence of early Upper Jurassic gravitational tectonics and Lower Cretaceous metamorphism are discussed on the base of geochronological data, detailed stratigraphic analysis, facies characteristics and stratigraphic evidence.

Góczán, F. and Oravecz-Scheffer, A., 1993. The Anisian/Ladinian boundary in the Transdanubian Central Range based on palynomorphs and foraminifers. Acta Geol. Hung., 36: 73-143.

Based on palynostratigraphic and foraminifer studies of Middle Triassic sections of the Balaton Highland and the Bakony Mountains a proposal is made to draw the parachronostratigraphic boundary between the Anisian and Ladinian. The proposal is based on the changes recognized in the sporomorph and foraminifer associations in the boundary beds of the Felsőörs Limestone Formation and Tagyon Limestone Formation and the Buchenstein Formation. These can be seen in the predominance relations and in the joint appearance of new genera and species. The suggested boundary almost coincides with the lower boundary of the *Xenoprotrachyceras reitzi* biozone s.l. in the classical sense.

Gomez-Gras, D., 1993. El Permotrías de la Cordillera Costero Catalana: Facies y petrología sedimentaria (Parte I). Bol. Geol. Min., 102(2): 115-161.

The facies and sedimentary petrology of the Permotriassic sediments outcropping in the Catalan Coastal Ranges are analyzed. The studied area has been divided into four zones.

Gomez-Gras, D., 1993. El Permotrias de las Balearas y de la vertiente mediterránea de la Cordillera Ibérica y del Maestrat: facies y petrología sedimentaria (Parte II). Bol. Géol. Min., 104-5: 467-515.

A petrological and facies study of the Permotriassic sediments outcropping in the Balearic ISlands and the Iberian Ranges. Four zones are recognized. The author presents a synthesis of the half-grabens in this part of the western Mediterranean and their genesis and histroy are discussed.

Good, S.C., 1993. Stratigraphic distribution of the mollusc fauna of the Chinle Formation and molluscan biostratigraphic zonation. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 155-159.

Nonmarine molluscs (unionacean bivalves and prosobranch gastropods) are broadly distributed both spatially and temporally throughout the Late Triassic Chinle, Dolores and Dockum basins of the American Southwest. Comprehensive systematic revision has been synthesized with a robust stratigraphic and geographic database of mollusc localities to produce biostratigraphic zonations. Applications of these zonations provide enhanced correlations within and between these basins. Two distinct localities of unionacean bivalves are recognized from the Monitor Butte Member, but are not sufficiently common or widespread for recognition as a molluscan biozone. Two molluscan biostratigraphic zones are recognized: the *Antediplodon graciliratus* biozone (earliest Norian) that occurs in the lower Petrified Forest Member, defined as the strata above the Moss Back Sandstone in the Fry Canyon area, Utah, and above the Sonsela Sandstone in Arizona; and the *A. thomasi* biozone (early Norian) that occurs in the upper part of the Petrified Forest Member. Many molluscan species are shared between these two zones, but they are distinguished by the mutual exclusion of the species for which the zones are named. The *A. graciliratus* biozone is dominated by fast velocity unionacean functional morphotypes, and only two species of *Lioplacodes* gastropods. The *A. thomasi* biozone is dominated by low velocity unionacean functional morphotypes, and a more diverse gastropod fauna that consists of *Ampullaria gregoryi* and four species of *Lioplacodes*. The molluscan fauna is reduced in the Owl Rock Member with regard to unionaceans; however, the prosobranch gastropods maintain the same diversity as in the underlying *A. thomasi* biozone. The lack of taxonomic distinctness prohibits identification of an Owl Rock Member molluscan biozone.

Gow, C.E. and Hancox, P.J., 1993. First complete skull of the Late Triassic *Scalenodontoides* (Reptilia cynodontia) from Southern Africa. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 161-168.

The first almost complete skull of the large traversodontid cynodont *Scalenodontoides macrodontes* from the lowermost Elliot Formation (Upper Triassic) of southern Africa is described. This taxon has previously been known only from a snout and jaw fragments. The North American species *S. plemmyridon* is known only from partial lower jaws and teeth. Maxillary postcanines have until now remained unknown, though presumed similar to those of the related and better known *Exaeretodon* of South America and India. The new skull is indeed similar to that of *Exaeretodon*, except for a transverse parietal platform capping the occiput, which is unique among Cynodontia. The well preserved braincase is very similar to that of *Diademodon* and thus more plesiomorphic than in stratigraphically older traversodontids.

Gradziski, R. and Uchman, A., 1994. Trace fossils from interdune deposits - an example from the Lower Triassic aeolian Tumlin Sandstone, central Poland. Palaeogeogr. Palaeoclimat. Palaeoecol., 108(1-2): 121-138.

The Tumlin Sandstone, up to 105 m thick, is the deposit of a extensive (at least 1500 km^2) midcontinent, dune field. It consists of dune deposits and of subordinate intercalations of interdune deposits. The latter are represented by horizontally bedded sandstone accumulated in frequently changing conditions: on dry, damp, and wet surface. Dry-surface deposits predominate. Subordinate but relatively common are damp-surface deposits with characteristic adhesion structures, and wet-surface deposits represented by very thin mudstone layers and horizons of wave-ripples, which originated in ephemeral ponds. The interdune deposits contain numerous trace fossils whose occurrence is almost entirely connected with wet-surface and damp-surface deposits. The dune deposits are devoid of trace fossils. The following forms have been recognized: *?Arenicolites* isp., *Cruziana problematica, Diplocraterion* isp., *Gordia marina, Planolites montanus, Planolites* isp., *Palaeophycus ?tubularis,* tetrapod footprints, radial structures, shallow double furrows, and various oval depressions. In places, intensive but shallow bioturbation of sediment is observable. The trace fossil assemblage is similar to the *Scoyenia* ichnofacies but lacks *Scoyenia* and *Ancorichnus*. The assemblage is more comparable to the mixed *Arenicolites-Cruziana* ichnofacies *sensu* Bromley and Asgaard (1979). The invertebrate burrows show an *r*-selected strategy in sediment colonization. Around the Palaeozoic/Mesozoic transition the highly diversified ichnofauna compared to the Permian interdune deposits show increased colonisation of interdunes by an invertebrate, mainly arthropod, fauna.

GUBIN, Y.M. and SINITZA, S.M., 1993. Triassic terrestrial tetrapods of Mongolia and the geological structure of the Sain-Sar-Bulak locality. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 169-170.

A brief note on the first discovery of reptiles (*Lystrosaurus hedeni*) in pre-Jurassic deposits of Mongolia.

HAMLEY, T. and THULBORN, T., 1993. Temporal fenestration in the primitive Triassic reptile *Procolophon*. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 171-174.

This paper reports the presence of a lower temporal opening in some examples of *Procolophon*, a well-known "parareptile" (primitive amniote of uncertain affinities) from the Lower Triassic of South Africa. This important anatomical feature was first discovered by H.G. Seeley in 1889, but its existence has been overlooked or denied in all studies of amniote phyiogeny for the past 90 years. The temporal opening is confined to the species *Procolophon laticeps*, which also appears to differ from the type species *P. trigoniceps* in at least four other aspects of cranial anatomy. Lower temporal openings originated so frequently among early amniotes as to be unreliable indicators of phylogenetic affinity, and they should no longer be used to define the amniote subclasses Diapsida and Synapsida.

HASIOTIS, S.T. and DUBIEL, R.F., 1993. Continental trace fossils of the Upper Triassic Chinle Formation, Petrified Forest National Park, Arizona. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 175-178.

A preliminary report of the continental trace fossils from the Petrified Forest and Owl Rock Members of the Upper Triassic Chinle Formation in Petrified Forest National Park (PFNP) are presented in abbreviated descriptions and discussions. Information in this report is part of an on-going study of the biodiversity of the ichnofauna and flora within the Park. Traces of organisms living in fluvial, marginal fluvial and lacustrine, and floodplain environments include beetles, termites, soil arthropods, horseshoe crabs and crayfish. Each trace represents specific behaviors not preserved by body fossils and contains important paleoenvironmental information.

HAUNSCHILD, H., 1993. Stratigraphische Ergebnisse der Kernbohrung Oberbreitenau, SE'Rothenburg o.d. T.. Geol. Bl. NO-Bayern, 43(4): 349-368.

Schilfsandstein with some coals and Estherien-Schichten haven have been cored in the well Oberbreitenau. The lithology and sedimentology are described and discussed. Marker beds allow a differentiation of the Estherien Schichten into three units. Geochemical data are presented in two tables.

HEITELE, H., 1993. Das Buntsandsteinprofil bei Landstuhl und seine Gliederung in Grundwasserstockwerke. Mainzer geowiss. Mitt., 22: 39-56.

The lithostratigraphy of the Buntsandstein (Bunter) near Landstuhl in the northern part of the Palatine Syncline is shortly described. The vertical succession of aquifers is presented.

Henrichs, C., 1993. Sedimentpetrographische Untersuchungen zur Hochdiagenese in der Kössen-Formation (Obere Trias) der westlichen Ostalpen und angrenzender Südalpengebiete. Bochumer geol. u. geotechn. Arb., 40: 206 pp.

Pre-orogenic heath (subsidence diagenesis) and an eo-alpine metamorphosis are in the Kössen Formation evidenced by changes of clay minerals and coalification of dispersed organic matter. Diagenesis trends and relationships of the individual parameters are studied sediment petrographically.

Herbst, R., 1993. Dipteridaceae (Filicales) del Triasico del Arroyo Llantenes (Provincia de Mendoza) y de Paso Flores (Provincia del Neuquen), Argentina. Ameghiniana, 30: 155-162.

The Dipteridaceae ferns *Dictyophyllum (Thaumatopteris) tenuiserratum* (Menéndez) com. nov. et emend. and *Dictyophyllum (Thaumatopteris) chihuiuensis* (Menéndez) nov. comb. from the late Middle Triassic of Arroyo Llantenes (Mendoza Province) are redescribed. A new species of *Goeppertella, G. stipanicicii* from the Upper Triassic of Paso Flores (Neuquen Province) is also described.

Hibsch, C., Cushing, E.M., Cabrera, J., Mercier, J., Prasil, P. and **Jarrige, J.-J.**, 1993. Évolution des paléo-contraintes en Grande-Bretagne du Permien au Cénozoïque: approche géodynamique de l'évolution des bassins méridionaux du Royaume Uni. Bull. Centres Rech. Explor.-Prod. Elf Aquitaine, 17(2): 303-330.

A microtectonic study of middle and northern England and southern Wales allows the recognition of several tectonic phases from the Permian to the Cenozoic. A correlation with the tectonic evolution of offshore basins is presented. The fives phases include a Permian to lowermost Triassic phase that is characterised by a NNW-SSE extension and an E-W to ENE-WSW extension during the Triassic-Malm with synsedimentary faults in the Keuper, Lias and middle Dogger.

Holz, M. and **Barberena, M.C.**, 1994. Taphonomy of the south Brazilian Triassic paleoherpetofauna: pattern of death, transport and burial. Palaeogeogr., Palaeoclim., Palaeoecol., 107: 179-197.

Taphonomic aspects of the paleoherpetofauna of the Santa Maria and Caturrita Formations (Triassic of southern Brazil) are for the first time specifically dealt with. A total of 1096 specimens, from articulated skeletons to reworked and isolated bone fragments were studied. the four major reptilian groups of the paleoherpetofauna (cynodonts, dicynodonts, thecodonts and rhynosaurs) from three distinct *local faunas*. Preservation of bones and their spatial distribution were analyzed, allowing the establishment of four *taphonomic classes*: (I) relatively articulated skeletons; (II) articulated bones; (III) isolated well-preserved bones; (IV) isolated fragmented bones. The numerical sequence of classes reflects the increasing disorganization of the skeletal material; the higher the class number, the more complex is the taphonomic story to be investigated. Class I is composed of transported and rapidly buried carcasses, under the influence of catastrophic events; on the other extreme, fragmented pieces from Class IV represent elements exposed for a long time to the influence of weathering, trampling and scavenger activity. The study of selective transport (*Voorhies's Groups*) of bone elements from dicynodonts and rhynosaurs (the most representative groups of the Triassic herpetofauna) revealed that hydraulic selection by moving water was not important as a factor of disarticulation and scattering, although it did occur at some sites. The computation of the fossil recovery rate showed that, in a general way, the preservation is low and that there is a bias favouring skulls (over-represented in the collection) and vertebrate (under-represented).

The analysis of size classes of the Triassic reptilian remains (taken as analogues to age classes) showed a distribution very similar to that exhibited by living communities, indicating that small (= young), intermediate and large (= old) individuals were buried together in proportions aproximating the distribution pattern in living populations. This is taken as an evidence of catastrophic rather than attritional death. By bringing together all the stratigraphic, paleontological and taphonomic data, the reconstruction of the taphonomic history was possible. This model postulates a multi-episodic history of catastrophic death and rapid burial of complete carcasses caused by periodic floods, which alternated with periods of exposure of bone elements and little or no burial, indicating that large amounts of water in the depositional system alternated with periods of low water level or even dryness.

Huber, P., Lucas, S.G. and Hunt, A.P., 1993. Revised age and correlation of the Upper Triassic Chatham Group (Deep River basin, Newark Supergroup), North Carolina. Southeastern Geol., 33(4): 171-193.

The Chatham Group of east-central North Carolina is exposed in a series of connected synrift basins collectively termed the Deep River basin. While a considerable flora and fauna clearly establish a Late Triassic age for these strata, age assignments at the stage level have ranged from early Carnian to Rhaetian. Recent studies combining palynomorphs, megafossil plants, fossil fishes, tetrapods and vertebrate ichnotaxa have reportedly developed a refined biostratigraphy for the Chatham Group, and recognize an early Carnian through early Norian? age for these strata. We are able to correlate tetrapods from the Chatham Group with similar faunas from the lower Chinle Group of the western United States and the Gettysburg-Newark basin of Pennsylvania and New Jersey. The oldest Chatham Group tetrapod fauna includes the aetosaur *Longosuchus meadei* and the dicynodont *Placerias hesternus*, which co-occur in the basal Chinle Group. This fauna is from the middle Pekin Formation and belongs to the *Paleorhinus* Biochron of Late Carnian (early Tuvalian) age. The phytosaur *Rutiodon* is common to the Cumnock Formation, formations of the lower Chinle Group, and the middle New Oxford, upper Stockton and possibly Lockatong Formations of the Gettysburg-Newark basin. Other taxa that occur in this interval include large metoposaurids (*Buettneria*), the aetosaur *Desmatosuchus*, and a diversity of ornithischian dinosaurs, all of which occur in two or more of the regions under consideration. These strata belong to the *Rutiodon* Biochron and are of Late Carnian (late Tuvalian) age. The aetosaur *Stegomus* has been found in the unnamed Sanford Formation equivalent in the Durham sub-basin, the lower Passaic Formation in the Newark Basin and the middle New Haven Arkose of the Hartford basin. These formations are in part, correlatives and are assigned to the *Stegomus* Faunachron. This review of Chatham Group tetrapods permits geographic extension of the Chinle Group provincial tetrapod biochronology to basins of the Newark Supergroup facilities direct stratigraphic correlations between these regions. The revised age determinations further suggest that palynostratigraphic correlations of the Newark Supergroup basins are not as accurate as previously believed.

Huber, P., Lucas, S.G. and Hunt, A.P., 1993. Late Triassic fish assemblages of the North American western Interior. In: M. Morales (ed.), Aspects of Mesozoic Geology and Paleontology of the Colorado Plateau, Mus. North. Arizona, 59: 51-66.

Fossil-fish-bearing, Upper Triassic (Carnian-Norian) strata of the Chinle Group are widely exposed in the North American western Interior. Newly collected specimens and refinement of regional stratigraphic correlations allow a greater understanding of the distribution of fossil fish in these sediments. One Carnian and two Norian fish assemblages may be recognized: (1) a late Carnian assemblage with cf. *Turseodus, Tanaocrossus sp., Cionichthys greeni,* representatives of the *Synorichthys-Lasalichthys* complex, indeterminate perleidids, cf. *Hemicalypterus, Chinlea sp., Arganodus sp., Xenacanthus moorei,* and *Lissodus humblei*; (2) an early-middle Norian assemblage consisting of cf. *Turseodus, Tanaocrossus sp.,* indeterminate redfieldiids and perleidids, *Semionotus* cf. *S. brauni, Chinlea n. sp.* and *C.* sp., *Arganodus* and *Acrodus* and (3) a late Norian assemblage with *Turseodus dolorensis, Tanaocrossus kalliokoski, Cionichthys dunklei, Synorichthys stewarti, Lasalichthys hillsi,* indeterminate perleidids, *Semionotus* sp., *Hemicalypterus weiri, Chinlea sorenseni, Arganodus* sp., and *Lissodus* n. sp. Assemblage (1) occurs in the Blue Mesa Member of the Petrified Forest, the Monitor Butte and the Bluewater Creek formations; Popo Agie Formation; Los Esteros Member of the Santa Rosa Formation; and the Garita Creek and Tecovas formations. Assemblage (2) is found within the Sonsela and Painted Desert members of the Petrified Forest Formation and the Owl Rock Formation; Trujillo and Bull Canyon formations; and assemblage (3) is restricted to the Rock Point, Redonda, Travesser, and Sloan Canyon formations. Our interpretation of this distributional pattern suggests that of the actinopterygians, the redfieldiid community is relatively stable through the Carnian-Norian, and *Semionotus* first appears in the early Norian. Contrary to some workers (e.g., Murry 1986), *Turseodus* is not an indicator of Carnian-age strata as the type of *T. dolorensis* is from late Norian Rock Point Formation. *Chinlea* and *Arganodus* are found at nearly all stratigraphic levels, but the new species of *Chinlea* (based on basisphenoid morphology) is found only in the Bull Canyon Formation (Eastern New Mexico). The Carnian xenacanthid-hybodont community is entirely replaced by hybodonts in the Norian.

Huber, P., Lucas, S.G. and **Hunt, A.P.**, 1993. Vertebrate biochronology of the Newark Supergroup Triassic, North America. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 179-186.

Five vertebrate fossil assemblages have time-stratigraphic significance and corresponding land-vertebrate faunachrons (lvfs) are defined, i.e. Economian (Anisan), Sanfordian (Ladinian-early Tuvalian), Conewagian (late Tuvalian), Neshanician (early-middle Norian) and Cliftonian (late Norian-Rhaetian). Biochronology of the Newark Supergroup vertebrate succession is correlated with Chinle Group of the western U.S.

Hunt, A.P., Lockley, M.G., Conrad, K.L., Paquette, M. and **Chure, D.J.**, 1993. Late Triassic vertebrates from the Dinosaur National Monument area (Utah, USA) with an example of the utility of coprolites for correlation. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 197-198.

The Chinle Group in northeastern Utah and northwestern Colorado has yielded a limited vertebrate body-fossil fauna. The Popo Agie fauna includes a large metoposaurid and a phytosaur. The Bell Springs Formation fauna includes a coelacanth, ?two other osteichthyans and a phytosaur. The upper Bell Springs and Sips Creek Formations contain a coprolite-rich horizon which can be correlated throughout this region.

Hunt, A.P., Lockley, M.G. and **Lucas, S.G.**, 1993. Vertebrate and invertebrate trackways from Upper Triassic strata of the Tucumcari basin, east-central New Mexico, USA. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 199-201.

The Tucumari basin of east-central New Mexico contains the best sequences of superposed ichnofaunas in the Chinle Group (Upper Triassic) of western North America. The Los Esteros Member of the Santa Rosa Formation (late Carnian) contains *Kouphichnium* sp. and *Acripes triassicus*. The Bull Canyon Formation (early-middle Norian) ichnofauna includes *Acripes triassicus* and *Barrancapus cresapi* (ichnogen. et sp. nov.). The Redonda Formation ((Rhaetian) has the most diverse vertebrate fauna which consists of *Grallator* sp., *Pseudotetrasauropus* sp. and *Brachychirotherium* sp.

Hunt, A.P. and Lucas, S.G., 1993. Taxonomy and stratigraphic distribution of Late Triassic metoposaurid amphibians from Petrified Forest National Park, Arizona. J. Arizona-Nevada Acad. Sci., 27: 90-96.

Fossils of two taxa of metoposaurid amphibians are present in the Upper Triassic Petrified Forest Formation in Petrified Forest National Park. *Buettneria perfecta*, represented by several skulls and much postcrania, is characterized by a large skull, a lachrymal that enters the orbit, deep otic notches, tabular horns and short intercentra. *Apachesaurus gregorii*, represented by one skull and many intercentra, is characterized by a small skull, shallow otic notch, lack of tabular horns and elongate intercentra. *Buetternia* is common in the late Carnian Blue Mesa Member and is rare in the early Norian Painted Desert Member. *Apachesaurus* exhibits the opposite distribution pattern. The late Carnian (late Tuvalian) thus is an acme for *B. perfecta* and the early-middle Norian is an acme for *A. gregorii*.

Hunt, A.P. and Lucas, S.G., 1993. Stratigraphy and vertebrate paleontology of the Chinle Group (Upper Triassic), Chama Basin, North-Central New Mexico. New Mexico Mus. Nat. Hist. Sci., 2: 61-69.

Triassic strata in the Chama basin of Rio Arriba County, New Mexico, pertain to the Upper Triassic Chinle Group (Agua Zarca, Salitral, Poleo, Petrified Forest and Rock Point formations). Several Chinle formations contain biochronologically important vertebrate 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.

Hunt, A.P. and Lucas, S.G., 1993. Triassic vertebrate paleontology and biochronology of New Mexico. New Mexico Mus. Nat. Hist. Sci., 2: 49-60.

New Mexico has a little studied record of Middle Triassic (Anisian) vertebrates from the Anton Chico Member of the Moenkopi Formation. But, the state has the most extensive Late Triassic vertebrate record in the United States from strata of the Carnian-Rhaetian Chinle Group. These Late Triassic vertebrates represent the Adamanian, Revueltian and Apachean vertebrate faunachrons and allow precise correlation of Chinle Group strata in New Mexico.

Hunt, A.P. and Lucas, S.G., 1993. Late Triassic microvertebrate localities in New Mexico (USA): implications for paleoecology. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 187-191.

There are eight major microvertebrate localities in the Chinle Group of New Mexico: (1) Hubble Bench in the San Pedro Arroyo Formation of Valencia County; (2) Lamy in the Los Esteros Member of the Santa Rosa Formation in Santa Fe County; (3) Revuelto Creek in the Bull Canyon Formation of Quay County; (4) Bull Canyon in the Bull Canyon Formation of Guadelupe County; 85) Shark tooth hill, (6) Apache Canyon and (7) Red Peak, all in the Redonda Formation of Quay Country; and (8) Sloan Canyon in

the Sloan Canyon Formation of Union Country. The authors recognize four categories of microvertebrate faunas based on total presentation of taxa by individual elements in all size classes: 8!9 fish dominated; (2) fish/phytosaur dominated; (3) phytosaur dominated; and (4) terrestrial reptile dominated. Fish dominated sites are of little biochronological utility.

HUNT, A.P. and LUCAS, S.G., 1993. A new Phytosaur (Reptilia: Archosauria) genus from the uppermost Triassic of the western United States and its biochronological significance. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 193-196.

Redondasaurus is a new genus of phytosaur from the western United states that is characterized by supratemporal fenestrae that are concealed in dorsal view. *R. gregorii* is a narrow-snouted species, and *R. bermani* is a crested species. *Redondasaurus* defines a *Redondasaurus* biochron that is Rhaetian in age.

HUNT, A.P., LUCAS, S.G. and BIRCHEFF, P., 1993. Biochronological significance of the co-occurrence of the phytosaurs (Reptilia: Archosauria) *Angistorhinus* and *Rutiodon* in the Los Esteros Member of the Santa Rosa Formation, Santa Fe County, New Mexico, USA. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 203-204.

A newly discovered phytosaur skull from the Los Esteros Member of the Santa Rosa Formation to is assined to *Angistorhinus*. This specimen demonstrates the first recorded co-occurrence of *Angistorhinus* with *Rutiodon*. Previously, *Angistorhinus* was only known from *Paleorhinus*-bearing strata. This co-occurrence indicates that there is a period of temporal overlap between the late Carnian *Paleorhinus* and *Rutiodon* biochrons.

HUNT, A.P., LUCAS, S.G. and LOCKLEY, M.G., 1993. Fossil limuloid trackways from Petrified Forest National Park, Arizona, USA. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 205-207.

A new specimen of limuloid trackway is described from Petrified Forest National Park (PEFO 378). This specimen is referable to *Kouphichnium arizonae* Caster 1944. It preserves two trackways of limuloid, one of which is turning sharply.

HUNT, A.P., LUCAS, S.G. and RESER, P.K., 1993. A complete skeleton of the stagonolepidid *Typhothorax coccinarum* from the Upper Triassic Bull Canyon Formation of east-central New Mexico, USA. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 209-212.

A skeleton from the Bull Canyon Formation of eastern New Mexico (NMMNH P-12964) is the most complete specimen known of the stagonolepidid *Typhothorax coccinarum*. *Typhothorax* has a very wide carapace, a very short neck and long tail and short lower hind limbs. This skeleton appears to have been scavenged and then rapidly buried.

HUNT, A.P., SANTUCCI, V.L., LOCKLEY, M.G. and OLSON, T.J., 1993. Dicynodont trackways from the Holbrook Member of the Moenkopi Formation (Middle Triassic: Anisian), Arizona, USA. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 213-218.

Therapsipus cumminsi gen. et sp. nov. is a dicynodont trackway from the Holbrook Member of the Moenkopi Formation (early Anisian) in northeastern Arizona. The trackmaker was a wide-bodied animal with blunt digits that walked with a primitive alternate gait.

Jalil, N., 1993. Triassic vertebrates of the Zarzaïtine Series (Algeria): new data, with particular reference to the prolacertiformes. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 219-222.

A new prolacertiform reptile is described from the Zarzaïtine Series (Triassic, Algeria). The presence of the dermal scutes of an aetosaur greatly favors the Upper Triassic age of this formation.

Jamnik, A. and **Ramovš, A.**, 1993. Holothurian sclerites and conodonts in the Upper Carnian (Tuvalian) and Norian limestones in the Central Kamnik Alps. Geologija, 35: 7-63 (In Slovenian with English summary).

In the Kamnik Alps, North of Ljubljana, holothurian skeletons and conodonts indicate two different developments of Upper Carnian and Norian. The Upper Carnian grey and brownish organogenic platy limestones contain individual remains of ammonoids, more frequently brachiopods, numerous foraminifers, rare holothurian skeletons, remains of floating crinoids, ostracods, conodonts and fish teeth. The first establishment of the open marine Upper Carnian in the Kamnik Alps reminds of the Hallstatt development and might indicate a deeper transversal west-east furrow between the northern Julian Alps and the central Kamnik Alps. This deeper marine development partly continued from the Upper Carnian into the Norian. Well-bedded dark grey micritic Norian limestones with chert nodules and lenses contain very rich holothurian skeletons (52 taxa) which provided evidence for the Norian. The Norian stage was proved also with conodont *Epigondolella abneptis*, which was found in the lower and in the uppermost part of the examined beds. Also in Norian could persisted the transversal furrow with deeper marine development which extended from the northern Julian Alps towards Sleme in the Kamnik Alps.

Kemp, A., 1993. Problematic Triassic dipnoans from Australia. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 223-227.

Dipnoan tooth plate and jaw bone material belonging to a new taxon, *Aphelodus anapes*, possibly allied to the European and North American genus *Sagenodus*, is described from the Triassic Blina Formation of Western Australia. The species is also represented in the Lower Triassic Arcadia Formation of western Queensland. A small lungfish skull of a second new taxon, *Namatozodia pitikanta*, that may be related to the European and North American genus *Gnathorhiza*, is also described from the Arcadia Formation. The specimens represent the first possible records of these groups from Mesozoic deposits in Australia.

Khudaiberdyev, R., 1993. Fossil woods of the genus *Xenoxylon* and their development in the Mesozoic of Middle Asia. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 229-231.

Kirby, R.E., 1993. Relationships of late Triassic basin evolution and faunal replacement events in the southwestern United States: Perspectives from the upper part of the Chinle Formation in Northern Arizona. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 233-242.

Analysis of a new vertebrate fauna and associated facies in the Owl Rock Member (Late Triassic: Norian) provides data on the depositional context of fossil assemblages in the upper part of the Chinle Formation along Ward Terrace in northern Arizona. Owl Rock floodbasin sequences in the study area were deposited as a series of aggrading meanderbelt channel/floodplain complexes overlying broad degradational surfaces of

low topographic relief, analogous to topographically more complex surfaces described for the underlying Petrified Forest Member. Plots of fossil occurrences against depositional environments indicate that non-random (facies-dependent) distribution and relative abundance of vertebrate taxa correspond broadly to environmental subdivisions of a floodbasin sequence in the uppermost Owl Rock Member, consistent with a habitat-specific community structure. Aggradational facies architecture and alternation of degradational and aggradational phases occurred in response to seasonal and longer-term base level fluctuations. Several interactive allocyclic controls may have influenced the base level-driven cyclicity, and consequent shifts in the distribution of floodbasin habitats: (1) arc-related tectonism, (2) intensification of humid-arid seasonality, and (3) sea level oscillations. Chinle faunal replacement patterns parallel the evolution of fluvial depositional environments, and are most compatible with mechanisms of differential environmental response. Episodes of deep alluvial dissection recorded within the upper Petrified Forest Member suggest that post-Carnian changes in the structure of habitat-dependent Chinle vertebrate communities were related to disruption of floodbasin ecosystems, coincident with extensive modification of Chinle drainage patterns and potentially linked to the interplay of Pangaean tectonic, climatic and sea level trends. The inferred abruptness of the Carnian-Norian Chinle faunal transition may in part be an artifact of the widespread occurrence of erosionally-generated stratigraphic breaks within floodbasin deposits.

KNOTT, S.D., 1994. Fault zone thickness versus displacement in the Permo-Triassic sandstones of NW England. J. Geol. Soc., London, 151: 17-25.

Fault zone displacement and thickness data (230 measurements) plus orientation and slip vectors from 55 faults were obtained from outcrops of Permo-Triassic sandstones. The data indicate that, generally, as fault displacement increases, the width of a fault zone also increases. In detail, the relationship between displacement and thickness is stepped with thickness increasing sharply above certain values (thresholds) of displacement. This indicates a discontinuous growth of the fault zone. There are at least two thresholds in the data presented. Previous well-and seismic-based studies in the North Sea have shown a clear positive correlation between the displacement, normalized as a fraction of the reservoir thickness, and the probability of a fault sealing. Displacement, therefore, can be used to give a rough estimate of the probability of a fault acting as a pressure barrier to fluids in sandstone-dominated successions. Porosity and permeability of the reservoir rock are reduced within a fault zone, therefore the wider the zone the more likely the fault will seal hydrocarbons. Rapid jumps in fault zone thickness at displacements of roughly 300 mm and 5000 mm indicate that the relationship between fault displacement and fault seal probability may not be linear, but to a fair approximation (± 15%) may be taken as such.

KOVÁCS, S., 1993. Conodont biostratigraphy of the Anisian/ Ladinian boundary interval in the Balaton Highland, Hungary and its significance in the definition of the boundary (Preliminary report). Acta Geol. Hung., 36: 39-57.

Bed-by-bed investigation of the Felsőörs, Mencshely and Vászoly sections in the Balaton Highland (Hungary) allowed the recognition of three main events of conodont evolution in the Anisian/Ladinian boundary interval: (1) the appearance of *Gondolella constricta postcornuta* near the base of the *Reitzi* Zone s.l. (slightly below the *Kellnerites felsoeoersensis* horizon), (2) the appearance of *Gondolella trammeri* at the base(?) of the *Halilucites costosus* horizon of the *Reitzi* Zone s.l., and (3) the appearance of *Gondolella transita* and *G.? praehungarica* near the base of the *Curionii*

Zone. The *Xenoprotrachyceras reitzi* horizon is not favourable for conodont investigations in the studied sections. The first occurrence of *"Metapolygnathus" hungaricus* lies much higher above the base of the *Curionii* Zone; accordingly, in the Epidauros section of Greece, where they coincide (Krystyn, 1983), there should be a considerable gap in the lower part of the *Curionii* Zone. The conodont events are correlated with the ammonoid chronology (based on Vörös, 1993) and the three (plus one) alternatives for the definition the Anisian/Ladinian boundary are discussed. The first alternative at the base of the *Reitzi* Zone s.l. (though the change in conodont evolution at this horizon is the least sharp, with a fairly gradual transition) is has not only by priority, but is also supported by the appearance of main Ladinian elements in the radiolarian fauna (Dosztály, 1993) and by palynomorphs and foraminifers (Góczán and Oravecz-Scheffer, 1993).

KOVÁCS, S., 1994. Conodonts of stratigraphical importance from the Anisian/Ladinian boundary interval of the Balaton Highland, Hungary. Riv. It. Paleont. Strat., 99: 473-514.

A preliminary description of stratigraphically important conodonts occurring in the Anisian/Ladinian boundary interval and a discussion of their evolutionary lineages. Among them are some new taxa: *Gondolella constricta postcornuta* ssp. n., *G. fueloepi* sp. n. with two subspecies, *G. liebermani* Kovács & Krystyn n. sp. and *G.? praehungarica* sp. n. *G. constricta postcornuta* and *G.? praehungarica* are recognized as zonal index forms in the Balaton Highland Middle Triassic.

KOZUR, H., 1993. *Gullodus* n. gen. - A new conodont genus and remarks to the Pelagic Permian and Triassic of western Sicily. Jb. Geol. B.-A., 136(1): 77-87.

Conodont faunas from the Middle Permian limestone blocks of the Sosio Valley area, western Sicily, contain a very distinctive new conodont genus, *Gullodus* n. gen. The paleoecology of *Gullodus* and, in connection with this, the paleogeographic position of the Sosio limestone blocks within the Sicanian paleogeographic domain are discussed. A revised stratigraphic column of the pelagic Permian and Triassic of western Sicily is presented.

KOZUR, H.W., 1993. Annotated correlation tables of the Germanic Buntsandstein and Keuper. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 243-248.

Correlation tables of the Germanic Buntsandstein and Keuper are presented. Some correlation problems and the position of the Scythian-Anisian boundary are discussed.

KOZUR, H.W., 1993. Range charts of conchostracans in the Germanic Buntsandstein. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 249-253.

Ten conchostracan zones can be discriminated within the Lower and Middle Buntsandstein. The lowermost of these zones belongs to Permian. Three zones can be discriminated within the Brahmanian and 6 zones in the Olenekian part of the Lower and Middle Buntsandstein. Two illustrated range charts of conchostracans in the Germanic Buntsandstein are presented.

KOZUR, H., KRAINER, K. and MOSTLER, H., 1994. Middle Triassic conodonts from the southern Karawanken Mountains (Southern Alps) and their stratigraphic importance. Geol. Paläont. Mitt. Innsbruck, 19: 165-200.

The conodont fauna of the south alpine Middle Triassic pelagic limestones (Loibl

Formation and Buchenstein Formation) of the Karawanken Mountains in Carinthia, southern Austria, is described and the systematics and stratigraphic importance of Late Illyrian and Fassanian gondolellid conodonts are discussed. The investigated conodont fauna contains the following new taxa: *Neogondolella cornuta ladinica* n. ssp., *N. aldae* n. sp., *N. aldae aldae* n. ssp., *N. aldae posterolonga* n. ssp., *N.? postpridaensis* n. sp., *Paragondolella? pridaensis posteracuta* n. ssp. and *Budurovignathus gabriellae* n. sp. The stratigraphic evaluation of the conodonts supports the priority of the position of the Anisian-Ladinian boundary at the base of the *Reitziites reitzi*-Zone, where a distinct change of all stratigraphically important microfossil groups is observed. The oldest investigated sediments are red fissure fillings within the uppermost part of the Late Anisian platform carbonates of the Contrin Formation, containing conodonts probably indicating latest Illyrian age. The conodont fauna of the Loibl Formation points to a Fassanian age. Sediments of the Buchenstein Formation range in age from Fassanian to late Langobardian (*Budurovignathus mungoensis*-Zone).

KOZUR, H.W., MAHLER, H. and SELL, J., 1993. Stratigraphic and paleobiogeographic importance of the latest late Olenekian to early Early Anisian conchostracan of Middle Europe. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 255-259.

The biostratigraphic and paleobiogeographic importance of the latest late Olenekian to early Bithynian (Early Anisian) conchostracan faunas of the Germanic Basin and the Mecsek Mts (southern Hungary) are discussed.

KOZUR, H.W. and MOCK, R., 1993. The importance of conchostracans for the correlation of continental and marine beds. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 261-266.

Conchostracans are excellent guide fossils for continental deposits. Because conchostracans are also common in brackish beds, they are very suitable for correlation of continental and marine beds. The known occurrences of conchostracans within the Alpine Triassic of Hungary, Slovakia and Italy and their importance for the correlation of the Germanic conchostracan fauna are discussed.

KRAINER, K., 1993. The Alpine Buntsandstein Formation of the Drau Range (Eastern Alps, Austria): Transition from fluvial to shallow marine facies. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 267-275.

Compared to the Southern Alps (Dolomites) where the Scythian sequence is composed of shallow marine sediments of the South Alpine Werfen Formation, in some the Upper Austroalpine Units of the Eastern Alps (Drau Range, Gurktal Nappe, western part of the Northern Calcareous Alps), the Scythian is represented by a clastic sequence of fluvial, sometimes shallow marine sediments of the Alpine Buntsandstein Formation, which is overlain by the Upper Scythian Werfen Formation. In the Drau Range (southern Austria), the Alpine Buntsandstein Formation rests upon Upper Permian red beds of the Gröden Formation and is divided into two fining-upward megasequences (Lower and Upper Alpine Buntsandstein). The sharp boundary at the base, probably corresponding to the Permian/Triassic boundary, is marked by a significant change in depositional environment and mineralogical composition caused by a climatic shift from arid conditions during the Late Permian to more humid conditions during the Scythian. Lower and Upper Alpine Buntsandstein are composed of conglomeratic and sandy fluvial sediments, at places grading upward into a shallow marine tidal clastic facies. The regressional event separating the Lower and Upper Alpine Buntsandstein can be correlated with the "Campill Event" of the South Alpine Werfen Formation, and the transgressional event forming the boundary between the Upper Alpine Buntsandstein Formation and overlying Werfen Formation corresponds to the "Val Badia transgression" of the South Alpine Werfen Formation.

Kristian-Tollmann, E., 1993. Zur paläogeographischen Verbreitung der Ostracoden-Gattung *Hermiella* an der Rhät/Lias-Grenze. Zitteliana, 20: 331-342.

The newly detected first species of *Hermiella* (*H. hermi* n. sp., *H. hagni* n. sp. and *H. oviformis* n. sp.) within the Rhaetian of the eastern part of the Tethys, namely of the Exmouth Plateau NW of Australia, represent together with the taxa of *Hermiella* of the Liassic in tethyal facies in Timor and individual group of forms. This group distinguishes namely by the morphology of its back part from the group of *Hermiella* of the European Liassic in Germanic facies. Intermediary represents of the remaining part of the Tethys are not known until today. The independence of *Hermiella* compared with *Ogmoconcha* could be confirmed once more by further investigations of the muscle scars of this genus.

Kürmann, H., 1993. Zur Hochdiagenese und Anchimetamorphose in Permotrias-Sedimenten des Austroalpins westlich der Tauern. Bochumer geol. u. geotechn. Arb., 41: 328 pp.

Röntgen diffraction, chemical analysis, light- and electron microscopical studies of 230 siliclastic and carbonatic samples from the Permian to Ladinian show the alpine diagenesis and anchimetamorphosis of the Austroalpine area west of the Tauern Window.

Litwin, R.J., Smoot, J.P. and **Weems, R.E.**, 1993. *Froelichsporites* gen. nov. - a biostratigraphic marker palynomorph of Upper Triassic continental strata in the conterminous U.S. Palynology, 17: 157-168.

A new genus of Late Triassic palynomorphs, *Froelichsporites,* is created and designated for azonate, obligate tetrahedral spore tetrads which characteristically are found in Upper continental (fluvial, interfluvial, and lacustrine) strata of the Newark Supergroup of the eastern United States and Canada, the Dockum Group of Texas and New Mexico, and the Chinle Formation of New Mexico, Arizona and Utah. This palynomorph is restricted geologically to strata comprising the upper Carnian and Norian Stages of the Upper Triassic, and is a geographically widespread form. *Froelichsporites traversei* (Dunay & Fisher) comb.nov. et emend., is most abundant in the conterminous U.S., but it also has been found in portions of eastern Canada and possibly may be present in Upper Triassic strata of Portugal.

N.B. Similar tetrads are present in the Tuvalian of the Alpine Triassic, as well as in the Lehrbergschichten of the Keuper in southern Germany; the species thus seems to have a considerable potential for long-range correlation (H. Visscher).

Lockley, M.G. and **Hunt, A.P.**, 1993. A new late Triassic tracksite from the Sloan Canyon Formation, Type section, Cimarron Valley, New Mexico. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 279-283.

A recently discovered Late Triassic tracksite in the Sloan Canyon Formation, Chinle Group of the Cimarron Valley area is situated in the immediate vicinity of the type section. The tracksite consists of a bedding plane exposure of about 200 m^2, partially covered with the tracks of at least three different trackmakers. A total about 70 tracks were mapped and resolved into trackways of at least 26 individual animals. The most common tracks are those of *Brachychirotherium*, suggesting that the tracksite falls within the *Brachychirotherium* track zone associated with the upper part of the Chinle Group. The second most common track is a large tridactyl track type attributed to *Grallator* sp., which is one of the largest morphotypes ever recorded from the Chinle Group. A third large track type, herein assigned to cf. *?Tetrasauropus*, and elsewhere named *Chirotherium* sp., is possibly attributable to a prosauropod or to some other large archosaur. The trackway assemblage is quite similar to one reported from a large site, with multiple track levels, in the Sloan Canyon Formation about 17 km to the west. The main differences are that the new site has a lower track diversity, and a greater proportion of theropod tracks. This could be due in part to the relatively small size of the exposure and the fact that identifiable tracks only occur at one stratigraphic level.

LOCKLEY, M.G., SANTOS, V.F. and HUNT, A.P., 1993. A new late Triassic tracksite from the Sheep Pen Sandstone, Sloan Canyon, Cimarron Valley, New Mexico. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 285-288.

A new tracksite in the upper part of the Sheep Pen Sandstone at Sloan Canyon, New Mexico has yielded a total of 18 tracks, representing at least three different species of trackmakers. The most common tracks are assigned to *Grallator. Pseudotetrasauropus* and a unknown ichnotaxon are also reported from the formation for the first time. This *Grallator*-dominated ichnocoenosis is similar to those reported from nearby localities in Oklahoma and Colorado, thus suggesting a distinct ichnofauna in this formation in this area.

LÓPEZ-GÓMEZ, J., MAS, R. and ARCHE, A., 1993. The evolution of the Middle Triassic (Muschelkalk) carbonate ramp in the SE Iberian Ranges, Eastern Spain: sequence stratigraphy, dolomitization processes and dynamic controls. Sed. Geol., 87: 165-193.

The Upper Permian-Triassic strata of the SE Iberian Ranges, display the classic Germanic-type facies of Buntsandstein, Muschelkalk and Keuper. The Muschelkalk is represented by two carbonate units with a siliciclastic-evaporitic unit in between. Their ages range from Anisian to basal Carnian (Middle Triassic to base of the Upper Triassic). The carbonate units represent ramps that evolved during the early thermal subsidence period which succeeded the first rift phase. Seven facies have been distinguished, representing shoals, tidal flats, organic buildups and lagoons, as well as a karst horizon in the lower carbonatic unit. Most of the carbonates were dolomitised. Three processes of dolomitization are invoked: mixing waters, penecontemporaneous seepage refluxion, and deep burial. The top of the Buntsandstein and the Muschelkalk facies are subdivided into two depositional sequences, including lowstand, transgressive and highstand systems tracts, with superimposed tectonic and eustatic controls.

LOZOVSKY, V.R., 1993. Early Triassic Pangaea. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 289-291.

A short note on the distribution of tetrapods in the Early Triassic.

LOZOVSKY, V.R., 1993. The most complete and fossiliferous Lower Triassic section of the Moscow Syneclise: The best candidate for a nonmarine global time scale. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 293-295.

A brief discussion of the Lower Triassic of the East European Platform as a candidate for the nonmarine global time scale.

LOZOVSKY, V.R. and MOLOSTOVSKY, E.A., 1993. Constructing the Early Triassic magnetic polarity time scale. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 297-300.

More than a some tens of sections of the Lower Triassic continental redbeds which have been studied in detail are known in the different structural-facial zones of the East European plantform. The compound scale of that region includes five paleomagnetic zones. The correlations of these magnetozones with units of regional and general scales and with groupings of vertebrate and invertebrate faunas are given.

LUCAS, S.G., 1993. Vertebrate biochronology of the Triassic of China. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 301-306.

A vertebrate faunachron is a biochronologic unit that is the time equivalent to the duration of a vertebrate fauna. In other words, a vertebrate faunachron is the temporal equivalent of an assemblage zone of vertebrate fossils. Land-vertebrate "age" and land-mammal "age" are less satisfactory terms synonymous with vertebrate faunachron. This article organizes the Triassic land-vertebrate faunas of China into four, temporally-successive vertebrate faunachrons (oldest to youngest): Jimsarian, Fuguan, Ordosian and Ningwuan. Biochronological organization of the Triassic vertebrate-fossil record of China leads to the following observations: (1) northern China has an Early and Middle Triassic vertebrate-fossil record as complete as any other sequence on earth; and (2) no significant record of Late Triassic terrestrial vertebrates is known from China.

LUCAS, S.G., 1993. The Chinle Group: Revised stratigraphy and biochronology of Upper Triassic nonmarine strata in the western United States. In: M. MORALES (ed.), Aspects of Mesozoic Geology and Paleontology of the Colorado Plateau, Mus. North. Arizona Bull., 59: 27-50.

Upper Triassic nonmarine strata in the western United States, exposed from Wyoming to Texas and from Nevada to Oklahoma, are assigned to the Chinle Group. The Chinle Group encompasses 27 formations and includes the Cameron Formation and Blue Mesa and Painted Desert Members of the Petrified Forest Formation, new lithostratigraphic units on the Colorado Plateau. Tetrapods, principally phytosaur and aetosaur reptiles, allow recognition of four tetrapod faunachrons represented by fossils from the Chinle Group. Correlations of and within the Chinle Group based on tetrapods are consistent with but more precise than correlations based on other types of fossils. These correlations indicate that the Chinle Group ranges in age from late Carnian (Tuvalian) to late Norian (Sevatian or Rhaetian). They also provide part of the basis for a comprehensive correlation of Chinle Group strata across their outcrop extent. This correlation suggests that the Chinle Group includes three depositional sequences bounded by unconformities, two of which are intra-Chinle Group unconformities not previously recognized.

LUCAS, S.G. and ANDERSON, O.J., 1993. Lithostratigraphy, sedimentation, and sequence stratigraphy of Upper Triassic Dockum Formation, West Texas. In: R.E. CRICK (ed.), 1993. Southwest Section Geological Convention, American Assoc. Petrol. Geol., Transactions and Abstracts, pp. 55-65.

Conflicting accounts of the stratigraphy of Upper Triassic rocks in West Texas were published recently. The authors here reassert, and provide additional data to support, their earlier interpretation and subdivision of the continental sedimentary rocks that have been called Dockum Formation, and briefly discuss them in terms of sequence stratigraphy. The regional stratigraphic relationship they envision, based on outcrop lithostratigraphic studies supported by faunal evidence, suggests that the base of the Dockum Formation is everywhere a sandstone, conglomerate, or conglomeratic sandstone. This basal unit called the Camp Springs Member is relatively thin, but characteristically contains siliceous (extrabasinal) clasts which contrast it with the coarser facies of a younger sandstone and conglomerate unit, the Trujillo Member. Contrary to other accounts these two are distinct units of demonstrably different age and are separated by as much as 67 m of red, yellow, purple, and green mudstone belonging to the Tecovas Member. At the top of the Dockum Formation, overlying the Trujillo Member, is the mudstone-dominated Bull Canyon Member, the only Dockum Formation unit to have a type section in New Mexico. Two sequences are identified in the Dockum Formation. They reflect two cycles of base-level change in the Chinle Group basin during the Late Triassic.

Lucas, S.G. and **Anderson, O.J.**, 1993. Stratigraphy of the Permian-Triassic boundary in Southeastern New Mexico and West Texas. New Mexico Geol. Soc. Guidebook, 44th Field Conf., Carlsbad Region, New Mexico and West Texas, 1993: 219-230.

At the Permian-Triassic boundary everywhere in west Texas and Southeastern New Mexico, Upper Permian (Late Ochoan = Changxingian), or older Guadalupian strata are overlain by Upper Triassic (late Carnian = Tuvalian) strata. The youngest Upper Permian strata are the Quartermaster Formation (= Pierce Canyon red beds = Dewey Lake Formation); the late Permian age of the Quartermaster is verified by invertebrate fossils, magnetostratigraphy and K-Ar ages. Vertebrate fossils document the late Carnian age of overlying Triassic strata of the Santa Rosa Formation and Camp Springs Member of Dockum Formation. No Lower or Middle Triassic Strata are present in Southeastern New Mexico and west Texas. The Permian-Triassic boundary in this area thus is a major unconformity that encompasses at least 25 million years. Because the Permian-Triassic boundary in Southeastern New Mexico and west Texas is bracketed by nonmarine siliciclastic red beds, it has often been incorrectly placed. Upper Permian Strata are distinguished by being brick-red, not variegated, texturally and mineralogically relatively mature, ripple-laminar to laminar and unfossiliferous, whereas Upper Triassic strata are greyish red, variegated texturally and mineralogically relatively immature, trough-crossbedded and fossiliferous. We describe 12 reference points in SE New Mexico and west Texas where the Permian-Triassic boundary is well exposed.

Lucas, S.G. and **Anderson, O.J.**, 1993. Triassic Stratigraphy in Southeastern New Mexico and West Texas. New Mexico Geol. Soc. Guidebook, 44th Field Conf., Carlsbad Region, New Mexico and West Texas, pp. 231-244.

Upper Triassic strata exposed in Southeastern New Mexico and southwestern Texas are assigned to the Santa Rosa, San Pedro Arroyo and Dockum Formations of the Chinle Group. In Southeastern New Mexico (Chaves, Eddy and Lea Counties) the Santa Rosa Formation is as much as 25 m thick and is mostly through-crossbedded extra-formational conglomerate and sandstone with minor beds of mudstone or siltstone. It disconformably overlies Upper Permian (Artesia Group or Quartermaster Formation) strata. The San Pedro Arroyo Formation conformably(?) overlies the Santa Rosa Formation and is at least 50 m of variegated smectitic mudstone and minor sandstone/ conglomerate. Regional geologic maps have greatly overstated the extent of Upper Triassic exposures in Southeastern New Mexico. In southwestern Texas (area from Pecos to Mitchell Counties) the Dockum Formation consists of the basal Camp Springs Member and overlying strata here assigned to a new stratigraphic unit, the Iatan Member. The Camp Springs Member is at least 15 m thick and is dominantly extra-formational, siliceous conglomerate. It disconformably overlies the Upper Permian Quartermaster (= Dewey Lake) Formation and is conformably(?) overlain by the Iatan Member, which is 80-100 m thick and characterized by intercalated, persistent intervals of red smectitic mudstone and through-crossbedded micaceous sandstone. Fossil vertebrates indicate the Camp Springs and Iatan Members are of late Carnian (Tuvalian) age. Physical stratigraphy and lithology suggest correlation of the Santa Rosa Formation with the Camp Springs Member and the San Pedro Arroyo Formation with the Iatan Member.

Lucas, S.G., Decourten, F.L. and Hunt, A.P., 1993. A phytosaur from the Upper Triassic Chinle Group in the San Rafael Swell, east central Utah. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 307-309.

A partial skull and postcranial skeleton of a phytosaur identified as cf. *Pseudopalatus* sp. is described from the Painted Desert Member of the Petrified Forest Formation in the San Rafael Swell of east-central Utah. This phytosaur fossil suggests a Revueltian (early-middle Norian) age.

Lucas, S.G. and González-León, C., 1994. Marine Upper Triassic strata at Sierra la Flojera, Sonora, Mexico. N. Jb. Geol. Paläont. Mh., 1: 34-40.

An 80-m-thick section of Triassic strata exposed at Sierra la Flojera near Hermosillo, Sonora, Mexico produces the ammonite *Hannaoceras nodifer* (HYATT & SMITH) indicative of the *Dilleri* Zone of late Carnian age. These strata thus are correlative with the upper part of the lower member of the Antimonio Formation near Caborca, 225 km to the northwest. This correlation confirms the great areal extent of the Antimonio suspect terrane of northwestern Mexico.

Lucas, S.G. and Huber, P., 1993. Revised internal correlation of the Newark Supergroup Triassic, Eastern United Sates and Canada. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 311-319.

We present a revised correlation of the Triassic sediments of the Newark Supergroup in all the basins from South Carolina to Nova Scotia. In so doing, we heavily emphasize tetrapod-based correlations based in large part on correlation with land-vertebrate faunachrons (lvfs) defined in the upper Carnian-Rhaetian Chinle Group of the western United Sates. Tetrapod-based Newark correlations conflict with some palynostratigraphic correlations which assigned many of the oldest Newark strata an early or "middle" Carnian age. Instead, we assign a late early Carnian (late Julian) or early late Carnian (early Tuvalian) age to the oldest fill of all but one of the Newark Supergroup basins; the exception is the Fundy basin where Middle Triassic (Anisian) strata are preserved at the base of the Newark section. Correlation of upper Carnian strata and placement of the Carnian-Norian boundary in the Newark Supergroup are fairly precise, but less fossiliferous Norian-Rhaetian Newark strata are more difficult to correlate with precision.

Lucas, S.G. and Hunt, A.P., 1993. A dicynodont from the Upper Triassic of New Mexico and its biochronologic significance. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 321-325.

Dicynodont fossils from the Upper Triassic (Upper Carnian) Los Esteros Member of the Santa Rosa Formation in north-central New Mexico do not pertain to *Placerias*, but instead most resemble South American Late Triassic dicynodonts and are identified as cf. *Ischigualastia* sp. Other identified North American Late Triassic dicynodonts pertain to the monospecific genus *Placerias* (we regard *P. gigas* Camp and Welles, 1956 as a junior subjective synonym of *P. hesternus*, Lucas, 1904). The possible occurrence of *Ischigualastia* in the Santa Rosa Formation supports recent assignments of a late Carnian age to the *Ischigualastia* occurrences in Brazil and Argentina. A recently published single-crystal age of 227.8 Ma ± 0.3 Ma from a tuff near the base of the Ischigualasto Formation in Argentina supports a late Carnian age assignment for the tetrapod assemblage from this unit, and thus the oldest Argentinian dinosaurs are late Carnian.

Lucas, S.G. and **Hunt, A.P.**, 1993. Tetrapod biochronology of the Chinle Group (Upper Triassic), western United States. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 327-329.

We propose formal terminology for the four land-vertebrate faunachrons (lvfs) recognized from tetrapod-fossil assemblages of the nonmarine Upper Triassic Chinle Group in the western United States and earlier recognized as informal lvfs. These are (in ascending order): Otischalkian, Adamanian, Revueltian and Apachean. Otischalkian and Adamanian are of late Carnian (Tuvalian) age; Revueltian is of early to middle Norian age; Apachean is of Rhaetian age.

Lucas, S.G., **Hunt, A.P.** and **Kahle, R.**, 1993. Late Triassic vertebrates from the Dockum Formation near Otis Chalk, Howard County, Texas. New Mexico Geol. Soc. Guidebook, 44th Field Conference, Carlsbad Region, New Mexico and West Texas, pp. 237-244.

Fossil vertebrates from the Otis Chalk area of Howard County, Texas represent a diverse fauna of fishes, amphibians and reptiles. These fossils are from the Iatan Member of the Upper Triassic Dockum Formation. The presence of the phytosaur *Paleorhinus* indicates a late Carnian (early Tuvalian) age for the vertebrate fauna.

Lucas, S.G. and **Kietzke, K.K.**, 1993. Calcareous microfossils from the Upper Triassic of Petrified Forest National Park, Arizona. J. Ariz.-Nev. Acad. Sci., 27: 55-68.

The authors processed more than 200 rock samples from the Upper Triassic Chinle Group in the Petrified Forest National Park, Arizona, to obtain calcareous microfossils (charophytes and ostracods) similar to those previously encountered in rocks of similar age in Texas and New Mexico. The microfossils they recovered are assigned to the charophyte, *Porochara abjecta*, and the ostracods, *Darwinula* sp. aff. *D. liulingchuanensis* and *Gerdalia* sp. cf. *G. triassica*. These calcareous microfossils are from the Painted Desert Member of the Petrified Forest Formation; none came from the Blue Mesa or Sonsela Members, despite approximately equal levels of sampling in these units. The microfossils recovered from the Petrified Forest National Park resemble those from the Norian of New Mexico and China. They indicate highly mineralized, permanent limnic environments with water depths of about 6-8 meters or less.

Lucas, S.G. and **Luo, Z.**, 1993. *Adelobasileus* from the Upper Triassic of West Texas: The oldest mammal. J. Vertebrate Paleont., 13(3): 309-334.

Adelobasileus cromptoni Lucas and Hunt, 1990 is based on an incomplete skull from the lower part of Tecovas Member of the Dockum Formation near Kalgary, Crosby County, Texas. Its age is late Carnian (Tuvalian), about 225 Ma, based on palynostratigraphy, ostracods, vertebrate biochronology, and sequence stratigraphy. This indicates that *Adelobasileus* is at least 10 million years older than any previously described mammal. The cranium of *Adelobasileus* shares a large suite of basicranial apomorphies with Liassic mammals. The distribution of 36 characters among 13 taxa of non-

mammalian cynodonts and mammals indicates that *Adelobasileus, Sinoconodon*, and other mammals form a monophyletic group. *Adelobasileus* is excluded from the monophyletic taxon consisting of *Megazostrodon, Haldanodon*, morganucodontids, triconodontis, multituberculates, monotremes, and therians. Partly because of incomplete knowledge of *Adelobasileus*, it is impossible to resolve the trichotomy of *Adelobasileus, Sinoconodon*, and other mammals. Some cranial features of *Adelobasileus*, such as the incipient promontorium housing the cochlea, represent an intermediate stage of the character transformation from non-mammalian cynodonts to Liassic mammals.

LUCAS, S.G. and MARZOLF, J.E., 1993. Stratigraphy and sequence stratigraphic interpretation of Upper Triassic strata in Nevada. In: G. DUNN and K. MCDOUGALL (eds.), Mesozoic Paleogeography of the western United States-II, Pacific Sec. SEPM, 71: 375-388.

Upper Triassic nonmarine strata exposed in Eastern Nevada (Clark and Elko Counties) are assigned to the Chinle Group of Late Carnian to Late Norian age. Three unconformity-bounded depositional sequences are recognized in the predominantly fluvial strata of the Chinle Group. These depositional sequences have biochronologically equivalent counterparts in the Upper Triassic Lovelock and Humboldt tectonic assemblages of the Mesozoic marine province of Northwestern Nevada. Recognition of correlative systems tracts implies that relative sea-level change controlled the stratigraphic architecture in all three regions. A genetic link thus can be established between Chinle Group strata and Upper Triassic marine strata in western Nevada.

MARTINEZ, S., FIGUEIRAS, A. and DA SILVA, J.S., 1993. A new Unionoidea (mollusca, bivalvia) from the Tacuarembó Formation (Upper Triassic-Upper Jurassic), Uruguay. J. of Paleontology, 67(6): 962-965.

A new genus and species of Unionoidea, *Tacuaremboia caorsii*, are described from the Tacuarembó Formation (Upper Triassic-Upper Jurassic) of Uruguay. The genus is distinguished from other Unionoidea by its large size, thickness, edentulous hingeline, and the presence of claustra. It has some similarities with Anodontinae and the Archanodontacea, but it cannot be assigned to any of the known family units.

MARZOLF, J.E., 1993. Sequence-stratigraphic relationships across the palinspastically reconstructed Cordilleran Triassic Cratonal Margin. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 331-343.

Comparison of palinspastically restored Triassic tectonosequences near the latitude of Las Vegas and on the Colorado Plateau with equivalent tectonosequences in the Mesozoic marine province of northwestern Nevada suggests that the latter lay in western Utah and easternmost Nevada during the early Mesozoic (state boundaries fixed relative to the Colorado Plateau). On the Colorado Plateau, Triassic stratigraphy is subdivided by regional unconformities into two tectonosequences. The Lower and Middle Triassic tectonosequence is divided by regional unconformities into four 3rd order sequences; the Upper Triassic tectonosequence, into three 3rd order sequences. Age constraints on all seven 3rd order sequences are permissive of a global eustatic sea-level control.

MOLINA-GARZA, R.S., GEISSMANN, J.W. and LUCAS, S.G., 1993. Late Carnian-Early Norian magnetostratigraphy from nonmarine strata, Chinle Group, New Mexico. Constributions to the Triassic magnetic polarity time scale and the correlation of nonmarine and marine Triassic faunas. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 345-352.

We report paleomagnetic and interpreted magnetostratigraphic data for selected stratigraphic sections of Upper Triassic rocks assigned to the Chinle Group. We compile a magnetic polarity sequence based on the correlation of tetrapod fauna as well as lithostratigraphic correlation of Upper Triassic strata across New Mexico. The magnetic polarity sequence, compared to recently published data from the Bolücektasi Tepe section, southwestern Turkey, and results from Newark Supergroup, eastern North America, suggest the presence of a large hiatus in the Norian section of the Chinle Group of eastern New Mexico, spanning most of the middle Norian. Present data are insufficient to compare directly with all the features observed in the polarity sequence of the Bolücektasi Tepe section, because large sampling gaps exist and our preliminary sampling scheme in the Chinle Group allows the identification of polarity zones with only intermediate resolution (the average sampling interval is about 2 m). Additional sections of the Chinle Group need to be sampled to test the reproducibility of the southwest North America magnetostratigraphic record. Magnetostratigraphy, however, may be invaluable in establishing a methodology for reliable correlation and refinement of nonmarine Late Triassic biochronologies.

MUTTONI, G. and KENT, D.V., 1994. Paleomagnetism of latest Anisian (Middle Triassic) sections of the Prezzo Limestone and the Buchenstein Formation. Southern Alps, Italy. Earth Planet. Sci. Newsl., 122: 1-18.

A paleomagnetic study was carried out at six stratigraphic sections (309 specimens) in the latest Anisian (Middle Triassic) Prezzo Limestone and the overlying Buchenstein Formation. These units outcrop over a wide area in the western Southern Alps, although most of the sampled sections are in the vicinity of the Late Eocene-Early Oligocene Adamello batholith. Three sites suffered a complete remagnetization induced by the Adamello, whereas a characteristic component with a positive fold test has been isolated at the three other sites. The mean pole of the characteristic component (Lat. 63.2°N, Long. 229.3°E, N = 3, A_{95} = 8°, k = 236) is in agreement with the Triassic portion of the West Gondwana apparent polar wander path (APWP), supporting the use of paleopoles from well-dated rocks in the Southern Alps are useful proxies for the African APWP. The characteristic component, where isolated in the sampled sections, is of normal polarity only, corresponding to the latest Anisian on the basis of well-defined ammonoid and conodont biostratigraphy, but the present results suggest that there are good opportunities for extending Middle Triassic magnetostratigraphy in these Southern Alps rock units. The mean pole of the Adamello-induced component (Lat. 74.5°N, Long. 172.1°E, N 0 4, A_{95} = 7.6°, K = 145) lies close to the Early Tertiary portion of the APWP for stable Europe. The post-folding, Adamello-induced directions confirm that the 30-42 Ma Adamello batholith intruded after Alpine deformation and that no further deformation apparently occurred in post-emplacement times.

MUTTONI, G. and RETTORI, R., 1994. New biostratigraphic data on the Triassic of the Marathovouno hillock area (Chios Island, Greece). Riv. It. Paleont. Strat., 99: 461-472.

This paper is focused on the micropaleontology and biostratigraphy of the Marmarotrapeza Formation (Lower/Middle Triassic) and the overlying Bunte Serie Unit (Middle Triassic) outcropping near the Marathovouno hillock section (Chios, Greece), proposed by Assereto (1974) as type-section for the Aegean substage (Lower Anisian). The results obtained allow to better define the age of the Bunte Serie basin and of the coeval carbonate platform, which ranges from Anisian (?Pelsonian) to Norian-?Rhaetian.

NAKAE, S., 1993. Jurassic accretionary complex of the Tamba Terrane, Southwest Japan, and its formative process. J. Geosci., 36(2): 15-70.

The Tamba Terrane, formed through subduction-accretion during Late Triassic to Jurassic time, occupies a part of SW Japan. Accretionary complexes of this terrane, which are termed the Tamba sedimentary complex, show a chaotically mixed feature and consist of various rock types. These rocks comprise fragments of volcanic seamounts and sedimentary rocks of pelagic and terrigenous realms ranging from Late Paleozoic to Jurassic in age.

NEWELL, A.J., 1993. Depositional environment of the Late Triassic Bull Canyon Formation (New Mexico): Implications for "Dockum Formation" paleogeography. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 359-368.

Exposures of Late Triassic sedimentary rocks in eastern New Mexico, which lie midway between the classic Chinle (Colorado Plateau) and Dockum terranes (northwest Texas), are critical to the evaluation of Late Triassic Paleogeographic reconstructions. In this study the depositional facies of the Norian Bull Canyon Formation (northeast New Mexico) are described. Many previous studies have advocated a lacustrine model to account for the great thickness of mudrocks which account for the bulk of the sequence. Here they are of desiccation and pedogenic modification. Associated sandbodies were deposited by low-sinuosity channels characterized by fluctuating discharge. Sandbody trend and foreset orientations indicate sediment transport to the north, away from the supposed depocentre of the Dockum basin. A hydrological link between the Dockum and Chinle Formations is postulated.

NOVIKOV, I.V., 1993. Triassic tetrapod assemblages of the Timan-North Urals region. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 371-373.

Six different tetrapod assemblages are described from the Lower and Middle Triassic of the Timan-North Urals region.

OCHEV, V.G., 1993. Early Triassic tetrapod biogeography. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 375-377.

A short note on the distribution of Early Triassic tetrapods.

OGG, J.G. and RAD, U. VON, 1994. The Triassic of the Thakkohola (Nepal). II: Paleolatitudes and comparison with other eastern Tethyan margins of Gondwana. Geol. Rundsch., 83: 107-129.

During the Triassic, the Thakkhola region of the Nepal Himalaya was part of the broad continental shelf of Gondwana facing a wide Eastern Tethys ocean. This margin was continuous from Arabia to Northwest Australia and spanned tropical and temperate latitudes. A compilation of Permian, Triassic and early Jurassic paleomagnetic data from the reconstructed Gondwana blocks indicates that the margin was progressively shifting northward into more tropical latitudes. The Thakkhola region was approximately 55°S during Late Permian, 40°S during Early Triassic, 30°S during Middle Triassic and 25°S during Late Triassic. This paleolatitude change produced a general increase in the relative importance of carbonate deposition through the Triassic on the Himalaya and Australian margins. Regional tectonics were important in governing local subsidence rates and influx of terrigenous clastics to these Gondwana margins; but eustatic sea-level changes provide a regional and global correlation of major marine transgressions, prograding margin deposits and shallowing-upward successions. A general mega-cycle characterizes the Triassic beginning with a major transgression at the base of the Triassic, followed by a general shallowing-upward of facies during Middle and Late Triassic, and climaxing with a regression in the latest Triassic.

Oldow, J.S., Satterfield, J.I. and Silberling, N.J., 1993. Jurassic to Cretaceous transpressional deformation in the Mesozoic marine province of the northwestern Great Basin. In: M.M. Lahren, J.H. Trexler Jr. and C. Spinosa (eds.), Crustral Evolution of the Great Basin and Sierra Nevada: Cordilleran/Rocky Mountain Section, Geological Society of America Guidebook, Department of Geological Sciences, University of Nevada, Reno: 129-166.

Much of the northwestern Great Basin is underlain by Triassic to Cretaceous carbonate, volcanogenic, volcanic, and siliciclastic rocks of the Mesozoic marine province. The Mesozoic strata were deposited in deep basinal to subaerial environments of a backarc basin bound on the west by the Sierran arc and on the east by the North American continent. During the late Mesozoic, the rocks experienced a complex contractional history and substantial transcurrent displacement occurred between the Sierran arc and the backarc basin. The location, timing, and sense of shear of the transcurrent fault system(s) are controversial. To a large degree, the controversy has entered on the northwest-striking Pine Nut fault which forms the western boundary of the Luning-Fencemaker fold and thrust belt in western Nevada. For most of its trace length, the Pine Nut fault is located approximately by the juxtaposition of coeval Mesozoic rocks with different structural histories. In the Wassuk Range of west-central Nevada, however, the fault is exposed discontinuously for over 50 km and is expressed as a brittle shear zone up to 3 km wide. Fault zone cataclasites, composed of Early Mesozoic plutons, metamorphic tectonites, and metavolcanic rocks, are crosscut by undeformed Late Cretaceous granitoids. The fault zone juxtaposes two coeval assemblages of the Mesozoic marine province that have different structural and stratigraphic histories. On the east, Mesozoic rocks are deformed in the late Mesozoic Luning-Fencemaker fold and thrust belt. To the west, coeval rocks are not involved in structures of the Luning-Fencemaker belt but rather share a structural history with the eastern Sierra Nevada. Displacements on the Pine Nut fault and the Luning-Fencemaker thrust belt are coeval and kinematically linked. They formed during late Mesozoic sinistral transgression and represent resolved components of regional displacement field.

Osborn, J.M. and Taylor, T.N., 1993. Pollen morphology and ultrastructure of the Corystospermales: permineralized in situ grains from the Triassic of Antarctica. Rev. Palaeobot. Palynol., 79:205-219.

Corystosperms, represented by *Dicroidium* leaves and *Pteruchus*-like pollen organs, are major components of the Early-Middle Triassic silicified flora from the Fremouw Formation of Antarctica. The micromorphology and ultrastructure of the in situ pollen contained within these organs are described. Pollen sacs of varying ontogenetic ages have been isolated. Mature grains are monosulcate and bisaccate, with large, crescent-shaped eusacci. The exine is relatively thick in the cappa region and thins toward the distal sulcus; surface ornamentation is psilate. In medial positions of the proximal wall, the exine is homogenous but becomes tectate-alveolate in more lateral regions of the cappa. The alveolar units extend int the sacci forming an endoreticulum; however, the endoreticulations are discontinuous and only attach to the outer walls of the sacci. A wedge-shaped unit, where the sacci attach to the corpus, characterizes both the proximal and distal poles. The sulcus is broad, extends the entire width of the grain, and is longitudinally flanked by elevated lips. The structural features of these grains are discussed with respect to other fossil and extant saccate pollen. The grains are systematically compared with those of other bisaccate pollen-producing plants with which the Corystospermales have been suggested to be closely related, including Glossopteridales, Caytoniales, and angiosperms (Lactoridaceae). The permineralized in situ grains are also compared with other compressed *Pteruchus* species known at the ultrastructural level and with morphologically similar dispersed palynomorphs known from Antarctic sediments.

Padian, K. and May, C.L., 1993. The earliest dinosaurs. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 379-381.

A short article with a discussion on the classification and occurrence of the earliest dinosaurs.

Pang, Q., 1993. The nonmarine Triassic and Ostracoda in northern China. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 383-392.

Nonmarine Triassic strata are widely distributed in north China, especially in the Ordos basin in Shanxi, Gansu and Ningxia provinces, Qinshui and Ningwu basins in Shanxi province, western Henan, and the Junggur and Tulufan basins in Xinjiang Autonomous Region. The Triassic terrigenous clasific sequences are well developed within these basins. The Middle and Lower Triassic sequences mainly consist of fluvial or lacustrine sedimentary rocks. The purple and reddish sediments indicate a dry and hot environment. The Upper Triassic sequence consists of fluvial and lacustrine coal-bearing detritic sediments which indicate a warm humid environment. An abundance of vertebrates, invertebrates, plant fossils and microfossils exist in the Nonmarine Triassic sequences. Among them, the Ostracoda is characterized by a *Darwinula-Lulkevichinella-Tungchuania* fauna which includes six fossil assemblages. The nonmarine Permian-Triassic boundary is discussed in this paper, and it probably should be at the base of the Lower Triassic Liujiagou Formation in north China. However, in the Junggur basin, there is a mixture of the Permian biota and Triassic biota in which a transitional relationship is indicated. So, the boundary should be within the upper Guodikeng Formation.

Parrish, J.M., 1993. Distribution and taxonomic composition of fossil vertebrate accumulations in the Upper Triassic Chinle Formation, Petrified Forest National Park. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 393-402.

A summary of the geographical and stratigraphic implications of the vertebrate fauna of the Chinle Formation of Petrified Forest National Park.

Paull, R.A. and Paull, R.K., 1993. Interpretation of Early Triassic nonmarine-marine relations, Utah, U.S.A. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 403-409.

The history of Lower Triassic rocks in Utah, U.S.A., is a complex interplay of three rapid marine transgressions followed by slower regressions with progradation of paralic and nonmarine sediments. The timing, geographic location, extent, and depositional characteristics of each of these events varies, but the repetitious pattern is well-documented. The emphasis of this paper will be on the earliest two transgressions and subsequent regressions. The information that details these depositional sequences is based on the study of 40 surface sections, and includes conodont biostratigraphic information from carbonate samples collected during the field study.

PÉREZ LÓPEZ, A., 1993. Estudio de las huellas de reptil del icnogenero *Brachychiroterium*, encontradas en el Trias subbetico de Cambil. Estudios Geol., 49: 77-86.

The first vertebrate tracks found in the Subbetic Zone are described. The detrital materials in which these tracks are printed belong to the Triassic outcroping at ESE of Cambil (Jaén). It is the trackway of a quadruped, formed by several pentadactyl footprints corresponding to the pes and manus impressions of a reptile. These tracks presumably belong to *Brachychiroterium* cf. *gallicum*. The preservation and and distribution of these tracks are discussed.

PIGG, K.B., DAVIS, W.C. and ASH, S., 1993. A new permineralized Upper Triassic flora from Petrified Forest National Park, Arizona: A preliminary report. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 411-413.

A small lens of cuticle shale in the Petrified Forest Member of the Chinle Formation in Petrified Forest National Park, Arizona contains calcareous nodules that include rare three-dimensionally preserved plant remains. The preserved plant organs in the nodules include numerous leaves, wood fragments, seeds, ovulate reproductive organs, cone scales, and microsporophylls bearing pollen sacs with *in situ* bisaccate pollen. Cuticular remains of *Dinophyton, Brachyphyllum* and *Pagiophyllum*, and a variety of palynomorphs including *Camerosporites secatus, Vallasporites ignacii*, and *Samaropollenites speciosus* are also present. These nodules are the first of their type to be described from the Chinle Formation and provide the potential of comparing the Chinle flora more completely with anatomically preserved forms from other localities and ages. This will, we hope, increase our knowledge of the structure and taxonomic affinities of the Upper Triassic flora of the Petrified Forest.

RAD, U. VON, DÜRR, S.B., OGG, J.G. and WIEDMANN, J., 1994. The Triassic of the Thakkhola (Nepal). I. Stratigraphy and palaeoenvironment of a north-east Gondwanan rifted margin. Geol. Rundsch., 83: 76-106.

The Mesozoic sediments of Thakkhola (central Nepal) were deposited on a broad eastern north Gondwanan passive margin at mid-latitudes (28-41°S) facing the Southern Tethys ocean to the North. The facies is strikingly similar over a distance of several thousand kilometres from Ladakh in the west to Tibet and to the paleogeographically adjacent north-west Australian margin and Timor in the east. Late Paleozoic rifting led to the opening of the Neo-Tethys ocean in Early Triassic times. An almost uninterrupted about 2 km thick sequence of syn-rift sediments was deposited on a slowly subsiding shelf and slope from Early Triassic to late Valanginian times when break-up between Gondwana (north-west Australia) and Greater India formed the proto-Indian Ocean. The sedimentation is controlled by (1) global events (eustasy; climatic/oceanographic changes due to latitudinal drift; plate reorganization leading to rift-type blockfaulting) and (2) local factors, such as varying fluviodeltaic sediment input, especially during Permian and late Norian times. Sea level was extremely low in Permian, high in Carnian and low again during Rhaeto-Liassic times. Third-order sea-level cycles may have occurred in the Early Triassic and late Norian to Rhaeto-Liassic.

Ramovš, A., 1993. Stratigraphic development of Triassic in northern Julian Alps and western Karavanke Mountains - correlation. 2. Upper Triassic. Rudar.-Metal. Zbornik, 40: 103-114 (in Slovenian with English summary).

Correlation of Julian/Tuvalian (middle and upper Carnian) and Norian/Rhaetian beds in the northern Julian Alps and western Karavanke Mountains shows that during the Julian/Tuvalian identical depositional conditions existed only in the territory of Belca (Karavanke) and in the area of Beli potok (Julian Alps). Both territories show also an approximately identical faunistic development. The Rzor Formation shows an essentially different lithological and faunistic development, distinguished in its upper part by the characteristic ammonite fauna of the Hallstatt type. Essential differences prevailed between the development of Beli potok and of Tamar in the territory of Tamar, and its characteristic development of Rabelj in the environs of Rabelj. During the Norian a carbonate Julian platform was newly formed and in both territories the same type of layered rocks were deposited. The same reef development as in the Julian Alps occurred in Begunjščica and partly east of Stol in Karawanke where the mighty growth of coral/sponge/spongiostromate reefs took place.

Ramovš, A., 1992. Stratigraphic development of Triassic in northern Julian Alps and in western Karavanke - correlation. 1 Lower and Middle Triassic and Cordevolian. Rudar.-Metal. Zbornik, 39: 307-312 (In Slovenian with English summary).

The correlation of development of Triassic beds in northern Julian Alps and western part of South Karawanke shows that during the Lower Triassic the depositional conditions on the unique Julian carbonate platform were approximately equal and supported the same biota. The twofold Anisian development of the Julian Alps (bedded dolomite and reef limestone) does not exist in Karawanke where the reef development is absent. The probably Lower Triassic or Anisian brecciated conglomerate in Karawanke is only a local formation which does not occur in the Julian Alps. The very diverse lithological and biological development of the Ladinian in the Julian Alps which is unique in the southern Alps does not have a counterpart in western Karawanke. Also the belt of igneous rocks and their tuffs in the northern Julian Alps is not reproduced in Karawanke. The local conglomeratic breccia in the northern Julian Alps has no parallel in the western Karawanke. In Ladinian times the two depositional environments must have been separated. During the Cordevolian the depositional area of the Julian Alps and western Karawanke was unified again, although in the Karawanke no extensive growth of the coral/sponge/spongiostromata reefs of the northern Julian Alps could be established.

Ramovš, A., 1993. The Hotavlje limestone through the ages. Rudar.-Metal. Zbornik, 40: 293-300 (In Slovenian with English summary).

The Hotavlje limestone (Cordevolian, Lower Carnian) is Slovenia's most decorative stone, occurring in variety of colours: purple red, violet red, marbled pink, light to dark grey, and rarely pitch black. In the Tethys corals, sponges, calcareous algae, echinoderms and, to a great extent, the limestone cores of Cyanobacteria formed a ridge.

Ramovš, A. and **Šribar, L.**, 1993. The Cordevolian reef of the Menina, Kamnik-Savinja Alps, Slovenia. Geologija, 35: 73-80 (In Slovenian with English summary).

The peaks of Menina consists of Cordevolian (Lower Carnian, Triassic) reef limestone and partly dolomitic limestone, and dolomite with corals *Margarophyllia capitata*, *Margarosmilia septanectens* and *Tropidendron* sp., sponges *Solenolmia manon* and *Alpinothalamina slovenica*, microproblematicum *Ladinella porata* and *Plexoramea*

cerebriformis. The reef limestone of Menina has the same faunistic characteristics with the same species of corals, sponges and microproblematica as the Cordevolian reef limestone in the northern Julian Alps, which is an indication of a unique sedimentation region for the two areas on the carbonate platform.

REIN, S., 1993. Eine Platte mit Kauapparaten der Germanischen Ceratiten. Veröff. Naturhist. Mus. Schleusingen, 7/8: 3-8.

Extraordinarilly preserved structures from the Gerenzschichten near Apolda are interpreted as lower jaw apparati of *Ceratites*.

REIN, S., 1993. Juvenile Ceratiten aus dem Hauptmuschelkalk. Veröff. Naturhist. Mus. Schleusingen, 7/8: 9-15.

In the Upper Muschelkalk (Anisian-Ladinian) juvenile forms of *Ceratites* are regarded as being extremely rare. The conditions for their fossilization are discussed under the aspects of their taphonomy and palaeoecology. Particular features in their morphology are described under their phylogenetic aspects.

RENESTO, S., 1993. A juvenile *Lariosaurus* (Reptilia, Sauropterygia) from the Kalkschieferzone (uppermost Ladinian) near Viggiù (Varese, northern Italy). Riv. It. Paleont. Strat., 99: 199-212.

A description of a juvenile *Lariosaurus* specimen from Viggiù and a comparison with a specimen from the Val Mara locality (Switzerland).

RENESTO, S., 1993. An isolated sternum of *Eudimorphodon* (Reptilia, Pterosauria) from the Norian (Late Triassic) of the Bergamo Prealps (Lombardy, Northern Italy). Riv. it. Paleont. Strat., 99(3): 415-422.

An isolated pterosaur sternum is described. It has been collected in the Zorzino Limestone (Norian, Late Triassic), at the locality of Endenna (Bergamo Prealps, Lombardy, Northern Italy). The shape and size of the bone are very similar to those of the sternum preserved in the holotype of *Eudimorphodon ranzii* Zambelli, 1973, collected from the same formation at the locality of Cene (Imagna valley, Lombardy, Northern Italy), and it is ascribed to this species. It represents the second well preserved *Eudimorphodon* sternum so far collected.

RENESTO, S., 1994. *Megalancosaurus*, a possibly arboreal archosauromorph (Reptilia) from the Upper Triassic of northern Italy. J. Vertebr. Paleont., 14: 38-52.

The Late Triassic reptile *Megalancosaurus preonensis* Calzavara et al., 1980, was previously known from a single incomplete specimen collected from the Norian "Dolomia di Forni" at the locality of Val Preone, near Ampezzo Carnico (Udine, Friuli, northern Italy). The recent discovery of a new specimen in the Zorzino Limestone, also of Norian age, at a locality near Zogno (Bergamo Prealps, Lombardy, northern Italy) allows a more complete description of the skeleton of *M. preonensis* and attribution of three other specimens, previously interpreted as juvenile individuals of *Drepanosaurus unguicaudatus* to the same taxon. *Megalancosaurus* was a small reptile with a high degree of adaptation toward arboreal life, and is probably an archosauromorph.

RETALLACK, G.J., RENNE, P.R. and KIMBROUGH, D.L., 1993. New radiometric ages for Triassic floras of southeast Gondwana. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 415-418.

New laser-heating $^{40}Ar/^{39}Ar$ radiometric ages have been obtained for volcanic rocks intercalated with sediments yielding megafossil plants, and in one case also marine fossils, in Australia and New Zealand. Plagioclase from the Dalmally Basalt Member of the Bardool Conglomerate in the southern Clarence-Moreton Basin of New South Wales has yielded an age of 237.0 ± 0.4 Ma (2 error). Biotites from an upper Etalian tuff in the Hokonui Hills of Southland, New Zealand, have yielded an age of 242.8 ± 0.6 Ma. The biostratigraphic transition from the *Dicroidium zuberi* to D. *odontopteroides* zones was before these ages, as was the appearance in New Zealand of the bivalve *Daonella* which defines the base of the Etalian age. Our new age determinations are compatible with a late Anisian appearance at roughly 244 Ma of *D. odontopteroides* and *Daonella* in southeast Gondwana and with a recently proposed Permo-Triassic boundary at ca. 251 Ma.

Sadovnikov, G.N. and Orlova, E.F., 1993. The lower boundary and biostratigraphy of the nonmarine Triassic in Siberia. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 421-422.

New palaeobotanical data show that Tutonthanian-Putoranian biotas are Permian instead of Triassic as is presumed conventionally. Also the Mariniskian may be Permian and only the Ustkelterian is undoubtedly Triassic.

Salas, R. and Casas, A., 1993. Mesozoic extensional tectonics, stratigraphy and crustral evolution during the Alpine cycle of the Eastern Iberian basin. Tectonophysics, 228: 33-55.

Sequence stratigraphy, subsidence analysis and the integration of the basin fill data allow to the identification of four successive evolutionary stages in the basins of the Eastern Iberian margin during Mesozoic extension: (1) Triassic rift (Late Permian-Hettangian); (2) Early and Middle Jurassic postrift (Sinemurian-Oxfordian); (3) Late Jurassic and Early Cretaceous rift (Kimmeridgian-middle Albian); and (4) Late Cretaceous postrift (late Albian-Maastrichtian). The present-day crustal structure of the Eastern Iberian Range and evidence of its evolution are deduced from the analysis of a new gravity map and other geophysical data.

Satterley, A.K., 1994. Sedimentology of the Upper Triassic reef complex at the Hochkönig Massif (Northern Calcareous Alps, Austria). Facies: 30: 119-150.

The Upper Triassic Dachsteinkalk of the Hochkönig Massif, in the Northern Calcareous Alps, corresponds to a platform margin reef complex of exceptional thickness. Platform interior limestones form equally thick sequences of the well known cyclic Lofer facies. Sedimentation in the reef complex was not so strongly controlled by low-amplitude sea-level oscillations as the Lofer facies. The westernmost of the 8 facies of the reef complex is an oncolite-dominated lagoon, in which wave-resistant stromatolite mounds with a relief of a few metres were periodically developed. The transition to the central reef area is accomplished across the back-reef facies. In the back-reef facies patch reefs and calcisponges appear. The proportion of coarse bioclastic sediment increases rapidly over a few hundred metres before the central reef area is encountered. The central reef area consists of relatively widely spaced small patch reefs that did not develop wave-resistant reef framework structures. The bulk of the sediment in the central reef area is coarse bioclastic material, provided by the dense growth of reef organisms and the wave-induced disintegration of patch reefs. Collapse of the reef margin is recorded by the supply of large blocks of patch reef material to the upper reef slope. Additionally, coarse, loose bioclastic debris was supplied to the upper reef slope and this was incorporated into debris flows on the reef slope and turbidites found at the base of the slope and in the off-reef facies. Partially lithified packstones and wackestones of the lower to middle reef slope were modified by mass movement to form breccia and rudstone sheets reaching out hundreds of metres into the off-reef facies environment. A reef profile is presented which was derived by the restoration of strike and dip information. In conjunction with constraints imposed by sedimentary facies related to slope processes, the angle of slope in the reef margin area ranged from 11° to 5°, forming a concave (dished downwards) slope. Water depth estimations require that the central reef area did not develop in water of less than 10 metres depth. At the reef margin water depths were about 30 metres, at the base of the reef slope 200 metres and deepening in the off-reef complexes to 250 metres. While previous work on reef complexes from this type of setting suggests growth in a heavily storm-dominated environment, the present author finds little evidence for the storm generation of the fore reef breccias, although there is good evidence for storm-influenced sedimentation and reworking in the central reef area.

SCHWARZACHER, W., 1993. Cyclostratigraphy and the Milankovitch Theory. Developments in Sedimentology, 52, Elsevier, Amsterdam. 238 pp.

This monograph discusses sedimentary cycles and their use in measuring geologic time. There is considerable effort made to clarify the term "sedimentary cycle", in particular, the two opposing concepts of cycling stratification and event stratification. The recognition of sedimentary cycles and of Milankovitch cycles specifically, is considered and care is taken with the question of relating sediment thickness to time. Chapter 8 deals with Triassic carbonate platforms.

SENGUPTA, D.P. and GHOSH, P., 1993. Morphometrics of some Triassic temnospondyls. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 423-428.

Various simple techniques of shape analysis have been tied together to provide a composite study of the late, mainly Triassic temnospondyls. The "skeletons" of the late temnospondyls suggest that the forms with vaulted pterygoid and anteriorly placed dentition preferentially thrived beyond the Triassic. Another important late temnospondyl, the metoposaurids, also have some minor variations of the shape of the skulls. This fact is always camouflaged by the overall similarity of their skull shapes. Factor analysis performed on some measured distances between different landmarks of metoposaurid skulls has brought out important shape variabilities within the family.

SENOWBARI-DARYAN, B. and STANLEY, G.D., 1994. Mesozoic spore assemblage in Peru. Zbl. Geol. Paläont., I, 1/2: 403-412.

Three different sponge associations are described from the Mesozoic carbonate rocks of the Pucará Formation exposed in central Peru: 1) The Upper Triassic Chambara Formation is characterised by the dominance of inozoid sponge genera including *Eusiphonella, Peronidella* and *Corynella*. The sphinctozoid sponges are very rare and represented by the genera *Amblysiphonella* and *Colospongia*. 2) The sponges of the Jurassic Condorsinga Formation are represented by two different associations characterised either by: a) the spinctozoan genus *"Stylothalamia"*, or, by b) the occurrence of "exotic" inozoan sponges representing new taxa.

SERENO, P.C. and ARCUCCI, A.B., 1994. Dinosaurian precursors from the Middle Triassic of Argentina: *Marasuchus lilloensis* gen. nov. J. Vertebr. Paleont., 14: 53-73.

A review of the morphology and systematics of *Lagosuchus* from the Middle Triassic Los Chañares Formation. Two species have been named, *L. talampayensis* and *L. lilloensis*.

Shields, O., 1993. Trans-Pacific biotic links in the Carnian: A test of reconstruction models. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 431-433.

A few plants and insects have Carnian distributions that suggest trans-Pacific linkages. These are best explained by earth expansion reconstructions that longitudinally close the pacific Ocean in the Triassic. Other reconstruction models (Pangaea-Panthalassa and Pacifica) are shown to be incompatible with these Carnian distributions. The dispersal pathways did not extend around the North Pacific region or across Antarctica, thus strengthening the argument.

Shishkin, M.A. and **Ochev, V.G.**, 1993. The Permo-Triassic transition and the Early Triassic history of the Euramerican tetrapod fauna. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 435-437.

A contribution with a short discussion on the latest Permian and Early Triassic tetrapod faunas.

Silvestri, S.M. and **Szajna, M.J.**, 1993. Biostratigraphy of vertebrate footprints in the Late Triassic section of the Newark Basin, Pennsylvania: Reassessment of stratigraphic ranges. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 439-445.

The discovery of the youngest *Brachychirotherium*, the youngest *Gwynneddichnium* and two new ichnotaxa, as well as documentation of other known ichnofauna from the youngest continuous stratigraphic section in the Jacksonwald syncline necessitate redefinition of previous vertebrate stratigraphic ranges and vertebrate diversity for the last seven million years of the Late Triassic (including the Rhaetian of some workers). This period has thus far been poorly prospected worldwide (Olsen and Sues, 1986). These new ichnological finds help to reconstruct faunal diversity and turnover near the Triassic-Jurassic boundary.

Storrs, G.W., 1993. Terrestrial components of the Rhaetian (Uppermost Triassic) Westbury Formation of Southwestern Britain. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 447-451.

The shallow/nearshore marine Westbury Formation is well known for its "bone beds" associated vertebrate remains. Terrestrial and nonmarine aquatic fossils also occur in these rocks and include fragmentary dinosaurs and problematic archosaurs, a lungfish, potentially the earliest known choristodere, and perhaps two primitive mammals or therapsid reptiles, as well as plants and insects. The formation represents a general transgression marking the end of typical Triassic continental sedimentation and the start of Lower Jurassic marine shelf deposition in Europe. It provides a brief glimpse into the poorly known British terrestrial biota of the latest Triassic.

Suárez, M. and **Bell, C.M.**, 1994. Braided rivers, lakes and sabkhas of the Upper Triassic Cifuncho Formation, Atacama region, Chile. J. South Amer. Earth Sci., 7: 25-33.

At 1,000-m-thickness of Upper Triassic (to possible Hettangian) sediments of the Cifuncho Formation are exposed in the coastal Cordillera of the Atacama region, Chile. These coarse-grained clastic terrigenous strata are interpreted as the deposits of braided rivers, ephemeral lakes, sabkhas and volcanoclastic alluvial fans. They include conglomerates, pebbly sandstones, fine to medium-grained sandstones and thin, finely-laminated limestones. Halite hopper-casts are abundant in sandstones near the top of the section. Approximately 90% of the clastic detritus was derived from an upper

Paleozoic metasedimentary accretionary complex located to the west. Andesitic debris flow and pyroclastic flow deposits occur near the base of the sequence. Isolated tuff intercalations and an ignimbritic lava flow occur higher in the section. The great thickness of coarse-grained and ill-sorted clastic sediments suggests deposition in an actively subsiding basin, probably a graben, adjacent to rising highlands. Overlying Hettangian-Sinemurian marine sediments were deposited by a transgression which occurred during a world-wide lowstand. This suggests that thermal subsidence followed the Triassic rifting.

SUBKOMMISSION PERM-TRIAS, 1993. Beschlüsse zur Festlegung der lithostratigraphischen Grenzen Zechstein/Buntsandstein/Muschelkalk und zu Neubenennungen im Unteren Buntsandstein in der Bundesrepublik Deutschland. Z. angew. Geol., 39(1): 20.

The lithostratigraphic boundary between the German Zechstein and the Buntsandstein has been defined at the basis of the Calvörde-Folge, being the new official name for the lower part of the Lower Buntsandstein. The upper part is now formally named Bernburg-Folge.

TAYLOR, E.L. and TAYLOR, T.N., 1993. Fossil tree rings and paleoclimate from the Triassic of Antarctica. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 453-455.

Fossil tree rings are described from fossil wood collected in the Lower- Middle Triassic Fremouw Formation, central Transantarctic Mountains, Antarctica. The wood consists of isolated logs within a paleostream channel, stems and roots within permineralized peat, and a standing fossil forest. The tree rings provide an accurate measure of abiotic factors important in understanding Triassic paleoclimatic in the southern hemisphere.

TAYLOR, T.N., TAYLOR, E.L. and DEL FUEYO, G., 1993. Permineralized Triassic plants from Antarctica. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 457-460.

Silicified plants of early Middle Triassic age occur at Fremouw Peak, Antarctica. The flora is represented by ferns, seed ferns, cycads and conifers; sphenophytes and lycopods are relatively rare. Several types of fungi demonstrate various levels of interactions. Because the plants in this flora are preserved as permineralizations, they offer a unique opportunity to examine the biology and evolutionary relationships of Mesozoic plants with the same degree of precision that has been attained with many Carboniferous floras.

THULBORN, R.A., 1993. A tale of three fingers: ichnological evidence revealing the homologies of manual digits in theropod dinosaurs. In: S.G. LUCAS and M. MORALES (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 461-463.

The earliest tracks of theropod dinosaurs, from Triassic continental sediments of Europe and the northeastern United States, sometimes include impressions of the manus. Those impressions reveal that the theropod manus was derived from the pentadactyl manus of primitive archosaurs through loss of digit 5 followed by loss of digit 1. The three digits of the typical theropod manus are probably numbers 2, 3 and 4 of the pentadactyl format and appear to be homologous with the digits of the avian manus. Conventional identification of theropod manual digits as numbers 1, 2 and 3 appears to be incorrect.

Tiwari, R.S., 1993. Evolutionary shifts in Triassic palynofloras and palynoevent stratigraphy. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 465-470.

The author discusses the floral development on the basis of palynofloras from the Permian-Triassic boundary to the Rhaetian and recognizes a number of floral shifts, i.e. at the P/T boundary, at the beginning of the Middle Triassic, in the early Carnian and at the end of the Norian.

Urošević, D. and Sudar, M., 1991. Ladinian and Carnian sediments in Ždrelo section, Eastern Serbia, Yugoslavia. Ann. Géol. Penins. Balk., 55(1): 57-66.

Detailed exploration of Triassic sediments in Ladne Vode section at Ždrelo provided an abundance of fossil remains from the Upper Anisian (Illyrian) to Dogger (Middle Jurassic) interval of the column that were used in identifying new evidences: the boundary was placed between Anisian and Ladinian stages (a transitional level so far), a greater Ladinian thickness was recognized, two more groups of strata in addition to the transitional one were separated in it, and, particularly important, documentation of the Upper Triassic Carnian stage.

Urošević, D. and Sudar, M., 1991. Triassic conodont fauna of the Yugoslavian Carphato-Balkanides. Ann. Géol. Penins. Balk., 55(2): 147-159.

The latest, initial results are considered of a Triassic conodont study in Eastern Serbia, that began since 1985 when Anisian, Ladinian, and Carnian conodont associations were found in the areas of the Yugoslavian Carphato-Balkanides' inner and central belts: Ždrelo locality (*Pg. bulgarica* R.-Z., *Ng. cornuta* R.-Z., *Ng. excentrica* I.-Z., and *Ng. transita* A.-Z.); the Panjevac River (*Ng. Cornuta* R.-Z.); Lomnica (*Pg. foliata* R.-Z., *Pg. polygnathiformis* A.-Z., and likely *Pg. nodosa* R.-Z.); and Vrelo on Stara Planina (*Pg. bulgarica* R.-Z.).

Ustaömer, T. and Robertson, A.H.F., 1993. A Late Palaeozoic-Early Mesozoic marginal basin along the active southern continental margin of Eurasia: evidence from the Central Pontides (Turkey) and adjacent regions. Geol. J., 28: 219-238.

Remnants of two "Palaeotethyan" oceanic basins are exposed in the Central Pontides of northern Turkey, separated by a continental sliver and an oceanic arc. The southern basin corresponds to the main Tethys ("Palaeotethys"), which partially closed in Early Mesozoic time following northward subduction under the southern, active continental margin of Eurasia. The northern basin (Küre Complex) opened above the "Palaeo-tethyan" subduction zone as a marginal basin, following rifting of a continental fragment (Istanbul fragment) from Eurasia. Marginal basin opening apparently dates from the Late Palaeozoic in the east (Küre basin) and from the Triassic in the West (Kocaeli basin). Basin closure was achieved by southward subduction-accretion, in pre-late Jurassic times, leaving "Neotethys" open to the south. Counterparts of the Küre Complex are found in the adjacent Crimea (Taurian Series), Istranca (Zabernevo Complex), Dobrogea (Nalbant flysch) and Caucasus (pre-Late Jurassic Southern Slope Basin) regions. Basin opening was accompanied by oceanic crust genesis, at least in the Pontides and Caucasus. Closure before Mid-Jurassic time was achieved by subduction-accrection processes, whereby oceanic crust and deep-sea sediments (including sulphides) were detached and structurally assembled, while oceanic basement was subducted. Marginal basin opening and closure is seen as one in a series of events along a long-lived, active south Eurasian continental margin.

Vörös, A., 1993. Redefinition of the Reitzi Zone at its type region (Balaton area, Hungary) as the basal zone of the Ladinian. Acta Geol. Hung., 36: 15-38.

The basal part of the Buchenstein Formation corresponding to the *Reitzi* Zone as introduced by Böckh (1873) has been studied in detail in several sections in its type region in the Balaton area. The *Reitzi* Zone was defined as the basal Ladinian (Norische Stufe at that time) by Mojsisovics (1882) on the basis of an assemblage of characteristic ammonoid species. New bed-by-bed collections in several sections in the Balaton area have revealed that these characteristic taxa appear in definite faunal horizons. The application of Mojsisovics' original definition means that the *Reitzi* Zone in the type region comprises is the *felsoeoersensis, liepoldti, reitzi* and *costosus* horizons. Since the *Reitzi* Zone is regarded as the basal zone of the Ladinian, the base of this stage should be drawn at the lowermost, *felsoeoersensis* horizon.

Vozenin-Serra, C. and **Salard-Cheboldaeff, M.**, 1994. Les données paléobotaniques dans le Sud-Ouest Pacifique au Permo-Trias - leurs confrontations aux modèls géodynamiques. N. Jb. Geol. Paläont. Mh., 1: 54-64.

An overview of the fossil woods from the Permo-Triassic of New Caledonia confirms that the climate then underwent seasonal changes, stimulates again the debate about the paleogeographical connections between southeastern Asia and eastern Australia. These relations might be explained either by the presence of a mountainous archipelago of islands between the Asian Mainland and Gondwanaland or by the tardy drift during the Jurassic-Lower Cretaceous of Himalaya terrane located southward of Yalu Tsangpo.

Wang Ziqiang, 1993. Evolutionary ecosystem of Permian-Triassic redbeds in North China: a historical record of global desertification. In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 471-476.

A full record of the evolution of a continental ecosystem, including a Permian regressive sequence of plant communities, a Triassic progressive one and the terminal Permian mass extinction, has been extracted from the Permian-Triassic redbed floras in North China. Furthermore, a diachronous two-step model of natural desertification is used to visualize the environmental transition from semiarid Sahel-type to arid Sahara-type in North China through Permo-Triassic time based on evidence coming from sediments, traces of windy activity, xeromorphism of plants etc. The terminal Permian mass extinction at least on the continents, should be seen as the inevitable end of the global Permian desertification over half of the Northern Hemisphere.

Xu Dao-Yi and **Yan Zheng**, 1993. Carbon isotope and iridium event markers near the Permian/Triassic boundary in the Meishan section, Zhejiang Province, China. Palaeogeography, Palaeoclimatology, Palaeoecology, 104: 171-176.

Investigations for carbon isotopes and iridium of the Meishan section were carried out using very narrow sampling intervals. The high-resolution results demonstrate the following characteristics: (1) A large drop in $\delta^{13}C$ 7 cm above the base of the Triassic with a magnitude of about 6‰. (2) A sharp Ir peak of 2.02 ppb 10 cm above the base of the Triassic whereas the Ir mean of six samples equals 0.4 ppb. The large negative carbon-isotope shift, the Ir anomaly within a thin sublayer and microspherules all occur within a 20 cm thick section above the base of the Triassic which has been defined to coincide with an abrupt facies change from carbonate to clay. The geochemical results and the microspherules suggest that the Permian/Triassic boundary event was catastrophic and probably caused by an extraterrestrial impact.

Weber, K.I., 1993. Paleosols in Triassic sediments of southeast Germany (Bavaria). In: S.G. Lucas and M. Morales (eds.), The Nonmarine Triassic, New Mexico Mus. Nat. Hist. Sci. Bull., 3: 477-478.

The Triassic sediments of the well "Obernsees" contain numerous geologic phenomena known from the literature as the so-called "purple beds". Multiple investigations with modern sedimentologic, petrographic and pedologic methods helped to piece another part of the puzzle together and to create a new model concerning the paleoenvironment and the soil and sediment-forming processes during the German Lower Triassic.

Weitschat, W. and Guhl, W., 1994. Erster Nachweis fossiler Ciliaten. Paläont. Z., 68: 17-31.

The first finds of fossil ciliates from the Lower Triassic (Upper Spathian) of Spitsbergen are described. The original pseudochitin of the ciliate tests is preserved because of replacement by apatite during a very early diagenetic stage. The fossil forms (*Triadopercularia spitzbergensis* n.g. n.sp., and *Tiacola ostracodarum* n.g. n.sp.) belong to the ciliate order Peritrichida (Sessilia), and, from the morphology of their tests, can be placed within Recent families. The preservation of these tiny delicate fossils is explained by their particular micro-environment, which resulted in rapid transportation to the sea floor. The ciliates had lived symphoriontic with scavenging ostracodes in a decaying ammonoid and have been phosphatized together with their hosts.

Werneburg, R., 1993. *Trematosaurus* (Amphibia) aus dem Mittleren Buntsandstein (Untertrias) von Thüringen. Veröff. Naturhist. Mus. Schleusingen, 7/8: 17-29.

The new species *Trematosaurus thuringiensis* n.sp. is described from the Middle Bunter (Lower Triassic) of Vacha (SW Thuringia). Characteristically are the very narrow snout, the narrow interorbital region, the dorsomedial expanded jugal, the very narrow postorbital and some interesting features in the pattern of the lateral line grooves. *Trematosaurus brauni* (= *T. "fuchsi"*) is also known from East Thuringia, the Middle Bunter of Altendorf near Kahla.

Zágoršek, K., 1993. New Anisian (Middle Triassic) bryozoa (Trepostomata) from the Vysoká Formation (Malé Karpaty Mts., western Carpathians) Slovakia. Geologica Carpathica, 44(1): 49-58.

Three new bryozoans, *Dyscritella? anisica*, sp.n., *Vysokella glabra* gen. nov. et sp.n. and *Vysokella acanthostylica* gen. nov. et sp.n. are described from the Anisian (Pelsonian to Illyrian according to conodonts) Vysoká Formation. *Leioclema sugyiamai* Sakagami 1979 is attributed to *Zozariella* Schafer & Fois 1987. The new family *Zozariellidae* is proposed.

Zappaterra, E., 1994. Source-rock distribution model of the Periadriatic region. AAPG Bull., 78: 333-354.

The Periadriatic area is a mosaic of geological provinces comprised of spatially and temporally similar tectonic-sedimentary cycles. Tectonic evolution progressed from a Triassic-Early Jurassic (Liassic) continental rifting stage on the northern edge of the African craton, through an Early Jurassic (Middle Liassic) - Late Cretaceous/Eocene oceanic rifting stage and passive margin formation, to a final continental collision and active margin deformation stage in the Late Cretaceous/Eocene to Holocene. This evolution occurred in a transtensional and transpressional framework resulting from the oblique separation and convergence of the African and European plates. Extensive shallow-water carbonate platform deposits covered large parts of the Periadriatic region in the Late Triassic. Platform breakup and development of a platform-to-basin

carbonate shelf morphology began in the Late Triassic and extended through the Cretaceous. On the basis of this paleogeographic evolution, the regional geology of the Periadriatic region can be expressed in terms of three main Upper Triassic-Paleogene sedimentary sequences. Middle-Upper Triassic to Lower Jurassic (Liassic) organic-rich, oil-prone and mature source beds generally are structurally controlled, and are closely associated with transtensional intraplatform basins formed in the early continental rifting stage.

ZASTROW, E., 1993. Kieselhölzer im Oberen Burgsandstein von Bubenreuth. Geol. Bl. NO-Bayern, 43(4): 315-328.

More than 1100 specimens of silicified wood have been collected near Bubenreuth. They occur in a zone with pebble beds marking a fluvial channel, presumably of the Keuper. The composition and distribution of these wood remains are discussed.

ZHENG, M., LIU, J., SCHULZ, O. and VAVTAR, F., 1993. Schichtgebundene Goldlagerstätten in kambrischen und triassischen Gesteinen in NW-Sichuan (China). Arch. f. Lagerst.forsch. Geol. B.-A., 15: 1-152.

A microscopical and chemical study of Cambrian and Triassic gold ore deposits in NW Sichuan.

The papers listed above have come to the compilers' 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.

ERRATA

Although we try to do the best we can, we regret that ALBERTIANA 12 contained two errors that need to be corrected:

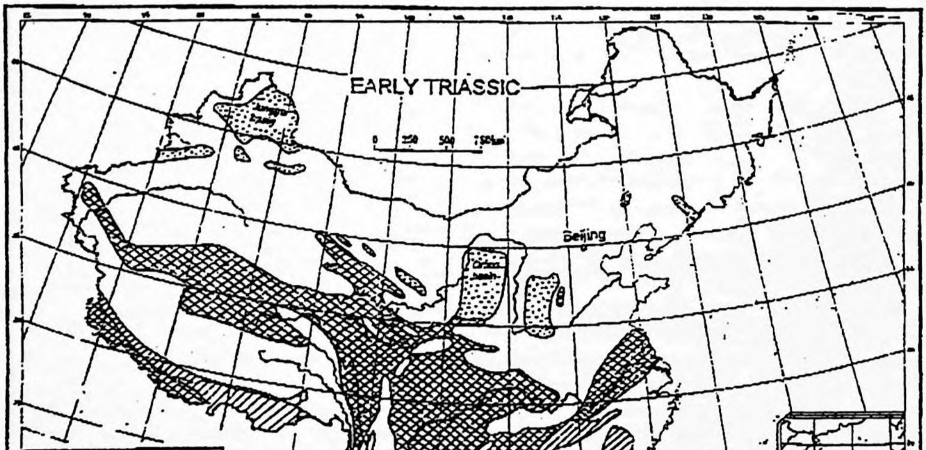
KOTLYAR, G.V., KOZUR, H. and ZAKHAROV, Yu.D., 1993. The Transcaucasian sections Dorasham 2 (Azerbaidzhan) and Sovetashen (Armenia), two candidates for P/T boundary reference sections. ALBERTIANA, 12: 36-38.

The first lines of the last paragraph of p. 34 of the above-mentioned paper should read:

> 'The sections Dorashamian 2 and Sovetashen represent fully marine continuous Tethyan warm-water sequences in the critical stratigraphic level. The microfacies was studied from thin sections of samples that have been taken overlapping each other in the interval from the top of the *Paratirolites* beds up to undoubtedly Triassic beds. Also these investigations have shown that there is no gap at the P/T boundary in these sections.'.

ZHENG-WU Cheng and LUCAS, S.G., 1993. A possible nonmarine GSSP for the Permian-Triassic boundary. ALBERTIANA, 12: 39-44.

After most of ALBERTIANA 12 had been printed we became aware that the map of China on p. 41 is not correct. Therefore most of the distributed copies contain an incorrect map. Prof. Zheng-Wu Cheng sent us another map which is reproduced below.



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This issue of ALBERTIANA was compiled and edited by Hans Kerp.
The help of Sabine Gibas and Heike Hagemann (Münster) is gratefully acknowledged.

The production and distribution of ALBERTIANA is sponsored by the LPP Foundation
Laboratory of Palaeobotany and Palynology, Utrecht

ALBERTIANA is published by the Subcommission on Triassic Stratigraphy. It provides a forum for short, relevant articles such as:
- reports on work in progress and new publications
- reports on conferences
- news items
- letters
- reviews
- notices
- comments

From 1993 onwards ALBERTIANA is published twice a year. Authors should send their contributions for the next issue to the editor of ALBERTIANA **before October 15th, 1994**. The layout of contributions should preferably be in accordance with that of those in the present issue (including the citation of references!). In order to facilitate the production of this newsletter and reduce typing errors, authors are kindly requested to submit their contributions on an MS-DOS formatted floppy disk (if possible). Files should be in plain ASCII format, Word, WordPerfect 5.0, Word-Perfect 5.1 or any other kind of word processing program which is convertible to WordPerfect 5.1. Manuscripts can be submitted on 5¼ inch or 3½ inch IBM (MS-DOS format) computer disks together with a printed hard copy. Because the costs of mailing floppy discs are twice as high as the costs of the discs themselves (at least in Germany), floppies will only be returned on special request.

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